Analysing the potential for wide scale roll out of integrated Smart Cities and Communities solutions

Final Report

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Abstract

Cities worldwide are growing fast. Over half of the global population lives in urban areas, and this share increases every year. Urban population growth means that services need to reach more and more individuals. Technology is of great help in this race against urbanisation, providing innovative and more efficient ways to respond to the increasing demand for more sophisticated and complex services. To exploit technological opportunities, city planners, administrators, citizens, entrepreneurs and all other stakeholders must reconsider the way they have approached urban service provision up until now.

This report outlines the results of the analysis performed on evidence from smart cities and solutions cases, assessing the main features impacting the roll-out opportunities of integrated smart city solutions.

The assignment was commissioned by the European Commission Directorate-General for Energy (DG ENER) to contribute to the knowledge base of the European Innovation Partnership by analysing Smart Cities and Communities (SCC) solutions and initiatives that are linked to the Strategic Implementation Plan (SIP) of the European Innovation Partnership on Smart Cities and Communities (EIP-SCC). It ultimately aims to use the analysis of SCC solutions to promote a better understanding of success factors for their deployment and roll-out.

Executive summary

This document is the Final Report of the study analysing the potential for wide scale roll-out of integrated SCC solutions, carried out by PwC, DTI, ISIS, SigmaOrionis, with the support of Sinergis and HIT.

The objective of this study is to support the European Commission in contributing to the knowledge base of the European Innovation Partnership by analysing Smart City solutions and initiatives that are linked to the Strategic Implementation Plan (SIP) of the European Innovation Partnership on Smart Cities and Communities (EIP-SCC), thereby promoting a better understanding of success factors for their deployment and roll out.

To support the understanding and sharing of the best practices for the roll-out of integrated SCC solutions, the following activities were carried out:

- Screening and review of the most **relevant literature** on SCC solutions;
- Identification of **300 examples of SCC solutions,** of which approximately 200 are European, while the remaining examples come from the rest of the world;
- Analysis and description of **80 best practice examples of SCC solutions,** selected from a list of **300 examples of SCC solutions** (see second bullet point);
- In depth analysis of **10 case studies** (selected from the 80 examples of SCC solutions), putting particular emphasis on their **business models,** so as to make evidence available for other possible SCC solution initiators.
- Identification and analysis of **10 examples of "failure" of SCC integrated solutions,** to identify the most typical patterns of failure;
- Analysis of **synergies between the most relevant SCC groupings and organisations,** and insight into how to successfully use these synergies to further advance the concept and roll-out of Smart Cities;
- Investigation of the **commonalities between the SCC settings of the EU and China,** which could be leveraged to increase replication and market potential for European Smart Cities in China.

For the purpose of collecting the sample, multiple sources were used to identify leading examples of SCC solutions. The main data sources were the literature analysis carried out across all SCC key domains, relevant international Smart City benchmark studies and rankings to identify the most prominent cities implementing SCC solutions and, finally, the EU-funded initiatives supporting the development and implementation of Smart City solutions.

The context of the study

Technological development has led to a changing approach to business practices in urban infrastructure development, allowing for accurate and reliable measurement of socio-economic and environmental impacts. It is therefore possible to quantify – and, consequently, to price – the externalities generated by investments in urban infrastructure. This opens up new sources of revenue for projects, new business models for recovery and value capture, and new opportunities for investors.

Specifically, the cases analysed made it possible to identify commonalities in the value created to communities, depending on the sector they referred to (as reported in the table below).

Type		Value proposition
Sustainable Urban Mobility	***Real-time road user information***	Enable people to take informed decisions about their mobility, saving time and energy.
	ITS-based enhancements of public transport	Reduce waiting time as well as emissions, and facilitate intermodal commuting.
	ITS for traffic monitoring, management and enforcement	Optimise fleet management and route scheduling.
Sustainable Districts & Built Environment	***Smart technologies for the built environment***	Pursue better living, resource efficiency and waste reduction.
	Sustainable districts	Reduce emissions and resource consumption by embedding integrated energy efficiency technologies.
	Place making	Create communities of interest that can be key to support integrated SCC solutions.
Integrated Infrastructure & Processes	***Smart City Platforms***	Allows real time monitoring and preventive steering of cities.
	Intelligent City Services	Co-ownership of local matters and outcomes. Efficiency savings for city administrations. Stimulate involvement at local level.
	Smart grids	Collected information and insights may serve planners and managers, but are often also shared with users, who can take more informed decisions and can also become *prosumers*, i.e. users that can switch from being energy consumers to becoming producers based on the circumstances.

Across the sample of analysed cases, city-wide integrated solutions were rare. Instead, solutions with higher levels of integration are emerging in smart districts, across some energy efficiency projects as well as in various mobility projects. These are generally encountered in urban development investments sustained by real-estate business cases, where the integrated SCC solutions are ancillary to more traditional business cases.

To ensure a comprehensive study, different aspects of SCC solutions' business models and deployment are assessed, namely:

- Ways and tools to govern SCC solutions, in particular for cities, which are faced with the challenge of exploring the economic return in SCC investments;
- How SCC solutions can be funded and which opportunities for financing arise from these new technological opportunities;
- Procurement process practices and tools are analysed in the context of SCC solutions.

- The importance of involving citizens and communities into SCC solutions.
- Features and conditions that favour and hinder the roll-out potential of SCC solutions;
- The opportunities for the EU to leverage the international dimension of SCC deployment by partnering with China.

Governance of integrated SCC solutions

City planning activities are changing due to technological development. The role of private companies shaping the development of cities has been increasing, whereby they act as investors, service or components providers, and users.

Budgetary constraints and the increasing complexity of urban investments for SCC solutions has lead city administrations to require the involvement of private players and, consequently, to adapt the governance of cities in order to attract them.

From a governance perspective, the following actions are suggested.

Manage the shift towards a collaborative operating model. Static and public administration-centred governance systems collide with the integrated SCC solutions approach. Collaboration must be favoured at different levels, specifically:

- **Integrating solutions enhancing coordination at city-governance level.** The analysis of SCC cases has shown that there still is a limited share of integrated solutions, as these tend to be developed at sectorial level. Although reasons are numerous, the separation at city government and planning level hinders coordination and collaboration among departments. This could be resolved by creating a centralized coordination office for integrated SCC solutions and by supporting city planning with appropriate tools/guidelines for SCC strategies and initiatives;
- **Strengthening multi-stakeholder partnerships at all levels.** SCC solutions are complex; they require the public sector to partner with private parties, which have the interest, capacity and skills to develop the projects. Thus, the governance of cities as well as that of specific SCC solutions should enhance the participation of the different parties, in partciular private companies and universities/research centres;
- **Enabling framework conditions for new business models**. Flexibility should be ensured in shaping roles and responsibilities related to SCC solutions. The public sector may consider taking charge of the management of project design and initial phases, but should ensure that this is done by maximising the involvement of the private sector and – potentially – users/universities, etc.

Establish a blueprint for an open, city-wide, service-oriented, interoperable IT platform, which would provide an agreed architecture on which city partners and suppliers can converge over time and establish a multi-level competitive landscape at the platform, services and application layers.

Manage data: data ownership and management is key in any digital process. As integrated SCCs make extensive use of data, which is collected, processed and shared in real-time, it would be advisable to **ensure that data is as free as possible.** Indeed, the more information is available, the higher the opportunities to use it for

solutions. However, **data must be protected, controlled and assessed in terms of quality.**

Funding and financing opportunities

Current budget limits and constraints (e.g. stability pact rules) are forcing public authorities to look for alternative sources of capital to support the development of SCC solutions on a wide scale. At the same time, the possibility to create value through innovative technologies opens interesting business opportunities for private investors as well.

However, limited access to finance affects small innovative companies and start-ups, especially those engaging in innovative and risky projects. This limits both their capacity to develop innovative solutions and their ability to bring their products to the market.

The following recommendations arise from the analysis undertaken.

Rationalize the supporting role of the EC to SCC projects, depending on whether these can potentially generate revenues or not. In order to increase efficiency in the allocation of public resources, it is recommended that a clear distinction should be made between projects that are developed for RDI purposes and those that are not. RDI projects – including small-scale projects contributing to larger scale ones – should necessarily be supported via grants, as it is unlikely that they could pay back the investments made. Conversely, SCC projects that aim to be replicable – and hence commercially viable – entail neither the risk level of RDI projects, nor the purpose, but are business oriented. Therefore, it is recommended that an assessment and definition of the various SCC project types be carried out, in order to organize the support the EC can provide.

Centralize EU competences and roles both for the provision of grants and forms of financing and other support (e.g. technical assistance). There are a number of opportunities that support SCC initiatives. The number of different sources and opportunities may create complexity in achieving an efficient support to SCC projects. A single entity managing the different possible types of support would facilitate the allocation of resources, the access to them as well as the selection of the most appropriate support for each case. Considering that not all sources of support are directly managed by the EC (i.e. some funds are managed at local level) this recommendation may be complicated to realise. However, it could still be possible to envisage the involvement of a single, centralised intermediate entity managing or co-managing the support at least at national level.

Create forms of technical assistance for project design and implementation. SCC projects do not require the same type of support (e.g. commercial-oriented solutions should not be supported with grants, etc.). It is expected that a relevant number of projects would not necessarily require capital to be granted, but could rather benefit more from assistance in designing and implementing the project. Hence, the recommendation consists in considering the creation of a dedicated Technical Assistance Unit (similar to ELENA for energy projects) that could support stakeholders from SCC project origination to development. This is relevant in particular for those projects that can potentially be replicated, and therefore be of commercial value. Further, although the ELENA initiative is expected to soon embrace the mobility sector as well, there is no Technical Assistance model currently active,

which goes beyond (or across) sectorial boundaries. Oppositely, it has been widely reported that SCC solutions tend to integrate energy, transport and ICT domains. Potentially, a coordinated and infra-sector Project Development Assistance (PDA) could be effective filling the current gaps arising from the current silo approach to Technical Assistance.

Develop business accelerators in the field of SCC initiatives, bringing together private and public investors and entrepreneurs. A central role that the Commission might want to play supporting SCC projects and initiatives is to make easier and more efficient for all interested players to share their contribution, increasing SCC projects' odds of success. However, these parties are often limited in their potential involvement due to uncertainties and risks related to such innovative projects. Different activities could be envisaged:

- Creating a physical space for stakeholders to meet at specific dates, but also through on-line platforms that facilitate cooperation and co-development;
- Sharing practices and recommendations on the basis of experiences, to target future efforts on the success stories;
- Using the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) as an effective tool convening: cities – large and small; with industry – large and small; with investors of all types; and trusted associations, academics and intermediaries.
- Organising dedicated sessions within SCC-related events for project promoters to open discussions on their projects with potentially interested private and public investors.

Support solutions to enable smaller companies and small-scale projects to receive appropriate finance. Further opportunities are yet to be consolidated in the new investment environment. Among the most promising opportunities, **investment platforms ensure access to finance to small-size promoters involved in SCC solutions.** These are co-investment arrangements – which can be supported by EFSI – that aim to reduce transaction costs and provide for more efficient risk allocation through the aggregation of thematic-focus (or geographic-focus) investments.

Procurement models

Cities strongly rely on external suppliers, as local authorities increasingly define themselves as commissioners and not deliverers of services. The creation and development of a SSC solution requires a continuous innovation process involving high numbers and different categories of stakeholders. In this context, public procurement becomes an opportunity for the public administration to foster the innovation process, stimulating innovation from the demand side, thereby supporting state-of-the-art SC projects and solutions.

The following recommendations arise from the analysis undertaken.

Foster the exchange of best practices also creating synergies between platforms. As Public Procurement of Innovation (PPI) models have recently been introduced, the EC should map each SCC solution that adopted a PPI model and spread the information; this would foster the exchange of best practices (including templates adopted for bids) among MS and city authorities and ensure that the

procurement models and practices that proved to work best are shared and known among practitioners. A specific focus should also be placed on how to make better use of standards in public procurement in order to resolve ICT lock-in (i.e. the public authority is unduly dependent on a single supplier, vendor or developer beyond the timeframe of the initial procurement contract, damaging competition for future procurement).

Support the development of user-friendly guidelines, templates and standard text to facilitate procurement. Also in terms of fostering the exchange of best practices and supporting the dissemination of knowledge, the EC should keep investing in developing guidelines for the effective take-up of SCC solutions. Guidelines should be practical, including examples showing how suggestions could be translated into reality.

Assess standards and specifications. The European Commission should assess standards and specifications in order to make sure that selected standards and specifications foster interoperability and reduce lock-in. This is currently organised on a national basis (e.g. within the context of MSs' National Interoperability Frameworks); however, there has been an effort at a European level to adopt a common framework that fosters collaboration between MS. It would be useful not only to map all standards available in the field of SC, and develop new ones when necessary, but to promote an awareness campaign towards the procurers to inform them on the use of platforms based on open standards and full interoperability.

Review procurement policies to ensure they are aligned with SC contracting principles. As anticipated in the governance section, the approach of public authorities towards urban development solutions requires a change. Data should be owned by the city and not by the supplier, or clear requirements on data availability via open standards should be included in the procurement; contracts should ensure that contractual arrangements encourage collaboration with other players to create new value, and the sharing of common city assets.

Put in place practices and agreements to avoid supplier lock-in. Potentially by integrating interoperability requirements into all ICT procurement, using commercial off-the-shelf products and open standards wherever possible, and factoring in the costs of exit from the outset.

Involving citizens and communities

There is a rich literature on the benefits of participatory approaches to city design, yet there is little consensus on what exactly these benefits are. Integrated solutions must acknowledge the different views and harmonize approaches effectively to maximize the impact for Smart City solutions.

Different possibilities are possible to ensure SCC solutions' success involving citizens and communities; the main ones are suggested below.

Enable community empowerment for the development of sustainable business models. Communities have a particular role to play in the development and success of smart solutions, yet, evidence shows that in most cases there is only a traditional citizen involvement strategy in place, involving promotion, recruitment of participants and community participation to a limited extent, and that little systematic data is available to assess these efforts. Successful solutions tend to be embedded in

a comprehensive smart city vision. Collaboration, co-creation and co-development are key conditions for success. Possibly, it would also be positive to insist on a consistent citizen engagement strategy and on making citizens, businesses and communities co-owners of integrated solutions in procurement processes.

Integrate citizens, businesses and communities into the entire project cycle, from development to implementation of integrated SCC solutions. The evidence of the best practise case studies shows that the multiple roles residents could play in regional and urban living labs are not utilized. In fact, emphasis is often placed on the innovative technological aspects but not on innovating the engagement process. Conversely, ensuring inclusive innovation in integrated SCC solutions, and working with stakeholders to ensure a shared understanding of citizen engagement in the process of designing, testing and implementing integrated SCC solutions would facilitate the match between the demand for solutions and their provision.

Create an open innovation ecosystem between different experimentation set-ups. The investigation of best practices has shown that there are bottom-up as well as outside-in solutions that are community-driven or driven by ICT-enabled business innovation. Furthermore, sharing economy solutions are emerging and innovating business models in integrated SCCs. The sharing economy is a topic of much discussion amongst city leaders as cities weigh the pros and cons of the disruption of traditional services with the benefits of potentially improved and expanded shared services.

The roll out of SCC solutions

Applying smart solutions to limited-scale contexts would certainly enable the testing of SCC technologies, governance approaches, etc. However, it would not serve the purpose of responding to the global needs arising from urbanisation. What is thus needed is to ensure that solutions can be scaled (increase in size) and replicated (rolled-out in an environment other than the one they have been applied to in the first place).

The analysis performed shows that there is no single element that represents more than others an obstacle or an enabler to the roll-out of SCC solutions. Instead, it is the joint action of different elements that would limit or facilitate the possibility for a project to be successfully implemented at a higher scale or in other contexts. These refer to the i) technological context (the presence of a technological support network for the SCC solution to function); ii) the socio-cultural context (the ability to respond to citizens' needs and make them a part of developing the solution); iii) the political-institutional context (level of required support from the public administration); and the iv) economic-business context (which refers to the business models and relative environment). The presence of an ecosystem, which is able to converge political institutions, investors, industry players and – to the extent required – citizens, facilitates the implementation of projects that have been successful elsewhere.

An effective way for a solution to succeed has proven to be testing it on small groups of citizens and stakeholders, adapting it and then scaling it to the whole city.

While demonstration projects seem to be a good tool to cope with the risk of project failure, which would otherwise be an obstacle for a public administration to endorse

innovative Smart City solutions, they also represent the risk of being endless tests, which never reach an operational status. The safe area represented by research projects does not have to lead to endless demonstrators, which may represent a form of failure in themselves if the specific solution does not become economically viable or if it keeps being based on different small projects without scaling up to the operational phase. On the other end, demonstration projects may serve the need of showing quick gains and encouraging stakeholders in taking actions.

Partnering with China

SCC solutions are not limited to the European context. It is widely acknowledged that the Asia-Pacific area – in particular China – will experience a significant increase in the number of SCC solutions being developed, becoming the leading region in this sector. For this reason, particular attention has been devoted to exploring the Chinese Smart City context and market – a growing potential source of opportunities for EU businesses – focusing specifically on three different levels of EU-China collaboration: industrial, research and policy-dialogues.

Partnering with Chinese companies – as well as with the Chinese institutions – would give European companies and research centres the opportunity to expand their business and cooperate towards innovative solutions. However, there are still questions on how to achieve the benefits offered by the Chinese market without running the risk of compromising competition.

The recommendation here is to **support the introduction of EU companies into the Chinese Smart City market by also providing the necessary protection frameworks.** The global race towards efficient solutions for urbanisation-related service demand will strongly benefit from international partnerships. Specifically, China seems to represent one of the key players for Europe to establish valuable cooperation and sharing of best practices. The Chinese side expressed a strong interest in having a platform to collaborate with the EU in the energy field at policy, technology and business levels. Such a platform may also be used for "matchmaking," which would provide insights into business options for both Chinese and European partners. What is important is to first define and agree on the necessary frameworks to ensure that competition stays fair both in China and in Europe.

Specifically, the main concern seems to be that foreign companies may replicate solutions developed by EU R&D centres and firms. To avoid this, **a supportive legal framework should be established for IP protection.** A good smart city regulatory environment will provide the protection that EU companies (especially SMEs and start-ups) need while being adaptable enough to allow for the risk-taking and trial-and-error that innovation requires. This means EU public entities may step in and agree with their Chinese counterparts on creating the right Intellectual Property (IP) protection laws and a supportive legal framework for companies wishing to provide their solutions on the Chinese market.

1. Introduction to the study and its methodological approach

1.1. Objectives and structure of the report

This is the final report of the study *Analysing the potential for wide scale roll out of integrated Smart Cities and Communities (SCC) solutions*.

This report was commissioned by the European Commission Directorate-General for Energy (DG ENER) to contribute to the knowledge base of the European Innovation Partnership by analysing Smart City solutions and initiatives that are linked to the Strategic Implementation Plan (SIP) of the European Innovation Partnership on Smart Cities and Communities, thereby promoting a better understanding of success factors for their deployment and roll out.

This study contributes to the identification and dissemination of Smart City solutions across and beyond Europe, which could represent the key to creating scale and reducing uncertainty among political decision makers as well as investors, thereby **smartening up Europe's cities.**

Smart City

In this report, and throughout the entire study, the definition of Smart Cities and Communities applied is that of the Strategic Implementation Plan of the EIP-SCC: *"Smart Cities should be regarded as systems of people interacting with and using flows of energy, materials, services and financing to catalyse sustainable economic development, resilience, and high quality of life; these flows and interactions become smart through making strategic use of ICT infrastructure and services in a process of transparent urban planning and management that is responsive to the social and economic needs of society."*

(European Innovation Partnership on Smart Cities and Communities (2013) Strategic Implementation Plan)

In short, it supports the **identification, exchange and dissemination of experiences and best practices of integrated, scalable and sustainable SCC solutions.**

This document is structured as follows:

- **Chapter 1 | Introduction to the study and its methodological approach,** which describes the overall context characterising SCC solutions as well as the approach and limitations to the study.
- **Chapter 2 | Analysis of integrated SCC solutions,** which presents:
    - How and under what conditions SCC solutions reshaped the urban infrastructure investment context;
    - How the business changed and adapted to new technologies (focusing especially on governance models, funding and financing mechanisms, procurement approaches and the role of citizens and communities in SCC solutions);
    - Key reasons behind the failure of SCC solutions (and, thus, lessons learned).

- **Chapter 3 | Analysis of the potential roll out of integrated SCC Solutions,** which describes:
    - The elements, factors and conditions that allow or hinder making the transition from a R&D and demonstration phase to actual wide-scale deployment of SCC solutions;
    - The replicability factors in different geographical contexts and how SCC solutions interface with the surrounding environment;
    - The external factors that support SCC solution roll-out;
    - The challenges and opportunities linked to collaboration between the EU and China, and the conditions for harnessing the power of an effective Smart City EU-China partnership.
- **Chapter 4 | Conclusions and Recommendations** presents the main conclusions and the key recommendations drawn from the whole study.

The main body of the report is complemented by the following annexes:

- **Annex I** presents the mapping of SCC solutions against the EIP-SCC "Strategic Implementation Plan" (SIP) priority areas.
- **Annex II** presents the mapping of the roll-out potential of 10 integrated SCC solutions. This section also acts as a short summary of each of the 10 cases presented in full in Annex IV.
- **Annex III** presents a toolkit for replicability assessment in specific geographical contexts.
- **Annex IV** presents the 10 case studies of best practices, which have been analyzed in greater detail, in particular with respect to their business model.

This document builds on a number of connected reports that have been delivered throughout the engagement and, in particular:

- An initial status report reviewing the **most relevant literature** on integrated solutions for Smart Cities in the EU and globally;
- A report focusing on **why integrated SCC solutions fail;**
- A thematic report focusing on the **role of citizens and communities** in SCC solutions;
- A thematic report on **funding and financing mechanisms** for SCC solutions;
- A thematic report on **public procurement models** for SCC solutions;
- A thematic report on **governing successful SCC solutions** and creating the right framework conditions;
- A report focusing on **EU/China partnerships** in the Smart City domain;
- A report analysing the potential for **synergies between key SCC actors;**
- **80 examples of European and global successful SCC solutions** (50 EU-based and 30 non EU-based solutions, each one presented in the form of a brief case study, connected to a GIS Smart City solutions database);

- A workshop report, presenting key insights emerging from the **expert workshop** held in Berlin in the initial phases of the engagement.

1.2. Overall context

1.2.1. Smart Cities and EU policy

The Europe 2020 Strategy, launched by the European Commission (EC) in 2010,[1] focused on technological solutions that could help in delivering "smart, sustainable and inclusive growth." Seven flagship initiatives have been proposed, including one calling for a "resource-efficient Europe."[2] To support this initiative, the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) was launched by the EC[3] targeting the **intersection between energy, transport and information and communication sectors.**

Seven challenges have been identified as the most prescient, three of which are directly related to the Smart Cities policy area: (i) secure, clean and efficient energy; (ii) smart, green and integrated transport; (iii) climate action, environment, resource efficiency and raw materials.

To represent this integration and in order to activate the EIP-SCC, a **Strategic Implementation Plan**[4] and an **Operational Implementation Plan**[5] (SIP and OIP, respectively) have been published by the EC. The SIP sets the domains and the strategic relationships between eleven different priority areas (thee vertical and eight horizontal, as shown in Figure 1 below), whereas the OIP defines the enablers and the intersections between these elements. The SIP priority domains are overarching and encompass many spheres of urban living, including knowledge sharing, technology, and a focus on people.

In order to meet this ambitious overarching goal, the Commission's Communication COM(2012)4701[6] states that "*this will be achieved through the wide-reaching roll out of **integrated, scalable, sustainable Smart City solutions** – specifically in areas where energy production, distribution and use; mobility and transport; and information and communication technologies, are intimately linked.*"

[1] European Commission (2010), Communication from the Commission, Brussels, 3.3.2010 COM(2010) 2020 final. Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF

[2] European Commission (2010), Communication from the Commission, Brussels, 26.1.2011

COM(2011) 21. Available at http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf

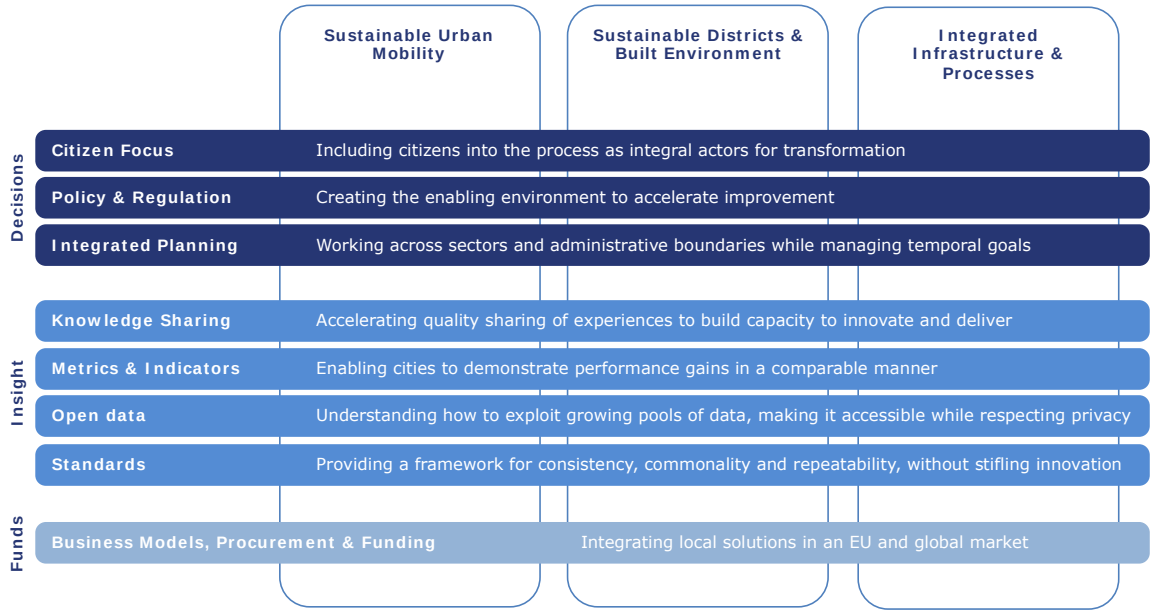
[3] European Commission (2012), Communication from the Commission, Brussels, 10.7.2012, C(2012) 4701 final. Available at http://ec.europa.eu/energy/technology/initiatives/doc/2012_4701_smart_cities_en.pdf

[4] European Innovation Partnership on Smart Cities and Communities, Strategic Implementation Plan: First Public Draft, 2013. Available at http://ec.europa.eu/eip/smartcities/files/sip_final_en.pdf

[5] European Innovation Partnership on Smart Cities and Communities, Operational Implementation Plan: First Public Draft, 2013. Available at http://ec.europa.eu/eip/smartcities/files/operational-implementation-plan-oip-v2_en.pdf

[6] Communication from the Commission on "Smart Cities and Communities – European Innovation Partnership", of the 10th of July 2012, setting the basis shortly after for the launch of the European Innovation Partnership on Smart Cities & Communities (March 2013).

Figure 1: EIP-SCC Strategic Implementation Plan Priority Areas



1.2.2. Smart cities to address future challenges

Global urban population is increasing and is estimated to double by 2050: consequently, the number of urban residents is growing by nearly 60 million every year.[7] Major urbanisation requires new and innovative ways to manage the complexity of urban living; it demands new ways to target the problems of overcrowding, energy consumption, resource management and environmental protection. It is in this context that Smart Cities emerge not just as an appealing trend for future urban living but also as a **strategy to tackle resource management** and, more generally, to better manage the needs of growing cities.

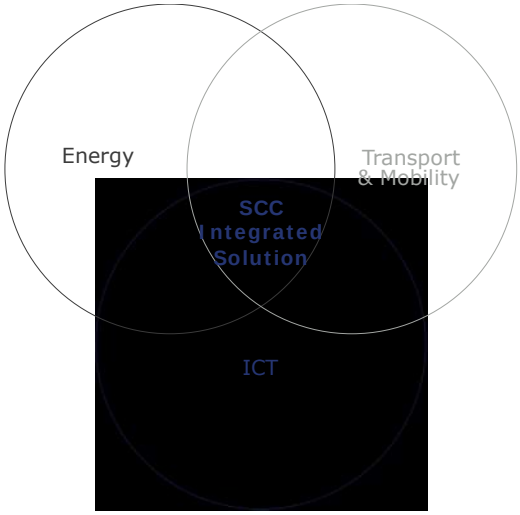
Smart City solutions apply digital technologies to address social, environmental and economic goals. They typically combine physical and digital infrastructure but can also be based on digital infrastructure alone. **Smart Cities evolve along with new modes of value creation through the intermediation of public-private partnerships, cross-sectorial collaboration, city-led "open innovation marketplaces" and other forms of governance.**

Smart Cities comprise a portfolio of initiatives, projects and solutions, with different (but often overlapping) focus areas, modalities, participants and constituents.

For the purpose of this study, we focus mainly on solutions that combine ICT-enabled energy, transport and mobility, and are governed to reach common goals, and that place particular emphasis on initiatives that actively involve citizens and communities. In short, the study focuses on crosscutting initiatives that create an intersection between technological solutions and the "softer" aspects of a Smart City.

[7] Who Urban population growth - The rise of modern cities. (2015). Available at: http://www.who.int/kobe_centre/publications/hiddencities_media/ch1_who_un_habitat_hidden_cities.pdf

Figure 2: Key domains of integrated SCC solutions



Examples of cross-cutting initiatives[8] are smart buildings (e.g. ICT solutions to design and operate new buildings, renewable energies, etc), smart services for better informed citizens (e.g. real-time energy usage information, demand response, smart metering, etc), sustainable urban mobility solutions (e.g. alternative energy carriers for public transport, freight distribution, etc) and smart and sustainable digital infrastructure (e.g. smart grids, smart city portals, etc).

In a nutshell, some key highlights about these initiatives include:

- They **optimise resources** through better information on where resources are being consumed in a wide range of domains (i.e. government, transport, energy, etc.). This enables better monitoring and management from the energy utility side and allows consumers to make more informed use of resources, lowering consumption. In turn, this reduces utility operating costs and extends the operating life of existing infrastructure.
- They are **disruptive technologies** that require system-wide deployment to yield the most benefits and **demand changes in existing processes.**
- Their successful deployment usually requires **collaboration between multiple actors in the value chain** which could be a barrier in some vertical markets/departments where there is little incentive for established players to change.
- Due to the **fragmented vision** that typically characterises them (especially when it comes to taking advantage of smart technologies) and a reluctance on the part of city authorities to deploy **untested but innovative products and services,** they usually create difficulties for innovative companies (especially SMEs) to deploy them, especially at a large scale.
- Their integration has a **strong technological component,** although it cannot be decoupled from softer implementation aspects. ICT layers applied on top of existing applications and services or developed to support data and information

[8] European Commission (2012), Communication from the Commission, Brussels, 10.7.2012; C(2012) 4701 final. Available at http://ec.europa.eu/energy/technology/initiatives/doc/2012_4701_smart_cities_en.pdf

management for various objectives (i.e. better service delivery, more efficient management or lower environmental impacts) constitute the technological components, whereas softer aspects of integration relate to governance, actors and financing factors.

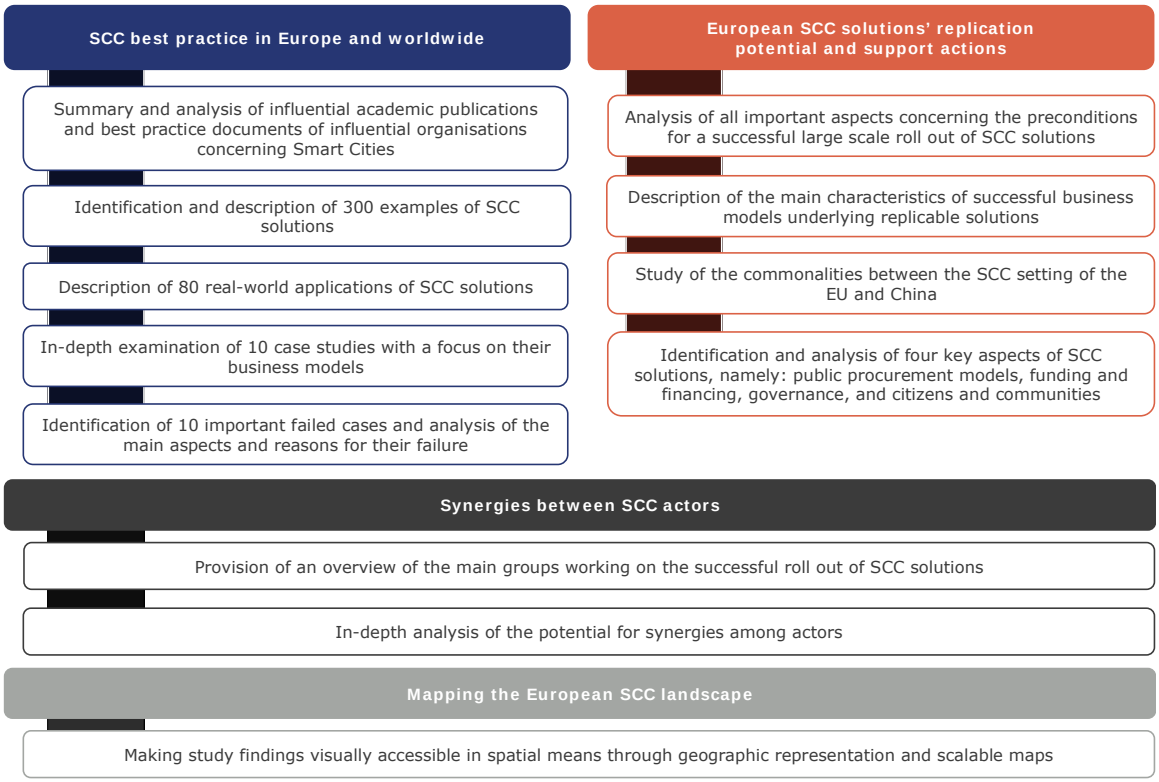
Moreover, successful solutions demonstrate that **higher impacts** are achieved when:

- The solutions' development and implementation involves a **large number of coordinated actors and stakeholders,** which have positive effects on securing financing mechanisms as well as on building the necessary critical mass in terms of ideas and thematic areas to address.
- The solution **tackles one prevailing issue in particular, but is also flexible enough to integrate various dimensions** and to scale and differentiate its outputs.
- The solution **interacts with other technologies** which is also ensured by the capacity of actors **not to work in silos.**

1.3. Overall approach to the study

The approach of the study has envisaged a unified methodology, illustrated in Figure 3 below and explained in greater detail in the following paragraphs.

Figure 3: Overall study approach



The study focuses in particular on the scalability and replicability of SCC solutions, as well as on a number of key factors such as funding and procurement mechanisms, public sector transformation to enable relevant governance, and the active engagement of citizens and communities.

The analysis has been articulated in the following steps:

- Screening and review of the most **relevant literature** concerning SCC solutions;
- Identification of **300 examples of SCC solutions**, of which approximately 200 are European, while the remaining examples come from the rest of the world;
- Selection,[9] analysis and description of **80 best practice examples of SCC solutions;**
- Identification and analysis of the key dimensions characterizing business models underlying SCC solutions, namely:
    - **Public procurement** models for SCC Solutions;
    - **Funding and financing** mechanisms of SCC Solutions;
    - **Governance** of SCC solutions;
    - **Citizen and community involvement** in SCC solutions.
- A more in-depth examination of **10 case studies** selected out of the 80 examples of SCC solutions, putting particular emphasis on the their **business models,** so as to make evidence available for other possible SCC solution initiators. In this respect, a business model is meant to generate added value that could entail economic revenues or even the internalization of externalities;
- Elaboration of a **Geographic Information System (GIS) database** that includes information on the identified examples of SCC solutions;
- Detection and analysis of **10 examples of "failure" of SCC integrated solutions,** carried out also through a dedicated web-based survey launched to identify examples of failed integrated solutions as well as the most typical patterns of failure;
- A specific investigation on the **commonalities between the SCC settings of the EU and China** which could be leveraged to increase replication and market potential for European Smart Cities in China;
- Elaboration of **synergies between the most relevant SCC groupings and organisations**, followed by the elaboration of recommendations on how to successfully use these synergies to further advance the concept and roll-out of Smart Cities.
- Elaboration of **recommendations,** developed on the basis of the previously mentioned pieces of analysis and meant to provide advice on how to support sustainable integrated SCC solutions, how to boost large scale roll-out of these, and – finally – what the European institutions' role in all this could be.

For the purpose of collecting the sample, multiple sources were used to identify leading examples of SCC solutions. The main data sources were the literature analysis

[9] Starting from the 300 long-listed examples, 80 "best practice" examples have been selected on the basis of: the level of integration of the SCC solution (at least 5 out of 11 SIP priority areas, of which at least 2 out of the 3 vertical technology driven pillars relevant to that SCC solution), the maturity level, potential replicability, use of particular financing and deployment models to allow for the investigation of different market and support mechanisms, focus on the integration of citizen/community involvement or activation, impact and relevance to EU 20/20/20 key goals.

carried out across all SCC key domains, relevant international Smart City benchmark studies and rankings to identify the most prominent cities implementing SCC solutions and, finally, the EU-funded initiatives supporting the development and implementation of Smart City solutions.

1.4. Limitations of this study

Determining the level of success for a Smart City solution, as well as its key characteristics, is limited by the availability of data and the implementation status of Smart City initiatives, as well as the clarity of definitions associated with Smart Cities.

Table 1 below presents some of the most significant limitations of such an approach from a methodological standpoint, as well as the strategies put in place to mitigate them.

Table 1: Main limitations and corresponding mitigation strategies

Main limitations	Mitigation strategies put in place
▪ The study relies on searching through and analysing available literature and online material, which is inevitably affected by the lack of: o Common terminology; o Time for successful SCC solutions to be published (particularly for the more recently implemented cases); o Consistent data across SCC solutions.	▪ A number of types of solutions have been identified and the most relevant areas in which SCC solutions are likely to emerge – like mobility/transport, smart neighbourhoods/districts, built environment or energy/smart grids – have been systematically reviewed.
▪ Some cities may over-emphasise the current level of activity of SCC solutions implemented, making it hard to provide a consistent approach in the measurement of impacts. ▪ The limited amount of available detailed information on SCC solutions at different lifecycle levels makes it less feasible to concretely connect the assessments made with statistical evidence from empirical observations.	▪ Where possible, data produced by cities and/or countries in which the cases are located has been validated though direct contact with the SCC solution representatives.

Finally, although this study provides general guidelines for Smart City managers and Smart City stakeholders, these should also always be adapted to the local context, as no two cities or communities are ever the same.

2. Analysis of integrated SCC solutions

Technological development has changed the approach to business practices in urban infrastructure development. Significant new opportunities arise from this evolution: for example, smart technology now allows for accurate and reliable measurement of socio-economic and environmental impacts. **It is therefore possible to quantify and price the externalities generated by investments in urban infrastructure.** This opens up new sources of revenue for projects, new business models for recovery and value capture, and new investment opportunities. This is the context where SCC solutions arise.

This section of the report researches and analyses this new business dimension in urban development investments. To ensure a more comprehensive analysis, different aspects of SCC solutions' business models are assessed:

- As previously mentioned, the creation of new business models is a consequence of technology enabling the internalisation of positive externalities in smart urban development. Coherently, sub-section 2.1 looks at **the conditions under which value is created in SCC solutions;**
- After assessing value creation, a closer look is taken at **how business models are evolving in SCC solutions** (sub-section 2.2), focusing on these aspects:
    - The **governance** of SCC solutions;
    - How SCC solutions are **funded and financed;**
    - The **procurement strategies** and opportunities;
    - The actors of these new models and, specifically, the role played by **citizens and communities.**
- Defining new models and business opportunities does not necessarily entail success. An analysis of cases where new patterns have been underestimated or misunderstood is reported in the **analysis of failures** (sub-section 2.3).

2.1. Creating value with integrated SCC solutions

Throughout this study, a wide range of ICT-driven Smart City solutions has been mapped and analysed to identify the elements, characteristics and contexts that enable the creation of the highest value. When assessing value creation, it is important to consider that solutions impact different urban areas. Therefore, the projects analysed in this study have been mapped following **the three SIP "vertical" priority areas**: (1) sustainable urban mobility, (2) sustainable districts and built environment and (3) integrated infrastructure and processes. By breaking these down further into homogeneous sub-categories, **9 main types of SCC solutions** w**ere identified.**[10] A short description of these categories, including examples of solutions and the associated value proposition can be found in Table 2 below.

[10] In addition to being associated with a main SIP vertical domain of reference, each mapped solution also embeds elements of at least one other SIP vertical priority area, so as to meet the minimum requirement to be considered an "integrated" example. In particular, to be considered an integrated SCC solution best practice in this study, each example had to be related to a minimum of 5 SIP priority areas: at least 2 vertical and 3 horizontal.

Table 2: Overview of solutions types and their relative value proposition

	Type	Short description	Examples of solutions	Value proposition
Sustainable Urban Mobility	***Real-time road user information***	Deliver real-time traffic information to road users.	Deployed technologies include variable message signs displaying traffic and parking information, bus stops with neighbourhood-specific information, dynamic pricing updates and mobile applications showing the location of the closest taxi stop and providing updates about train arrivals.	Enable people to take informed decisions about their mobility, saving time and energy.
	ITS-based enhancements of public transport	Public transport provider uses intelligent transport systems (ITS) as a support for the management of its assets and to enhance its service for the users.	Examples of technologies include contact-less public transport cards, sharing economy concepts for public fleets as well as applications for mobile payment.	Reduce waiting time as well as emissions, and facilitate intermodal commuting.
	ITS for traffic monitoring, management and enforcement	Collection and central processing of information to adjust traffic flows in urban areas.	Sensors for traffic monitoring, such as automatic traffic counting, cameras, vehicle location or even satellite imaging linked to central traffic control centres.	Optimise fleet management and route scheduling.
Sustainable Districts & Built Environment	***Smart technologies for the built environment***	Involve technologies and approaches for smart and intelligent management of assets and resources within the built environment.	Typical solutions integrate ICT to increase the level of automated monitoring and control of equipment, such as smart meters and appliances, home automation and outdoor automation, and intelligent waste collectors. Included here are also smart streets, i.e. limited geographic areas that concentrate a variety of technologies such as open Wi-Fi, building energy management, smart lighting, traffic or air quality measurement, smart waste management, electric vehicle charging and bike sharing.	Pursue better living, resource efficiency and waste reduction.
	Sustainable districts	Has a wider geographic scope and entails district energy systems, energy efficient neighbourhoods and eco-urban developments.	Smart waste water networks, district-wide building energy management solutions, district heating and cooling networks, EV integrated infrastructure, district-level smart lighting, interconnected systems of decentralised energy sources, urban	Reduce emissions and resource consumption by embedding integrated energy efficiency technologies.

	Type	Short description	Examples of solutions	Value proposition
			development projects that re-qualify entire districts based on state-of-the-art technologies.	
	Place making	Focus is clearly on community engagement, favouring the communication between the public entities and the single citizen.	Smart places that stimulate the valorisation of community data, community development and collective awareness platforms to promote sustainability and social innovation or mobile-based civic engagement and empowerment.	Create communities of interest that can be key to support integrated SCC solutions.
Integrated Infrastructure & Processes	***Smart City Platforms***	Integrate large amounts of data and information collected by distributed sensors within the city, possibly including humans as sensors, which are then used by city managers or urban planners to guide the Smart City development process as a whole.	Typical solutions in this area are large-scale, transversal ICT platforms able to collect and analyse large amounts of data coming from a variety of sensors, common digital infrastructures that in a sense connect the entire city.	Allows real time monitoring and preventive steering of cities.
	Intelligent City Services	ICT-enhanced public service provision mechanisms.	Examples of solutions in this area are city open integrated data hubs, GIS applications, technologies bridging different sources of data such as social media and real-time monitoring tools, smart IT-based toolkits to ensure reciprocal communication between city authorities and citizens.	Co-ownership of local matters and outcomes. Efficiency savings for city administrations. Stimulate involvement at local level.
	Smart grids	Address energy issues with innovative ICT and data related components.	Analysed smart grids range from modernisation of distribution networks to more advanced, fully automated systems that include smart meters and appliances at the household level. Some reviewed solutions also integrate electric vehicles as storage units or develop parallel energy markets where prices try to reflect real-time demand and supply status.	Collected information and insights may serve planners and managers, but are often also shared with users, who can take more informed decisions and can also become *prosumers*, i.e. users that can switch from being energy consumers to becoming producers based on the circumstances.

Across the sample of analysed cases, **city-wide integrated solutions were rare.** Instead, **solutions with higher levels of integration are emerging in smart districts, across some energy efficiency projects as well as in various mobility projects.**[11]

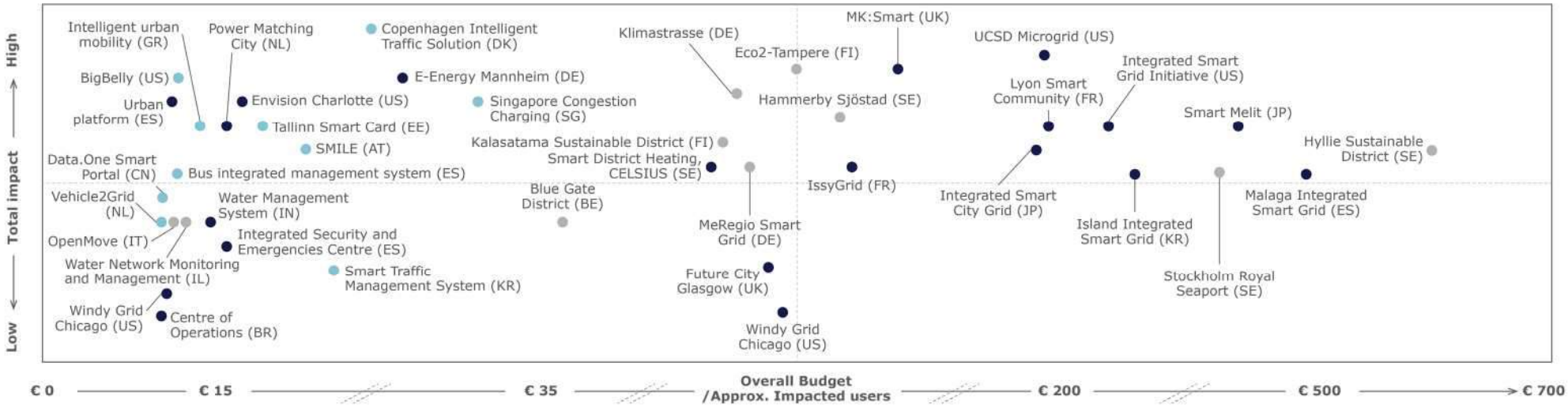
Although the sample of cases has been categorised based on the purpose of the study, another analytical step was necessary to assess value creation. Coherently with the data and information available and following thorough research, each project has been evaluated assigning a score ranging from 1 to 5, where 1 is a perceived low level and 5 is a high one. This assessment is summarised for each of the case using a dashboard format, as depicted in Figure 4 below.

As technology enables the internalisation of externalities, the higher the positive impact, the higher the value created and the possibility to transform such value into business opportunities.

Figure 4: Example of an SCC solution assessment dashboard

[11] An overview of the 80 examples of successful SCC solutions analysed across this study, with indication of their prevalent SIP vertical priority technological dimension, covered secondary domain/s, and different degrees of integration of the panel of selected cases is included in Annex to this report.

Figure 5: Positioning of the analysed SCC solutions in respect to their overall impact and their budget per impacted user



Source: Our elaboration, based on the 80 analysed examples of SCC solutions for which data was available

Note:

The following data assumptions apply to the analysis presented in the scatterplot:

(i) ***Overall total impact*** *is the sum of economic, environmental and social impacts, as estimated in each solution's assessment dashboard;*

(ii) ***City population levels*** *refer to 2014 available data. In the case of solutions impacting only part of the city population, when the number of affected users was not identifiable in any other way, a flat-rate of 20% of the total city population has been used. When only the number of impacted "households" was available, an average of 3 people/users per single house has been used.*

The analysis shows **3 main clusters of integrated SCC solutions:**

- ***High cost/high impact (top-right quadrant):***
  District level demonstrators of energy efficiency and Smart Grid projects
  Both brownfield and greenfield developments show high degrees of integration of the energy, mobility and smart built environment agenda combined with a clear emphasis on including and activating the relevant communities living and working in these districts. What could be improved is the systematic working relationship and scaling of successful solutions to the rest of the city and/or region. Furthermore, most Smart Grid solutions fall in here: whilst most smart grid projects experiment with EV vehicles and therefore integrate all three key SIP "vertical" priorities, they do not aim to create sustainable solutions directly. Aspects of these solutions then scale up by being integrated in future large-scale roll outs.

- ***Low cost/high impact (top-left quadrant):***
  Intelligent transport solutions
  While these usually start as pilot projects, intelligent transport solutions are increasingly integrating energy efficiency considerations and linking to the smart built environment to offer customers and citizens more personalized services. However, the link to energy efficiency needs to be strengthened to guide smart mobility solutions and integrate them better.

- ***Low cost/low impact (lower-left quadrant):***
  Data solutions
  An emerging cluster of solutions are data platforms and data centres at city level. These are looking for innovative and new ways to manage energy efficiency at city level as well as offer improved transport conditions.

Together with the analysis at cluster level, the mapping and assessment of solutions helped to identify certain **common features of high value-added integrated SCC solutions:**

- **Data-driven transformation:**
  An aspect common to most integrated solutions is the emergence of data centres and, more generally, they use of data to steer integrated solutions, personalise services and manage the solution. Data enables both the creation and provision of entirely new Smart City services, and the integration of siloes across city government structures.

- **A fast-growing "sensor environment" across cities:**
  Most of the SCC solutions mapped share the common feature of an increasing number of sensors being deployed. Although it is only in a limited number of cases that these devices are collecting personal information, there is still a missing overall regulatory framework in place to govern them. As a fundamental part of a Smart City's Internet of Things infrastructure, these sensors should be subject to city guidelines on the type of data they collect and how this is used.

- **Open standards**
  To avoid vendor lock-in and enable the procurement of the best technologies available, many cities employ open standards both on the technological and on the business level.

- **Involvement of the local community and of local businesses**
  Integrated SCC solutions aiming to be sustainable have a strong focus on community involvement and the activation of local businesses. To create lasting impact in the context of Europe 20/20/20, integrated solutions require collective awareness and commitment to develop services that support behavioural change and more energy efficient solutions for the future.
- **Sustainable solutions with a triple bottom line**
  Meeting local needs and demands as well as contributing to higher objectives such as CO_2 reduction or making daily travel more efficient and safer, are the driving factors behind integrated solutions.

The results of the analysis helped to understand the key dimensions that create value. Simplifying to the greatest possible extent, what emerges is that the **level of integration** and the **role of citizens** are the key factors that affect value creation.

Key finding

Cities that focus on **integrated** Smart City solutions create the most value.

The study shows that **the best results have been registered when solutions are integrated and dynamically designed or informed by the users.** As in the EIP-SCC vision, this integration runs mainly across the areas of energy, transport and ICT, but it also embeds more transversal enabling factors.

Integration can create considerable opportunities for added value in any city. The best practices of integrated solutions mapped through this analysis have shown that – in most cases – these can actually help cities to improve efficiency, enhance economic potential, reduce costs, open the door to new businesses, and improve the living conditions of their citizens. The inter-linkage between areas concerning energy production, distribution and use; mobility and transport; and information and communication technologies offer **new interdisciplinary opportunities to improve services while reducing energy and resource consumption.**

Similarly, the involvement of citizens is crucial to identify the issues to be tackled by SCC solutions, therefore offering the first best option to match supply (i.e. the services offered) and demand (i.e. the benefit for final users), ensuring the creation of value added for these innovative urban systems.

The citizen focus (bottom-up approach) does not exclude the need for an organised approach to SCC solutions, which is often ensured through a **centralised management** (top-down approach).

In summary, the successful development of a Smart City has been often found when a **bottom-up system approach is combined with top-down service development and a data-centric strategy.** Integrated resource management, governance capabilities and supporting ICT infrastructure are essential for implementing SCC solutions successfully; this integrated approach was found in several examples of SCC solution best practices and has shown itself to create advantages for the entire system.

2.2. Business models of integrated SCC solutions: Success factors and support mechanisms

As mentioned at the beginning of section 2, technological development has enabled new opportunities, which have reshaped the business approach to urban investments.

Although technology is the key enabler in the rise of new business models, the analysis shows that, without a coherent approach to new business opportunities, solutions are likely to fail (see sub-section 2.3). **Local stakeholders must think beyond the technological aspect, and be realistic about planning aspects, required inputs and sustainable initiatives, also in terms of governance and funding.** City decision-makers should start to define a rigorous business approach and to stimulate the commitment of investors and stakeholders from the early phases of the planning stage.

The identification of success factors in the literature review phase of this study has revealed a number of recurrent enabling factors for successful integrated Smart City solutions. These **key dimensions characterizing business models underlying SCC solutions are:**

- **Governance:**
  Governance relates to the mechanisms, relations and approaches to direct and manage integrated SCC solutions. As SCC solutions tend to involve public entities, it is often the case that public entities define the approach to, *inter alia,* cooperation levels between departments and/or different actors, data management, etc.

- **Funding and financing:**
  Financing and funding represent two key elements in the creation and roll out of a Smart City initiative. Current budget limits and constraints are forcing public authorities to look for the right financial and funding mechanisms that support strategic planning and integration across municipal departments, as well as the procurement processes necessary to develop SCC solutions on a wide scale. Similarly, financial constraints affect private technological players as well (especially small innovative companies and start-ups developing risky projects), limiting both their capacity to develop innovative solutions, and their ability to bring their products onto the market.

- **Procurement:**
  The complexity of cities, in terms of stakeholders involved and processes, including procurement, represents one of the main barriers towards the adoption of SCC integrated solutions. This complexity emerges in many areas (policy, regulatory, governance, economic and organizational) of local governments and may create difficulties for city leaders and stakeholders to agree on the methodologies for implementing SCC solutions. From the analysis carried out, it appears that a crucial factor able to accelerate the deployment of SCC solutions is an open and collaborative market, which is able to bring into it the greatest number of SCC solutions, and which – as a direct consequence – assures lower implementation costs. Procurement, and, more specifically, procurement of innovation, is a factor that can create this type of open and collaborative market.

- **The role of citizens:**
  There is growing recognition amongst Smart City practitioners and policy

makers that the shift required to achieve sustainable SCC solutions that produce outcomes such as higher resilience of cities, increased liveability of cities and lower resource consumption, is a momentous paradigm shift for most cities. At the heart of this paradigm shift is the role of citizens, local businesses and communities in developing, implementing and maintaining sustainable and high-impact SCC solutions.

The following sections give a summary of the main findings of a series of background reports developed as part of this study, focusing on the above-mentioned four key dimensions.

2.2.1. Governance tools to manage integrated SCC solutions

City governments are faced with the challenge of exploring the economic return in Smart City investment, the business models, the value that it brings to citizens and the role that they should play within an ecosystem of delivery partners and stakeholders. Further, they **must be responsive to the changing context**, understanding how new opportunities for investments align to existing local and national political priorities and strategies.

Researching how governance tools manage and enable SCC solutions to succeed, within this study, we have identified and analysed governance models across the sample of integrated SCC solutions.

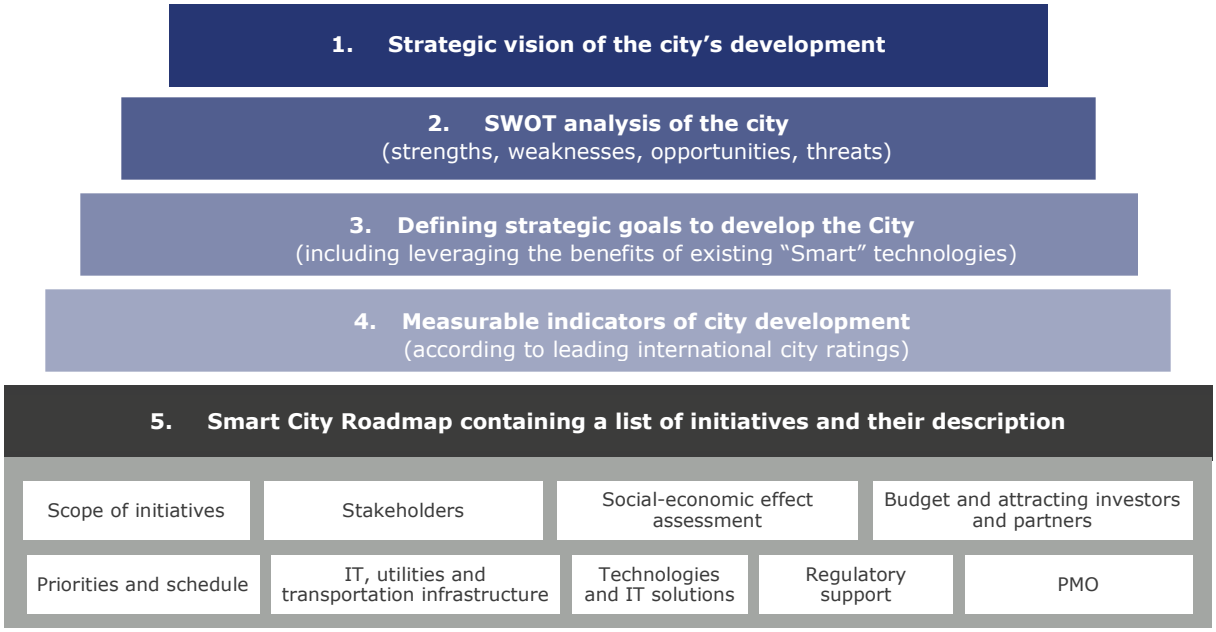
Governance

Governance relates to the institutional capacity of cities to develop, pilot and deploy integrated Smart City solutions.

At a first analysis, governance appears to rely on the public sector. This is expected as SCC solutions are generally managed as part of urban development planning projects. In this sense, governance represents the management of the planning of city development interventions.

Evidence of the analysed cases of both successful and failing SCC initiatives demonstrates the **importance of structuring the approach to SCC solutions from the definition of a coherent and shared strategic visions down to the definition of the city needs, to initiatives roadmap definition** (see Figure 6).

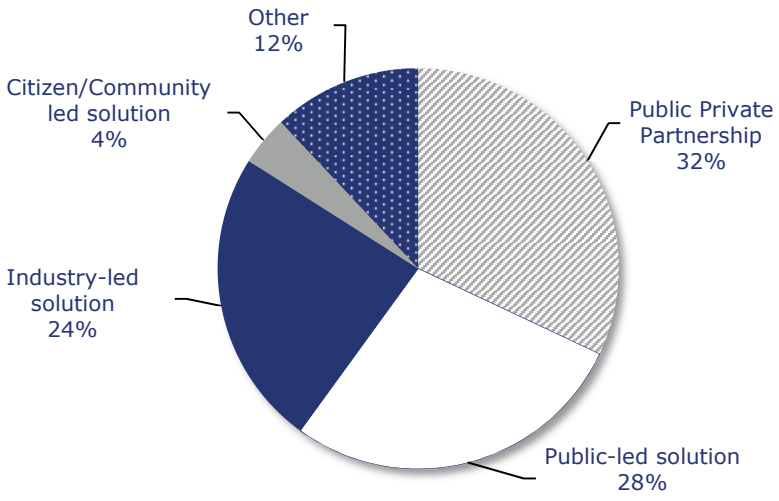
Figure 6: Comprehensive planning and strategy for SCC solutions integrated in urban development



Source: Own elaboration based on PwC strategy toolbox for operational roadmap of initiatives for smart and resilient city development

Empirical evidence from the sample of integrated solutions analysed shows a strong reliance on public leadership, rather than on private parties, as is expected due to the integration of city planning and SCC solution governance within the same organisation. **More than half of the analysed sample of integrated solutions is driven by the public sector and by public financing,** whereas 28% of the solutions is mainly driven by the industry or even directly by the community.

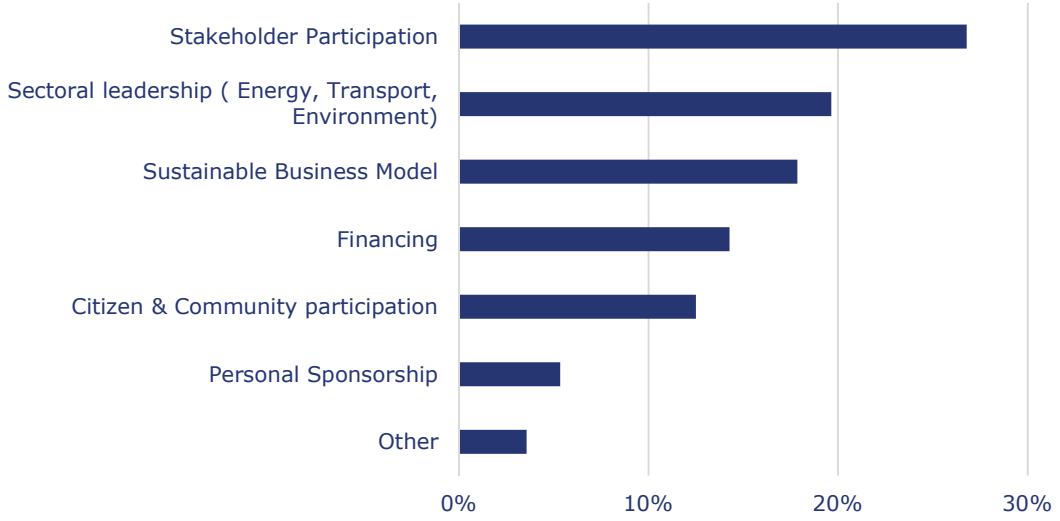
Figure 7: SCC solutions' distribution according to prevalent funding / financing model (sample)



Source: Outcomes of the analysis on a sample of SCC solution representatives (25 different respondents)

Furthermore, the relevance of a strong and efficient governance is reaffirmed by the stakeholders involved, who state that **the capacity to manage partnerships and sectoral leadership are essential for integrated SCC solutions to succeed** (see Figure 8 below). This requires integrated, multi-party and flexible governance models.

Figure 8: Most important factors for implementation and SCC solution sustainability



Source: Outcomes of the analysis on a sample of SCC solution representatives (25 different respondents). The table is based on answers to the question "Which of these were the most important success factors for the implementation of the solution and for its sustainability?"

From the analysis of the integrated SCC solutions, three emerging governance models may be identified:

- **Strong cross-departmental Smart City governance:**
  In particular, larger cities and cities with strong leaders and an established focus on Smart City projects have developed governance entities to manage the digital transformation required by SCC solutions.
- **Sectoral leadership with strong supportive Smart City co-ordination mechanisms:**
  Most cities operate in silos and demonstrate a weak SCC solution governance and co-ordination structure. This is a barrier to integrated solutions, as innovation leaders develop solutions that only fit into the innovation profile of their own sectoral priorities.
- **Open governance model (platform model):**
  Data is transforming cities as it is becoming available in increasingly large quantities and qualities.

There is no best governance model for integrated SCC solutions, as the context plays a great role in determining the adaptability of each model to a given SCC solution. The following table outlines some of the strengths and weaknesses of key types of governance models of integrated SCC solutions.

Table 3: Strengths and weaknesses of key types of governance models of SCC solutions

Type	Strengths	Weaknesses	Example cities
Strong cross-departmental smart city governance	▪ Allows the city to become a more involved partner in integrated solutions. ▪ More agile and responsive structure, which means barriers can be more efficiently addressed.	▪ Very dependent on the leader and thus possibly not sustainable.	**Boston, Lyon, Tallinn, Vienna**
Sectoral leadership with strong supportive Smart City co-ordination mechanisms	▪ Fits cities with a multi-departmental set-up. Collaboration is established based on need and political will. ▪ Benefit of integrated solutions starting in a sector is the focus, and thus the often higher cost benefit analysis (CBA).	▪ Difficult to identify responsibility and leadership ▪ Difficult to manage all interests ▪ Budget risks due to other budget priorities at sectorial level	**Amsterdam, Copenhagen, Seoul**
Open governance model (platform model)	▪ Allows a higher degree of integration with citizens and the private sector and particularly local businesses ▪ Innovation is driven by the private sector and the market ▪ Creates a framework that fosters competitiveness within the integrated solution framework	▪ Government has less power and becomes more of an enabler ▪ City governments need to be willing and prepared to change.	**Barcelona, Chicago, Helsinki, Manchester, Milton Keynes**

Source: Our elaboration

The governance models help to define SCC solution features, such as the level and type of collaboration and the data ownership and governance.

All the governance projects that are arising show Smart City solutions shifting away from silo-based delivery of services. Instead, an integrated, multi-channel governance approach is preferred. This **facilitates a whole-city-view of the customer and an ability to deliver services to citizens and businesses where and when they need them the most,** including through one-stop services and private and voluntary sector intermediaries.

Smart City experimentation partnerships require strong cross-departmental governance

In the case of **Lyon**, a project team working under an innovation director is in charge of the Lyon Smart Community project. They are not located within any specific administrative domain, but rather they bring in actors from the domains with specific knowledge in traffic, energy and environment if necessary. This cross-departmental governance structure ensures the integration of the Lyon Smart Community in terms of mobility, built environment and infrastructure and processes.

Another key feature governance models are required to manage in SCC solutions is **data.** As already mentioned in this report, data is transforming cities as it is becoming available in increasingly large quantities and qualities. City data platforms are an essential tool to achieve the goal of ensuring data sharing and availability and enhancing efficiency and coordination across different administrative domains/partners/agents. Data platforms make it possible to connect, standardize and automate processes across domains. When it comes to data integration, however, the governance can strongly differ.

The analysis performed makes it possible to identify two main different data integration approaches:

- One that focuses on the alignment and standardization of data within each silo in order to bring in more integration in the future (bottom up-approach);
- Another that looks to collaborate with ICT partners to establish an overall city IT architecture from the beginning (top down approach).

Bottom-up approach: Open data management across city departments with future integration in mind

In **Copenhagen,** all data on mobility is gathered and monitored by a traffic data management centre. Copenhagen is now developing data integration systems that can combine data from all administrative domains, such as the integration of data on mobility and energy in the city service development. The basic idea is that data is the main foundation for future integrated solutions in Copenhagen, but the right data sources must be in place before data integration can be possible and successful. Therefore, the first task is to build a common set of data collection tools in each silo, which is not an easy task due to the difference in data format, data type etc. Afterwards, it will be possible to integrate these systems into one city data dashboard.

Top-down approach: The establishment of an overall city platform

In the case of **Barcelona,** the Urban Platform is a transversal technological programme through which city information can be collected, managed and communicated in a common way. Barcelona collaborates with its technological partner to create a service provision platform for more efficient management of the city through a holistic vision of all available municipal services. Compared to the case of Copenhagen, the Urban Platform stands out as a basic infrastructure ICT tool that needs to be established before further integration will be possible.

Overall, the analysis performed demonstrates that there is no blueprint for city governments investing in smart technology, and no universal approaches that are

relevant to all jurisdictions. Instead, city governments must forge their own paths that respond appropriately and effectively to their individual needs and opportunities.

However, common trends have been identified. These are:

- The need to embrace a more cooperative governance system than that of traditional projects and programmes, which facilitates stakeholder involvement;
- Sustainable smart city solutions need to be citizen-centric;
- Governance needs to adapt to the key role played by data (e.g. data-sharing, ownership, management).

2.2.2. Funding and financing to enable and support integrated SCCs

Financing and funding represent the central driver of any SCC solution's business model. Budgetary constraints are forcing public authorities to look for alternative sources of capital to support the development of SCC solutions. Similarly, limited access to finance also affects small innovative companies and start-ups, especially those engaging in risky projects. This limits both their capacity to develop innovative solutions and their ability to bring their products to the market.

The empirical analysis carried out as part of this study has emphasized the **central role played by PPPs in funding and financing SCC projects.** Moreover, large and complex solutions in the domain of **Sustainable Districts & Built Environment** appear to be those more significantly financed by a mix of public and private funds. The larger amount of capital made available through PPPs may explain this.

Public funds appear to be a very common funding option for Sustainable Urban Mobility and Integrated Infrastructure projects. A possible reason for this is the availability of specific funding schemes both at regional, state and EU level for projects focusing on these domains.

Private financing is equally distributed among the different SCC domains. It is worth noticing that some SCC solutions adopted less traditional sources of financing, such as crowdfunding and venture philanthropy.

Finally, several funding and financing instruments/opportunities offered by public entities, development banks, financial intermediaries and private investors make a wide offer and **provide relatively easy access to capital** both in terms of financing and funding for SCC projects across Europe.

Funding

Government-supported programmes and funds – at EU, national and regional level – represent one of the main sources of capital for SCC projects. At EU level, a macro distinction can be made between European Structural and Investment Funds (ESIF) and other EU Programmes.

Besides the funding opportunities available at EU level, single MS have also established their own funding schemes with the aim to support solutions in the SC domain.

Financing

Financing, which typically takes the form of debt, equity and guarantees, can come either from the government and public institutions or from private entities. A distinction ought to be made between the following:

- Financial products supported by **public funding** (including, for example, European Funds for Strategic Investments (EFSI), InnovFin and Financial Instruments);
- Financial products provided by **commercial banks;**
- Specific programmes supported by **development banks** or similar (e.g. European Investment Bank, *Cassa Depositi e Prestiti, Kreditanstalt für Wiederaufbau*).

Another interesting form of financing consists in **financial instruments that translate part of the resources made available via ESIF into financial products such as loans, guarantees and equity.** The main innovation is that, as opposed to grants, final recipients are supposed to repay the contribution received. Projects expected to generate the necessary income to pay back the support received are the recipients of such products. Financial Instruments may be managed by European (i.e. EIB), national or regional financial institutions and support a range of investment areas, including: RDI, EE, Rural and Urban Development, ICT and last mile infrastructure.

As for additional financing sources, a distinction should be made between:

- **Bond financing,** which includes a wide spectrum of different bond options issued by states, local authorities, or corporates to finance different projects;
- **Pension fund private placement bonds,** which is a peculiar case of bond financing that entails pension funds with large amounts of capital to invest through non-public offerings.
- **Equity investment and infrastructure fund managers,** which includes investments made as part of a e.g. diversified securities portfolio.
- **Venture capital (VC),** which includes money provided to seed, early-stage and emerging growth companies. Venture capitalists invest in companies in exchange for equity in the companies they invest in;

Funding

Funding is the long-term cash inflow to pay for the implementation of a project. It does not imply any repayment. Instead, it represents the payment of benefits (both direct and indirect) from those that primarily benefit from the project. Typical examples of sources of funding include government bodies and the corporate sector through their corporate social responsibility programmes.

Financing

Financing is the source of capital to pay for a specific project (in other words, who lends or invests in the project). Financing is a temporary provision of cash-flow resources that is expected to be paid back at a specific point in time. Sources of financing may be multiple, such as bank loans both from commercial banking institutions or governmental banks, or development banks such as the European Investment Bank (EIB). Other options include bonds, equity, leasing and vendor financing solutions.

- **Crowdfunding,** which enables groups of individuals (i.e. financiers) to financially support a certain solution by pooling their resources. It uses the internet as a major channel whereby financiers are able to fund a project according to their geographical interests or emotional preferences;
- **Venture philanthropy** refers to private investors, foundations or private-equity firms using VC approaches to provide financial support to viable projects with high levels of social interest.

Different types of financing schemes: Project financing and public-private partnerships (PPP)

Project financing consists of a financial transaction used by public administrations or banks to finance public works, especially large-scale infrastructure projects. Compared to more traditional forms of lending, project financing focuses on the financial assessment of a given project, rather than on the business/enterprise as a whole. The remuneration is set according to the estimated cash flows and profits generated by the project. Some of the positive outcomes include the fact that it mitigates government risks and it allows them to acquire precious skills that may not be available.

Within a **Public-Private Partnership (PPP),** private sources of financing along with funding from a public source come together to support the development and implementation of SCC solutions. One of the main aspects that has to be taken into consideration while implementing an SCC solution is the level of risk (from market risk to policy risk) embedded in the initiative which could discourage private partners from actively participating and could limit access to finance. The advantage of a PPP is that it allows for a balanced allocation of risks among private and public partners.

When it comes to SCC solutions, the following types of PPP contractual models should be mentioned:

- **Build-Operate-Transfer (BOT):** This involves an agreement between the private and public counterparts committed to covering the design, building and operational phases of the investment project. Revenues for the operator company are usually obtained in the form of a fee charged to the community/government;
- **Design-Build-Finance-Operate (DBFO),** whereby a single contractor with financing capabilities designs, builds and operates the project for a certain period of time;
- **Build-Own-Operate (BOO),** which involves a private sector partner taking under its responsibility all the phases in a project from building and financing to operations. The main difference with other models, especially DBFO, is related to the fact that a company could build, operate but also own a project for all its physical lifecycle;
- **Energy Service Companies (ESCO):** Thee provide direct financing to the investment and use their in-house expertise and know-how to develop projects further. The main steps that are usually followed by ESCOs in relation to projects involve: a first analysis of data gathered, contracting, designing, execution, monitoring and maintenance;

- **Financial Lease** involves three main actors; a financing entity, the contractor (private entity) and the principal (public entity). Under this contractual form, capital is provided to the contractor by the financing entity, which is then repaid by the public entity through lease payments;
- **Sponsorship Agreement,** which allows public entities to cooperate with the private sector in order to promote innovative projects in the government sector and to execute public works, increasing the quality of services. The role played by the private entity is usually related to the provision of capital or goods, whereas the public entity is mostly focused on setting goals and objectives for the project.

Investment platforms

Investment platforms are co-investment arrangements – which can be supported by EFSI – structured with a view to catalysing investments in a portfolio of projects (as opposed to individual projects) with a thematic or geographic focus[12].

Investment platforms aim to **reduce transaction and information costs** and provide more efficient risk allocation between various investors. Ultimately this enables financing solutions to be spread over a wider range of projects, some of which would otherwise not be reached by other means (e.g. the EIB).

The range of products that can be provided through platforms is vast and includes:

- **Equity and quasi-equity** investment in projects or funds;
- **Loans** to projects, including subordinated loans to those provided by, for example, National Promotional Banks or private investors;
- **Guarantees,** which can include both guarantees directly to projects or guarantees and/or counter-guarantees to intermediaries who invest in projects.

Investment platforms are flexible instruments also in terms of sectoral scope (in this case, reference is made to mono-sector focus versos multi-sector focus), thus providing a unique window of opportunity for combinations of, for example, energy and mobility SCC projects. Investment platforms are also best suited to providing financial products to support small or medium-size projects, which would not otherwise be able to benefit from the opportunities offered by the wide range of financing solutions available on the market[13].

Common trends across integrated SCC solutions

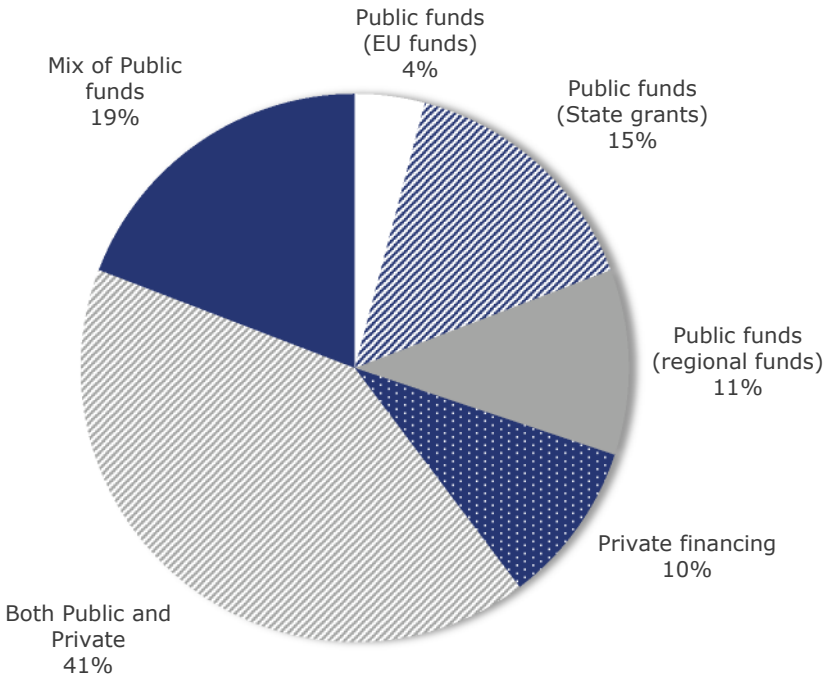
Looking at the panel of analysed integrated SCC solutions, an initial categorization has been made by dividing the different financing/funding options into the following six major clusters: i) EU funds (both ESIF as well as other EU programmes); ii) State grants; iii) Regional funds (funds made available by single regions from national budget); iv) mix of public funds (including the use of one or more of the previously mentioned funding options); v) private financing; vi) both private and public

[12] http://ec.europa.eu/economy_finance/financial_operations/documents/efsi_rules_applicable_to_operations_en.pdf
[13] http://ec.europa.eu/regional_policy/sources/thefunds/fin_inst/pdf/efsi_esif_compl_en.pdf
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1017&from=EN

financing/funding (mix of private financing including for example loans and public funding in the form of EU funds, State grants, Regional funds).

These categories were used to group the funding/financing options chosen by SCC solutions, as is illustrated in Figure 9 below.

Figure 9: Funding/financing options chosen by SCC solutions



Source: Our elaboration

The majority of solutions analysed have adopted a mix of public-private funding/financing (e.g. Hafen City Hamburg, University of California San Diego, Hudson Yards New York, etc.) in order to sustain SCC projects.

Example of a mix of public funds
New Fleet Management System, Donostia, San Sebastian (ES)

The "New Fleet Management System" became fully operational in 2010 and currently enables the efficient planning and management, via an ICT platform, of the public transportation system in the city. The solution was funded through a mix of public resources, with 70% coming from EU funds while the remaining part was made up of from regional funds. The funding coming from the EU was raised through the 7th Framework Research Programme.

Public-private funding/financing is followed by a mix of public funds (e.g. Bus integrated management system in Donostia, San Sebastian; MnPass Minneapolis), which consists of state grants (e.g. MeRegio, Future City Glasgow), regional funds (e.g. Citizens Connect), private financing (e.g. Vienna Citizens' solar power plant) and the use of individual EU public funding options (Interoperable open platform – Iscope, 3eHouses).

Example of private financing
Green Bond financing of Smart City projects, Gothenburg (SE)

The City of Gothenburg became the first city in the world to use **Green Bonds** for financing projects in 2013. The total amount of green bonds issued for the City of Gothenburg in three years amounts to € 353 Mln. Examples of projects that have been financed via Green Bonds include: Energy Celsius Project (district heating system), *Lokalforvaltningen* (several projects related to sustainable housing and schools) and other investments in deploying approximately 100 electric cars across the city.

Example of EU fund
Efficiency financing via EFSI (FR)

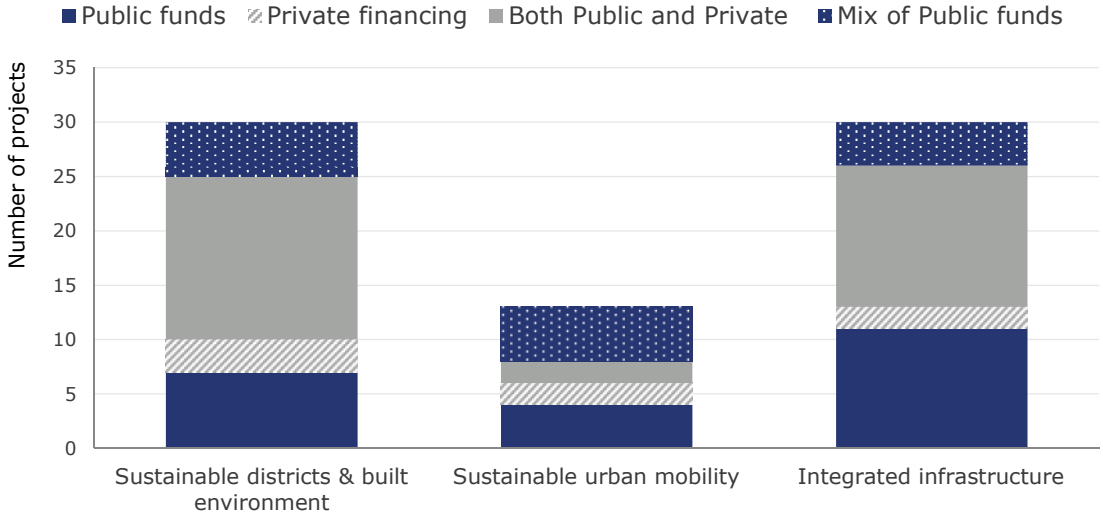
One of the main projects involving the deployment of EFSI funds relates to the plan to improve EE performance in more than 40,000 houses and flats across France.

The aim of the project is to improve the insulation as well as to renovate the heating and ventilation system, therefore reducing energy consumption.

The overall capital received by the EIB amount to € 400 Mln and cover half of the total project cost. The capital will be provided by the EIB via local intermediaries.

It is worth noting that, according to the data available in relation to the 80 best practices, **PPP seems be especially popular in SCC projects focusing on the Sustainable Districts & Built Environment domain.** The bar chart in Figure 10 below shows the distribution of the above-mentioned funding/financing options,[14] applied to the three major domains of SCC projects.

Figure 10: Funding/financing options for each domain[15]



Source: Our elaboration

[14] To make the chart more readable, the wide range of public funding options have been clustered into the more general "public funds" definition.

[15] The bar chart was made using the data available from approx. 70 best practice examples of SCC solutions.

The widespread use of PPP to fund Sustainable Districts & Built Environment projects may be due to the complexity of these projects, which often require access to a larger amount of capital and resources. Moreover, since they often involve large urban redevelopments, specific institutions become operational in order to oversee the different project phases. Therefore, **the presence of a solid, but also dynamic organizational structure, results in a more direct and effective control over some of the critical aspects of a PPP** including financial management, project evaluation and risk allocation.

Public funds appear to be a very common funding option for Sustainable Urban Mobility and Integrated Infrastructure projects. A possible reason is that such projects are generally characterised by a relatively small size, high risks and limited private involvement. Coherently, specific funding schemes both at regional, state and EU level have been made available for projects focusing on these domains. Regarding private financing, all the three different Smart Cities domains account for similar shares and no major trends can be identified.

Public funding of an integrated infrastructure project
SC Platform, Valencia (ES)

The platform was unveiled by the Valencia City Council in 2014 with the aim of collecting different indicators related to transport management, air quality, waste collection, public lighting and local police.

The solution is entirely funded by the local government. A four-year contract has been established between the Municipality and *Telefonica*, the Spanish telecommunication operator that won the contract. The total budget amounts to € 4.8 Mln. It is estimated that the project will produce a high amount of savings that will cover the cost of the service.

The city administration is analysing three different financial models to ensure the long-term sustainability of the platform. These are: i) introduction of a fee in the specification of the urban services offered by the platform, during the bidding process; ii) introduction of a mix of contributions from local public authorities; iii) introduction of a fee for all service providers.

In conclusion, the analysis of funding and financing mechanisms for SCC solutions has showed that in this case, too, there is no **"one-size-fits all"** approach, and that one of the main drivers to succeed, is to properly **balance the short-term pressures to deliver results with the long-term benefits of partnering with the private sector.**

Common trends have also been detected with respect to the scale of SCC solutions (where scale means the overall amount invested in the initiative):

- **Small scale projects** find it difficult to access the main funding and financing sources, mainly due to a limited awareness of what the financial market offers, and to the fact that they are usually not very interesting to banks (i.e. too small to be relevant). The most common funding/financing approaches for them include crowdfunding, venture philanthropy and specific EU/national funds.
- **Medium-sized projects,** depending on the context and type of solution, can benefit from certain dedicated public support mechanisms, but mostly rely on venture capitalists to have their solutions financed. The most common

funding/financing approaches in this case include venture capital and EU/national funds.

- **Large-scale projects,** which are usually real-estate driven, are those that find it easier to access finance. This is because promoters generally know the market and the range of products offered, and also due to the fact that they usually involve major private sector companies that blend SCC solutions into other businesses (real-estate). The most common funding/financing approaches in this case include bond financing and financial products provided by commercial banks.

2.2.3. Procurement models for cities to enable integrated SCCs

Municipal authorities strongly rely on external suppliers, a trend that is growing as local authorities increasingly define themselves as commissioners and not deliverers of services. In the field of Smart Cities, **the creation and development of a SCC solution requires a continuous innovation process involving high numbers and different categories of stakeholders**. One way the public administration can foster this kind of innovation process is by using **public procurement as a tool to stimulate innovation from the demand side,** thereby supporting state-of-the-art SCC projects and solutions.

This is particularly true for Smart Cities, which are characterized by areas of application where public authorities have a strong potential to stimulate demand (e.g. the transport and the energy sectors). Moreover, public authorities may not only buy a product, they can also make a request for products that are not available yet, generating innovative dynamics and solving market failures.

Therefore, it is clear that **Europe has an enormous and overlooked opportunity to spur innovation by using procurement.** However, as SCC solutions are by definition multi-component systems, their procurement may sometimes be complex. These issues have all created barriers to new players accessing this market. Combined with the need for integrated solutions such as those of SCCs, this presents a major challenge to local authorities, which have traditionally developed responses through a silo approach.

Evidence for the relationship depicted above is that, historically, it has been difficult for newly founded firms to win business from public bodies like municipal governments. Therefore, it seems that **public sector procurement practices themselves can represent an obstacle to accelerating the growth of SCC solutions.** From both the public and private sector sides of the market, there is some evidence that traditional procurement of city services is stifling innovation and inhibiting the ability of cities and industry to jointly undertake real life R&D and to pool intellectual property for mutual benefit. Equally, there is an increasing consensus on new, smarter approaches to public procurement, which are already starting to develop and should be more widely adopted.

Avoiding lock-in

Vendor lock-in is a phenomenon that takes place when **a public authority is unduly dependent on a single supplier, vendor or developer** beyond the timeframe of the initial procurement contract, damaging competition. This happens in cases such as: i) Long contracts that encourage up-front capital investment to build bespoke tools and that depreciate over a number of years; ii) One supplier entrenched over a number of years to provide mission critical systems, requesting backward compatibility with systems of which only few suppliers have knowledge.

By limiting the procurement choices of public authorities to certain vendors and the suppliers of their products, lock-in can reduce the ability of other market participants to compete in contracts for public procurement. This in turn can lead to lower levels of innovation, and higher prices. **Lock-in, as well as increasing costs, excludes new and innovative companies from providing alternative solutions and causes the market to stagnate.**

ICT standards may play an important role in preventing reliance on single vendors for products and system components that implement desired technologies by **identifying the key element of the technology required and ensuring that its use is not limited to a specific product or service.** Procuring a product from one supplier that is based on standard technology helps to ensure that future purchases are not limited to the original supplier, as others are also able to implement the technology.

High-performing city governments increasingly recognize the value of acting as customers of innovation. **Opening up procurement mechanisms to make them accessible to younger, smaller businesses allows cities to access a wider range of new ideas and technology than traditional market procurement.** As a result, cities have been looking for new ways to ensure innovation is built into the actual procurement process, as is explained in the following paragraphs.

In the procurement of SCC products and services (e.g. retrofitting of public sector buildings, smart energy grids, electric vehicle charging infrastructure, installation of heat networks, renewable energy generation), cities may essentially adopt two models: i) Traditional procurement, or ii) Public procurement of innovation (PPI).

Before carrying out one of these two traditional forms of procurement, cities may carry out a **preliminary market consultation**, whose aim is to gather information from the market and inform potential suppliers about future procurement opportunities.

Common trends across integrated SCC solutions

A categorisation has been made dividing the different procurement models adopted by the case studies analysed into eight major clusters, namely: i) Preliminary market consultation; ii) Pre-commercial procurement; iii) Competitive dialogue; iv) Competitive procedure with negotiation; v) Innovation partnership; vi) Open procedure; vii) Restricted procedure; viii) No procurement.[16]

[16] This may be for a variety of reasons, including the fact that the consortium includes players able to provide components or expertise, which therefore did not need to be acquired from the market. It might also be due to the fact that some SCC solutions are privately owned, and therefore do not require public procurement.

The majority of the SCC solution examples analysed through this study (72%)[17] report that PPI procedures were relevant for their solution. Within the three major domains – from a technological-prevalence point of view – of SCC projects (i.e. Sustainable Districts and Built Environment, Sustainable Urban Mobility, and Integrated Infrastructure), **a particularly popular model appears to be the innovation partnership for Integrated Infrastructure.** The Sustainable Districts and Built Environment[18] as well as the Sustainable Urban Mobility domains are characterized by a similar distribution of procurement models.

It is worth noting that none of the solutions analyzed use the restricted procedure, and that most of the solutions that do not use public procurement are in the domain of Integrated Infrastructure. In the Sustainable Districts & Built Environment and the Sustainable Urban Mobility domains, it seems that most solutions were purchased using PPI approaches.

Also notable is the fact that PPI adoption was reported in 61% of cases, whereas traditional forms of procurement were employed in only 10% of cases. Indeed, 23% of respondents reported that they did not use it. As illustrated in the figure below, this phenomenon is substantiated by the **innovation partnership model representing the largest share of procurement models adopted** in the case studies. Coherently with this, preliminary market consultations, competitive procedures, negotiations and competitive dialogue follow in terms of market share.

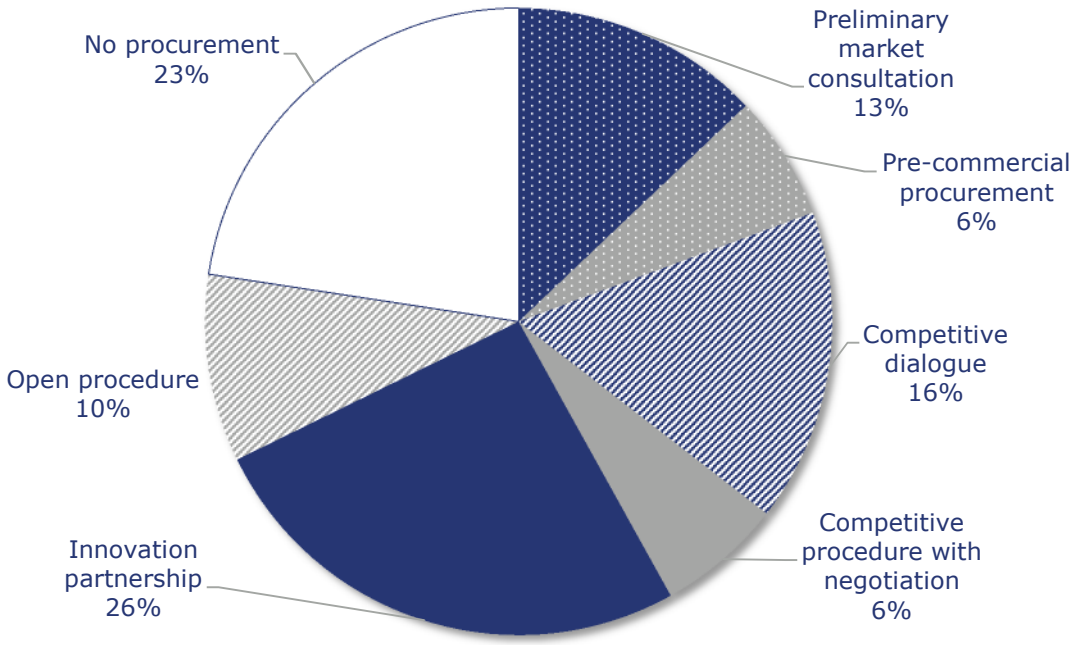
Besides market consultation – which is not a "pure" procurement method, given that it aims to gather information from the market with a view to later procurement – all others are innovative procurement models, particularly suited to SCC solutions. Their extensive use (according to these statistics) means that, when a public authority sought a SCC solution, it felt "sufficiently" uncertain (e.g. legal and financial set-up of the contractual relationship with the supplier) even after a market consultation.

Such models, although more slowly implemented, especially if the authority is using them for the first time or does not have adequate capacity, have the clear advantage that they allow **greater interaction with the market** in order to refine requirements and award a contract, compared to open or restricted procedures.

[17] This percentage is calculated as the number of cases that used the PPI models (i.e. PCP, competitive dialogue, competitive procedure with negotiation, and innovation partnership), over the total number of cases that used procurement.

[18] This includes projects that involve intervening on the existing building stock with the aim of improving energy efficiency, generating low carbon energy, modernizing infrastructure and creating high quality living environments. Interventions to find energy efficient, low carbon solutions for new buildings and districts are also included.

Figure 11: Procurement models adopted by SCC solutions



Source: Our elaboration

With regards to the innovation partnership model, **innovation platforms** (also called participation platforms) are of particular interest: public authorities are increasingly adopting these tools to facilitate their procurement procedures. The example case presented in the box on the following page shows the use of an innovation platform in the city of **Copenhagen.**

The use of an innovation platform in Copenhagen, Denmark

By 2025, Copenhagen's ambition is to become carbon neutral. With this aim in mind, in October 2013 the Copenhagen Cleantech Cluster and the City of Copenhagen established a strategic partnership to explore new methods for using public procurement. The result of this was the setting up of a platform where companies could meet and get to know each other, and where they could apply their specific knowledge and skills to create solutions together.

The project was based on a **Public-Private Innovation,** a model that can be divided into several phases:

- **Identifying and prioritizing challenges**: The public authority identified and prioritizes challenges.
  In this case, Copenhagen's ambition to become a SC was set as the grand challenge.
- **From grand challenge to specific problems:** The public authority collects information about the challenge, as well as ideas on how it might be solved.
  In Copenhagen, experts, entrepreneurs and other stakeholders were invited to help to understand the grand challenge in more detail, and break it down into more specific problem areas. The first finding was that citizen engagement and data availability were the most important issues, thereby making it possible to give the platform a better focus.
- **Innovation teams:** Partners and stakeholders with the competencies to contribute to solving this more specific challenge are identified, and possible solutions and barriers are explored in greater detail.
  The topics addressed in Copenhagen included data availability, open versus closed standards, business models for establishing a digital infrastructure, waste management, water management, transportation, energy consumption, etc.
- **Procurement and implementation:** Based on the information collected, the next step is to issue a tender for a new solution. The identity of the procurer is not given; it might be a public authority, or an association with public sector backing.
  In the case of Copenhagen, a test case was developed in the area of traffic. The city wishes to reduce CO_2 emissions produced from traffic generated by looking for available parking spots.

As previously mentioned, not only the innovation partnership but also the **competitive procedures with negotiation and the competitive dialogue[19] are flexible procedures used in complex projects** where there is a need for the contracting authority to discuss all aspects of the proposed contract with potential suppliers.

These models allow for **discussion with suppliers and innovators during the tendering procedure, enabling them to develop a solution based on a better understanding of the exact needs of the authority**. Generally, these approaches provide structured tendering processes with more flexibility to develop innovative solutions, allowing for a constructive dialogue between suppliers and contracting authorities. However, **the process requires skilful management:** as it often takes longer than other processes, making it extremely **resource-intensive**, as a dedicated project team will need to meet regularly and for extended periods of time. Moreover, the process of constantly refining the proposals during the dialogue phase requires considerable investment for the economic operators concerned. Accordingly, it is

[19] The only difference between these two is that the competitive procedure, unlike the competitive dialogue, requires that the authority can specify the required characteristics of the goods or services prior to the competition.

advisable to foresee an adequate reimbursement for the economic operators participating, through, for instance, stipulating in the contract the conditions of payment or prices for the participants at the dialogue. The example below provides some insights on how the **competitive dialogue** was carried out in the case study of the city of **Barcelona.**

The competitive dialogue procedure adopted in Barcelona, Spain

Given the lack of similar products in the market, the city of Barcelona decided to adopt the competitive dialogue procedure in order to obtain the most appropriate **City OS Urban platform,** a type of ICT architecture that provides a transversal service that interconnects the entire city. Barcelona adopted this model to innovate and develop the requirements for this system jointly with companies. The competitive dialogue procedure was carried out in stages:

- The process began in April 2013 and 23 enterprises applied; some presented themselves individually and others formed Joint Temporary Ventures. This process continued with the final selection of 13 candidates.
- During the next stage, the procurement body evaluated the documents received from the various bidders and invited a maximum of six candidates – the ones with the highest scores – to take part in a dialogue stage.
- This was followed by the opening of the development stage, an interaction with candidates to determine and establish the most suitable solution or solutions to meet the needs of the procurement body.
- Once these stages were completed, the procurement body called on the candidates to submit their final tenders, based on the specific solution or solutions presented during the dialogue stage. The candidates presented their tenders, which were evaluated under the initially established contract-awarding criteria, ending with the proposed contract award in April 2015.

Pre-commercial procurement is designed to steer the development of solutions towards concrete public sector needs. In order to do so, PCP occurs through a number of phases that focus on R&D activities, and it involves different suppliers competing through different phases of development. In spite of the fact that, among the SCC solutions analysed through this study, PCP was not used as much as the other PPI models, on the basis of a literature review, it appears that it is one of the models increasingly adopted by municipal authorities when procuring SCC solutions. As a result, **PCP has now become quite a popular procurement tool, although the process that needs to be followed by public procurers is not so simple.**

Examples EU-funded FP7 projects fostering PCP

ENIGMA is a FP7 project that aims to implement a joint transnational PCP procedure in the field of public lighting. Coordinated by the city of Eindhoven, the project's partner municipalities cooperate on procuring innovation and testing in a real life environment the technologies that their commercial subcontractors develop. Through a learning platform, ENIGMA encourages city-to-city learning and exchanges on PCP methodologies and public lighting innovation. Other interesting examples include: **P4ITS** (a network focusing on developing PCP solutions for innovative ITS and services); **Smart@Fire** (procurement of innovative fire fighting equipment, aimed at reducing risks and better handling city emergencies); **V-CON** (procurement of a virtual modelling road infrastructure solution).

PCP is applied when market consultation activities indicate that there is currently no solution to the city needs. Since R&D services for new technologically demanding solutions, such as those for SCC solutions, require considerable funding, **PCP necessarily requires collaboration with authorities and bundling of demand.**

A clear advantage of such a model is that, by leaving a clear separation between the pre-commercial R&D phase and the roll-out of commercial end-products resulting from the R&D, it enables public purchasers to filter out technological R&D risks before committing to procuring a full-blown innovative solution for large-scale commercial roll-outs. Importantly, any follow-up procurement of commercial volumes of end-products most likely requires a **competitive tendering procedure** in accordance with the EU Procurement Directives. The **Klimastrasse** case illustrates how PCP was carried out outside the FP7 framework.

PCP outside the FP7 framework - Klimastrasse, Cologne, Germany

The Klimastrasse project focuses on the development of sustainable streets and neighbourhoods and it concentrates on several areas, including: optimized building insulation, renewable energy, innovative use of electricity, intelligent energy management, etc.

The project procurement was conceived as a PCP. The key market consultation instrument was held in September 2012, in the form of a workshop with regional industry and local companies. The project co-ordinator RheinEnergie drafted an invitation list out of a "business directory" with Cologne and long-time RheinEnergie partners in other projects (e.g. Bayer, Siemens, Alstom).

However, not all cases adopt PPI models. The example below illustrates how a traditional procurement model was adopted for the development of the **Valencia SC Platform.** Based on the exchange with stakeholders, it appears that **the traditional model is best when the will of the city's authority as well as the objectives of the SCC solution are clear since the very beginning.**

The open tender procedure adopted for the Valencia SC Platform

The Valencia SC Platform (VLCi Platform) enables the city to centralize information on municipal services thanks to the use of a technological solution. The Platform compiles key indicators of city management and urban services and it aims to improve and rationalize the governance model and encourage greater participation by civil society, organizations and companies in municipal service provision.

In November 2013, the ICT Service of Valencia City Council opened a public tender for the development of an **integrated City Platform.** Out of the seven companies that presented their proposal, Telefonica I+D obtained the best score in the evaluation process and in July 2014, it won the public tender. Given the requirements of the tender, which envisaged an "open" platform based on recognised standards, **the winning proposal was based on the European open standard Fi-Ware.**

A 4-year contract was established for the development of the platform with a budget amounting to c. € 4.8 million. The contract also defined **the obligation of the private company to transfer the technological solutions to municipal staff according to a training plan approved by the Municipality.**

2.2.4. Involving citizens and communities to create sustainable SCCs

Citizens, businesses and communities play a central role in the development and sustainable implementation of integrated SCC solutions. The literature agrees on the benefits of participatory and engagement approaches to city design, but research shows that there is a **lack of consistency** in how the role of citizens, business and communities is perceived by stakeholders.

Citizens

In the context of this study we have chosen to interpret "citizens" widely, to include local business partners and the role of communities.

Generally, in **most of the successful SCC solutions analysed, it is claimed that participation from the citizenry should increase,** as citizen participation and engagement are key to ensure the development of sustainable solutions and business models. **However, evidence shows that the actual approach is to have only piece-meal involvement of citizens and communities**.

This study has investigated a variety of methods used to engage citizens, local businesses and local communities during the key stages of project design and implementation for integrated SCC solutions. These are:

- **Co-developing city solutions:** Giving citizens a voice in local matters;
- **Crowdsourcing the city:** Citizen-led issue reporting, data crowdsourcing, crowd-funding;
- **Co-designing tomorrow's cities:** The role of the citizen in living labs, test-beds, demonstrators;
- **Community-driven SCC solutions:** Citizen-owned energy grids, grassroots community projects, sharing economy;
- **Smart neighbourhoods and districts:** Regeneration projects with the vision and design of smart districts;
- Ensuring inclusive innovation;
- **Outside-in innovation:** Tapping into collective community action.

These participatory and engagement approaches have been identified through a keyword clustering exercise across the 80 best practise examples of SCC solutions. The models of key approaches that describe the role of the citizen in more detail have either been derived from the sample of 80 best practice examples, or they have been identified through the literature review/desk research.

This mapping exercise lead to the identification of **methods used within the context of integrated SCC solutions** in the three main phases of deployment: (I) the design and development phase; (II) the implementation and management phase; and (III) the roll out phase (see Table 4 below).

Table 4: Examples of methods used to engage citizens, businesses and communities in integrated Smart City solutions

	(A) Design & Development Phase		(B) Implementation & Management		(C) Roll out phase	
	Methods	**Examples**	**Methods**	**Examples**	**Methods**	**Examples**
(I) Providing insight, information & resources	Design-thinking & user-led research; crowd-sourcing; civic crowdfunding; participatory planning	Integrated bus management system, San Sebastian, Spain; App-based reporting of issues, Citizens Connect, Boston, USA	Customer insight and action research; data analytics and solutions; awareness raising, promotion and education	Real-time 2-way communication for traffic and emergency management, Rio, Brazil	Crowd-sourcing; city level data analytics; awareness raising, promotion and education	Impact data to help change behaviour gathered around multiple cities, Urban Ecomap, San Francisco, USA
(II) Co-design, co-creation, collaborative problem solving	Design-thinking approaches applied in pilots and demonstrations; Living labs; participatory planning & policy making	Early user inclusion in master planning, Barangaroo District, Sydney, Australia	Dynamic master planning; co-creation of services; civic technologies; open data	Co-creation of public services, Santander City Brain, Urban Platform, Santander, Spain; Establishment of open data community groups & events, Hong Kong	Incubation and acceleration techniques; Public sector research laboratories; city collaborations	Mindlab, Copenhagen, Denmark; European city network projects
(III) Collaborative governance; open innovation; Joint decision-making	Crowdsourcing of ideas; participatory budgeting; Civic crowd funding	Common goal-setting of the fossil free Växjö programme, Växjö, Sweden;	Multi-sided business models; multi-stakeholder partnership models (PPPPs); representation of citizens on local boards	Co-ownership & governance of renewable energy plant; Vienna, Austria	Holistic Smart City vision; representation of citizens on national boards; city collaboration; cross-border Smart City services	Stakeholder Advisory Committee (SAC), Waterfront, Toronto, Canada; Permanent consultation in Lyon Smart Community, Lyon, France

	(A) Design & Development Phase		(B) Implementation & Management		(C) Roll out phase	
	Methods	**Examples**	**Methods**	**Examples**	**Methods**	**Examples**
(IV) Collective action; social innovation	Idea camps; Community-based solutions	Open Glasgow (Hackathons, mobile engagement hubs, community mapping), Future City, Glasgow, Scotland	Nudging methods	Peer benchmarking and proactive advice on how to be more energy efficient, Issy Grid, Issy-les-Moulineaux, France; Fare saver to encourage walking, Octopus Card, Hong Kong	Impact investing; shared Smart City manifesto; support & investment in independent community solutions	Contests aimed at specific communities such as minorities & women owned businesses, Fiber Optics Smart Grid, Chattanooga, Tennessee, USA

Source: Our elaboration

The above-mentioned **key approaches to citizen engagement** and evidence of their application across the SCC solution best practise examples are outlined below.

Co-developing city solutions: Giving the citizens a voice in local matters

Technological innovations allow for new and diverse forms of participation and the co-development of city solutions. Of particular relevance are those applications that provide new ways of collecting data, gathering feedback, democratizing decision-making and creating built-in sustainability of solutions by creating community ownership. Examples include city idea banks, participatory budgeting, a gaming based methodology to engage citizens in designing new city solutions and ICT enabled deliberation in the context of climate change.

Citizens being involved as active participants in the planning phase

In the case of the **Barangaroo District Renewal Project - Sydney**, the final design was the result of early user inclusion and community consultations to shape the master planning of the area, carried out mainly through stakeholder forums (meetings), an online forum, and a qualitative and quantitative interview-based consultation of over 2,000 people.

Crowdsourcing the city

Crowdsourcing is an umbrella term for a broad range of activities. Crowdsourcing takes place when the public (as opposed to experts, for instance) provide information or means. Examples include citizen-led issue reporting, data crowdsourcing, and crowdfunding. Most intelligent transport solutions, city platform solutions and smart energy solutions include aspects of crowdsourcing data in different ways. The approach to crowdsourcing, however, remains explorative at the moment, as one of the challenges is to ensure that the information collected is reliable and accurate, and that data privacy and security are respected

Getting connected with the city

Recent years have seen a proliferation of online platforms in cities that provide a simple, low-cost way for large groups of citizens to contribute data on their experiences. This enables citizen-lead issue reporting and/or the contribution of citizen data.

For example, in the civic sphere, **FixMyStreet** invites users to report potholes, broken street lights and other issues encountered in their neighbourhood. The app **Citizens Connect - Boston**, gives citizens the opportunity to report problems and issues via their smart phones. The City's work order management system then redirects the message to the person in the city who is supposed to deal with the problem. The German platform **Wheelmap** asks citizens to contribute data on the wheelchair accessibility of public locations such as cafes and restaurants in their city.

Co-designing tomorrow's cities: The role of the citizen in living labs, test-beds and demonstrators

City centres and neighbourhoods increasingly exhibit a number of district level innovation spaces such as large-scale demonstrators, living labs or smart streets, which are ideal platforms to explore the needs of users as residents and citizens. In

theory, these district level innovation spaces operate as intermediaries among cities, regions, firms, the third sector and research organisations, as well as citizens, for joint value co-creation, and rapid prototyping or validation to scale up and speed up innovation and businesses. However, evidence across the best practice examples collected in this study shows that there is generally no co-ordination between experimentation projects, and hardly any systematic reporting on added value reached through citizen engagement across experimentation projects. This means that there is a lack of any resulting principles, rules, standards and guidelines that other cities may benefit from.

Community-driven SCC solutions

Community-driven innovation in cities can have many facets. It can be innovation owned and driven by a community, aimed at a community and more recently has enabled new business models based on community platform applications supported by mobile technologies such as sharing economy services and solutions. Examples include: citizen owned energy grids, grass root community projects, sharing economy.

Community-based business models as part of the Sharing Economy

The sharing economy is also commonly referred to as collaborative consumption, the collaborative economy, or the peer-to-peer economy. This term refers to business models that enable providers and consumers to share resources and services, from housing to vehicles and more. These business models typically take the form of an online and/or application-based platform for business transactions. Cities play a central role in deciding which sharing economy practices are adopted and which are rejected. A feature of many of the best practices reviewed is the emergence of sharing economy business models as an integral part of the integrated SCC solution. For instance, **Lyon Smart Community – France**, launched a car sharing service integrated in a wider Smart City solution. Most major cities also have ride sharing and bike sharing services either as private services or

Smart neighbourhoods and districts

A common feature in Smart Cities is brown-field development – a re-development of an often former industrial estate for mixed use. These are often regeneration projects – for instance harbour redevelopments that come with the vision and design of smart districts and thus become an important feature (and driver) of the Smart City they are part of. Examples include: industrial zones, mixed use redevelopment sites, eco districts. Districts and neighbourhoods can be seen as strong drivers of Smart City ambitions and the development of solutions that then can be rolled out across the entire city or region. The best practise examples show that this level is very effective at delivering integrated solutions, and that efforts already exits to enable better knowledge sharing between districts and neighbourhoods.

Ensuring inclusive innovation

In simple terms, inclusive innovation is the means by which new goods and services are developed for and/or by those who have been excluded from the development mainstream; particularly the billions living on lowest incomes. In the context of integrated Smart City and community solutions this means the city's role and ambition

to make the future city inclusive for all, including the elderly, the marginalized and particularly the poor and unemployed. Examples include energy efficiency pilots in social housing. Whilst the social model is a clear added value for European integrated SCC solutions, evidence suggests that this is a difficult target group to work with, and that research shows mixed outcomes for the adoption of SCC integrated solutions and for the implied support of changing behaviour towards zero emissions.

Inclusive innovation as a driver for SCC integrated solutions

Examples from the best practice cases with elements of social innovation include the **3e-Houses** solution in **Bristol – UK,** which brought ICT-enabled energy efficiency measures in the context of social housing, providing real-time monitoring and management of energy consumption, integration of renewable energies, and creating awareness for lower energy consumption. Likewise, one of the four pillars of the **Smart Community project, Lyon – France** focuses on energy consumption monitoring on a micro level through the instalment of energy monitoring systems in social housing, as well as actions aimed at raising awareness and promoting behavioural change of the inhabitants.

Outside-in innovation - tapping into collective community action

Outside-in innovation is innovation brought into the city by actors other than the city administration (and budgets) themselves. This could be community-lead innovation, or private sector-lead innovation. In particular, the opening up of databases and public sector data in recent years has enabled many more people and actors to access data, combine it with other sources and present it in interesting ways that can reveal new perspectives. Mapped examples include Urban Ecomaps, as well as Open city platforms. Data presents a new way of combining information across silos in city structures, and can include data collected in and around the city too. This seems to be a starting point for service innovation across established actors, SMEs, start-ups and communities to develop integrated solutions for Smart Cities.

Collected empirical evidence has showed that the significance of co-developing SCC solutions lies both in incorporating preferences and local specificities, and in achieving "buy-in" if not "co-ownership" by the key target constituents. **Despite the potential of co-designing approaches, only very few SCC best practice examples show an explicit usage of co-developing approaches,** both at the level of desk researched best practices and at the level of case study research. This indicates that the potential for co-development and the active inclusion of citizens in the planning and development phase of integrated solutions could be further explored.

2.3. Learning from failure: Key reasons why SCC solutions have failed

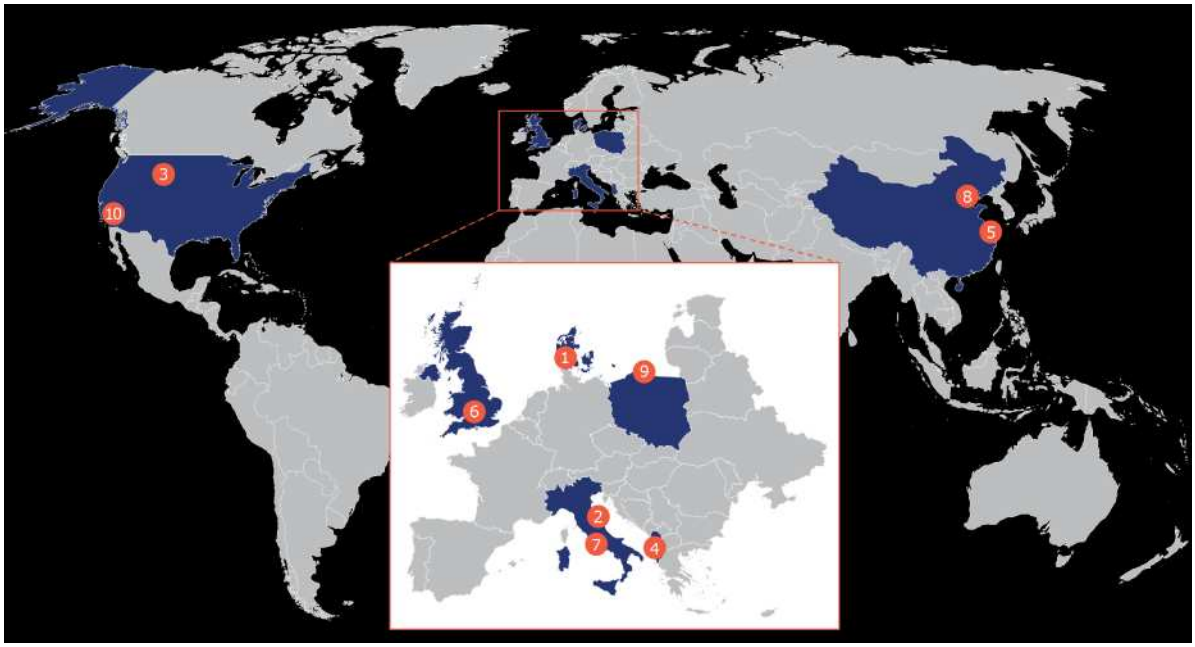
The previous sub-sections presented the analysis of how innovative technologies reshaped the approach to urban infrastructure investments in terms of governance, funding and financing opportunities, procurement models and involvement of actors. This assessment was based on success stories but, as can be expected, this is not always the case. The following pages look at how technology is an enabler for new models but does not implies success *per se*. As demonstrated through case study analysis and as supported by the literature, **cases of failure can often be tracked**

back to a lack of attention to the needs of users, which is independent from the technological development of solutions.

As reported by several academics, SCC projects are not necessarily developed to succeed in the same way a business project would.[20] Therefore, their failure is to be determined differently as well. To solve the impasse of defining the criteria for projects to be considered as failed, it was deemed most appropriate to involve stakeholders, both through dedicated questions within a web-based survey and by asking for their opinion during a workshop held in Berlin. In addition to this, the identified cases had to comply with the scope of the analysis and had to be SCC solutions that failed to integrate at least two out of the following sectors: Energy, ICT and Mobility and Transport.

Each of the ten cases of failures assessed (and shown in Figure 12 below) represents an example of SCC solution that integrates in a different way with the context and environment (technological, political-institutional, socio-economic/cultural, management).

Figure 12: The ten selected examples of SCC solutions presenting elements of failure



1. **Copenhagen, DK**
   Better place
2. **Bologna, IT**
   Automatic detection of motorbikes
3. **Boulder, US**
   The smart grids
4. **Tirana, AL**
   The new Urban Regulatory Plan
5. **Suzhou, CN**
   The innovative industrial park
6. **Bracknell, GB**
   The roll-out of smart meters
7. **Rome, IT**
   Electric bus network
8. **Tianjin, CN**
   The eco-city
9. **Hel Peninsula, PL**
   The smart grid pilot
10. **Bakersfield, US**
    The smart meters

More specifically, the analysis looks at the conditions and elements that caused failures to occur in these cases. Empirical findings, confirmed also by the literature review, have shown that SCC solutions often focus principally on the ICT dimension, which is designed around innovative technologies, rather than adapting these to the

[20] Stimmel C. L., 2016, *Building Smart Cities. Analytics, ICT, and Design Thinking.* CRC press. Taylor & Francis Group. New York, U.S.

social and cultural dimensions. **Designing solutions starting from the citizenry is possibly the most relevant lesson that can be learnt from past experiences.**

The analysis of cases reported that SCC solutions often fail because they are conceived and planned based on the available technology and on simplified user behaviour. Indeed, cases of failure demonstrate the limits of such an approach. All examples of failure that have been identified are characterised by a limited inclusion of the cultural dimension within the focus of the SCC solution.

In a few cases, issues have been encountered in the selection and use of the technology. In particular, this is the case of the *Better place* (Copenhagen) project, where lack of standardization in several components of the electric vehicle chain (plug and roaming standards, batteries, etc) contributed to the failure of the solution. However, this cannot be considered as a purely technology-related issue, but rather as a case where a failure in integrating existing and well-established technology occurred due to a **lack of appropriate planning.**

Furthermore, the solution was characterised by a **lack of motivation from the citizenry,** which limited its spread. It thus ended up into an overly narrow project that, once political support stopped providing resources, was not backed by any real intention on the part of users to support it.

Several other projects focused on achieving a quasi-utopian long-term vision with limited consideration on the need to involve the citizenry in defining it. This is the case of most projects, such as the electric bus network in Rome, or the smart grid in Boulder. The lack of attention to actual citizenry needs was most perceived where the involvement of the users in the SCC solution was most required. This is the case of new cities being developed as the cases of Tianjin and the Suzhou Industrial Park, which failed to attract their final users.

Key findings:
Lessons learnt on failure of SCC integrated solutions

The joint analysis of the case studies, the literature and the opinions of stakeholders made it possible to identify certain commonalities that unsuccessful integrating SCC solutions shared. These are related to two main dimensions:

- **Inability of solutions to integrate with the urban dimensions** that their success depend on. In particular, this risky element has been recognised when designing and developing solutions without the sufficient involvement of the citizenry and – in several cases – of the political-institutional authorities. This involvement has rarely been constant throughout the project duration; most often it has been focused on the initial phases only.
- Despite a strong vision on how SCC solutions had to evolve and integrate with the urban environment in the long-term, a common **inability to translate the long-term orientation into a coherent action plan** strongly contributed to limit the chances of success of the cases analysed.

The technological dimension was hardly an issue at all.

What is seen when dealing with social phenomena like cities (whether or not they are "smart") is necessarily impacted by them being complex phenomena. As such, they consist of many autonomous, diverse components that are highly interconnected and interdependent. Not understanding the importance of this interdependence has been the reason that ultimately lead the analysed SCC solutions to fail.

The underestimation of the role of interconnections is typical of the traditional approach to analysing complex phenomena: this entails breaking down the object of the analysis into its smallest components and focusing on each of them, as if they were separate entities. Whether or not it happens voluntarily, this approach has led planners and investors to focus on one specific aspect of the analysed SCC solutions (usually the technology) and **neglect the interrelations that the users of this technology have in creating a functioning system** (at single user level and – to a lesser extent – at community level).

Conversely, this analysis suggests following **a holistic approach to defining the complex phenomena** (i.e. the SCC solutions), and therefore starting from the idea that the success necessarily comes from integrating technology, institutions and, most of all, final users. Indeed, final users are those who have the strongest interconnections with the technology deployed and with the system in general.

While it is key to consider that the interaction with the technology necessarily needs to account for the role played by users, it is at least as important to consider the centrality of the citizenry when conceiving and planning integrated SCC solutions**.**

Cities develop as social entities, which generate an order within which citizens live and carry out their activities. **Changes in the stability that citizens accept and belong to must be supported by the population.** Otherwise, they will be neglected, abandoned or even fought against. Citizens accept the change – or even call for it – when they feel they require a different allocation of resources, a different organisation or set of rules, or when they feel that their needs are unsatisfied. However, in the case of smart cities, this is seldom the case.

In particular, the cases of cities being built ex-novo appear far from being solutions to respond to the needs of citizens for better conditions, organisations, etc. These perfect cities may not be responding to the needs of the people that should live in them, but rather to abstract concepts of what people should need. Eventually, they fail.

Key findings:
Possible approaches to avoid the failure of SCC solutions

- **Simulations:** These can be especially useful to determine how the system reacts to the different stimuli produced by users' interaction. User interaction with the technology is a necessary enabler of integrated SCC solutions. Coherently, the use of simulation models like agent-based models (ABSs) and individual-based models (IBMs) to account for the different scenarios depending on user behaviour can help to identify and prevent situations leading to failure.
- **User Experience (UX):** Also in relation to the central role of humans in SCC systems, UX enables the assessment of what citizens need and what they experience when dealing with any specific SCC solution. As they would determine its success or failure, understanding how and if their needs are (over-) satisfied or neglected by solutions is essential.
- **Round-tables:** By definition, integrated SCC solutions involve different aspects of the urban dimension, which are to be carefully planned and accounted for by experts. What appears to be often lacking is the inclusion of experts such as urban planners, sociologists, transport experts, psychologists and ICT engineers, at least in the planning phase, when identifying the main risks and success factors.

3. Analysis of the potential roll out of integrated SCC solutions

When looking at Europe's urban innovation strategies and initiatives (which Smart Cities and Communities are a large share of), what emerges is the need to invest in solutions that can be implemented at a wide enough scale for them to have a positive effect on citizens. For SCC solutions to achieve this result, they must upgrade from local, pilot experiments and become large, highly replicated projects.

The search for innovative SCC solutions evolving into full-scale projects has become a hot topic both in Europe[21] and overseas.[22] Indeed, this a natural consequence of the significant investments that have been made to constantly develop new projects (which are at an R&D and demonstration stage) and to support their transition into a full deployment phase.

To provide a comprehensive picture on the subject, this section will:

- Report on the outcome of the analysis on replicating and scaling integrated SCC solutions;
- Carry out a macro-level analysis of the the roll-out potential for SCC solutions, with a specific focus on the case of China and its potential partnership opportunities with the EU.

3.1 Replicability and scalability of integrated SCC solutions

3.1.1. Dimensions and definitions

The academic world generally agrees that the roll-out of innovative solutions – no matter how they are defined, as long as they are differentiated from traditional ones – needs to comply with two requirements: scalability and replicability:[23] [24] [25] [26]

- **Scalability** refers to the possibility of increasing the size of a project without compromising its efficiency and effectiveness. Scalability is the characteristic that projects must have to evolve from experiments to full-scale urban projects.
- **Replicability** refers to the possibility of applying the same solution/technology to achieve the same objective in a different city. Replicability may be in terms of both scale (i.e. the extent to which a solution can adapt to the different configurations of the environment) or a specific case (i.e. whether the solution can be replicated in a specific, different context).

[21] Jiménez, M.S.; Onyeji, I.; Colta, A.; Papaioannou, I.; Mengolini, A.; Alecu, C.; Maschio, I. 2012. *Smart Grid Projects in Europe: Lessons Learned and Current Developments*; Publications Office: Luxembourg, Luxembourg

[22] U.S. Department of Energy. 2012. *Leading the Nation in Clean Energy Deployment;* U.S. Department of Energy: Washington, DC, USA

[23] Food and Agriculture Organisation of the United Nations 2014 Evidence-based assessment of the sustainability and replicability of integrated food-energy systems, FAO Rome 2014.

[24] Yaneer Bar-Yam, 2011 *Conepts: Scale* New England Complex System Institute

[25] Sridhar P. and Madni A. M. 2009 Scalability and Performance Issues in Deeply Embedded Sensors Systems *International Journal on Smart Sensing and Intelligent Systems,* vol. 2, n.1, March 2009.

[26] May K. *et al.*2015 Improving Scalability and Replicability of Smart Grid Projects *23rd International Conference on Electricity Distribution*

There is no single way to address SCC solutions' scalability and replicability. However, academics seem to agree on four main dimensions shaping the roll-out potential of solutions: **the technology dimension; the political dimension; the social/cultural dimension and the economic dimension.**[27] These can be assessed depending on whether – from a project management perspective – these depend on endogenous factors, exogenous factors or something in between.

There are various elements impacting scalability and replicabiliy. The main ones identified by experts and researchers in the field are listed in Table 5 below.

Table 5: Replicability and scalability indicators

Dimensions	Scalability	Replicability
Technology	▪ Modularity; ▪ Maturity of technology; ▪ Netting support;[28] ▪ Trialability;[29] ▪ Interface.	▪ Standardisation of the technology; ▪ Maturity of technology; ▪ Interoperability; ▪ Netting support.
Socio-cultural	▪ Social compatibility/ consent; ▪ Interaction.	▪ Social compatibility/ acceptance; ▪ Market demand/ Response to citizenry needs; ▪ IT Literacy level.
Political-Institutional	▪ Regulatory environment; ▪ Institutional support. ▪ Ecosystem	▪ Need to change in rules and regulations; ▪ Regulatory environment; ▪ Institutional support. ▪ Ecosystem
Economic/ Business	▪ Possibility to achieve economies of scale; ▪ Profitability.	▪ Macro-economic factors; ▪ Business model; ▪ Market design.

Source: Consortium elaboration of May et al. 2015, Jiménez et al. 2012, Bosch et al. 2016[30]*.*

[27] see e.g. May K. *et al.*2015 Improving Scalability and Replicability of Smart Grid Projects *23rd International Conference on Electricity Distribution*

[28] Throughout the document, with the term "netting support" it is meant the technological infrastructure and related actors, which support the functioning of a given technology.

[29] As defined by Bosh et al in the CITYkeys study, trialability refers to the possibility of a solution to be experimented on a small scale before being expanded to full scale, without compromising its key features.

[30] Bosh P., Jongeneel S., Rovers V. Neumann H., Airaksinen M. Huovila A. 2016 CITYkeys Deliverable 1.4 Smart-city KPIs and related methodology – final

Technology is hardly ever a limiting factor to the replication of a solution, as increasing globalisation creates homogeneity in terms of technological developments across countries.[31] What matters for the roll-out of SCC solutions is the presence (or absence) of support services, i.e. the set of ancillary technologies, agents, systems, etc. that allow a certain technology to function in a given environment.

As is also outlined in sub-section 2.2.4, **the socio-cultural dimension reflects the fact that projects must be accepted by the population.** To the extent the interaction with citizens and communities is required, SCC solutions have to respond to the population's needs. Paying only limited attention to the socio-cultural differences across countries, cities and districts prevents the successful replication of solutions. This becomes even more relevant when citizens become involved in projects and/or strategies.[32] [33] [34]

The political-institutional dimension refers to the regulatory environment and to the institutional support.[35] Where the regulatory environment is simple and does not represent a limiting factor, the project is more likely to scale up and to be replicated elsewhere. At the same time, the simpler the project, the less it is expected to interact with the political-institutional environment, therefore making it more adaptable.

Finally, **the economic/business dimension relates to how the solution is configured, shaped and developed from a project management perspective.** Therefore, it has an impact on its ability to easily scale up and to interact with different environments without compromising profitability.

The analysis of these dimensions also requires the examination of the interfaces between the solution and the environment, as well as of the internal ability of the solution to adapt to a different size and/or context. As a result, it can be assumed that **the higher the complexity of a project, the higher the required interactions at technological, political-institutional, socio-cultural and economic level.** This relates to both agents that participate in a solution and those that interact with it (i.e. administrators, politicians, citizenry, etc).

As agents interact, they gradually achieve agreement on the desired solutions. In this way, solutions are backed and aided by cooperation.

3.1.2. Analysis

Although the population's involvement shapes socio-cultural complexity, it should be analysed as a separate variable. Indeed, the involvement of the citizenry determines how relevant the socio-cultural dimension is. In other words, a solution that does not involve any action from the population (i.e. "fully automated solution") is more likely to not encounter any culture-related roll-out issue. However, integrated SCC solutions

[31] Archibugi D. and Pietrobelli C. 2003 The globalisation of technology and its implications for developing countries Windows of opportunity or further burden?; Technological Forecasting & Social Change 70 (2003) 861 – 883

[32] Hofstede, Geert: "The Cultural Relativity of Organizational Practices and Theories", Journal of International Business Studies, Fall 1983

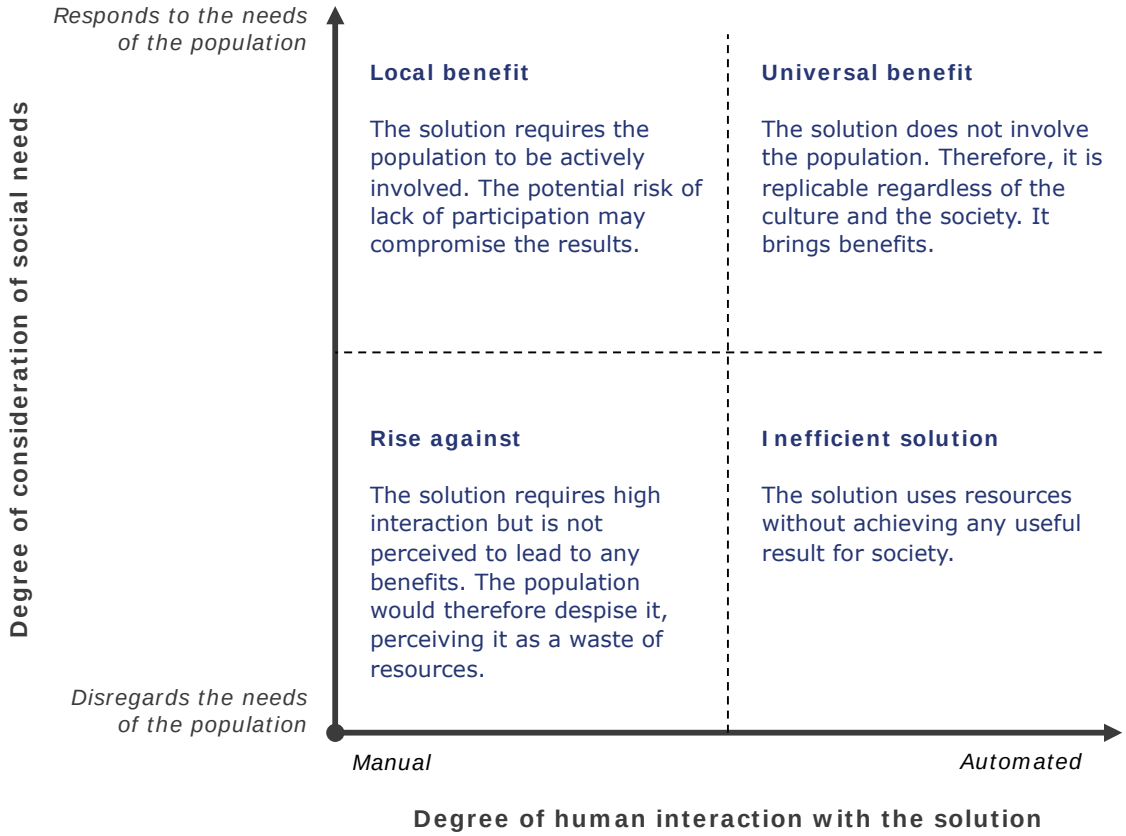
[33] Hofstede, Geert: "Cultural Constraints in Management Theories", Academy of Management Executives, 1993,Vol.7, no. 1

[34] Holden, Nigel: "Why Marketers Need a New Concept of Culture for the Global Knowledge Economy", International Marketing Review, 2004, 21, 6

[35] Please consider that the institutional support does not refer to the financial support provided with public resources, but to the administrative and regulatory support.

are hardly ever fully automated. **When the involvement of the population is required, the more this interaction is focused on shaping the solution's design and development, the higher the chance of replicability success.**

Figure 13: Matrix of user interaction versus response to population needs of solutions



Source: Our elaboration

While the socio-cultural dimension may represent a limiting factor when not sufficiently accounted for, it can also become an enabler in those cases where the interest of the society for SCC solutions is such that it defines a favourable ecosystem. This then requires the institutional-political dimension to follow, as the citizenry would require the political leadership to take concrete steps towards sustainability and smart solutions.

Considering the approach described, the assessment of the potential roll-out of a solution is determined by the criteria outlined in Table 6 below. For the sake of simplicity, roll-out potential is considered as an indicator of both scalability and replicability.

Table 6: Assessment criteria for roll-out potential

Dimension	Roll-out potential evaluation criteria
Technology	▪ Is the technology well-established? ▪ Is the technology standardized and/or interoperable with different IT systems? ▪ How big and complex is the netting support required to sustain the project from a technological perspective?
Socio-cultural	▪ How relevant is the involvement of the society for the solution to work? ▪ Is the solution responding to a pressing need (general perspective)? ▪ Would the solution require a radical change in the users' habit?
Political-institutional	▪ Is the project requiring strong political commitment to be developed (general perspective)? ▪ Would the administration need to be directly involved?
Economic/ Business	▪ Is the project able to achieve economies of scale if its size is increased? ▪ Can the project benefit economically from international implementation (e.g. standardization of technology/ equipment/ solutions, etc)? ▪ Is the business model flexible to changes?

It should be noted that responding to these criteria would not determine how a specific integrated SCC solution would succeed when rolled-out in a specific environment. Instead, this type of assessment would provide insight on how probable it is that the solution could be adapted to diversified environments.

To determine the roll-out potential in a specific environment, additional analysis on how a SCC solution relates with the specificities of the local culture, infrastructure and institutional context is required. An example of a toolkit that could be used for this is provided in Annex III.

So far, it has been recognised that the environment is key for the successful roll-out (and thus replicability) of integrated SCC solutions. Coherently, the role of agents active in making this environment more SCC-friendly can greatly support the solutions' roll-out. Indeed, in certain cases, industry, academia, institutional players, support organisations, etc, collaborate, creating an ecosystem[36] that facilitates the development of integrated SCC solutions. These ecosystems act as interfaces between the projects and the social/ political-institutional/ economic contexts, contributing to the creation of the right conditions for smart solutions to be successfully implemented, concentrating:

- **Financial resources:** Financiers (i.e. venture capitalists, etc), institutions granting subsidies, etc;
- **Human and technical resources:** A talent pool of knowledge professionals, universities and research institutes, etc;

[36] There is no unique definition of what an ecosystem is. Within this document the term is referred to the network of agents or hubs supporting the development and the operation of SCC solutions. The definition is hereby recalled from Bahrami and Evans, who describe it as "consisting of interdependent institutions, social norms, and communities that create an environment encouraging the evolution of existing firms and, especially, the creation of new firms".

- **A sophisticated service infrastructure,** which includes:
    - Administrative/ institutional entities;
    - Organisations and initiatives by both public and/or private entities;
- **Citizens and communities,** which represent the customers, lead-users, and early adopters of solutions/products.

The box below presents the case of **umbrella organisations,** which are strongly active in ensuring favourable ecosystems for SCC solutions to proliferate.

Organizations shaping favourable ecosystems

As opposed to more traditional businesses, the roll-out of SCC solutions generally requires a stronger commitment at public and private level and can benefit from the role played by a number of key actors acting as facilitators, enablers or supporting coordination bodies. In this context, the so-called **umbrella organisations and initiatives**[(a)] play an important role. Cooperation and collaboration – both internal and external – are key enablers for SCC solutions to be deployed successfully. In more general terms, these organizations enable:[(b)]

- **Organisational synergies,** which relate to collaboration among actors in the social, cultural and political dimensions, e.g. joint training programmes, knowledge sharing practices, as well as joint participation in higher coordination bodies.
- **Policy synergies,** which relate to collaboration among actors in the political-institutional dimension, e.g. joint membership to thematic groups/committees, promotion of country level goals, sharing of organisational strategies.
- **Operational synergies,** which relate to collaboration among actors in the economic/ business dimension, e.g. joint research activities, carrying out projects together to be more effective, co-organisation of relevant events, and collaboration in writing papers.

Overall, collaboration activities contribute to strengthening the institutional and operational foundations supporting the roll-out of SCC solutions.

To effectively achieve their aim, umbrella organisations and key SCC supporting actors must be **attractive** (in terms of the degree to which organisations are interesting for other entities in related businesses to enter into partnership with), and the entities within the environment must be **aware** of the organisations' existence and activities.[(c)] Figure 14 on the next page shows the results of the research on main SCC supporting actors in terms of level of cooperation, presented as a comparison between the attractiveness and awareness dimensions presented against the attractiveness and awareness dimension. According to the analysis carried out, organisations can be clustered into:

- **Most well-known and attractive organisations** (high awareness, high synergy attractiveness, many cooperation activities in place): This category groups actors recognised as the most well-known and attractive in terms of synergy potential (e.g. Eurocities, Iclei, Polis, Covenant of Mayors, EIP-SCC). They are most helpful in shaping the supporting environment of SCC solutions.
- **Organisations with good potential** (lower awareness, high synergy attractiveness): These organisations have been rated with good levels of synergy attractiveness, even though they are less well-known. Other actors who are aware of them appreciate their work and would like to cooperate with them (e.g. Concerto, Epomm, EIT).
- **Single player organisations** (lower awareness, lower synergy attractiveness): This cluster includes organisations that are less known, and which are regarded as slightly less attractive for creating partnerships. As depicted in Figure 14, there seems to be a direct correlation between the ability of organisations to support cooperation – and, ultimately, SCC roll-out – and the degree to which such organisations are known and attractive for stakeholders to partner with.

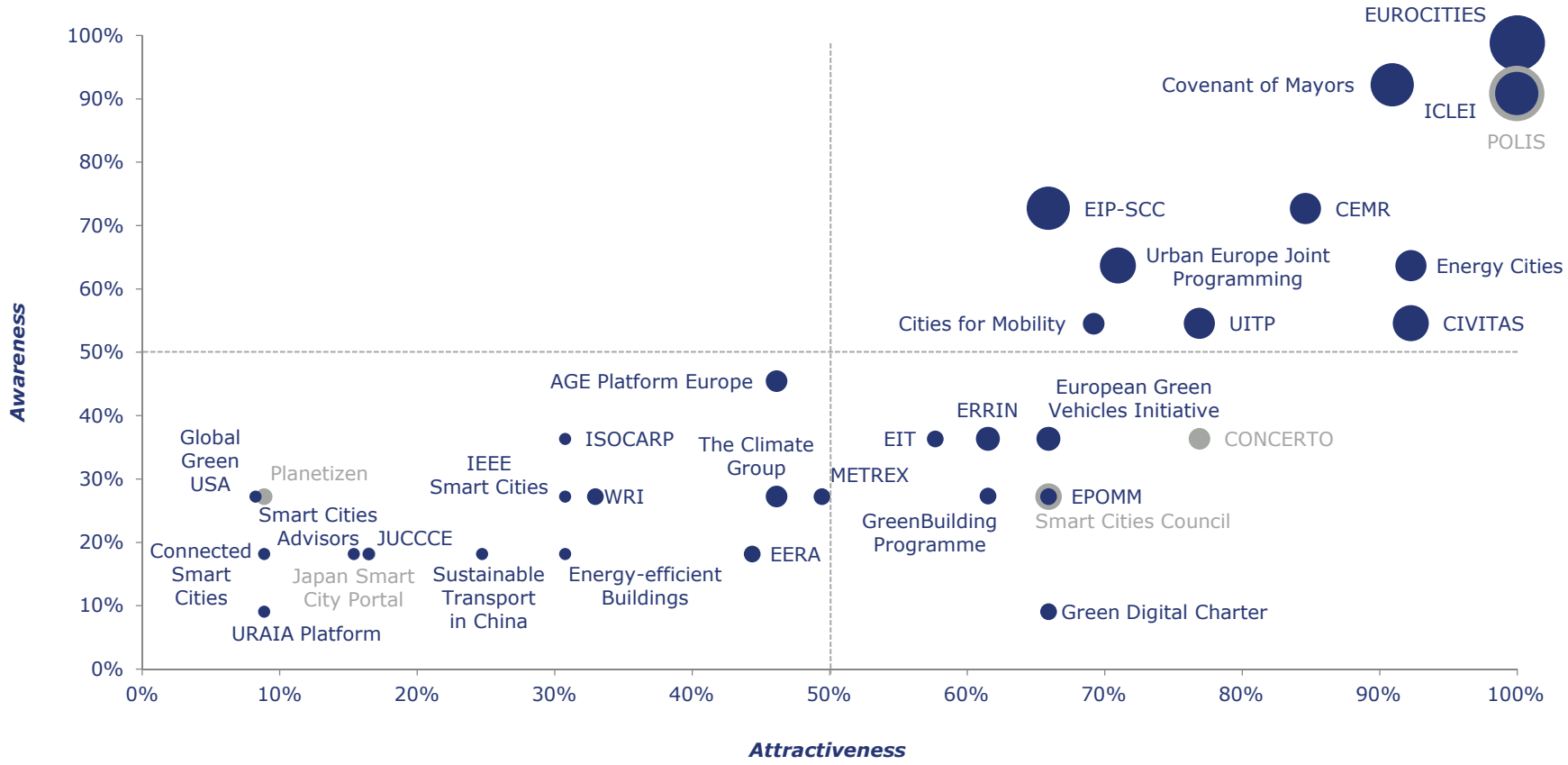
Coherently, SCC roll-out is expected to be most favoured where organisations increase communication efforts, and are characterised by a higher number of links with other organisations/ SCC players.

(a) The term "umbrella organisations" refers to associations of institutions, business players and – more generally – entities that work together to coordinate activities and pool resources.

(b) European Commission, Directorate-General for Regional and Urban policy REGIO DG 02 (2014). *Enabling synergies between European Structural and Investment Funds, Horizon 2020 and other research, innovation and competitiveness-related Union programmes.*

(c) Data on both of these variables was gathered based on the scores provided by the web survey respondents, who were asked to evaluate the level of awareness and potential collaboration in relation to the main organisations/initiatives analysed and listed in the questionnaire. All the scores have been harmonised on a scale from 0 to 100, in order to make organisations comparable.

Figure 14: Main actors' positioning with respect to their level of awareness and the potential for synergies



Source: Our elaboration based on survey results

Note:

The size of the bubbles represents the actual cooperation level, rated according by the respondents.
The sole purpose of the colours is to distinguish one organisation/initiative from the other.

3.1.3. Evidence of roll-out potential across case study examples of integrated SCC solutions

During the analysis of the 10 case studies, an assessment of how projects responded to each dimension was carried out, using the set of criteria listed in Table 6 above.

The analysis shows that **there is no single element that stands out above the others as an obstacle or an enabler to the roll-out of SCC solutions.** Rather, it is the joint action of different elements – categorised in different dimension – that limits or catalyses the ability of a project to be successfully implemented at a higher scale or in different contexts (see Annex II).

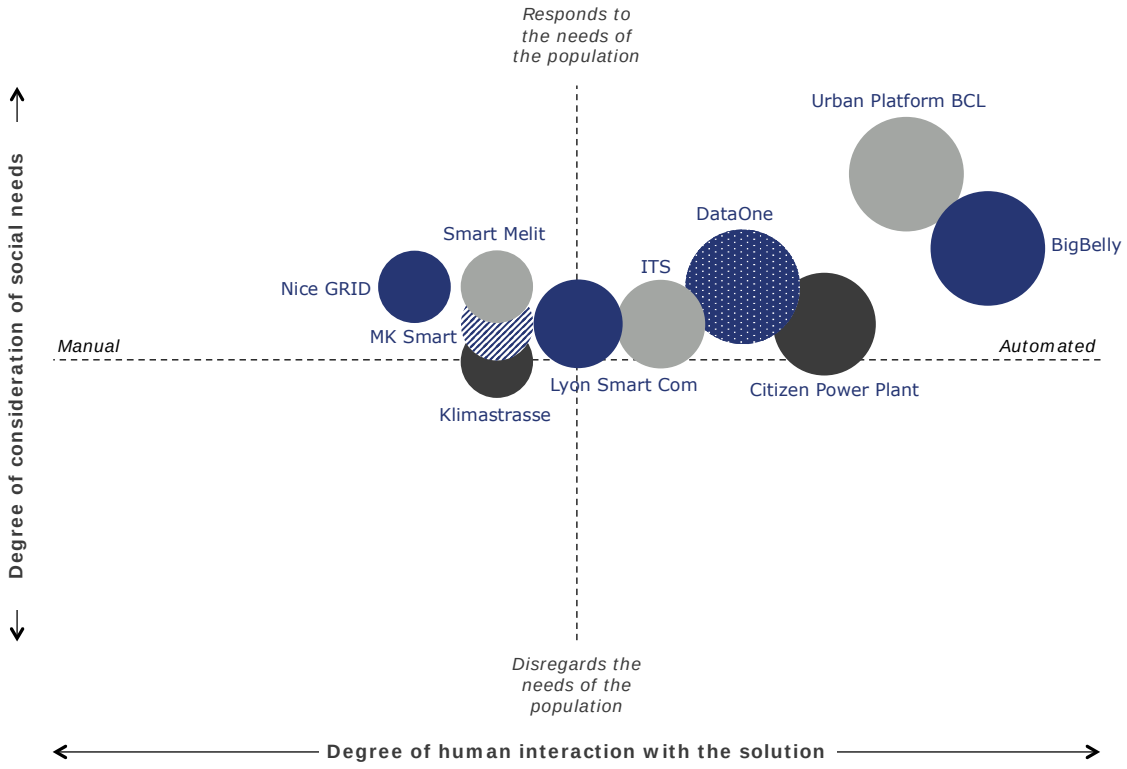
The analysis also shows that the presence of an ecosystem that can bring together political institutions, investors, industry players and – to the extent required –citizens, facilitates the implementation of projects that have been successful elsewhere.

A key element that is also supported extensively in the literature is that **an exclusive focus on technology is not sufficient to guarantee the effectiveness of SCC solutions:** in the past, the absence of technology was used as an excuse not to enforce certain types of policies (e.g. congestion charges); however even though technologies have developed since then, certain policies – for instance, environmental sustainability ones – are not always applied because of political and strategic reasons.

What has emerged from the research is **the strategic role of policies, available alternatives and human behaviour:** there is the need for a human component in smart technologies to effectively improve cities as well as the quality of life of their inhabitants.

As described in the previous sub-sections and as depicted in the matrix in Figure 13 above, solutions may either be useful to responding to citizens' needs, or they will be perceived as failing to do so. This difference identifies how – for the citizenry – the solution represents an efficient or inefficient use of resources. At the same time, citizens can either be directly involved in the solution or they can be the passive beneficiaries. In the first case, behavioural aspects and cultural aspects would strongly contribute to shaping the roll-out potential of a solution. In Figure 15 below, the 10 best practice case studies are mapped onto the matrix developed in Figure 13.

Figure 15: SCC solution case studies and citizen involvement



Source: Our elaboration

Note:

The size of the bubbles indicates the roll-out potential.
The sole purpose of the colours/patterns is to distinguish one case from the other.

Study findings also show that **the presence of a Smart City vision, which contextualises the deployment of a specific solution within an overall smart framework, is generally connected to positive results.** An example is represented by the Smart City vision of Stockholm, which has been developed by the municipality with the aim of committing all the departments and companies to work towards improving the levels of smartness in the city through their activities and operations. An application of this vision is represented by the public-private partnership established for the building of the Royal Seaport of Stockholm, which features major technology players successfully collaborating with academia and the City Council for the development of the project.

A centralised public governance structure is often a positive factor, as public entities are best able to adapt the institutional and political dimension to facilitate the development of SCC solution. However, Smart City solutions do not all follow the same implementation path (e.g. from city vision to effective implementation). SCC solutions can also be implemented following a "bottom-up" approach by individual commercial agents, and then later be integrated into a wider vision. However, these **bottom-up solutions require a business-friendly environment and a stable and trustworthy legal and regulatory framework,** which are exogenous to the solutions' promoters.

An effective route to success for SCC solutions is to begin by testing the project on small groups of citizens and stakeholders, later adapting it and then scaling it up to the whole city. This also makes it possible to concentrate the involvement of citizens, making sure that they are aware of the benefits it can deliver.

While **demonstration projects** seem to be a good tool to cope with the risk of project failure (which would otherwise be an obstacle to public administration bodies wanting to endorse innovative Smart Cities solutions) they also risk becoming an endless test, which never reach operational status. The safe area represented by research projects does not have to lead to endless demonstrators. Indeed, **staying at demonstration phase is in itself a form of failure, as it usually means that the specific solution has not become economically viable, and will continue being based on different small projects without scaling to the operational phase.** Nevertheless, it should also be noted that demonstration projects are useful to show quick gains and encourage stakeholders to take action.

3.2. The potential of key Smart City target markets for roll-out: A better partnership with China

3.2.1. Global urban challenges and trends

In order to understand the target markets for SCC solutions, it is helpful to start from the **greatest regional urban challenges** as identified by the World Economic Forum through a survey carried out end of 2015, focusing on urban services. These challenges (listed in Figure 16 below) contribute to shaping the demand for Smart City solutions, as each region has different priorities and will therefore be concentrating more resources on supporting solutions addressing those needs.

Figure 16: Greatest regional urban challenges

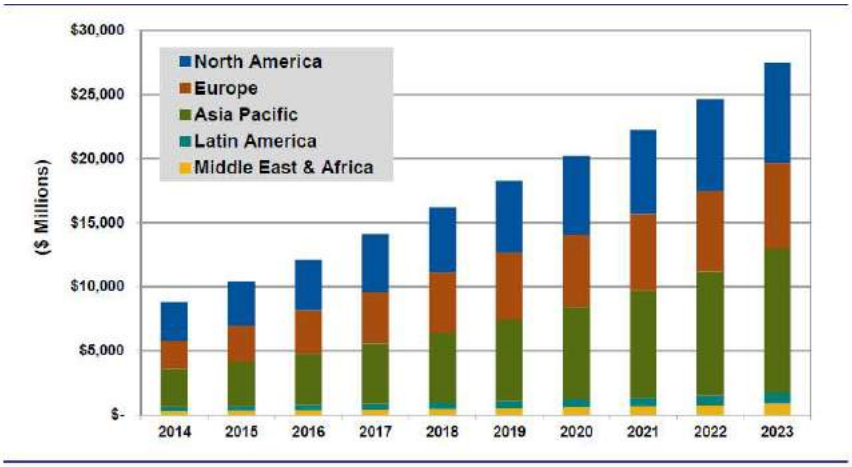
Source: World Economic Forum, Shaping the Future of Urban Development & Series Initiative, Global Survey on Urban Services (Oct.-Dec. 2015)

As already stated at various points in this report, and also according to IDC,[37] **intelligent system integration is a key driver of value in the Smart City roadmap;** the biggest market players – such as IBM, CISCO, Schneider Electric, Siemens and Microsoft – are gaining their competitive advantage thanks to their ability to provide integrated, tailor-made solutions.

However, this roadmap to Smart City implementation and, consequently, the speed of adoption of the numerous solutions, varies widely across regions, depending greatly on the availability of resources dedicated to support actions within a given domain. Furthermore, **integrated solutions embedding diverse components are also usually characterised by different technology maturity levels** of each of these elements, again possibly varying through regions.

Grand View Research estimates that, up until 2013-2014, North America accounted for the largest market share of Smart City solutions.[38] More recently, **the Asia Pacific region – particularly China and India – has seen an expansion in the demand for Smart City solutions due to increasing environmental and energy instability.** The Smart Cities market in Europe is expected to be promising for global market growth through the forecast period, owing to increasing investments in infrastructure to improve public facilities, with Horizon 2020 goals driving many cities to adopt a Smart City strategy to accommodate local climate goals. **Increased demand for smart transport and energy management in Europe has considerably driven regional market growth** (Grand View Research, 2014).

Figure 17: Smart City Technologies, Annual Revenue per Region



Source: Navigant Research, 2014

Gartner indicates that the Asia Pacific region, where the city population is often in the several millions, applies smarter operations and governance to build basic city infrastructure and to connect them with intelligent IT systems for improved service and maintenance environments. Navigant Research data on Smart City technology market revenues confirms the important role that Asian countries have recently

[37] IDC Government Insights 2015, *Methods and practices: IDC Government Insights' Worldwide Smart city Taxonomy*.

[38] Grand View Research 2014, Smart Cities Market Analysis by Application (Smart Energy Management, Smart Security, Industrial Automation, Smart Healthcare, Smart Buildings, Smart Homes, Smart Transportation) and Segment Forecasts to 2020

started to play in boosting demand, followed by North America, and then by Europe (see Figure 17 above).

In terms of regional market trends in the next decade, Navigant Research foresees a constant increase in market revenues for that Asia Pacific, which will continue leading global aggregate demand. Indeed, the revenues generated in the sector by the Asia-Pacific market alone will be worth $11.3 Bln annually by 2023. **Europe has also started investing more in SCC technologies, and will spend more than $5 Bln in 2023, accounting for nearly 18% of the overall global market revenues.**

SCC solution markets are very fragmented, with each city requiring a customized strategy and every Smart City project targeting specific needs coming from the city's individual infrastructure and priorities. Therefore, **companies that cover a wide range of Smart City sectors, products and technologies are best equipped to become distinguished market players,** as they can offer pre-packaged bundled solutions or provide ad-hoc solutions based on a city's key priority, be it smart transportation, energy or infrastructure.

However, despite the huge advantage experienced by these leading market players, **the competition in this market is still lively thanks to fast-paced growth, technological evolution and high fragmentation, which allows smaller and more specialised companies to compete.** This is very much a composite market, where many industries co-exist and that varies widely across regions, based on urbanisation patterns, environmental challenges and region-specific government priorities, sustained by the significant estimated progression pace foreseen for the coming years.

It is widely acknowledged that the Asia-Pacific area – in particular China – will experience a significant growth in the next decade, becoming the leading region driving the market for Smart City solutions and technologies. For this reason, particular attention has been devoted to exploring the Chinese Smart City context and market – a growing potential source of opportunities for EU businesses – focusing specifically on three different levels of EU-China collaboration: industrial, research and policy-dialogues.[39]

3.2.2. Challenges specific to EU-China collaboration

China's new urbanisation development strategy has attracted much attention worldwide. Approximately 300 Mln Chinese rural residents will become city dwellers in the next 15 years and they will find jobs and make their living in cities, which will likely be a key driver for world economic growth in this century. In the draft 13th Five-Year-Plan (2016-2020), China has set clear management goals for economic efficiency, environmental protection, clean energy, utilities management and living security systems for its residents. Implementation of the Plan will potentially attract broader participation from global investors as China's economy continues to grow.

Having established the strategic importance of the Chinese market for European businesses in the field of SCCs, some specific challenges have been identified through

[39] Past and current bilateral collaboration on SCC-related topics between China and EU have been explored as a way to evaluate possible barriers, needs and interoperability. In doing so, ten successful EU-China collaboration initiatives have been selected, analysed and documented, engaging relevant stakeholders via a standardised survey as well as through a number of single interviews, carried out in the Oct-Dec 2015 period.

a number of EU-China collaboration initiatives examined for the purpose of this study. Raising awareness on these challenges, as well as the lessons learned and ways to overcome them, provides valuable inputs to facilitate future collaborations and support policy-makers in their attempt to foster new openings for EU companies in the Chinese Smart City market. The following paragraphs describe the main challenges identified.

Cross-cultural awareness and sensitivity

First of all, both regions can look back on a history of thousands of years and, consequently, ways of doing business have been well established for a long time. Hence, for Europeans it is essential to develop insights into China's business culture and social etiquette to avoid misunderstandings. As an example, oral and (sometimes) written agreements may not be interpreted as binding on the Chinese side. Silences in correspondence and steps backward in collaborations are also not uncommon in China. Equally, Chinese partners have observed an unwillingness to cooperate and share information after an initial agreement to do so from Europeans. The bottom line is that **patience on both sides is a prerequisite for a smooth and successful cooperation.** Relationship building takes time in China and engaging with the Chinese in a purely commercial way is difficult.

Chinese government structure

Also in relation to cultural differences, especially when dealing with public bodies, the centralization of the government of China has to be considered. Additionally, the concept of public versus private institutions has different meanings in Europe and in China. **Accounting for the Chinese government's structure is essential in business collaborations with Europe and initiating Smart City projects requires the involvement of Chinese government officials.** In this sense, engaging representatives of Chinese cities has often proven to be insufficient, as decisions are made at provincial or central government level. Therefore, it is important to understand the Chinese government structure and decision-making process in order to ensure bilateral collaborations are fruitful. The Chinese government also plays a dominant role in Chinese business participation in Smart City development in China. This governmental presence can especially be felt in the field of Smart Cities, as city planners (employed by public bodies) play an important role. This means that **city planners' expertise and involvement from the very early stages are crucial for the success of a project.**

Funding

The government structure of both regions inevitably influences funding possibilities. For example, funding for Chinese companies is especially problematic and is often why cooperation with EU-based projects or companies – even though highly desired – cannot be carried out at all or as fast as one would hope. Likewise, on the European side, funding may also pose difficulties. While there are vast funding opportunities, e.g. the Horizon 2020 programme for research and innovation, access to public funding is highly competitive and also constitutes an obstacle on the European side. Additionally, the study has raised the issue that European funding for EU-China collaborations seems to benefit China more in the long term. Indeed, in the framework

of the analysed collaboration initiatives, European companies have seldom been established in China, whereas Chinese companies have started implementing their Smart City solutions in the EU. This highlights **the challenge of making sure EU funds actually help EU companies break into the Chinese Smart Cities market.**

Replication potential and scaling-up

As has been shown, the premises for EU-China collaborations are quite challenging. When it comes to the actual uptake and replication of European projects in China, the picture becomes even more complex. Examined initiatives show that, generally, **the replication potential is significant and viewed as the most important output of the collaboration.** Overall, it has been noticed that collaboration initiatives are progressing at a different pace, usually starting from a policy dialogue phase and progressively turning into industrial cooperation. As of now, the studied collaborations showed that Chinese companies have 'hit' the EU ground, while EU companies are still trying to find their way into the Chinese Smart Cities market. In parallel, Chinese companies involved in industrial projects in the EU can use the knowledge gained through their European experience back in China, and decrease the need for European counterparts over there. It is crucial that both Europe and China benefit from cooperation and that there is always reciprocity when knowledge is shared and goods are exchanged.

Legal and economic frameworks

Once the collaboration initiatives are over, **it is often unclear to EU partners what the legal and economic implications are regarding the future use of project outputs in China.** For example, information on intellectual property rights and copyright issues appears to be lacking to a large extent in the studied collaboration initiatives. EU companies would need support on these issues, especially if they have formally agreed to co-create and implement Smart City solutions in China.

3.2.3. Opportunities linked to EU-China collaboration

Although there are a number of challenges that need to be overcome, they may also be turned into new opportunities. The studied collaborations feature some of these opportunities, in particular with respect to the Chinese Smart Cities market and research landscape.

Fields of cooperation

First of all, the study has shown that **China is actually in synergy with the main trends of the EU.** Indeed, China has adopted similar terminologies, definitions and goals (cf. Smart Cities, Smart Communities, Eco-Cities). Furthermore, the areas for cooperation – mainly mobility, energy and ICT – are complementary with EU interests. Therefore, with this mutual understanding, target areas can be identified where both regions want to invest in future cooperation projects, e.g. urban planning, energy, smart traffic, smart mobility, and the environment.

Standards

Another point to be raised is **the importance of standards, as well as the favouring of open source solutions and interoperability options.** The majority of survey respondents from both the EU and China acknowledged interoperability as a strategic driver. Open source solutions are also recommended, due to the fact that Chinese parties will give preference to this option over the uptake of European or North American products. The Chinese government has pursued an open source policy, e.g. favouring Linux over Microsoft. The development of shared standards between the EU and China seems especially promising. Shared standards in innovative and only partially regulated areas such as Smart Cities, would give a head start to both the EU and China.

Funding mechanisms

Funding mechanisms do not only pose a challenge (see previous section) but also an opportunity. Innovative mechanisms such as **Public-Private Partnerships (PPPs)** may offer interesting prospects for rolling out Smart City solutions in China, also because this kind of funding model would mean **better risk-sharing between the two regions and public and private entities.**

3.2.4. Harnessing the power of a Smart City EU-China partnership

Both the EU and the Chinese government have included Smart Cities as high priority in their strategic 2020 plans. Therefore, it is expected that there will be many opportunities for funding joint initiatives in the coming years. This gives EU organisations a window for sustaining the initiated collaborations and establishing themselves in China; this is particularly relevant for EU companies, which can use their advanced knowledge in sustainable urban planning to enter the market in China. Indeed, such profiles are highly requested in China to support Smart City development in an integrated way.

With the Chinese Smart City market's huge potential in mind, the main area of concern for Europe is to know how to stay into it while generating profit. Often, collaboration initiatives turn out to be of little profit for European companies; it is therefore recommended that **European companies enter into agreements with China where they can be assured of being involved in a portfolio of operational projects** – ideally with a specific budget and timeline for each project, and a total number of cities to serve as clients. In exchange for these guaranteed contracts over a period of time, European companies can pledge to train a portion of the Chinese staff and work alongside them as a way to transfer knowledge to China.

Furthermore, it is advisable to **target new cities in rural China.** Indeed, there is already an influx of investment within Chinese megacities, and the government needs a way to reverse the trend of overcrowding in these cities. In other words, attracting investment elsewhere would be desirable.

4. Conclusions

Technological progress gives rise to new approaches to the management and the development of cities (and the districts within them). Furthermore, **growing urbanisation and the increased demand for efficiency in the provision of services is calling for more efficient urban management solutions**. Smart Cities therefore emerge as a strategy to tackle resource management and – more generally – better manage cities' needs.

Smart City solutions apply digital technologies to address social, environmental and economic goals. A distinctive feature of SCC solutions is the ability to measure (and internalise) the value created, responding to the modern population's needs (i.e. positive externalities). Consequently, business models are adapting.

Governance of SCC solutions (and of the cities managing them) has been changing towards a more dynamic and open architecture. **Silo-based approaches are being replaced by cooperative governance systems.** Similarly, an unprecedented involvement of private parties managing solutions together with public entities is being encountered.

The possibility to measure and monetize positive externalities from investing in smart infrastructure enables a radical change in the funding and financing opportunities. Budgetary constraints are forcing public authorities to look for alternative sources of capital to support the development of urban solutions. Private involvement through PPPs is increasingly used to raise finance (in particular in larger, more standardised, energy provision contracts). However, most innovative approaches arise from financing solutions, which are either being supported by public funding (e.g. EFSI, InnovFin and Financial Instruments), financial products provided by commercial banks, or specific programmes supported by development banks or similar institutions (e.g. EIB).

Further opportunities are yet to be consolidated in the new investment environment. Among the most promising opportunities, **investment platforms ensure access to finance to small-size promoters involved in SCC solutions**. These are co-investment arrangements – which can be supported by EFSI – that aim to reduce transaction costs and provide for more efficient risk allocation through the aggregation of thematic-focus (or geographic-focus) investments.

New opportunities require new strategies and models to design and develop SCC solutions. The public administration can involve several service providers and stimulate innovation through public procurement. Furthermore, opening up procurement mechanisms to make them accessible to younger, smaller businesses allows cities to access a wider range of new ideas and technology than traditional market procurement. What is however demonstrated is that **there is no best procurement model; new business models must adapt to procurement practices, and each solution requires careful consideration on how to involve service providers.**

The most distinctive feature of SCC technology is the wider involvement of stakeholders, and technology users in particular. **Having citizens and communities participate in SCC solutions enables the best match between the demand and supply of services, ultimately determining their success.** However, not all SCC

solutions share a significant involvement of citizens. This has been demonstrated as one of the most distinctive attributes of failing SCC solutions. Indeed, **although technology makes it possible for SCC solutions to be developed, it is the interaction of this technology with users that determines their success.**

Innovative technologies in urban investments have the potential to reshape the way resources are exploited to provide services to our population. For this to happen, it is necessary for solutions to be implemented at a wide scale. Again, when considering the roll out of SCC solutions (either in different geographical contexts or at different scales) technology is hardly ever the limiting factor. What is more relevant is the involvement of the population and the political-institutional support. As the socio-political dimension is the most important element, determining the roll-out potential of SCC solutions, organisations and entities favouring the SCC solution's development become most relevant (i.e. the so-called umbrella organisations and initiatives). These organisations increase the synergies and the awareness of actors, favouring the involvement of political leadership, the population, (service) providers and investors as well.

Applying smart solutions to a limited-scale context would certainly enable the testing of SCC technologies, governance approaches, etc. However, it would not serve the purpose of responding to the global needs arising from urbanisation. What is thus needed is to **ensure that solutions can be scaled (increase in size) and replicated (rolled out in a different environment than that they have been applied in the first place)**.

The analysis shows that **there is no single element that represents more than others an obstacle or an enabler to the roll-out of SCC solutions.** Instead, it is the joint action of different elements that can limit the possibility for a project to be successfully implemented at a higher scale or in different contexts. These refer to the technological context (the presence of a technological support network for the SCC solution to function); the socio-cultural context (the ability to respond to citizens' needs and to make them part of the solution); the political-institutional context (level of required support from the public administration); and the economic-business context (which refers to the business models and relative environment). The presence of an ecosystem that can bring together political institutions, investors, industry players and – to the extent that it is required – the citizenry, facilitates the implementation of projects that have been successful elsewhere.

Urbanisation is an international concern; coherently, SCC solutions are being developed across continents. It is widely acknowledged that the Asia-Pacific area – in particular China – will experience significant growth in the next decade, becoming the leading region driving the market for Smart City solutions and technologies. For this reason, particular attention has been devoted to exploring the Chinese Smart City context and market – a growing potential source of opportunities for EU businesses – focusing specifically on three different levels of EU-China collaboration: industrial, research and policy-dialogues.

Analysing EU-China Smart City collaboration initiatives standing at the intersection between the energy, transport/mobility and information and communication sectors has led to the identification of opportunities for future EU-China cooperation. **Both EU and Chinese central governments have included smart cities as high priority domains in their strategic 2020 plans.** Therefore, it is expected that there will be

many opportunities for funding joint initiatives in the coming five years. It gives EU organisations a window for sustaining the initiated collaborations and establishing themselves in China. This is particularly relevant for EU companies, which can use their advanced knowledge in sustainable urban planning to conquer market shares in China. Indeed, such profiles are highly "wanted" in China to support the smart cities' development in an integrated and methodical way.

With the Chinese smart cities market's huge potential in mind, the main area of concern for Europe is to know how to enter the Chinese market, and how to generate profit from it. Often, collaboration initiatives turn out to be of little profit for European companies, since **Chinese competitors quickly replicate European know-how and then attract most of the public spending**. It is therefore recommended that European companies enter into agreements with China where they can be assured of being involved in a portfolio of operational projects – ideally with a specific budget and timeline for each project, and a total number of cities to serve as clients. In exchange of those guaranteed contracts over a period of time, European companies can pledge to train a portion of the Chinese staff and work alongside them as a way to transfer knowledge to China.

Furthermore, it is advisable to **target new cities in rural areas of China.** Indeed, there is already an influx of investment within Chinese megacities, and the government needs a way to reverse the trend of overcrowding in these cities. In other words, attracting investment elsewhere would be desirable.

5. Key recommendations

Collaborative operating models should be developed, facilitating the involvement of different actors.

This requires that effort be made at different stages of SCC solution development. More collaboration-oriented operating models may indeed envisage a revision of the approach of the public administrations (usually cities) to urban planning. Generalising to the extent possible, this requires a governance structure that favours the collaboration of the different parties involved.

City-level administrations may consider breaking the boundaries between sectorial offices.

This is in order for the city to be able to respond to potentially inter-sectorial, complex and integrated demand for technological innovations in service provision. For example, this may be achieved through the designation of planning powers to a centralised, dedicated office and a coherently integrated city planning, coherently with the strategic vision of the urban development. The planning could also focus t on cross-sectorial innovations, which would further require the different administration offices to partner. Conversely – in particular for broader urban areas – it might be appropriate for central administration to maintain a certain organising power, but to delegate smart planning at district level. Finally, it is advisable to revise the tools that are supporting urban planning (e.g. guidelines, models,) to embed the innovations brought by the new technologies.

Create the conditions for integrated solutions to be developed based on the same standards.

This is important to favour the involvement of the different players – private sector and SMEs in particular – in shaping the urban innovation. These conditions would also increase the possibility for roll-out and replicability). The possibility to develop solutions on shared standards – and even open standards – creates flexibility in deploying solutions, modifying them and, potentially, in having solutions developed directly by the citizens asking for them.

Enable community empowerment for the development of sustainable business models.

Communities have a specific role to play in smart initiatives; yet, the evidence from the best practice examples shows that in most cases there is only a traditional form of citizen involvement strategy in place, involving promotion, recruitment of participants and community participation to a limited extent. However, in-depth case studies confirmed that citizens and communities are not given a strategic role in the development and execution of integrated SCCs, and that the relevant communities are emerging as a key success factor for a sustainable business model. Different opportunities to involve communities in collaborating, co-creating and co-developing solutions can be leveraged, spanning from increasing communication to creating initiatives bonding smart city actors together.

Create an open innovation ecosystem between different experimentation set-ups.

The multiple roles residents could play in regional and urban living labs is under-utilized. Emphasis is often set on the innovative technological aspects but not on innovating the engagement process, with almost no co-ordination between experimentation projects. Coherently, there is no coordination in the development of principles, rules, standards and guidelines that other cities may benefit from. Different city experimentation set-ups could form an innovation ecosystem consisting of citizens, ICT companies, research scientists and policy-makers. The challenge in this layer is to create a collaborative approach to innovation ecosystems based on sustainable partnerships among the main stakeholders from business, research, policy and citizen groups, and to achieve an alignment of local, regional and European policy levels and resources. Municipal authorities should cultivate an innovation ecosystem across the city and among its suppliers, including: publishing city-level procurement policies, ensuring that changes following reviews are known; publishing and updating a pipeline of major city procurement opportunities, to allow enterprises to plan in advance; involving suppliers in the definition of products, respecting transparent procedures and ultimately enhancing competitiveness.

Investigate the relevance of new ICT-enabled business models, such as the sharing and the circular resource economy for integrated SCC solutions.

In particular, the European Commission is committed to developing a European agenda for the sharing or collaborative economy by 2016. This should include the impact of disruptive business models such as the collaborative economy on cities of the future. Furthermore, cities and regions should promote sharing-economy initiatives addressing the specific needs of local communities.

The importance of data-driven SCC solutions is increasing; it is therefore necessary to learn how to manage them.

Data is transforming cities as it is becoming available in increasingly large quantities and qualities. However cities need to look at the wider digital infrastructure to enable integrated SCCs – this includes the telecommunications infrastructure, publically owned digital infrastructure on multiple levels, sensors and data. In a digitalised environment, the possibility to create an open, service-oriented, interoperable IT platform enables multiple solutions to be developed and modified according to changing population needs. Effort needs to be made to ensure that data is reliable and easily accessible – when needed and for who it is needed by. New capabilities should be developed by administrators e.g. developing (or favouring the development of) standards for data exchange and protection; providing the necessary guidance, frameworks, specifications, protocols and vocabulary to create a common understanding for solutions developers, administrators and users.

Simplified information for SCC actors would support the replication of SCC solutions.

Major SCC players perceive the EU as lacking of a consistent approach concerning Smart Cities. In particular, the European Commission is currently running Smart Cities

projects across a wide number of different Directorates (just to quote the most active: DG Energy, DG Transport, DG Connect, but also DG Regional Policies, DG Environment, DG Research, DG Growth). To help SCC actors identify and focus on their topics of interest – thereby facilitating synergies – it is necessary to simplify and concentrate the available information, by centralising data on all running initiatives and activities. A unique EU point of access on Smart Cities would be useful to all actors seeking information on what is happening across Europe concerning Smart Cities and looking for best practices, support, etc.

Create and share a platform where EU and non-EU actors could jointly discuss SCC solutions.

As SCC solutions do not only concern EU Institutions, but are international and involve private actors as well, it might be useful to create a platform for them to share their main activities, thereby enhancing their mutual awareness. Furthermore, this platform might also facilitate and encourage a proper business matching among key EU and non-EU actors, reducing single efforts and contributing to aligning practices with non-EU countries.

Need to rationalise the management of funding and financing tools for SCC solutions.

The European Commission is a key player in ensuring that solutions receive the necessary resources to develop. However, the support provided may be better rationalised by assessing and defining the various SCC project types (revenue generating vs. R&D projects) and coherently organising the support the EC can provide. Potentially, the **centralisation of the competences for both the provision of grants and forms of financing** – as well as other support e.g. technical assistance – would further increase the efficiency of the EC's support. The number of opportunities to support SCC initiatives is varied and it is managed by different entities/institutions. The number of different sources and opportunities may create complexity in achieving an efficient support to SCC projects. Coherently, a single entity managing the different possible types of support would facilitate the allocation of resources, the access to them as well as the selection of the most appropriate support for each case.

Set up the EC's funding, financing and technical assistance programmes so as to overcome sectorial barriers.

This would be in the interest of achieving an integrated vision of city planning and SCC solution development. Coherently, these programmes are distinguished on a sector-basis; this differentiation would hardly fit into an integrated solution, which – by definition – embraces more sectors.

Develop business accelerators in the field of SCC initiatives, bringing together private and public investors and entrepreneurs.

The European Commission has the possibility of gathering the relevant stakeholders (e.g. financial services providers, promoters of SCC solutions, technology suppliers, etc.) in the same room. Projects in the SCC field have often been integrating the

public and private sectors to succeed. Indeed, more efficient ways to collect capital, skills and partners can be achieved by bringing stakeholders together. Different ways to achieve this cooperation can be investigated by the Commission, also leveraging the experience from previous initiatives, even if they are very distant from the SCC sector:

- Creating a physical space for stakeholders to meet at specific dates, but also through on-line platforms that facilitate cooperation and co-development;
- Potentially using open specifications/ standards, to further facilitate synergies between players and industries.
- Using the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) as an effective tool convening: cities – large and small; with industry – large and small; with investors of all types; and trusted associations, academics and intermediaries.
- Organising dedicated sessions within SCC-related events for project promoters to open discussions on their projects with potentially interested private and public investors.

Support stakeholders in procuring SCC solutions and avoid complex procurement frameworks that inhibit innovation.

For example, this could involve the development of user-friendly guidelines, templates and standards, which also support the exchange of best practices and the dissemination of knowledge. In this context, the EC can play a relevant centralising and standardising role.

Develop procurement and supplier management strategies.

Municipal authorities should develop procurement and supplier management strategies that enable rather than block their vision for more citizen-centric and integrated service delivery. Also, when developing integrated solutions requiring a certain degree of interfacing with several contractors, municipal authorities should consider designing Service Level Agreements (SLAs) that clarify how contractors interact with one another. The European Commission should assess standards and specifications in order to make sure that the selected standards and specifications foster interoperability and reduce lock-in. This is currently organised on a national basis (e.g. within the context of MSs' National Interoperability Frameworks); however, there has been an effort at a European level to adopt a common framework that fosters collaboration between MS.

Support the introduction of EU companies into the Chinese smart city market along with providing the necessary protection frameworks.

The global race towards efficient solutions for urbanisation-related service demand will strongly benefit from international partnerships. Specifically, China seems to represent one of the key players for Europe to establish valuable cooperation and sharing of best practices. The Chinese side expressed a strong interest in having a platform for collaborating with the EU in the energy field both at policy, technology and business

levels. Such a platform may also be used for "matchmaking." which would provide insights into business options for both Chinese and European partners.

Provide a supportive legal framework for IP protection.

A good smart city regulatory environment will provide the protection that EU companies (especially SMEs and start-ups) need while being adaptable enough to allow for the risk-taking and trial-and-error that innovation requires. This means EU public entities may step in and agree with their Chinese counterparts on creating the right Intellectual Property (IP) protection laws and a supportive legal framework for companies wishing to provide their solutions on the Chinese market.

Annex I. SCC Initiatives and relative priority areas

Colours indicate the EIP-SCC "Strategic Implementation Plan" (SIP) priority areas (vertical/horizontal) that the initiative covers:

Main area covered by the initiative (vertical variable)

Second area covered by the initiative (vertical variable)

Other areas covered by the initiative (across both vertical and horizontal variables)

Solution	City	Population	Country	VERTICAL			HORIZONTAL							
				Sust. Urban Mobility	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
Barangaroo District Renewal	Sydney	> 500.000	AU											
Waterfront Toronto	Toronto	> 500.000	CA											
Smart Buildings - Pudong New Area	Shanghai	> 500.000	CN											
Octopus System	Hong Kong	> 500.000	HK											
Water Network Monitoring and Management	Jerusalem	> 500.000	IL											
Water Management System	Mumbai	> 500.000	IN											
Smart Melit	Toyota City	100.000 < x < 500.000	JP											

Solution	City	Population	Country	VERTICAL			HORIZONTAL							
				Sust. Urban Mobility	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
Integrated Smart City Grid	Yokohama	> 500.000	JP	■	■	■	▒		▒		▒			
Smart Traffic Management System	Buncheon City	> 500.000	KR	■		■	▒	▒	▒					▒
Island Integrated Smart Grid	Jeju Island	> 500.000	KR	■	■	■	▒	▒	▒	▒	▒	▒		
Citizens Connect	Boston	> 500.000	US		■	▒	▒			▒		▒		
City Services Smart Platform	Carson City	< 100.000	US	▒	■	■			▒	▒		▒		
Envision Charlotte	Charlotte	> 500.000	US	▒	■	■	▒	▒	▒		▒		▒	▒
Fiber Optics Smart Grid	Chattanooga	100.000 < x < 500.000	US		■	■	▒		▒		▒			
Windy Grid Chicago	Chicago	> 500.000	US	▒	▒	■				▒		▒	▒	▒
Integrated Smart Grid Initiative	Glendale	100.000 < x < 500.000	US	▒	■	■			▒	▒		▒		
Streetline Parker	Los Angeles	> 500.000	US	■		■	▒	▒	▒					▒
Big Belly Smart City Waste Management	Philadelphia	> 500.000	US	▒	■	■	▒		▒		▒			▒
UCSD Microgrid	San Diego	> 500.000	US	■	■	■	▒	▒	▒			▒		▒
Vienna Citizens' Solar Power Plant	Vienna	> 500.000	AT		■	■	▒	▒	▒	▒				▒
Blue Gate District	Antwerp	100.000 < x < 500.000	BE	▒	■	▒	▒	▒	▒	▒				
Center of Operations	Rio de Janeiro	> 500.000	BR	▒		■	▒	▒	▒	▒		▒		

Solution	City	Population	Country	VERTICAL			HORIZONTAL							
				Sust. Urban Mobility	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
Hengqin Smart Grid	Hengqin New Area	< 100.000	CN		■	■								
MeRegio Smart Grid	Baden Württemberg Region	> 500.000	DE		■	■								
Bremen Building Management System	Bremen	> 500.000	DE		■									
Klimastrasse	Cologne	> 500.000	DE	■	■	■								
Connected Smart Port Logistics	Hamburg	> 500.000	DE	■		■								
Smart Power - Intelligent Network of Urban Infrastructures	Hamburg	> 500.000	DE		■	■								
E-Energy Mannheim	Mannheim	100.000 < x < 500.000	DE		■	■								
Nordhavnen Smart District	Copenhagen	> 500.000	DK	■	■	■								
Waste Water Management System	Copenhagen	> 500.000	DK		■	■								
Copenhagen Intelligent Traffic Solution	Copenhagen	> 500.000	DK	■		■								
Island EcoGrid	Bornholm	< 100.000	DK		■	■								
Tallinn Smart Card	Tallinn	100.000 < x < 500.000	EE	■		■								
City Protocol	Barcelona	> 500.000	ES	■		■								

Solution	City	Population	Country	VERTICAL			HORIZONTAL							
				Sust. Urban Mobility	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
Smart Street Sant Cugat	Sant Cugat	< 100.000	ES											
Urban Platform	Barcelona	> 500.000	ES											
Districlima Network	Barcelona	> 500.000	ES											
Neighbourhood Urban Observatory	Bilbao	100.000 < x < 500.000	ES											
Bus Integrated Management System	Donostia-San Sebastian	100.000 < x < 500.000	ES											
Integrated Security and Emergencies Center	Madrid	> 500.000	ES											
Kalasatama Sustainable District	Helsinki	> 500.000	FI											
ECO2- Tampere	Tampere	100.000 < x < 500.000	FI											
IssyGrid	Issy-les-Moulineaux	< 100.000	FR											
Lyon Smart Community	Lyon	100.000 < x < 500.000	FR											
Connected Boulevard	Nice	> 500.000	FR											
Intelligent urban mobility management and traffic control system	Thessaloniki	100.000 < x < 500.000	GR											
Data One Smart Portal	Hong Kong	> 500.000	HK											
Interoperable Open Platform -	Zadar County	100.000 < x < 500.000	HR											

Solution	City	Population	Country	VERTICAL			HORIZONTAL							
				Sust. Urban Mobility	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
iScope														
OpenMove	Trento	100.000 < x < 500.000	IT											
Climate Street	Amsterdam	> 500.000	NL											
Power Matching City	Hoogkerk	< 100.000	NL											
Schools Energy Management System	Lisbon	> 500.000	PT											
Smart District Heating - CELSIUS	Gothenburg	> 500.000	SE											
Hyllie Sustainable District	Malmö	100.000 < x < 500.000	SE											
Stockolm Royal Seaport	Stockholm	> 500.000	SE											
Energy Efficient Housing - 3eHouses	Bristol	100.000 < x < 500.000	UK											
Future City Glasgow	Glasgow	> 500.000	UK											
Mass-retrofitting - Hackbridge	London	> 500.000	UK											
Corridor Manchester	Manchester	> 500.000	UK											
MK: Smart	Milton Keynes	100.000 < x < 500.000	UK											
Urban EcoMap	San Francisco	> 500.000	US											
Smart Grid Newcastle	Newcastle	> 500.000	AU											

Solution	City	Population	Country	VERTICAL			HORIZONTAL							
				Sust. Urban Mobility	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
MNPass	Minneapolis	00.000 < x < 500.000	US	■										
HafenCity	Hamburg	> 500.000	DE	■	■									
Energy Matching Infrastructure - eHub	Leuven	< 100.000	BE		■	■								
Demo Norway Smart Grid	Rogaland Region	100.000 < x < 500.000	NO		■	■								
Hudson Yard	New York	> 500.000	US	■	■	■								
Vehicle2Grid	Amsterdam	> 500.000	NL	■	■	■								
Singapore congestion charging	Singapore	> 500.000	SG	■										
Data-driven Pop-up Busses	Boston	> 500.000	US	■										
London Underground Energy Recovery	London	> 500.000	UK	■		■								
Malaga Integrated Smart Grid	Malaga	100.000 < x < 500.000	ES	■		■								
Växjo - Fossil Fuel Free City	Växjo	< 100.000	SE	■	■									
Hammarby Sjöstad	Stockholm	>500.000	SE	■	■	■								
Nice-grid	Carros	< 100.000	FR		■	■								
Tram Smart Enhancement	Melbourne	> 500.000	AU	■		■								
Valencia Smart City Platform	Valencia	> 500.000	ES	■	■	■								
SMILE and Integrated eMobility	Vienna	>500.000	AT	■		■								

				VERTICAL			HORIZONTAL							
Solution	**City**	**Population**	**Country**	*Sust. Urban Mobility*	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
Service for Public Transport														
Smart Santander Urban Platform	Santander	100.000 < x < 500.000	ES											

Annex II. Mapping of the roll-out potential of 10 integrated SCC Solutions

	Technology	*Socio-cultural*	*Political-Institutional*	*Economic/ Business*	**Roll-out potential**
Bigbelly *Philadelphia, U.S.*					

Bigbelly represents a case in which success is ensured by simplicity.

The SCC solution does not require any innovative technology (nor complex netting support) to be implemented. Similarly, it does not require an important change of habits among citizens, unless a need to pay stronger attention to recycling. Also, the population hardly notices the difference, as the solution only slightly involves human interaction.

From an economic perspective, the solution is modular, therefore can be simply scaled and is simple, therefore it can simply be replicated, without requiring to be deeply modified to be adapted to the new environment.

It may be worth however considering that the solution is most likely to be successful in cities where more users can be served (to achieve economies of scale) and where the population density is higher (higher demand for intelligent-waste systems).

Citizen Power Plant *Vienna, Austria*					

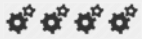
The Power Plant project in Vienna is somewhat complex in some aspects. From a business perspective, it requires a certain involvement of the society, the public administration and the business side. This increases the possibility for issues replicating the project (i.e. it would hardly work where individuals are less concerned with the environment or not aware of the potential of solar power). Legal and normative constraints may be other factors limiting replication as some countries limit the possibility to sell energy.

DataOne *Hong Kong, China*					

Among the key attention factors of the DataOne solution is the cultural dimension and the institutional involvement, which are required to adapt to a collaborative approach for the whole society's benefit. Another aspect is the citizen engagement through social network and other media that in this project was used to increase popularity of the project laying down the basis for its potential scalability.

The project aims to solve simple daily issues of the population facilitating communication; to do it, it uses simple and shared technology.

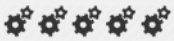
Differently from most SCC solutions, DataOne is expected to best fit in a densely urban context. Indeed, the higher the complexity of the city, the higher the demand for the services it provides.

	Technology	*Socio-cultural*	*Political-Institutional*	*Economic/ Business*	**Roll-out potential**
ITS *Copenhagen, Denmark*					

The solution, although successful, is still subject to a context in which the social-context is very strong and individuals are used to ITC solutions. Technology is available, however requires quite an architecture to be established upon.

Worth to mention is the importance that pilot testing had as a mean to ensure the scalability and later on replicability of the solution as well as the strong cooperation that took place both at national and international level which opened up opportunities for replication.

The ITS solution is expected to be less successful in smaller contexts, where the solutions proposed are less pressing. This however relates to the perception of individuals and, ultimately, on their culture.

Klimastrasse *Cologne, Germany*					

The project puts together a set of different solutions (LED lighting, electric vehicles, residential smart energy management, etc). This increases the complexity, but, on the other side, favours the modularity (i.e. potentially only part of the project can be replicated). The project is based on taking into account the citizens' needs throughout political steps and thanks to: (i) a steering board at City level and (ii) a comprehensive project management carried out by the energy local provider. This was a guarantee of success.

The solution roll-out potential is expected to be different depending on which of its components is assessed. Whilst LED lighting deployment is already being implemented in several cases and appears to be – at least partially – replicable and scalable everywhere and to whatever dimension, this may not be the case for the electric transport system and the smart-home technologies. Both cases refer to not particularly innovative ideas, which therefore can benefit from being tested in several cases and from a higher share of population being somewhat familiar with them. However the commitment required is high and this may be more difficult to be achieved in larger-scale environments.

MK:Smart *Milton Keynes, UK*					

Very wide project, which may be complex to establish as it requires to be developed from a large enough scale from the beginning. It requires an almost full commitment from institutions and a coordinated approach from the different departments, though it could be relatively inexpensive if the city possess the right set of skills. The management of the solution is also very complex.

To ensure its long term sustainability and replicability, project partners committed themselves to design a commercialisation plan since its very early stage of implementation, without postponing the decision to when the research project is close to its end. The project is expected to be best suited for small urban centres being newly created or expanding.

	Technology	*Socio-cultural*	*Political-Institutional*	*Economic/ Business*	**Roll-out potential**
Nice GRID *Carros, France*					

The Nice GRID project requires a strong participation from the local residents, which is expected to limit the scalability in bigger environments. Although technology is there, the number of partners, involved agents, regulatory framework, etc. for the solution to work make it difficult to be replicated without a very strong and shared commitment. However, in those cases where this coordination issue can be can be more easily overrun (e.g. by integrating the solution with other final electricity users), the solution appears to have no significant limitations to roll-out potential (i.e. see sub-section 3.4 on the ecosystem supporting SCC solutions roll-out).

The case of Carros is quite specific in the solutions it tackles. However, it should be considered that it is expected to best serve a small city – or a city area – as its complexity increases exponentially with the urban dimension.

Lyon Smart Community *Lyon, France*					

The Lyon project is a demonstration one, however it does not seem to have specific elements hindering its scalability to a city-level one. The requirement of a significant amount of initial capital can hinder the replicability, however, once the commitment from the institutions is ensured and the investments guaranteed, the project – and its components – are well scalable and replicable. The technology allows a strong degree of automization, which facilitates the roll-out of the solution, in particular to small-scale areas in urban centres, which can then be expanded to include whole cities..

Smart Melit *Toyota City, Japan*					

Apart from a very complex solution at technological level, the Smart Melit project is very tailored to a specific culture and specific needs of a society, which may be difficult to be translated into others. Further, it requires a strong involvement of all parties, being government, households, the Consortium. In other words, the holistic approach adopted is itself challenging its replication.

From a business perspective, it requires strong infrastructure-level investments (sensors, etc.) being installed and maintained. It is expected that the project brings positive results, but rather to inform other solutions than to be replicated as it is. While difficult to roll-out as it is, the solution can still be developed at small scale and is potentially adaptable as it is scaled-up.

Urban Platform *Barcelona, Spain*					

The solution is characterised by a strong involvement of the institutions, but is designed to limit the interaction with the citizens to providing new and more efficient services. This solution represents a very replicable concept, where services provided can be adapted to the demand, but the underlying

	Technology	*Socio-cultural*	*Political-Institutional*	*Economic/ Business*	**Roll-out potential**

network is substantially replicable and scalable. Key component of the solution is its transparency, which allowed city government to explain why they developed new smart applications or publicly sensitive solutions.

The Urban Platform solution is expected to be best replicable in large cities. Indeed, the services it provides would most likely be demanded in complex environments. Further, the larger the audience, the higher the potential for economies of scale, as a relevant portion of the costs would be fixed or semi-variable.

Legend
(min to max)

Technology:
Min: Max:

Socio-cultural:

Political-Institutional:

Economic/ Business:

Roll-out potential:
Min: Max:

Annex III. Toolkit to assess replicability in specific geographical contexts

The toolkit designed to support the roll-out assessment of a given SCC solution recalls the dimensions outlined in the main body of this report. However, these are presented differently below and in another order. They follow the logical steps that are suggested should be covered when addressing the roll-out.

Table 7: Potential roll-out at specific geographical level

Dimension	Roll-out potential evaluation criteria	Sample of KPIs
Political-Institutional	▪ Is there strong enough political commitment at State level? Municipal level? ▪ How difficult would it be to involve the institutions? ▪ Which degree of involvement of the public administration is required? Is it willing to? ▪ Which is in the specific country/ city, etc. the level of trustiness of the population towards the political entourage?	▪ Expenditure in R&D; ▪ Capacity for institutions to lead development (i.e. power distance[40]/ trust in leadership[41]); ▪ Regulatory barriers
Economic/ Business	▪ Is the project able to achieve economies of scale if its size were increased? ▪ Can the project benefit economically from international implementation (e.g. standardization of technology/ equipment/ solutions, etc.)? ▪ Is the business model adaptable to the resources/ stakeholders/ etc. that present in the business environment where the solution would be rolled-out?	▪ Business model-related KPIs ▪ Trialability; ▪ Break-even sales; ▪ Contribution margin; ▪ Conditions of the financial market; ▪ Risk propensity; ▪ Familiarity with similar products; ▪ Instruments offered by financial institutions; ▪ Size and type of potential investors.

[40] *Power distance* hereby refers to the indicator created by Hofstede analysing societies.

[41] *Trust in leadership* can be differently calculated. Hereby reference is made to the Edelman Trust Barometer: http://www.edelman.com/insights/intellectual-property/2016-edelman-trust-barometer/global-results/

Dimension	Roll-out potential evaluation criteria	Sample of KPIs
Socio-cultural	▪ How relevant is the involvement of the specific part of the population that will use and interact with the solution? ▪ Is the solution responding to a pressing need of the very population that will be using it? ▪ Which level of change in the users' habit would the solution entail?	▪ Market demand[42]; ▪ Advantage for end-users/ stakeholders[43]; ▪ Degree of users' interaction. ▪ Propensity to technological innovation; ▪ Degree of cultural collectivism.
Technology	▪ Is the technology advancement coherent with the level of technology it interacts with where the solution is implemented? ▪ Is the technology used able to integrate with the IT systems present where the solution is implemented? ▪ How big and complex is the netting support required to sustain the project from a technological perspective? Is this available? Can it be available in the next future?	▪ On-site verification of eventual technology gaps.

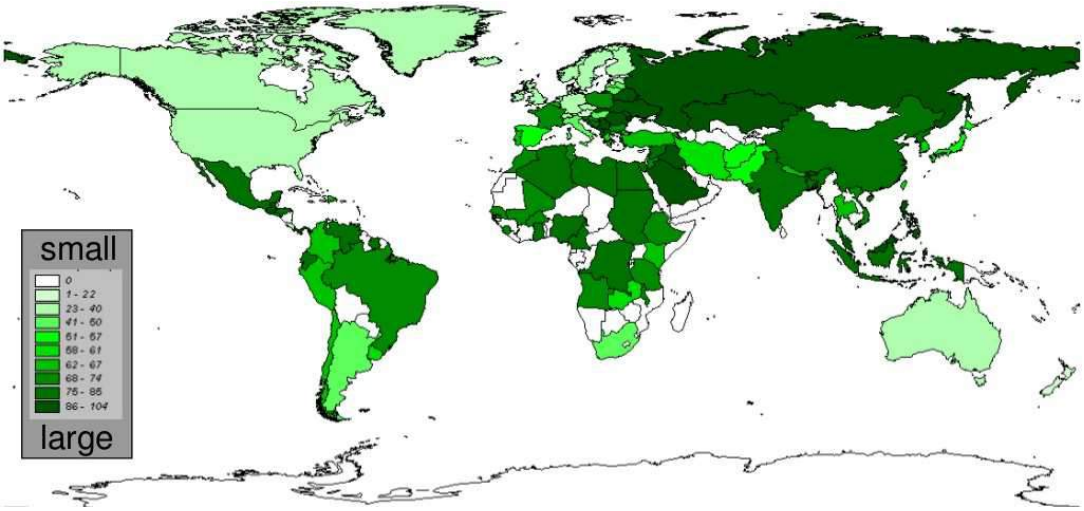
- The first level of analysis concerns the political and institutional environment. The broad indicators listed below are designed to support the understanding of how the political environment would support the roll-out of a specific SCC solution. In particular, it is suggested to analyse:
    - Whether the administration is keen to implement innovative solutions. A synthetic indicator could be represented by the share of GDP in R&D, etc.
    - It is also relevant to consider how keen the society is to follow the political leadership. Such dimension provides the degree at which – in a given environment – the political-institutional dimension can influence the socio-cultural one. A proxy for such assessment can be the analysis of the level of power distance of the society[44].

[42] The indicator – possibly the most relevant one in business replication – is differently addressed, but present in all studies and researches on the subject. Hereby reference is made to the indicators *market demand* and *advantage for end users / stakeholders* in the "replication & scalability" analysis in the CITYkeys study (*Bosch* et al. *2016);*

[43] *Ibid.*

[44] "People in societies exhibiting a large degree of Power Distance accept a hierarchical order in which everybody has a place and which needs no further justification. In societies with low Power Distance, people strive to equalise the distribution of power and demand justification for inequalities of power." Geert Hofstede, Gert Jan Hofstede, Michael Minkov, Cultures and Organizations: Software of the Mind. Revised and Expanded 3rd Edition. New York: McGraw-Hill USA, 2010

Figure 18: Power distance in world societies



Source: Elaboration of Hofstede 2010[45]

Trustees in leaders' choices help to shape the behaviour of the population interacting with the SCC solution (see socio-cultural dimension below). The public support to SCC solutions in countries where the government is highly regarded may help the population perceiving the *innovation* as more positive.

Table 8: Trust in institutions index

Source: Elaboration of Edelman 2016[46]

- Whether there are sensible differences in the regulatory frameworks impacting on solutions from the environment where the project was first implemented

45 Geert Hofstede, Gert Jan Hofstede, Michael Minkov, Cultures and Organizations: Software of the Mind. Revised and Expanded 3rd Edition. New York: McGraw-Hill USA, 2010

46 Edelman 2016 Trust Barometer. http://www.edelman.com/insights/intellectual-property/2016-edelman-trust-barometer/

and where it should be replicated (or, in case of scalability, whether the increase in size would entail a different regulatory framework being applied).

From a business perspective, analysing the possibility and capacity of the business dimension to be applied in a different environment – or scale – translates into the analysis of the flexibility and replicability of the business models. These have been extensively assessed in the previous sections of this document. A brief outline of the main elements required to enable and/or facilitate the roll-out is provided below.

Business models as replicating factors in the roll-out of integrated SCC solutions

For the sake of simplicity, all the elements characterising projects analysed in the previous paragraphs of section 3 have been considered as non-mutating factors. The roll-out potential of projects have been considered on the basis of what SCC solutions were and not what they could have been adapted to be. Whilst this simplification is generally accepted for the exogenous factors , endogenous factors may – under certain limits – be adapted to the different conditions of the environment the projects are to be replicated – and/or scaled – into. This is particularly true when business models are considered in the analysis.

Projects can become more or less "adaptable" to environments depending on how well they configure their business model to match with the local needs, institutional environment, financial market, etc.

The definition of what a business model is vast in the literature. For the purpose of this chapter, the term business model is simplified and entails the strategic approach that considers how to organise the resources to adapt to the context and achieve the objective the project aims to.

Business models are – by definition – adaptable . Hence they represent elements that facilitate the replicability of projects in contexts that present a certain degree of differences from the mother project (i.e. the original project that has been replicated). Specifically, the adaptability of business models focuses on how the resources are gathered and exploited (i.e. financial instruments may be developed to adapt the financial needs of projects to the supply of instruments and resources, etc.).

Business models are therefore keen to innovate – as Casadesus-Masanell and Zhu (2013) said, "At root, business model innovation refers to the search for new logics of the firm and new ways to create and capture value for its stakeholders; it focuses primarily on finding new ways to generate revenues and define value propositions for customers, suppliers, and partners" . Different starting points of business models being adapted to different SCC solutions' context have been analysed in sub-section 2.3.2.

The analysis of how business models adaptability may facilitate the replication of successful integrated SCC solutions is however too complex to be further detailed in this chapter. Indeed it requires that a certain number of solutions are categorised into homogeneous sets – in terms of demand for e.g. resources, risk adversity of shareholders, etc. – and then that common business model solutions to be adapted to them depending on the opportunities that each environment where solutions would be replicated can offer are identified.

It is however suggested that further research is carried out on such aspect of integrated SCC solutions, as the consideration of business model solutions as facilitators for rolling-out may greatly support the spread of innovative, economically sustainable solutions.

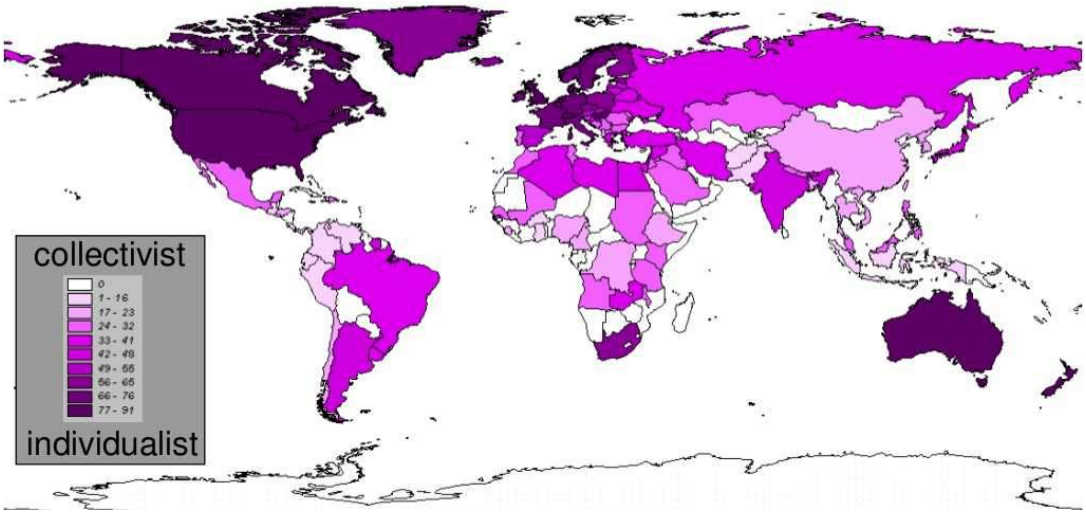
From a social perspective indicators that are relevant being assessed may include:

- Whether the solution **responds to a pressing need** for the society. This element is solution-specific and therefore does not related to a culture, but rather to the single society in which the SCC project is to be implemented. Several indicators can be used depending on the purpose of the SCC solution; e.g. in case of urban mobility the average driving time per households can be considered; for improved ICT systems the average time spent per person in

public administration offices; for safety the number of deaths and injuries due to road accidents, etc.

- Whether the solution requires **the citizenry to interact.** In such case, it is worth considering that the users' behaviour may represent a limiting element for the roll-out of solutions or, rather, a neutral one. As a result, the degree at which a solutions' replicability (and scalability) is limited depends on the propensity of the population to collaborate. SCC solutions are generally related to social and environmental related goals; thus the problem can be simplified in the propensity of the population to act in the society's own good.

Figure 19: Individualism vs. Collectivism in world societies

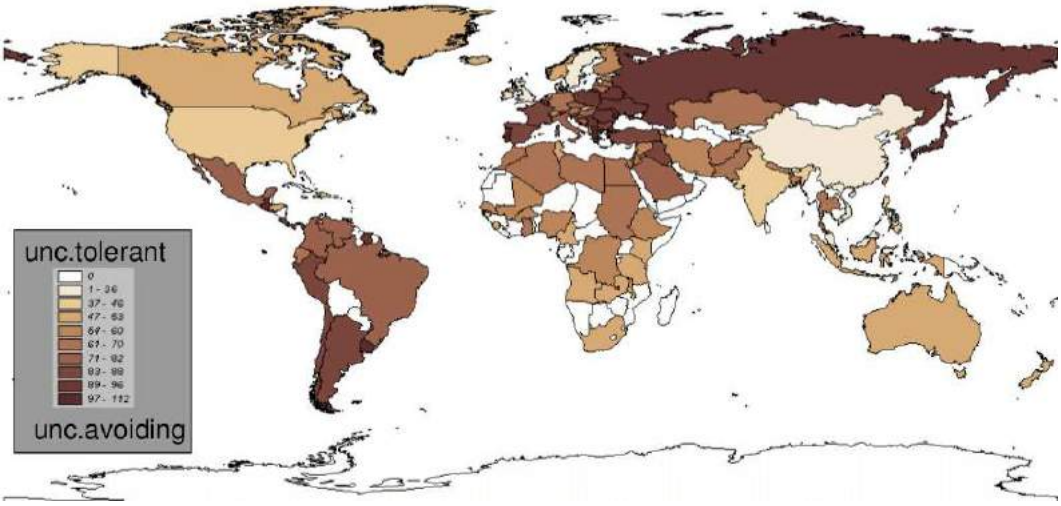


Source: Elaboration of Hofstede 2010[47]

- Whether **society is willing to accept behavioural change** (to the extent required – see citizens' involvement indicator). Depending on the culture users belong to, they may be more or less keen to accept changes in their behaviour and in their daily routine for the progress' sake. A proxy for such assessment can be the analysis of the level of cultural orientation towards conservativism or innovation.

[47] Geert Hofstede, Gert Jan Hofstede, Michael Minkov, Cultures and Organizations: Software of the Mind. Revised and Expanded 3rd Edition. New York: McGraw-Hill USA, 2010

Figure 20: Uncertainty avoidance in world societies



Source: Elaboration of Hofstede 2010[48]

Whilst the analysis has identified a set of indicators for three dimensions, it is worth considering that for the fourth (i.e. technology) the analysis is different. The technological dimension of the analysis is hardly the one limiting the roll-out and – in particular, the replicability of solutions (by definition, technology is the dimension through which globalisation proceeds). However, to scale up or replicate technology-driven solutions it is mainly required that the technology-related network system is able to sustain the infrastructure that is developed. This is ensured through an analysis of the technology required and that present on-site.

Summarising, the successful deployment of SCC solutions in a specific environment strongly depends on how these interface and interact with the environment. It was previously defined that the environment is essentially composed by behavioural attitudes – either at individual or aggregate level. The opportunity to direct such attitudes towards the creation of a SCC-friendly environment would therefore facilitate smart projects' deployment.

The following sub-section briefly presents how the ecosystem – i.e. the sum of stakeholders involved in SCC solutions and relative businesses – can support shaping the environment to support SCC projects' deployment.

[48] Geert Hofstede, Gert Jan Hofstede, Michael Minkov, Cultures and Organizations: Software of the Mind. Revised and Expanded 3rd Edition. New York: McGraw-Hill USA, 2010

Annex IV. In-depth case studies

This section presents the complete description and analysis for the ten in-depth case studies of SCC solution best practices, with a specific focus on each of the business models. The cases are presented in the following order:

- BigBelly, Philadelphia (US)
- Citizen Power Plant, Vienna (AT)
- Data.One, Hong Kong (CN)
- Intelligent Traffic Solutions, Copenhagen (DK)
- Klimastrasse, Cologne (DE)
- MK:Smart, Milton Keynes (UK)
- Nice GRID, Carros (FR)
- Lyon Smart Community, Lyon (FR)
- Smart Melit, Toyota City (JP)
- Urban Platform, Barcelona (ES)

BigBelly

Philadelphia, US

→ Replication potential	♻♻♻♻♻	→ Economic impact	€€€€€
→ Complexity	⚙⚙⚙⚙⚙	→ Environmental impact	🍃🍃🍃🍃🍃
→ Citizens' involvement	🧍🧍🧍🧍🧍	→ Social impact	🏠🏠🏠🏠🏠

Assessment based on feedback provided by the solution's representative as well as on the available sources analysed by the study team.

Short description of the case study

		Key facts and figures
BigBelly solution	**Type of solution**	*Smart Grid for Waste & Recycling*
	Project stage	*2009 (first deployment). Later stages of implementation took place in 2010 and 2013*
	Actors involved	*Public authority and industry (e.g. airports, corporate and governmental campuses, private trash collectors, large retailers, etc)*
	Roll-out of the solution	*Bigbelly first scaled up from pilot areas to cover the entire neighbourhood and then entire city. It has also been replicated in over 40 American states and 20 countries*
	Barriers	• *Low sustainability in scarcely populated areas* • *High cost of the solution (40x traditional garbage bins)*
	Implementation best practice city	*Philadelphia (US)* *(1.5 Mln inhabitants)*
	Main technological areas covered	*Waste management integrated infrastructure*
	Funding mechanism	*Grant, leasing or capital expenditure*
	Economic, social & environmental impact	• *€ [1]773,500 immediate savings in the first year* • *€ 11.8 Mln ongoing savings over 10 years* • *70% annual operating cost reduction* • *Advertising revenue potential* • *Increased waste recycling, etc*
	Replicability factors	• *Collaboration with stakeholders* • *Proper planning of procedure* • *Training and evaluation actions*

[1] $1 = €0.91

Case summary

With a population of about 1.5 Mln people, Philadelphia is the largest city in Pennsylvania and the sixth most populous city in the United States. In 2011, the Philadelphia City Planning Commission adopted a Citywide vision, which, together with 18 District Plans, forms **Philadelphia 2035**, a guide on how to develop the city over the next two decades. With a strong will to build on the city's strengths (which were identified to be a strong metropolitan centre, diverse and authentic neighbourhoods, and industrial-legacy areas) the city clustered its future development efforts around three themes: **Thrive, Connect and Renew.**

The **Connect** section focuses on the public services related to mobility and utilities. Among the objectives related to these fields, is the goal to divert 70% of the city's solid waste away from landfills through reuse, recycling and composting.

With this in mind, the City decided to change the way waste management was done and, consequently, it decided to deploy **the BigBelly solution, an innovative approach to trash collection** developed by Bigbelly Solar, a company founded in 2003 in Newton, Massachusetts, by an MBA student at Babson College.[2]

The Bigbelly solution consists in three key elements:

- **Solar-powered compactors:** Garbage bins equipped with solar photovoltaic panels that turn daylight into electricity, and that enable the automatic compaction of waste;
- **Recycling units,** which are attached to the solar powered compactors to facilitate separation of trash from recyclable material;
- **A CLEAN software solution,** which sends signals to the waste department, notifying when when a collection is needed, so as to reduce unnecessary collection journeys to partially-full garbage units.

Between May and July 2009, about 450 BigBelly units with 210 recyclers were deployed in the Center City area of Philadelphia. The next deployment of 205 units with 100 recyclers was completed between April 2010 and September 2011 along the business corridors outside Center City. The third deployment of 235 units with 84 recyclers was completed between July 2010 and October 2010 along North and South Broad Street and additional business corridors. By July 2013, over 1,400 stations were installed (compactors and recyclers). This extensive deployment makes Philadelphia the first city to use BigBelly units in such large quantities and along entire collection routes.

Each BigBelly Solar Compactor costs around € 3,400-3,600 whilst the recycling kiosk comes to around € 700. In Philadelphia, almost 90% of the costs were covered through a Recycling Performance Grant funding and Commerce Department Capital project funds.

Simultaneously to the first deployment of BigBelly, and as part of the broader initiative **Green works Philadelphia** – the comprehensive sustainability framework designed to help the City meet the goal of becoming "America's number one green city" – the city launched a major public relations and neighbourhood education campaign called **Philly Throws Green.** The campaign's website, whose tagline is "One goal, many hands," includes descriptions of how the solar compactors work, a map of locations, and information on how the machines help.

As a result of the deployment of the solution in Philadelphia, first estimates of the impacts in Philadelphia include:

- Immediate and ongoing cash flow savings;
- Annual operating cost reductions of 70%;
- Advertising revenue potential.

[2] The company received several rounds of equity investments, the last of which was in 2009 for approx. € 2.9 Mln.

Other tangible benefits of the solar-powered compactor deployment that go beyond the cost-saving impacts described above are:

- Reduced truck traffic and thereby reduced congestion, traffic and road wear;
- Increased waste recycling;
- Reduced litter and improved cleanliness and appearance of public spaces;
- Pest-resistance;
- Reduced CO_2 emissions;
- Discouraged household dumping.

The devices are being tested by governments and others customers in 40 states and 20 countries. About 100 BigBelly compactors are being used by various entities in New York, including the Bronx Zoo. Chicago has 90. There are about 30 in Vancouver. Vienna has 60 and they are also being used in parts of Australia, Israel, the UK and France.

As far as this study is concerned, this project is relevant because, as depicted in the following figure, it **covers all the three vertical/technological priority areas of the EIP-SCC Strategic Implementation Plan and most of the horizontal/transversal ones.** The project involves an ICT infrastructure that provides data to the city, and include applications and digital solutions relevant to the transport and garbage management domain.

Figure 1: SCC Solution Integration Dashboard

Market analysis

Today, cities face an enormous challenge: to keep or increase the level of service provision in spite of city budgets shrinking as a result of austerity measures. BigBelly can reduce the maintenance costs of collecting garbage and can ultimately save portions of municipal budget that can be devoted to other services.

Smart waste management is at a nascent stage of development. Even in mature waste management markets like North America and Western Europe, opportunities abound for commercializing emerging technologies and extending investments across the entire waste management value chain. Overall, **the Municipal Solid Waste (MSW) management industry is entering a period of active development,** as the total volume of waste generated globally is expected to grow from 1.5 Bln tons in 2014 to 2.2 Bln tons by 2023.

Navigant Research[3] estimates that **644 Mln tons of MSW was managed by smart MSW technologies in 2014.** This volume is expected to increase to 938.4 Mln tons by 2023, representing € 38.4 Bln in cumulative revenue generated from installed smart MSW technology over the forecast period. Between 2014 and 2023, annual revenue from smart MSW technology is expected to experience a 12.2% compound annual growth rate (CAGR), significantly outpacing annual revenue growth from conventional MSW technology (4% CAGR).

Main impacts

The first estimates of the impacts of the deployment of BigBelly in Philadelphia include:[4]

- **Immediate savings:** By signing up to a 3-year financing arrangement, the city did not have up-front capital costs and could realize cash flow savings in the first year of approximately € 773,500;
- **Ongoing savings:** The City was able to save nearly € 11.8 Mln in cumulative operating cost savings over the 10 years after the deployment of the solution;
- **Annual operating cost reduction of 70%:** Lower collection demand reduced operating costs and associated vehicle fuel use and emissions;
- **Increased waste recycling:** The solution made it possible to divert waste from landfills, avoiding fees and creating new revenue streams from the recycled material flows.

> "The City says the BigBelly cans save them about € 0.96 Mln a year in collection costs, because sanitation workers dont have to swing by as often to collect the trash, given the compacting function."
>
> (Kerkstra, P. from phillimag.com)

The City identified a number of other tangible benefits of the solar-powered compactor deployment beyond the cost-savings described above:

- **Reduced truck traffic:** Avoiding 12 collection trips per week, and avoiding the second or third collection trip each day, keeps collection vehicles off the streets and thereby reduces congestion, traffic and road wear;
- **Reduced litter:** The compactors are enclosed, which decreases litter and improves the cleanliness and appearance of public spaces;
- **Pest-resistant:** The compactors' enclosed design prevents rodents, birds and other pests from accessing the trash;
- **Reduced C02 emissions:** Reduced collection trips leads to reduced fuel consumption and associated greenhouse gas emissions;
- **Discourage household dumping:** The limited size of the insertion hopper makes illegal dumping of household or commercial trash more difficult;
- **Advertising revenue potential:** The City is considering potential revenue from selling advertising space on the compactors and recycling units.

The programme also supports the City's commitment to advancing recycling and sustainability by introducing public space recycling to the City for the very first time, and by **reducing waste collection vehicle trips by 70%.**

[3] Navigant research (2014) Smart Waste - Advanced Collection, Processing, Energy Recovery, and Disposal Technologies for the Municipal Solid Waste Value Chain: Global Market Analysis and Forecasts

[4] City of Philadelphia (June 2009) Case study: cost-savings from solar-powered compactors for trash and recycling. Impacts of solar-powered trash compactors, companion recycling units and wireless notification technology on operating costs, fuel consumption and vehicle emissions in center city Philadelphia. Inaugural Report.

Rich Picture Model

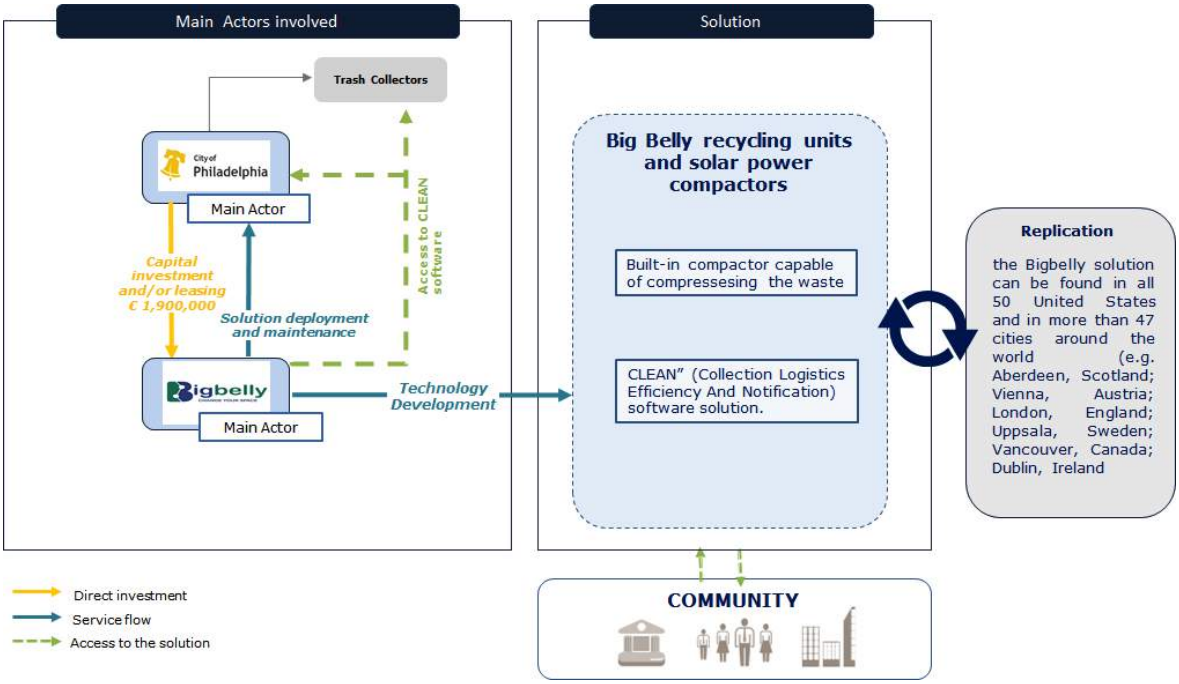


Figure 2: Rich Picture approach of BigBelly

As illustrated in the picture above, customers (in this case the City of Philadelphia) can have access to the BigBelly solution through **capital investment and/or leasing.** BigBelly provides customers with recycling units and solar-powered compactors; these are equipped with the CLEAN software solution, through which cities and trash collectors can monitor the usage of trash collectors and organise waste collection.

Business Model Canvas

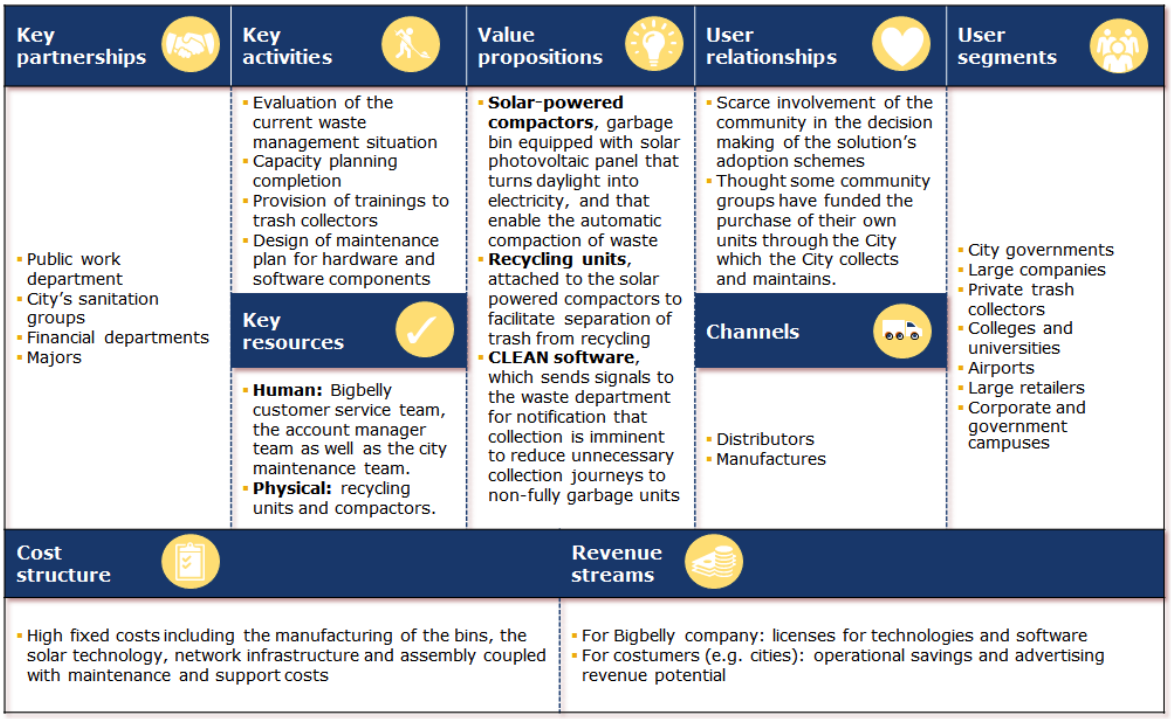


Figure 3: Business Model Canvas of BigBelly

User segments

The **customers** are mainly city governments (especially medium- or large-density cities). Large companies and private trash collectors could also use the system to reduce costs. Other consumers include: park systems, colleges and universities, airports, large retailers, corporate and government campuses that want to reduce the cost of a mandatory but expensive and time-consuming service: waste disposal and recycling.

Value proposition

The BigBelly System is a "Smart Grid for Waste & Recycling" for its customers, providing visibility and control for the management of waste and recycling collection operations.

BigBelly compactors are **solar-powered,** requiring no wiring or external electrical connection, and automatically compact the waste. The solar photovoltaic panel turns daylight into electricity, which is stored in a small battery inside the unit, allowing the machine to run at night and during prolonged periods of bad weather solely on battery reserve power. As users deposit trash, it falls into a 120 litre bin inside the machine. When the level of trash rises above the top of the inner bin, the trash interrupts an electric eye beam, triggering the motor of a built-in compactor that compresses the waste down into the bin to allow up to eight times the amount of litter to be accommodated prior to emptying the trash.

This process repeats automatically as needed until the machine is ready for collection, typically holding about 600 litres of un-compacted trash. The recycling units are attached to the solar powered compactors to facilitate separation of trash from recycling. The recycling units are non-compacting, and have a 190 litre inner bin.

In addition, the solution is fitted with technology to reduce unnecessary collection journeys to non-full garbage units: each BigBelly Solar Compactor is fitted with the **CLEAN** (Collection Logistics Efficiency And Notification) software solution. When the compactors are almost full, the LED light indicator on the front panel goes from green to yellow, and the machine sends a wireless message to a central computer server, notifying staff that the unit is ready for collection. When the machines are unable to compact any more trash in the inner bin, the LED indicator turn red, notifying staff that immediate collection is required. In this way, the waste department managers can optimize collection routes in real-time.

> "When they're full they send us a text message."
>
> Andrew Stober, from the Mayor's Office of Transportation and Utilities

Moreover, CLEAN software produces useful data, such as:

- **Real-Time Data:** Up-to-the-minute status on which locations need to be collected and which ones do not;
- **Historical Analysis:** Track the city's progress as it starts reducing the collection frequency and reallocating resources to other tasks;
- **Heat-mapping:** Location-specific data to drive capacity planning activities, route optimization and more;
- **Diversion Rate Reporting:** Volume-based reporting on each collection point, giving you powerful data to report to constituents and stakeholders.

The following figure summarises the key features of the solution.

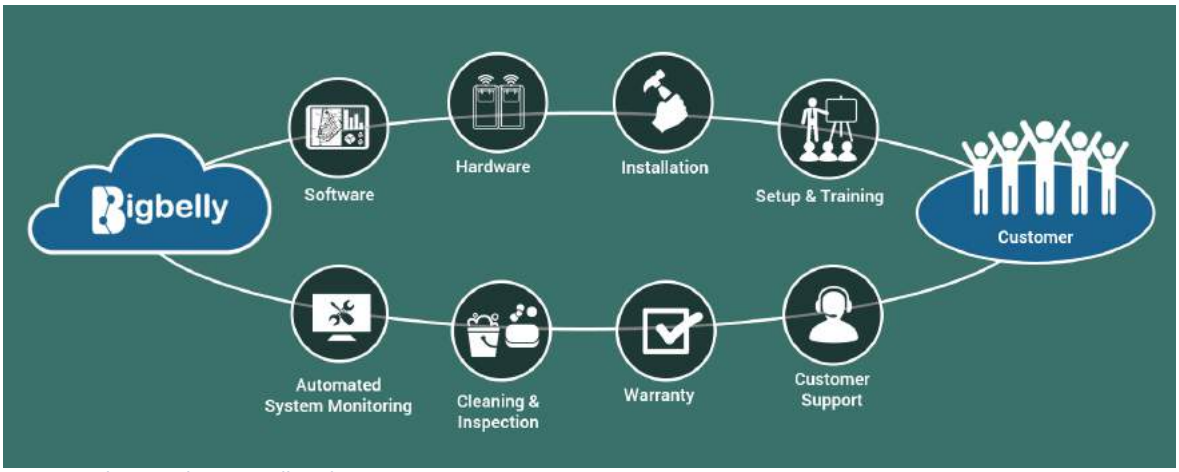


Figure 4: The complete BigBelly solution

Channels

In general, the channel to customers are the **distributors.** However, in Philadelphia the first deployment of BigBelly stations took place directly through the manufacturer.

User relationships

Although citizens and users influenced the design of the compactors, there is no direct involvement of the community in the decision making of the solution's adoption schemes.

However, according to Mr. Nutter, Mayor of Philadelphia, the public response has been very positive. As an example, several community groups have funded the purchase of their own

units, which the city collects and maintains. Also, the Philadelphia Streets Department worked with the City's Mural Arts Programme to address graffiti on some units.

Revenue streams

The revenue streams for the company are **licenses for technologies and software.** The cities or clients pay to use the system which is then implemented by BigBelly and operated by a contracted third-party.

The two typical business models adopted by cities to cover the investment are: capital investments (especially for European cities) or leasing (approx. 80% American cities); the latter has recently become more widespread, as it is easier for municipalities to justify a monthly fee (i.e. leasing) in their balance sheets rather than a up-front capital investments. In this respect, BigBelly offers a leasing programme called "Connect," in which consumers pay a monthly service fee and engage in a 5 year period service package which provides the installation of stations and maintenance.

The table below illustrates the sources of funding adopted from the first deployment of the solution up to 2013. The data shows how a major deployment took place in 2010, and that a major source of funding was Act 101 (American Recovery and Reinvestment Act) and the Recycling Performance Grant funding, which allowed the city to receive the fund provided that it met the performance requirements of the grant, which it did.

Funding Source	2009	2010	2011	2012	2013	Total	C*	R**
BigBelly Lease Purchase 3 year term Funded with PA Act 101 Section 904 Grant Funds	*660,046*	*660,046*	*660,046*	-	-	*1,980,139*	*500*	*210*
Philadelphia Authority for Industrial Development Grant Agreement (use of Bond Funds)	-	*813,606*	-	-	-	*813,606*	*220*	*100*
Energy Efficiency and Conservation Block Grant (US Department of Energy funded by American Recovery and Reinvestment Act)	-	*886,116*	-	-	-	*886,116*	*245*	*84*
Commerce Department Bond Funds	-	-	-	*245,977*	-	*245,977*	*56*	*25*
City Council Transfer Ordinance and Sanitation Division Operating Budget (Act 101 Section 904 Grant Funds)	-	-	-	*59,150*	*71,721*	*130,871*	*20*	*75*
Philadelphia Redevelopment Authority (Pt Breeze)	-	-	-	-	*38,915*	*38,915*	*10*	*10*
Funded by Community Organizations	-	-	-	-	*65,388*	*65,388*	*16*	*14*
Total	660,046	2,359,770	660,046	305,127	176,025	4,161,017	1,067	518
						Actual deployment	**992**	**415**

Table 1: Funding sources

** Compactors* *** Recyclers*

Subsequent purchases were financed through a leasing programme offered by BigBelly, which therefore did not require an upfront capital expenditure by the city. The financing arrangement lasted three years, during which the equipment lease costs was less than half the amount of the operating cost savings, resulting in a **net cash-flow savings for the city during the lease period.**

BigBelly solutions usually generate **operational savings.** In central Philadelphia for instance, the 450 BigBelly units replaced over 700 litter baskets. The solar compactors increase capacity by approximately 5 times, compared to the City's wire mesh litter baskets, enabling Philadelphia to reduce its collection frequency from 17 times per week to 5 times per week, and to reduce budgeted staffing from 33 to 9, operating on a single shift rather than three, allowing these crews to be redeployed for other work. Reduced collection trips also substantially cut related fuel use and greenhouse gas emissions. The annual cost of collection with the new system is estimated to be approximately € 655,200 – representing a 70% reduction from the old system. Over the ten-year useful life of the compactors, the cumulative projected savings that the city expects to realize is about € 11.8 Mln. For the city, the return on investment on the initial purchase was approx. after 2 and a half years.

Figures that compare collection frequency and associated costs under the old system versus the new system are summarized in the table below.

	Before	After	Savings
Collection frequency	17/week	5/week	12/week (71%)
Number of workers	33	9	24 (73%)
Number of shifts	3	1	2 (67%)
Annual operating cost (€)	2.1 Mln	655,000	1.5 Mln (67%)
Cumulative 10-year cost (€)	20.9 Mln	9.1 Mln *	11.8 Mln (70%)

Table 2: Comparison of collection frequency and associated costs

*Including the cost of the solar compactor and recycling equipment

Additional research carried out by BigBelly reveals that for some cities (especially those that are very densely populated) the average cost of emptying a waste can is approx. € 2,730 a year; that cost could drop to less than € 540 with BigBelly.

BigBelly was procured through a **traditional procurement bid,** which was awarded to BigBelly as the only bidder with a one year base term and three one year renewals at the City's sole option.

Key resources

Key resources are of human and physical nature. These include the BigBelly customer service team, which takes care of all hardware related issues, and the account management team, which deals with all software, including maintenance. Human resources include also the city maintenance team and the employees involved in the trash collection.

Physical resources include both solar compactors and recycling units.

Key activities

Before the deployment of the BigBelly solution, City officials and specialists from BigBelly Solar evaluate the current waste management situation by **jointly completing a comprehensive analysis of the number and placement of all trash receptacles, the timing of the collection routes, and the costs associated with the entire operation.** Then, the parties complete capacity planning and determine the optimal deployment of BigBelly solar compactors, their companion recycling units, and related wireless notification technology. Once this analytical work is completed, BigBelly proposes a solution which is best targeted to the city.

Once the solution is deployed, other key activities include the provision of training to trash collectors, as well as the maintenance of both hardware and software components.

Key partnerships

In Philadelphia, the BigBelly Programme was implemented by the Streets Department's Sanitation Division. The network design was created by the Sanitation Division using the existing litter basket deployment as a guide. In addition, the Commerce Department, although not directly involved in selecting specific locations, marked out specific corridors where they have partnerships with community groups and business districts and provided a significant amount of funding. The Mayor's Office as well as City Council have been very supportive of the BigBelly Programme.

Cost structure

The cost structure is characterized by **high fixed costs,** including the manufacturing of the bins, the solar technology, network infrastructure and assembly. The software development should also be considered. High maintenance and support costs would also be encountered to ensure the systems stay functional. Aside from this, there are **low variable costs** as little labour is needed once the system is sold.

In Philadelphia, the purchase of the first 450 BigBelly Solar Compactors and 210 Single Stream Recycling Kiosks along with wireless communication hardware, software, training/installation support, a four year warranty and € 143,623 in interest charges, cost € 1,980,140. The contract was for a one year initial term with an option to renew for up to three additional one year periods. Moreover, the city incurred an additional € 227,000 in equipment added to the system to the Philadelphia commerce department.

Each BigBelly Solar Compactor cost around €3,400-3,600 whilst the recycling kiosk was around € 700. In addition to this up-front investment, other costs that might be incurred during the lifetime of the solution might be:[5]

- **Battery replacement,** needed after three-five years and estimated to be in €455 per unit;
- **Maintenance costs due to graffiti, vandalism or malfunctioning:** Estimated to be approximately € 23-27 per work order (in Philadelphia, there are approx. 300 work orders per month for an overall 1,100 units spread throughout the city) and € 36,400-54,600 in components a year to maintain the system;
- **Labour costs:** For BigBelly repair operations, in Philadelphia there are three employees dedicated to this, whose overall salary is approximately € 81,900;
- **Training costs** for the employees that would be responsible for collecting garbage in low use parks, equal to approx. €18,200 (including BigBelly field technical support);
- **Communication costs, including the CLEAN website,** bundled together and estimated to be approx. € 113,750 per year.[6]

In addition, in 2014 the Division of Philadelphia in charge of BigBelly completed a main controller board upgrade at a cost of about € 45,500 for 173 units to improve the communications, upgrade software and diagnostics capabilities of the older equipment.[7]

Moreover, in an effort to save parts costs, the Division developed a process to restore the solar bubbles, side skins, trash hopper doors, and mounting plates. Additionally, units that are destroyed by vehicle accidents are typically reconstructed in the Department's metal shop.

[5] Evans School of Public Affairs (2013) Benefit-Cost Analysis of BigBelly Solar Trash Compactors in City of Seattle Parks
[6] This cost has been covered by PA Act 101 Section 904 grant funds as well as about 50% of the parts costs
[7] This project was funded with PA Act 101 Section 904 funds.

Barriers/challenges

There are two main barriers reported. Firstly, BigBelly is particularly applicable to medium/large cities or to very densely populated neighbourhoods. In other words, the solution would be **much less economically sustainable in smaller cities without a very dense population,** where garbage collection frequency is not that high. The second main barrier is the **high cost of the solution,** which is about 40 times more expensive than traditional garbage bins. This in particular might create difficulties for politicians trying to justify the expense, especially in times of budget cuts and austerity measures.

Replicability factors

Developing a successful public space recycling programme requires **collaboration with stakeholders,** involvement with the community, the creation of a recycling collection infrastructure and a clear articulation of the environmental benefits.

Proper planning is needed when changing modes of operation, including planning procedures, training, and evaluation actions. Cities need to schedule periodic training of the staff and schedule periodic maintenance, purchasing proper tools or supplies to clean and maintain the compactors. When developing programmes, municipalities need to consider the successes and challenges of their existing recycling programmes and identify long-term goals. Cities could also carry out a cost benefit analysis before putting the solution in place, as the impacts vary according to the city environment the solution is put in.

In short, the key ingredients for successful replication include:

- Carrying out a cost benefit analysis to estimate the impact of the solution in a given environment;
- Identifying the right neighbourhood (high traffic area with high foot traffic) to carry out a pilot phase and test citizen response;
- Pick the right amount of units and identify the best places to locate them;
- Develop a maintenance plan, as for the first 2-3 years maintenance is minimal, but it becomes more intensive afterwards.

As depicted in the following figure, the BigBelly solution can be found in all 50 United States (including: Cincinnati, Colorado, Ohio, Boston, Massachusetts, Provincetown, Massachusetts, Chicago, Illinois, Dallas, Texas, Baltimore, Maryland, Philadelphia, Pennsylvania, Ventura, California, Oakland, California, San Diego, California, Queens, New York, Aberystwyth, Boston) and more than 47 countries around the world [e.g. Aberdeen, Scotland; Vienna, Austria; London, England; Uppsala, Sweden; Vancouver, Canada; Dublin, Ireland (which, so far, has been so far the most successful case outside the US)].

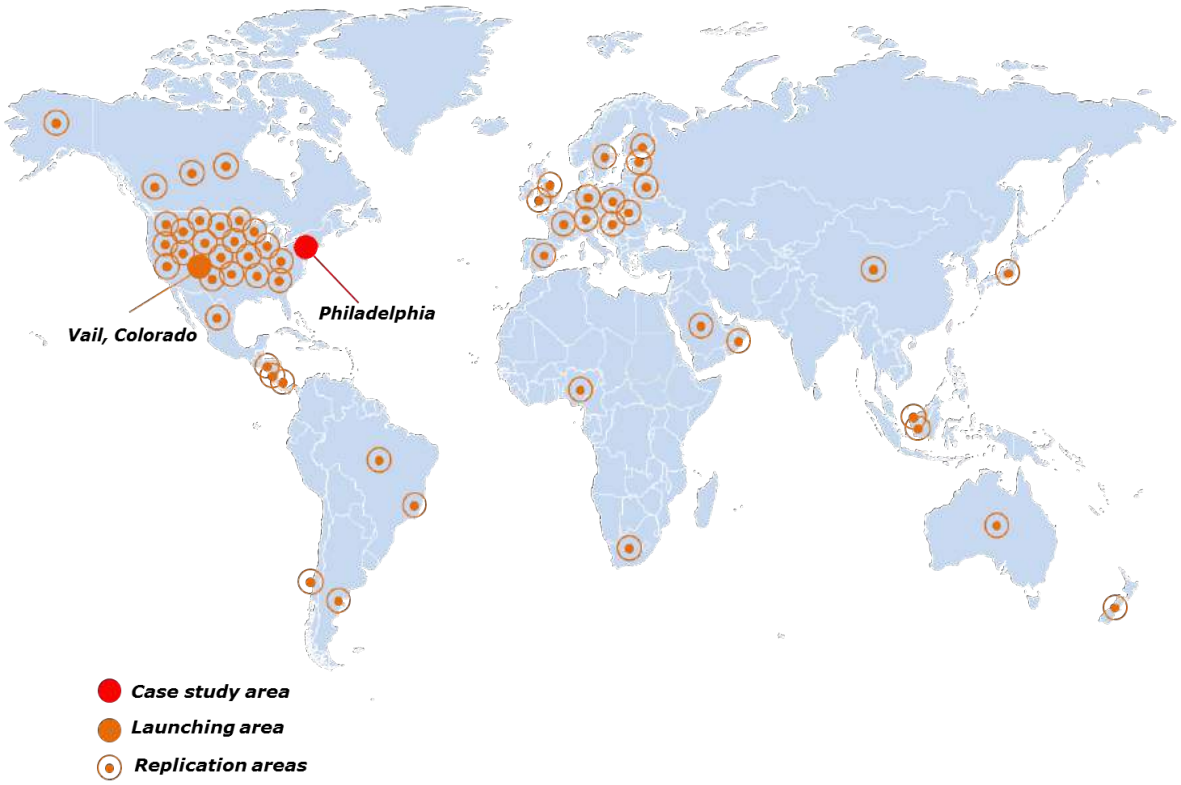


Figure 5: Replication areas of BigBelly

	"Replication recipe"
Problem definition	✓ *Carry out a cost benefit analysis before purchasing the solution, as its impacts may vary significantly from city to city or neighbourhood to neighbourhood (i.e. the solution is more economically sustainable in more densely populated areas)* ✓ *Define the budget, program scope, and implementation phases* ✓ *Identify and prioritize public spaces also based on visibility and popularity*
Infrastructure and financing	✓ *Develop systems to track and measure diversion, and a maintenance plan* ✓ *Select the right financing/funding scheme (BigBelly offers both leasing programmes or purchases through capital investments) also according to the area selected. Consider crowdfunding as an option, as it proved to be particularly successful in some districts of Philadelphia*
Governance	✓ *Build partnerships with all stakeholders, including community groups*

Table 3: Replication recipe of BigBelly

Sources

Interviews / Contact persons	› Leila Dillon, VP Marketing and NA Distribution at BigBelly › Claude LeBlond, VP International Business at BigBelly › Rick Gaudette, BigBelly Philadelphia account representative › Bill Eddy, BigBelly Philadelphia account representative › Donald Carlton, Deputy Commissioner for the City of Philadelphia, › Scott McGrath, engineer at the City of Philadelphia,
Literature supporting the research of this case	› Alan Butkovitz (July 2010) Purchase and deployment of BigBelly solar compactors › Evans School of Public Affairs (2013) Benefit-Cost Analysis of BigBelly Solar Trash Compactors in City of Seattle Parks › City of Philadelphia (June 2009) Case study: cost-savings from solar-powered compactors for trash and recycling, Impacts of solar-powered trash compactors, companion recycling units and wireless notification technology on operating costs, fuel consumption and vehicle emissions in center city Philadelphia, Inaugural Report,
Internet sources	› BigBelly, Waste Advantage Magazine: Thinking Outside the Bin http://bigbellysolar,com/wasteadvantage-magazine-thinking-outside-the-bin/
Figures sources	› http://bigbelly.com/

Citizen Power Plant

Vienna, Austria

→ Replication potential		→ Economic impact	
→ Complexity		→ Environmental impact	
→ Citizens' involvement		→ Social impact	

Assessment based on feedback provided by the solution's representative as well as on the available sources analysed by the study team.

Short description of the case study

		Key facts and figures
Citizen Power Plant solution	**Type of solution**	*Citizen renewable energy power plants*
	Project stage	*First pilot of 500 kW photovoltaic power plant was set up in 2012. Now, 21 photovoltaic plants and 2 wind farms are operating in the Vienna region*
	Actors involved	*The city's electric company (Wien Energie), public and private actors that rent the ground or the roof for the plants, engineering, construction, and operations and maintenance companies, citizens*
	Roll-out of the solution	*The Citizen Power Plant solution has scaled up from a pilot photovoltaic plant in Vienna, to 21 photovoltaic plants and 2 wind farms in the city and in the Vienna region. It has also been replicated in other regions in Austria and in other countries around the world*
	Barriers	• *Banking legislation* • *Regulation in the electricity sector*
	Implementation best practice city	*Vienna (Austria)* *(1.7 Mln inhabitants)*
	Main technological areas covered	*Renewable power plants (photovoltaic and wind)*
	Funding mechanism	*Citizen sales and lease back model*
	Economic, social & environmental impact	• *7,000 tons of CO_2 avoided yearly* • *€ 25 Mln of investment from citizens (to date)* • *8,000 families supplied with renewable energy*
	Replicability factors	• *Strong political will* • *Legal system*

Case summary

As Europe continues to experience a significant transition towards the increased use of renewable forms of power generation, the municipality of Vienna, through Wien Energie (the electric company that it owns), has pioneered the development of several citizen solar plants since 2012.

In Vienna the majority of citizens live in flats. There are many hurdles and burdens for tenants/flat owners who wish to take part in renewable energy deployment. For example:

- Complex ownership structures;
- Approval procedures;
- Downscaling investment options;
- No technical expertise;
- Conservation of ancient houses.

Wien Energie's **"Sale & Lease" participation model** overcomes these hurdles and provides a simple, profitable and secure option for interested people to participate in renewable energy development.

By investing in community-funded renewable energy power plants (solar, wind and potentially others), Viennese citizens have the opportunity to participate in the development of renewable energies. In 2012, the Citizens' Solar Power Plants marked the beginning of the dawn of this scheme for Vienna and showed the city's clear commitment to developing renewable energy power plants.

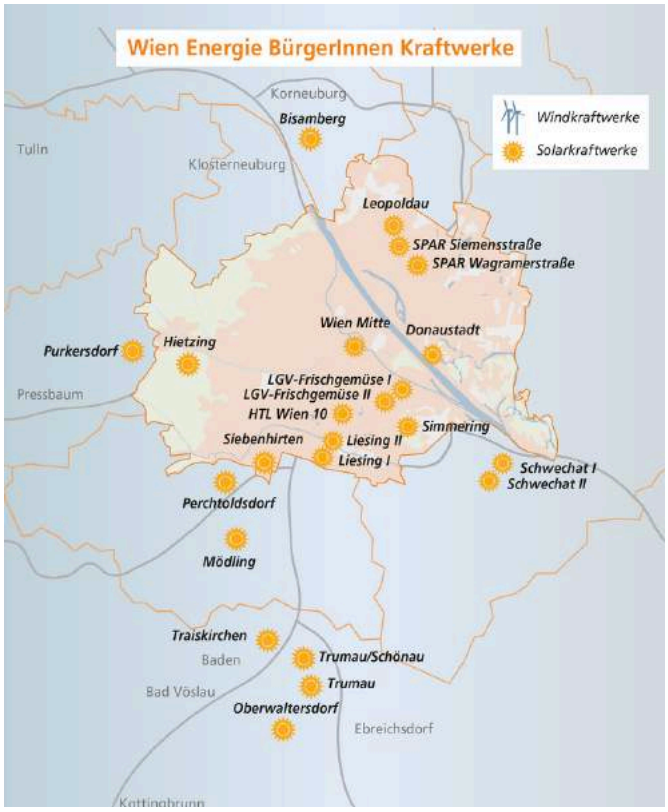
The main concept is to sell solar panels to those citizens unable to install them due to their lack of rooftop space and to then let the electric company plan, build and operate the solar power facilities. In this way consumers operate (with the support of the electric company) as an energy provider as they sell the power to the grid and earn revenues. **The business model turned out to be sustainable and profitable for the electric company.** There are currently 21 citizen solar plants in and around the Vienna region and panels/shares always become sold out in a very short amount of time.

> Since 2012, a total of 21 plants with around 25,000 modules are being operated in the Vienna region; 5,500 people have been involved in these projects, with an investment of more than € 20 Mln (as of July 2015).

According to Vienna's Department of Energy, the potential of the roofs on which it will be possible to build photovoltaic solar plants in Vienna is important: theoretically, more than 50% of the roofs would be available to produce energy from the sun.[1]

The following figure illustrates the distribution of citizen renewable power plants (both photovoltaic and wind) in the area of Vienna. In the city of Vienna there are 13 photovoltaic power plants in operation whilst 8 photovoltaic and 2 wind power plants are located in the Vienna region.

[1] https://www.wien.gv.at/stadtentwicklung/energieplanung/pdf/energiebericht2013-en.pdf



NB: Pottendorf/Tattendorf I and II wind parks not shown on map

Figure 1: Citizen renewable power plants in the area of Vienna

The following table gives further details on the 21 citizen photovoltaic power plants in the city and in Vienna region.

#	Name of the plant	Power kWp	Number of panels/shares	Yearly produced Energy MWh	Year of installation
1	Purkersdorf	150	576	150	2016*
2	LGV Frischgemüse II	555	2,177	575	2015
3	Traiskirchen	100	400	100	2015
4	Abfallverband Schwechat	80	308	80	2015
5	HTL Wien 10	255	1,021	255	2014
6	Liesing II	494	1,976	500	2014
7	Siebenhirten	132	528	132	2014
8	SPAR Wagramer Straße	96	377	100	2013
9	SPAR Siemensstraße	80	314	84	2013
10	LGV Frischgemüse	300	1,200	300	2014
11	Wien-Mitte	356	1,424	324	2013
12	Hietzing	135	538	135	2013
13	Liesing	500	2,000	500	2013
14	Simmering	490	1,920	490	2013
15	Abwasserverband Trumau-Schönau	220	880	220	2013
16	Bisamberg	91	366	91.5	2013
17	Oberwaltersdorf	500	2,000	500	2013
18	Perchtoldsdorf	207	826	207	2013
19	Trumau	300	1,200	300	2013
20	Donaustadt	500	2,040	500	2012
21	Leopoldau	480	1,920	432	2012
Total	**-**	**6,021**	**23,991**	**5,975**	**-**

Table 1: Deployed citizen photovoltaic power plants

The 21 citizen photovoltaic power plants cover the electricity consumption of 2,500 families and save 2,000 tons of CO_2 each year.

Due to the success of the scheme, as of 2015 the municipality of Vienna (through Wien Energie) was able to branch out into wind energy. This is the first time a participation / crowdfunding model of this kind has been implemented in an urban area and it has proven economical even without subsidising feed-in tariffs. At the moment, two wind power plants have been created and in both cases the shares sold out within minutes of being advertised.

The following table gives further details of the 2 citizen wind power plants in the city and in the Vienna region.

#	Name of the plant	Power kWp	Number of panels/shares	Yearly produced Energy MWh	Year of installation
1	Pottendorf-Tattendorf	3,200	2,579	7,040	2015
2	Pottendorf-Tattendorf II	3,200	2,579	7,040	2015
Total	**-**	**6,400**	**5,158**	**14,080**	**-**

Table 2: Deployed citizen wind power plants

The two citizen wind power plants cover the electricity consumption of 5,600 families and save 5,100 tons of CO_2 per year.

By conducting all these investments, Wien Energie aims to increase the amount of electricity produced from renewable energy sources by up to 50% by 2030. The use of renewable energy represents a key focus in the company's commitment to energy security and sustainability[2].

In addition, it is important to note that **this solution represents an attractive investment opportunity for citizens, given the current environment of very low interest rates,** which may benefit from an annual payment that is well above the current rates available on savings accounts. However, a much more important point is that this solution enables the population to actively participate in efforts to increase the use of renewable energies.

This business model is profitable because the costs payed by the citizens largely cover, even without subsidised feed in tariffs, the plants' contruction, operation and maintenance and the ground/roof renting, resulting in a solid win-win solution. For both the present and the future, what **with the continuosly lowering costs for the construction of photovoltaic power plants, this business model will continue to become even more profitable and sustainable.**

The strength of this business model is that it enables citizens who may not be able to install and own renewable power plants to participate in the distributed deployment of renewable energy. This solution also presents itself as something that goes beyond (environmental) sustainability, and as **an interesting financial instrument, similar to an obligation,** with a guaranteed annual interest rate.

A key requirement of this solution is strong long term political and regulatory stability on distributed electricity generation in Austria, and a deep trust by all stakeholders in the institutions.

As far as this study is concerned, this project is relevant because, as depicted in the following figure, it covers two of the three vertical/technological priority areas of the EIP-SCC Strategic Implementation Plan (Sustainable District & Built Environment, Integrated Infrastructure & Processes) and many of the horizontal/transversal ones. As mentioned above, citizens are very much involved and they participate in the deployment of renewable power plants through an innovative and interesting business model and funding mechanism. Furthermore, the dedicated

[2] http://www.wienenergie.at/media/files/2015/0605_we_englisch_151231.pdf

web portal and app make it possible to monitor energy production and act as communication channels, thereby ensuring knowledge sharing. This project has required an in depth assessment of policy and regulation of the electricity sector and shows a level of planning that is well integrated with the city's sustainability targets.

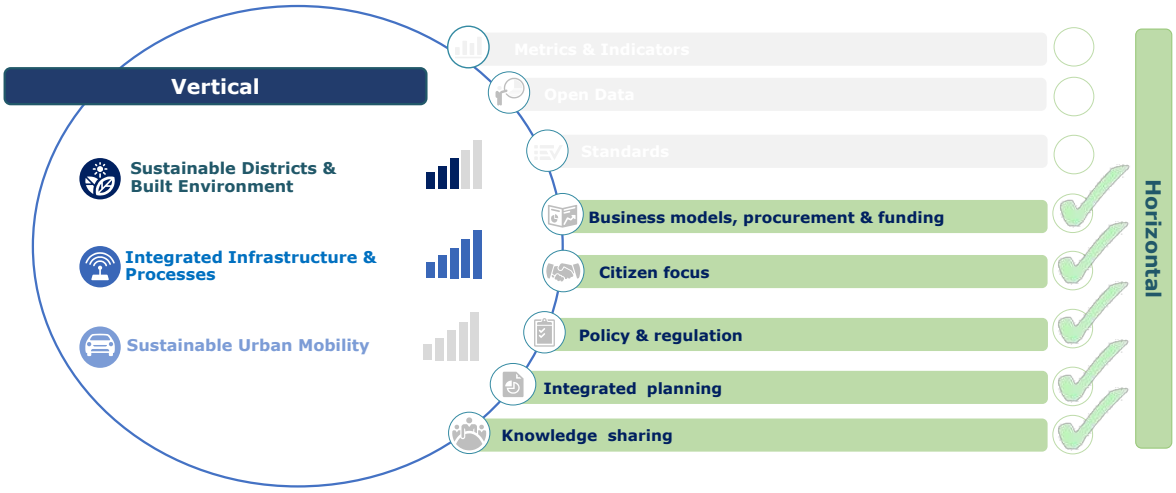


Figure 2: SCC Solution Integration Dashboard

Market analysis

This solution is spreading rapidly to many other parts of the world and is **attracting much interest among citizens, because it gives them the chance to participate in renewable and sustainable energy projects regardless of their ability to have a renewable power plant installed on their own premises** (some of the barriers to installation include the high cost of the power plant, home ownership limits (rental) and unsuitable rooftops due to orientation or shading).

Community-owned renewable energy projects are emerging with a variety of models in an increasing number of countries, including Australia, Canada, Japan, Thailand, the US, the UK and other areas of Europe, including also rural and more remote regions. Both Denmark and Germany have a long tradition of community and local ownership of renewable energy systems: in Germany, 47% of the renewable energy generation was owned by individuals or investor co-operatives as of 2012,[3] although that percentage has declined in recent years. In the US, community solar gardens, which sell power to local utilities in exchange for monthly credits to investors, have continued to spread over the course of 2014, and several US states actively promote these structures. **Community-owned micro-utilities relying on solar PV are also becoming more common developing countries.** Today, shared ownership is expanding through a variety of means, including innovative financing mechanisms such as crowdfunding.

> The market of community renewable power plants is a rapidly emerging model that combines the value of direct customer "ownership" of rooftop solar infrastrucutre with the flexibility and economic advantages of utility-scale

[3] http://eeg.tuwien.ac.at/eeg.tuwien.ac.at_pages/events/iewt/iewt2015/uploads/fullpaper/P_319_Salm_Sarah_ 31-Jan-2015_13:20.pdf

People have many reasons for organizing or participating in a community solar project. Just as their motives vary, so do the possible project models, each with a unique set of costs, benefits, responsibilities, and rewards. The main ones are:

- **Utility-Sponsored Model,** in which a utility owns or operates a project that is open to voluntary rate-payer participation (such as Sacramento Municipal Utility District – SolarShares Program and Tucson Electric Power – Bright Tucson Program);
- **Special Purpose Entity (SPE) Model,** in which individual investors join in a business enterprise to develop a community solar project (such as University Park Community Solar, LLC; Clean Energy Collective, LLC);
- **Non-Profit "Buy a Brick" Model,** in which donors contribute to a community installation owned by a charitable non-profit corporation (such as Winthrop Community Solar Project, Solar for Sakai)[4].

It is also worth mentioning the American community-owned solar market, which is approaching a tipping point: by 2020, community-owned solar in the US will be an annual half-gigawatt opportunity, according to a GTM report.[5] With 66 cumulative megawatts installed through to the end of 2014, the US community solar market is just getting off the ground. Between 2014 and 2020, the report expects US community-owned solar to have a compound annual growth rate of 59%.

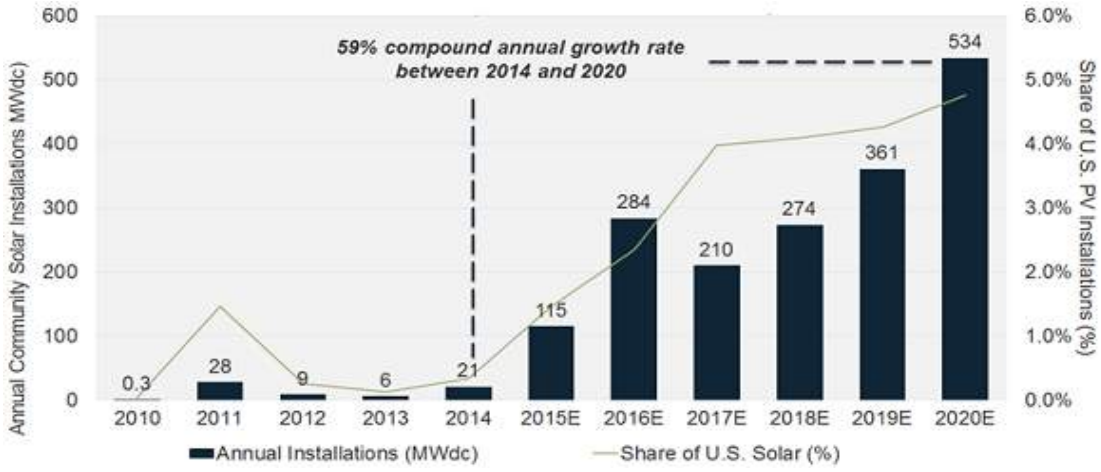


Figure 3: Annual U.S. Community Solar Installations, 2010-2020E Source: GTM Research's U.S. Community Solar Outlook 2015-2020

According to the report, there are 24 states with at least one community solar project online, and 20 states have or are in the process of enacting community solar legislation. California, Colorado, Massachusetts and Minnesota are expected to install the majority of community-owned solar structures over the next two years. According to the Solar Energy Industry Association (SEIA), at least 10 states are encouraging their growth through policy and programmes to promote shared resources.[6]

For instance, California is preparing to implement two community solar programmes, one for utility-led development and another for third-party development. The programme calls for 600 megawatts (MW) by 2019, with 110.5 MW required by 2016.[7]

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[4] http://www.nrel.gov/docs/fy12osti/54570.pdf
[5] US Community Solar Outlook 2015-2020, GTM Research: http://www.greentechmedia.com/research/report/us-community-solar-market-outlook-2015-2020
[6] http://www.seia.org/policy/distributed-solar/shared-renewablescommunity-solar
[7] http://technewsrss.com/community-solar-farms-to-grow-500-this-year/

Focus on the photovoltaic market in Austria

Austria is one of the countries with the highest share of renewable electricity in Europe. About 75% of the electricity supply is based on renewable energy,[8] of which the largest part is hydro power, with more than 65%, wind energy with about 7.5%, some bio-electricity and, as of the last few years, there has been a significant rise in photovoltaics, with about 1.3% in 2014.[9]

The target for the national PV market is laid down in the national **Green Electricity Act (GEA),** first issued in 2002, and revised several times since. The official market target is currently set at 1.2 GW in 2020. As of the end of 2014, about 0.8 GW had already been already installed in Austria.

Austria's support for PV relies on a mix of capped FiT (Feed in Tariffs) and investment grants. Due to a "stop and go" unclear funding situation for the annual support cap, and excessive bureacraucy, the development of PV in Austria remained constrained at a relatively low level, with a market below 100 MW until 2011. With 175 MW in 2012, 263 MW in 2013 and 159 MW in 2014, when the support was reduced, the market grew and then declined. The sum of electricity produced by PV plants in operation amounts to 785.25 GWh in 2014 and has lead to a reduction in CO_2 emissions by 659,607 tons. In 2014, the PV cumulative installed capacity was 787 MW. In general, the country's support for PV has been characterized by a series of changes that have influenced the market evolution in the last years[10]. For the next years, it is foreseen that the photovoltaic market in Austria will remain at reasonable levels[11].

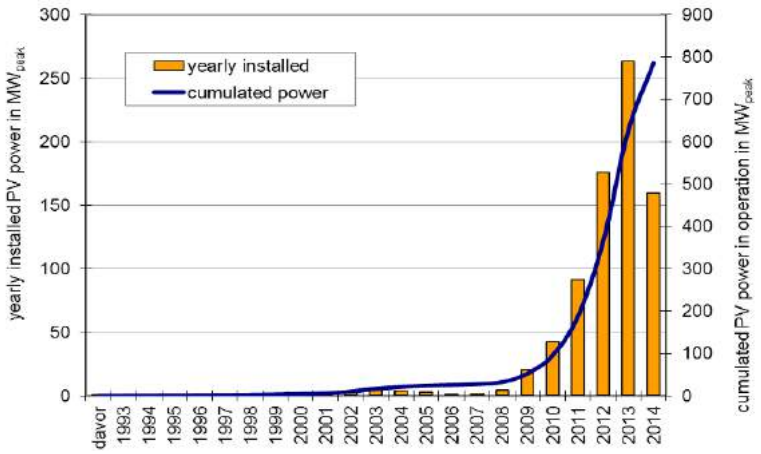

Figure 4: Market development of installed photovoltaic systems in Austria until 2014 (Source: FH Technician Wien)

The main applications for PV in Austria are grid-connected distributed systems, representing more than 99% of the total capacity; grid-connected centralised systems in the form of PV power plants play a minor role. Building integration is an important issue and a cornerstone of the public implementation strategy.

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8 http://www.theguardian.com/world/2015/nov/06/all-electricity-in-austrias-largest-state-now-produced-from-renewables

9 http://www.nachhaltigwirtschaften.at/iea_pdf/reports/iea_rewp_national_update_austria2015_ praesentation_ indinger.pdf

10 http://www.iea-pvps.org/fileadmin/dam/public/report/national/IEA-PVPS_-_Trends_2015_-_MedRes.pdf

11 http://www.iea-pvps.org/fileadmin/dam/public/report/technical/PVPS_report_-_A_Snapshot_of_Global_PV_-_1992-2014.pdf

Smart city projects are well supported by the Austrian Climate and Energy Fund. Furthermore, PV features as a significant and visible sign of a sustainable energy future in urban areas, frequently also in combination with the use of electric vehicles. **In Austria, the level of public know-how and interest in the potential of PV is continuously growing and PV is considered an essential part of the future energy strategy.**

The Austrian photovoltaic industry is highly diversified, covering production of PV modules and inverters as well as other PV components and devices. Furthermore, there is a high density of planning and installation companies for PV systems as well as specialized institutions and universities, which play an important role in international photovoltaic R&D.[12]

Main impacts

The Citizen Solar Power Plant enables citizens to invest in renewable energy. The project highlights several important factors for the community of Vienna:

- Adding local value;
- Enhancing quality of life in the city;
- Encouraging ecological awareness and climate protection;
- Enhancing independence of power imports;
- Income return.

In this way, the citizens of Vienna are able to be involved in setting the agenda and pace for Vienna's renewable energy policy. Furthermore, they are actively reducing local pollution levels while making a sound investment.

> "The citizen solar plant is not an investment vehicle. It is a vehicle for distributed generation and people participation."
>
> – Gudrun Senk, Head of Renewable Energy at Wien Energie GmbH

- **Energy savings:** All the implemented power plants (both photovoltaic and wind) produce 19,825 MWh/year of renewable energy, covering the electricity demands of 8,000 families;
- **Green electricity produced:** Compared to conventional electricity production, harnessing the sun as an energy source saves around 7,200 tons of CO_2 per year;
- This initiative received **particular interest from those citizens who live in flats or do not own a home** (live in a rented house) or who are unable to utilize their roof, giving them the opportunity to participate actively in environmental protection and in increasing the sustainability and quality of life in Vienna through participation in the development of renewable energies. This solution turns out to be a ground-breaking participation project;
- The Citizen power plant has received an enormous response from the Vienna community, with **all PV modules/shares becoming sold out in a short amount of time;**
- **Economic sustainability:** The solution is economically sustainable and profitable for the electric company;
- **Unique selling proposition:** The solution helps the electric company to create trust among its customers and builds a unique proposition compared to the competitors;
- **Attractive form of financing:** The is also a form of financing with attractive remuneration with respect to interest rate levels.

Two other relevant impacts are that **green electricity is produced close to the consumer,** in order to minimize transmission losses and reduce dependence on electricity imports, and that, for the first time, a **participation model** like this one becomes economically possible in the urban area without subsidized feed-in tariffs.

[12] http://www.nachhaltigwirtschaften.at/iea/results.html/id8079

Rich Picture Model

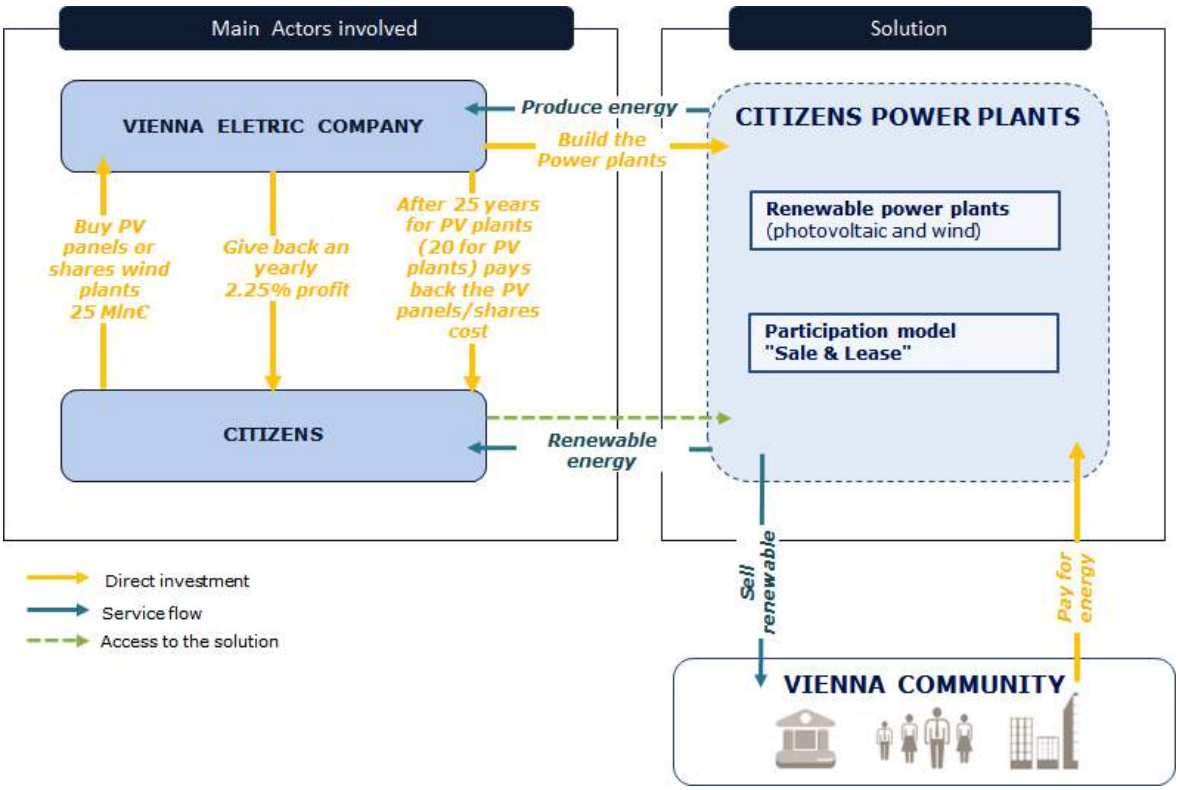

Figure 5: Rich Picture approach of Citizen Power Plan

As illustrated in the image above, the solution works as follows: Vienna citizens buy shares of wind power plants or PV panels and rent them to the electric company, which designs, builds, operates and maintains the plants. The renewable energy produced by the power plant flows in the city electrical network and is sold by the electric company to the wider Vienna community. With the cash obtained from selling the renewable electricity, the electric company is able to pay a yearly 2.25% profit to the citizens who bought the PV panels/shares. At the end of the plant's lifetime (25 years for PV and 20 years for wind power plants), the electric company pays back to the citizens the cost of the PV panels or the wind shares they bought. This business model is profitable for the electric company and may be seen as a win-win solution for citizens, the community and the electric company.

Business Model Canvas

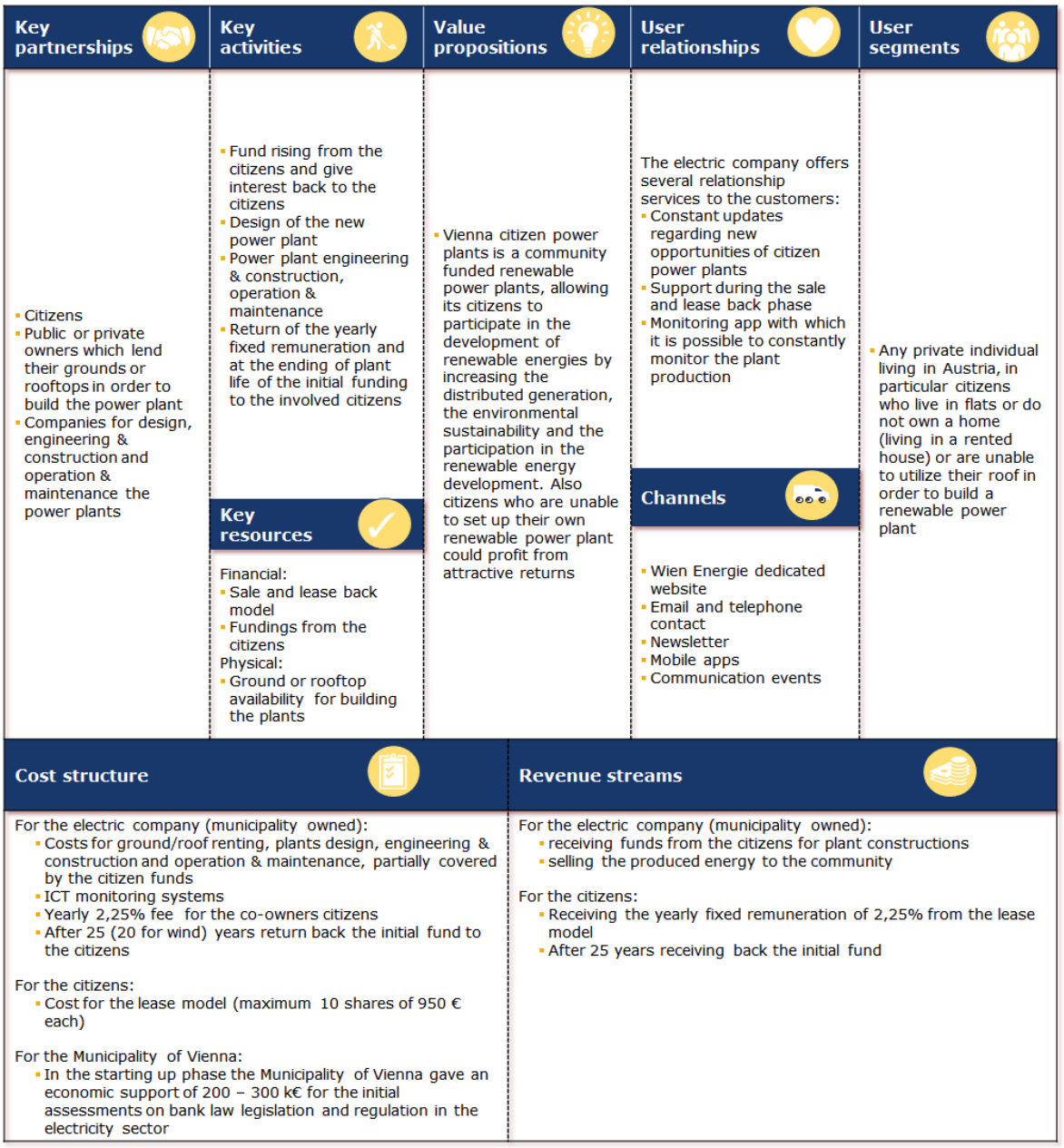

Figure 6: Business Model Canvas of Citizen Power Plant

User segments

People that may participate in the Citizen Power Plants in Vienna include any private person (of legal age) residing in Austria. In particular, this initiative received significant levels of interest from those citizens who live in flats or who do not own a home (live in a rented house) or are unable to utilize their roof in order to build a renewable power plant. An existing contractual relationship with the electric company, Wien Energie, is not a prerequisite for participation.

Value proposition

The Vienna Citizen Power Plant is a series of community-funded renewable power plants, allowing its citizens to participate in the development of renewable energies by increasing distributed generation, environmental sustainability, and participation in renewable energy development. Even citizens who are unable to set up their own renewable power plant could profit from attractive returns.

Key facts regarding the value proposition of the PV part of this project are detailed below:

- Each photovoltaic panel costs € 950, and it is possible to buy a maximum of 10 panels;
- Upon payment, a contract between the citizen and and Wien Energie is established, and citizens become official co-owners of the panels;
- The electric company manages the photovoltaic module for the citizen;
- The modules are owned by the citizen, who rents them back to the electric company, receiving an annual 2.25% interest payment on the amount invested as remuneration;
- The minimum duration of the contract is five years and there is a possibility for early termination upon payment of an administrative fee (€ 75);
- At the end of the useful life of the modules (approximately 25 years), the electric company buys back the modules and the full amount invested is returned to the original investors.

Key facts regarding the value proposition of the wind power part of this project are detailed below:

- A share costs € 950, and it is possible to buy a maximum of 10 shares;
- Upon payment, a contract between the citizen and and Wien Energie is established, and citizens become official co-owners of the wind power plant;
- The electric company builds the wind turbine for the citizens;
- The electric company manages the operation and maintenance of the wind power plant and behald of the citizen, who receives an annual 2.25% from the invested amount as remuneration;
- The minimum duration of the contract is five years and there is a possibility for early termination upon payment of an administrative fee (€ 75);
- After expiration of the contract (20 years) or early termination, Wien Energie buys back the shares and the original amount invested goes back to the original investors.

Channels

Many channels have been implemented through which to communicate, update and build trust with the customers, including a dedicated website (https://www.buergerkraftwerke.at), email and telephone contact, a newsletter and an app that customers may use to monitor electricity production. Upon the release of a new citizen power plant, the electric company organizes launch and communication events, in order to communicate and promote the initiative.

User relationships

Although there is no direct involvement on the part of the community in the decision making of the solution schemes, citizens have responded to this solution in a very enthusiastic way, always buying up the contracts in a very short time and look forward to the next public offering. The relationships with the users are versatile, in particular by the electric company. For example, these include:

- Updates about new opportunities for particpation in citizen solar/wind plants;
- Support during the purchasing phase of the modules/shares;

- Provision of an app through which citizens can monitor electricity production for their co-owned plant.

Revenue streams

The main strength of this solution's business model is that it can involve all citizens, even those who are not able to install their own renewable energy power plant.

It is a win-win solution, even without subsidies, for all the involved stakeholders: for the community, it enables the development of sustainable energy; for the electric company, which is able to design, construct and conduct renewable power plants without strong economic exposure and with an economically sustainable business model; for the citizens who via a financial tool (that is similar to an obligation) are able to participate in the development of renewable energy, receiving a guaranteed annual income.

For Wien Energie, revenues come in different phases:

- In the designing and selling phase, the electric company receives funds from citizens for ground/roof rental from both public than private entities and plant constructions. In particular:
  - For the photovoltaic power plants, it receives 100% of funds, in other words every module of the photovoltaic power plant is completely sold to the customers that actually own their modules and, in the case of insolvency of the electric company, they could literally take back their panels;
  - Regarding the wind plants, as it is not possible to clearly divide the whole plant and due to the higher costs, citizens may hold only 49.9% of the cost of the plant, with the electric company holding 50.1%.
- Once the plant is in production, the electric company manages the earnings that come from selling the produced energy to the community of Vienna or from penalties that the customers have to pay in case they quit before the end of their contract.

For citizens, revenues come from:

- Receiving the yearly fixed remuneration of 2.25% from the lease model (it is important to note that this form of investment brings higher remuneration with respect to other conventional forms of savings);
- After 25 years, getting back the initial fund they gave to the electricity company in buying the photovoltaic modules or their share of the wind plant.

All citizens can participate, earning an annual fee of 2.25% and promoting the development of renewable energy.

Key resources

The first resource is the **financial sale and lease back model,** which needs to be well defined and established among the different partners.

A second key financial resource is the **funding from the citizens,** which is crucial for the deployment of the solar/wind power plants.

Key physical resources include the photovoltaic modules and the other plant components (inverters, structures, etc), the wind power plants as well as the availability of ground or rooftop spaces both from public or private sources on which to build the plants.

Key activities

The principal activity consists in fundraising the money for the power plants from the citizens, selling 100% of the solar plant (i.e. all the photovoltaic modules) and 49.9% of each wind plant. Each PV module or wind share costs € 950 (or a half costs € 450) and it is possible to buy a maximum of 10 units.

From the electric company side, other relevant activities consist in design, engineering, construction, operation and maintenance of the renewable citizen power plants, along with several partners who help with the deployment of this solution.

The last relevant activity is the return by the electric company to the involved citizens of the yearly fixed remuneration of 2.25% and, after 25 years for PV and 20 years for wind power plants, of the initial fund.

Key partnerships

The most relevant partnership for this solution is with citizens, who pay for solar panels/wind plant shares and thereby enable the implementation and construction of the power plants.

Another important partnerships in this solution is with public or private owners who are interested in lending their grounds or rooftops in order to let the electric company build the power plant.

Other important partnerships are with technical companies for plant design, engineering, construction, operation and maintenance to support the electric company.

Cost structure

In the starting phase, **the Municipality of Vienna gave economic support to Wien Energie** in order to assess the legal and regulatory status of the electricity sector and define possible collaborations and partnerships. The amount of this funding was € 200-300,000.

The **electric company** (municipality owned), incurs costs for ground/roof renting, plant design, engineering, construction, operation and maintenance. These costs are completely covered by citizen funds. Other cost categories also include ICT monitoring systems, the yearly 2.25% fee that is returned to the citizens and the return of the initial amount funded to the citizens at the end of the power plant's lifetime.

For the citizens, costs consist in the purchasing price of the photovoltaic modules or wind shares. Citizens can buy a maximum of 10 shares for € 950 each.

Further details on installation costs, cost per installed kWp and ground/roof renting costs from public and private entities are publicly disclosed by Wien Energie.

Barriers/challenges

The main relevant barriers are legal and normative constraints in involving citizens in energy production (e.g. participation issues, insolvency, early termination and others), in the sale and lease back model, as well as regulatory aspects in the energy sector which need to be fully assessed in order to verify whether this kind of production model could be allowed.

A second barrier might be the building of solid partnerships with stakeholders that can collaborate in the project (ground or rooftop rental, voucher model).

A third barrier is the capacity in engaging the citizens, building with them a strong relationship based on trust and communication.

Indeed, there is a strong need to build trust with the stakeholders, guaranteeing a long term, constant policy and regulatory framework for the renewable energy sector, thereby creating a positive and durable feeling for the continuity, solidity and persistence of this kind of understanding between the citizens and the electric company/municipality in the medium/long period.

Replicability factors

This solution is of great interest and could potentially be implemented in several places in the world thanks to its clever and linear business model.

One of the main factors that could allow the development of this kind of solution is **a strong political will in implementing distributed renewable energy power plants and increasing citizen participation,** making it possible to merge social, environmental and economic aspects, guaranteeing a costant policy and regulation scenario in the distributed energy generation for a long period of time.

Another relevant aspect in planning and coordinating this kind of project is a strong and clear definition of the available budget, programme scope and implementation phases, **differentiating between a feasibility assessment, a pilot and a full solution deployment phase.**

Thanks to its high scalability, this solution could be implemented both in small and large cities, enabling in both cases interesting returns and opportunities for citizen participation.

A third factor is **the absence of legal and normative constraints** regarding the banking legislation in plant leasing and regulation in the electricity sector with respect to the sale of electricity.

Furthermore, an in-depth cost benefit analysis should be conducted before putting this solution into place, and it should consider the engineering, construction, operation and maintenance costs and the great number of variables that need to be set (such as the price at which to sell the PV modules/wind shares and the fixed remuneration level), as the impacts may differ depending on the environment of the city that the solution is replicated in.

As depicted in the following figure, besides Vienna, citizen power plants can be found in several other countries, including Germany, Denmark, the UK, Canada, the US, Japan, Thailand and Australia.

Figure 7: Replication areas of Citizen Power Plant

	"Replication recipe"
Political will	✓ *Define the political strategy for renewable, distributed and sustainable energy and citizen participation*
Planning and coordinating	✓ *Define budget, programme scope, and implementation phases* ✓ *Assess the bank legislation* ✓ *Asses the legal system* ✓ *Assess regulation in the electricity sector*
Build partnership / define new business models	✓ *Build partnerships with all stakeholders, in order to find potential sites in which to build the plants and create collaborations*
Communication, transparency and trust	✓ *Develop systems to communicate and constantly update the customers in order to create a unique selling proposition* ✓ *Transmit trust and solidity to the customers*

Table 3: Replication recipe of Citizen Power Plant

Sources

Interviews / Contact persons	› Mads Gaml, Project Responsible of the ITS solution, Technical and Envi › Gudrun Senk - Head renewable energy Wien Energie GmbH › Ilona Matusch - Corporarate Communications - Wien Energie GmbH › Boris Kaspar - Spokesperson - Wien Energie GmbH
Literature supporting the research of this case	› BürgerInnen - Solarkraftwerk – Sonnenenergie für alle http://www.tinavienna.at/sites/default/files/B%C3%BCrgerInnen%20Solakraftwerk.pdf
Internet sources	› https://www.buergerkraftwerke.at/ › http://www.wienenergie.at/eportal2/ep/channelView.do/pageTypeId/67856/channelId/-51132 › https://smartcity.wien.gv.at/site/projekte/menschen-gesellschaft/burgerinnen-solarkraftwerk/ › http://www.tinavienna.at/de/stadt-themen/smart-city/b%C3%BCrgerinnen-solarkraftwerk › https://www.buergerkraftwerke.at/media/files/2015/bskw_faqs_online_135917.pdf › https://www.wien.gv.at/stadtentwicklung/energieplanung/ › http://www.ren21.net/wp-content/uploads/2015/07/GSR2015_KeyFindings_lowres.pdf › http://fortune.com/2015/12/11/community-solar-will-explode/ › http://www.scottmadden.com/insight/941/community-solar-overview-of-an-emerging-growth-market.html › http://www.nachhaltigwirtschaften.at/iea/results.html/id8079 › http://iea-pvps.org/index.php?id=6&no_cache=1&tx_damfrontend_pi1%5BshowUid%5D=1129&tx_damfrontend_pi1%5BbackPid%5D=6 › http://www.japanfs.org/en/news/archives/news_id035404.html › http://www.nachhaltigwirtschaften.at/iea_pdf/reports/iea_rewp_national_update_austria2015_praesentation_indinger.pdf
Figures sources	› https://smartcity.wien.gv.at/site/en/projekte/menschen-gesellschaft/burgerinnen-solarkraftwerk

Data.One

Hong Kong, China

Assessment based on feedback provided by the solution's representative as well as on the available sources analysed by the study team.

Short description of the case study

		Key facts and figures
Data.One Hong Kong city solution	**Type of solution**	*Data.One is a portal that facilitates a wider dissemination of Public Sector Information (PSI) for value-added re-use. Data includes water quality, weather, population census, public transport and more.*
	Project stage	*The project kicked-off in March 2011 with a further upgrade in 2015.*
	Actors involved	*City government, citizens and business communities*
	Roll-out of the solution	• *The Government of the Hong Kong special Administrative Region launched an 18-month pilot scheme in March 2011 to make geo-referenced public facility data and real-time traffic data available.* • *In 2015, an upgrade has improved data availability.*
	Barriers	• *Internal barriers in public administrations*
	Implementation best practice city	*Hong Kong (China)* *(7.2 Mln inhabitants)*
	Main technological areas covered	• *Open data, transport*
	Funding mechanism	• *€[1]0.6 Mln project, funded by the Hong Kong government*
	Economic, social & environmental impact	• *Strong driver for the development of applications through the release of open data* • *Over 2011-2012, it is estimated that the solutions have lead to a relocation and reduction of bus trips, contributing to a reduction in congestion levels*
	Replicability factors	• *Stakeholder engagement* • *Clear governance structure*

[1] The conversion rate used is this case study is HK$1 = €0.118.

Case summary

Hong Kong has become a major information, communication and technology hub in the region. According to the latest Global Innovation Index co-published by Cornell University and other organisations, Hong Kong was one of the top 11 innovative places out of some 140 economies surveyed. However, due to the intense economic activity, the transportation system is under strain. In a report released in 2014[2] by the Hong Kong Transport Advisory Committee, five recurrent causes of road traffic congestion have been acknowledged:

- Limited scope for more road transport infrastructure;
- Excessive number of vehicles;
- Competing use of road space;
- Management and enforcement issues;
- Road maintenance work.

In this context, in March 2011 the government of the Hong Kong special Administrative Region launched **Data.One**, an 18-month pilot scheme, which was originally conceived to make geo-referenced public facility data and real-time traffic data available for free download and value-added re-use. Today, Data.One is a data portal that facilitates a wider dissemination of Public Sector Information (PSI) for value-added re-use. Data includes water quality, weather, population census, public transport and more. The datasets are provided by different government departments and public/private organisations. The portal is maintained by the Office of the Government Chief Information Officer.

Funded with € 0.6 Mln by the **Office of the Government Chief Information Officer (OGCIO),** the Data.One portal was revamped in March 2015, making all government information already released online and free of charge for public consumption available in digital format, with a view to tapping the creativity and wisdom of the community in developing innovative applications with public data, thereby improving the lives of citizens and creating business opportunities for the industry. The portal currently provides over 4,500 datasets under 18 broad categories.

The data portal shows a great level of integration: 16 categories comprising about 3,000 PSI datasets are available, including real-time road traffic information, air pollution indices, weather data, geo-referenced public facility data, population census statistics, and public transport routes and fares.

The following sections are of particular interest:

- **Application:** A selection of creative web and mobile applications and solutions developed by the Government and community with DATA.GOV.HK datasets is available. Among the applications relevant from a transportation point of view, there are Citymapper and HK Drivers. The former is an iPhone/Android/Web application with a comprehensive source of information for navigating Hong Kong, including information on the Citybus, First Bus, Green Minibus, ferries, light rail, trams, cycling, and Uber, with real-time information when available. HK Drivers is an all-in-one app for

> Dr Ray Cheung Chak-chung, director of the City University of Hong Kong's Apps Lab, welcomed the move.
>
> "App developers need more government data to develop apps. It can help Hong Kong become a smart city. For example, the government can release data on the usage of parking meters around Hong Kong. With an app based on that data, drivers can know where to find a parking space."

[2] Report on Study on Road Traffic Congestion (2014), Hong Kong Transport Advisory Committee

drivers to easily access real-time traffic and other essential information (e.g. carpark, garage, etc). It provides an intuitive and streamlined interface to easily access information while driving.

- **Open data:** It contains the list of data providers and format with which data can be used. Ten data categories are included: Finance, Commerce and Industry, Law and Security, IT and broadcasting, Development, Environment, Transport, Food and Health.

As depicted in the following figure, the Data.One portal addresses two vertical/technological priority areas of the EIP-SCC Strategic Implementation Plan and three horizontal/transversal ones. As mentioned above, the project was originally conceived to release data and information dealing with sustainable urban mobility through the provision of data and applications related to the use of public transportation, managing real time traffic information data. Integrated infrastructure projects involve the set-up of sensors and traffic count to support transportation data collection and geo-referenced data. Open data has been provided and the related common standards have been developed to solve problems of data integration among different departments. The standards have been defined in the Government Interoperability Framework[3] supporting the Government's strategy concerning new e-Government infrastructure systems, new Government to public (including businesses) systems, and new inter-Bureau and Department (B/D) systems by facilitating the interoperability of technical systems between Government departments, as well as between Government systems and systems used by the public (including citizens and businesses). Policy and regulation, i.e. the set-up of a common legal structural development for public data, is also concerned, due to the required definition of rules and regulations to settle the arrangement amongst data providers.[4]

> Open Data has the potential of saving 1,425 lives a year (i.e. 5.5% of the European road fatalities). Furthermore, applying Open Data in traffic can save 629 Mln hours of unnecessary waiting time on the road in the EU.

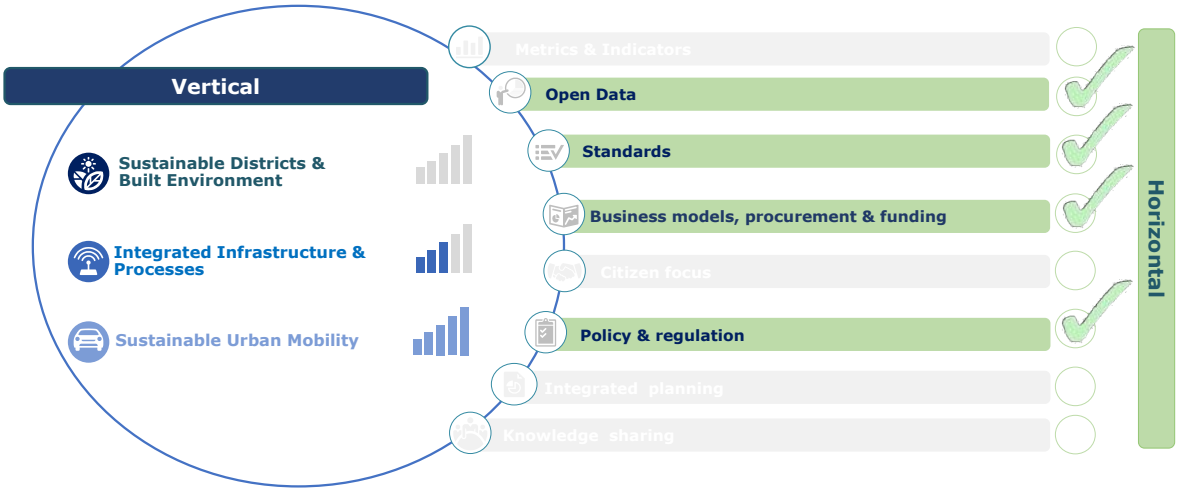

Figure 1: SCC Solution Integration Dashboard

Market analysis

The market volume for open data and the associated portala is growing. According to a recent study,[5] when dealing with the potential market size of open data and portals, a distinction can be made between the direct economic benefit (e.g. the number of jobs involved in producing a

[3] Office of the Government Chief Information Officer "The HKSARG Interoperability Framework", 2015
[4] https://data.gov.hk/en/terms-and-conditions
[5] European Union.2015 Creating Value through Open Data: Study on the Impact of Re-use of Public Data Resources

service or product) and the indirect market size (e.g. indirect economic benefits include new goods and services, time saving for users of applications using Open Data, etc). Together they form the total economic benefit for Open Data. It has been estimated that for 2016, the direct market size of Open Data is expected to be € 55.3 Bln for the EU 28+. Between 2016 and 2020, the market size is expected to increase by 36.9%, to a value of € 75.7 Bln in 2020, including inflation corrections. For the period 2016-2020, the cumulative direct market size is estimated at € 325 Bln.[6] In terms of economic potential, as stressed by the OECD report7, the commercialisation potential for re-use of public data may be significant in the geospatial applications. The Data.One case confirms the relevance of geographical data, to the extent that most of the applications hosted by the portal concern with use of spatial data, e.g. traffic flows data. However, as stressed in the study, such evaluations of the market size are available from ex-ante estimations. The evaluations are mostly established on the basis of surveys or indirect research and provide for a wide range of different calculations. No comprehensive and detailed ex-post evaluations of the materialised costs and benefits of Open Data are available.

Main impacts

The main impacts of the portal concern the environmental and the economic side. Concerning the environmental side, it is estimated that the solutions, due to the optimization of transport services, over the period 2011-2012 have led to a re-location and reduction of bus trips, contributing to congestion reduction: 252 bus trips in Central, 177 bus trips on Yee Wo Street and 294 bus trips on Nathan Road were reduced (annual data, 2012)[8]. In terms of CO_2 saving, the resulting impact can be estimated in the order of magnitude of 960 t/year[9]. On the economic side, economic benefits are associated with new business stimulation, e.g. private companies have developed mobile applications using the traffic data of Data.One. 70 internet applications have been developed using government data since the administration began releasing data for public use in 2011. Spill-overs are relevant, for example in 2014/2015 the revenues for digital map orders only reach € 500,000[10]. Local economy spillovers are also expected by the development of applications. The "Data.One App Competition" launched from 2012, has spurred over 100 new applications, addressing publlic services, commerce and tourism. Commercial viability of the new solutions is one of the key criteria to award prizes to the winners. For example, the Axon's HKBus+ is an information platform offering a public transportation information service in Hong Kong, covering franchised buses, mini-buses, MTR, ferries and trams. By combining the open data released by the Hong Kong Government and data collected from the Internet, the app offers up-to-date traffic information to the public, including traffic conditions of the three cross-harbour tunnels. HKBus+ is one of the most popular public transportation apps in Hong Kong, with over 470,000 downloads per year[11]. Furthermore, the social impacts are also deemed to be concerned. As by-product of the portal, a lively development of social communities dealing with the use of open data has been established. The Hong Kong Open Data Community (https://opendatahk.com/community/) is currently supporting the discussion on the potential of open data, with working groups involving citizens, associations and experts on science, policy and research & communication areas.

[6] http://www.europeandataportal.eu/en/content/creating-value-through-open-data.
[7] OECD, Directorate For Science, Technology And Industry Committee For Information, Computer And Communications Policy "Working Party on the Information Economy", Digital Broadband Content: Public Sector Information And Content, 2066
[8] Environmental Report Transport Department, 2012
[9] On the basis of the public bus composition in 2012 (66% LPG and 34% diesel). "A Clean Air Plan for Hong Kong in collaboration with the Transport and Housing Bureau, Food and Health Bureau, Development Bureau", March 2013
[10] https//www.hkmapservice.gov.hk
[11] http://entrepreneurhk.org/hkstp-partner-companies-and-incubatees-winners-at-hk-ict-awards/

Rich Picture Model

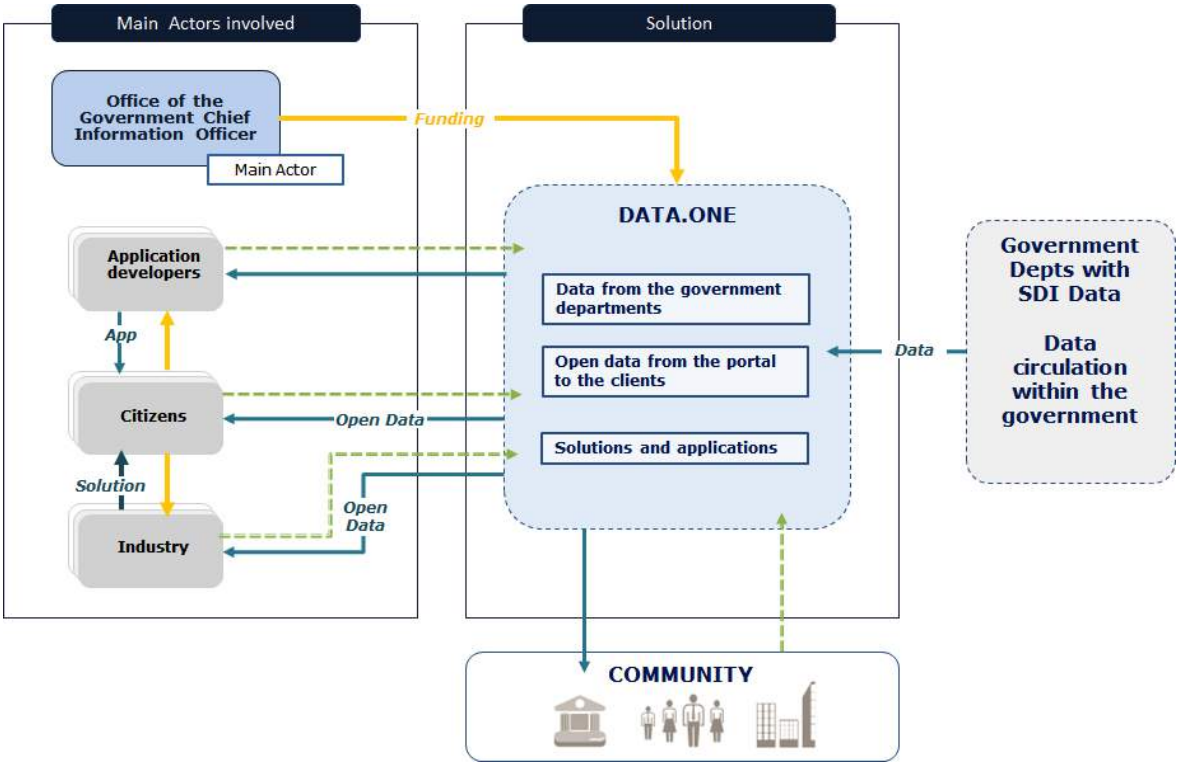

Figure 2: Rich Picture approach of Data.One

As illustrated above, the Data.One portal is funded by the Hong Kong Office of the Government Chief Information Officer (OGCIO), coordinating the development of information and communications technology of the Hong Kong government. There are three main products delivered by the solution.

- **Data** from the government departments, which need to be delivered according to a common standard in order to be processed and made available for the public at large. Data are in fact originally different as for quality, standard and structure. Data circulation and integration within the government departments has been ensured by the set-up of protocols and standards for a harmonised information and data exchange system.
- **Open data** from the portal to the clients. Open data released in several formats, making their download and use possible;
- **Solutions and applications,** from application developers, which are made available to citizens for free (from the Data.One portal).

Finally, citizens, developers and industry have access to the services through the Data.One web portal.

Business Model Canvas

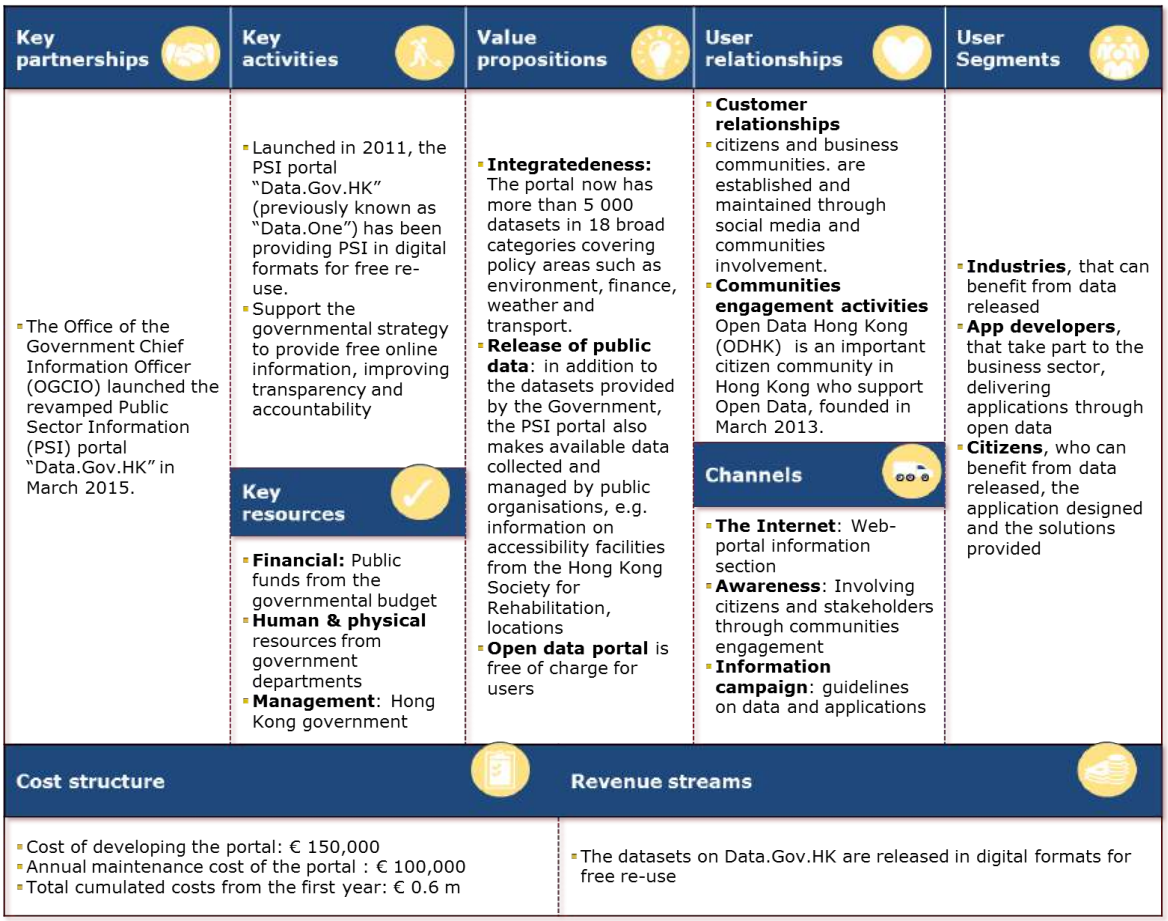

Figure 3: Business Model Canvas of Data.One

User segments

The following table shows the key users and the corresponding main services provided by the solution.

Key users	Data.One services
Citizens	Data on public services, e.g. transportation, health, financial services.
App developers and industry	Open data released through standard formats

Table 1: Data.One services per key user

The data released by Data.One are broad, serving potentially a wide range of users, from city users, e.g. data on frequency of transport means, traffic situation, availability of public services, stores, etc., to citizen's informational needs, as factsheets on population, property, tax allowances, etc.

App developers and industry can use data as raw materials for developing applications. For example, from open data on traffic situation and geo referenced data on buildings and landscape app developers have released several applications, basically focussed on transportation.

Value proposition

The Data.One portal supports the implementation and use of Information Technologies to reduce congestion and improving public transport. It also supports the development of new applications through the re-use of public data, involving citizens and business communities in using open data for improving the quality of life through innovative solutions. Important implications for smart government, i.e. major transparency and citizens' involvement in public policy are also expected. The Data.One portal started as a tool for delivering geo-referenced government data and traffic-related data; then progressively evolved as a platform for the dissemination of open data. Government of Hong Kong launched the Road Traffic Information Service (RTIS) on a dedicated website in February 2009. The service integrated the dissemination of 4 types of real-time traffic information by a single website, namely the Special Traffic News, the CCTV snapshots of traffic condition, the cross-harbour journey time between Hong Kong Island and Kowloon, and the traffic speed map for road users to better choose their transport mode and plan their journeys. To enable road users using the service at any time and place that is convenient to them, the mobile version of the service was launched in May 2010. Since March 2011 real-time traffic information has been disseminated via the Data.One website of GovHK. From 2015 onward, the Office of the Government Chief Information Officer (OGCIO) launched the revamped PSI portal, Data.Gov.HK, embedding the Data.One portal features.

The solution provides a wide array of government information disseminated in digital format free-of-charge to facilitate value-added re-use by the public. In particular, the Data.One portal enables to get real-time transportation information from a range of sources, e.g. sensor, traffic count, etc., across the city, providing innovative tools (application) to enable a much more efficient use of transport for the user.

In terms of value proposition, it is important to stress that in Hong Kong apps were based on private car traffic, e.g. using the real time information on congested cross-harbour tunnel traffic. However, the vast majority (around 90 %) of Hong Kong citizens is using public transport, and there was a real lack of customer friendly applications for bus transport. For example, while citizens in New York and London can easily check on their smart phone or through a digital display at the bus stop when their next bus is coming, Hong Kong citizens never knew exactly when their bus was coming because no real-time information was available. The recent generation of applications tend to fill this gap, as indicated in the following list:

- Hong Kong Bus pass This app provides an intelligent search of public transport routes, the traffic condition en-route and the estimation of the taxi fee for the same journey to help commuters make informed decisions. Dataset(s) used
    - Routes and fares of public transport
    - Traffic Speed Map
    - Journey Time Indicators
    - Geo-referenced Public Facility Data
- Hong Kong Traffic Ease: this app allows to quickly search for public transport routes with just a few clicks and provides the street view of the destination to make the trip easier and enjoyable. It also features real-time traffic snapshots and news to give the users a more comprehensive experience. Dataset(s) used are:
    - List of GovHK Notifications
    - Details of GovHK Notifications
    - Routes and fares of public transport
    - Geo-referenced Public Facility Data
    - Traffic Snapshot Images.
- Citymapper: Citymapper is an iPhone/Android/Web application with comprehensive source of information for navigating Hong Kong, including information on the MTR, KMB, Citybus,

First Bus, Green Minibus, ferries, light rail, trams, cycling, and Uber, with real-time information when available. Dataset(s) use are:

- Routes and fares of public transport
- Download link for iOS.

Furthermore, among the core offer of the solution, there is the support to the development of innovative applications. In fact, The Hong Kong Government launched a competition for best applications and ideas using the Data.One data sets. In 2013 there was 41 entries.

Channels

The main channel through which the solution is delivered is **the Internet**. The reason, other than rooted in the specific feature of the service, i.e. downloadable application and data in digital format, relies on the following facts[12]:

- Hong Kong's average peak Internet connection speed at 94.8 Mbps and average Internet connection speed at 17.0 Mbps, among the fastest in the world (2nd Quarter, 2015);
- Hong Kong's household broadband penetration rate reached 83.0 per cent, among the highest in Asia (July 2015);
- Hong Kong's mobile subscription rate reached 228.8 per cent, one of the highest in the world (July 2015);
- the penetration of public Wi-Fi is among the highest in the world with 39,267 wireless hotspots installed by the Government and the private sector (September 2015);
- Hong Kong was ranked as the city with the least risks in Asia Pacific for data centre establishment in the Data Centre Risk Index for three consecutive years from 2011 to 2013; and
- Over 12 hectares of land in Industrial Estates have been granted for data centre development since 2010. The Tseung Kwan O Industrial Estate, which currently houses a total of 11 high-tier data centres, is the largest data centre cluster in Asia Pacific

> "We will encourage the departments to release more data. In the past, government departments needed to give data to us for uploading. But now, with the launch of the new platform, they can go to the platform themselves to release data. We organised seminars and released guidelines and circulars to them on how to use the new portal"
>
> Joey Lam, deputy government chief information officer

Other channels concern **awareness and information** campaigns to involve citizens in the innovation process, and in encouraging city department in the policy of data release (see the box).

Furthermore, delivery channels also include publicity campaigns comprising a series of promotional activities, talks, training courses, application competitions and exhibitions.

User relationships

Dealing with open data, digital environment and business environment, initiatives in the direction of user relationships often start by building a multi-stakeholder community through public events where officials, digital community, business and citizens meet and discuss about open data in a way that was not possible in the times when public information was not readily accessible in open formats, not accessible at all, or only upon request. This is the rationale behind the set-up of Open data Communities.

[12] Hong Kong Special Administrative Region Government Office of the Government Chief Information Officer, October 2015

Building such a community is important because open data is still a new field for most stakeholders, and it also provides a space to negotiate and define the expectations and terms of using and re-using public data before a policy on public data is developed. Questions around licensing, technical standards, and cost need to be agreed upon based on practical experiences in the new open data environment as well as on an analysis of the outcomes.

Such Open Data community meetings can also inspire unexpected, new uses of existing data. The most interesting developments in such a field is the establishment of the **Open Data Hong Kong Community (ODHK)**, an open, participative, volunteer-run group composed of Hong Kong citizens who support Open Data.

On the **citizens engagement front**, through the ODHK a series of workshops aimed at gathering ideas from local citizens, related to how open data can be used, have been established. The communities of computer science and users have been involved too. On June 2013, it took place the first Hong Kong Hackathon, followed by the 2015 AngelHack Hong Kong Hackathon meeting.

This is also an instrument to address the **business engagement front**, for through the ODHK open data supporters and mobile app developers can be consulted regularly.

Revenue streams

It is funded by €0.6m by the OGCIO. The datasets on Data.Gov.HK are released in digital formats for free re-use.

Key resources

The key resources required to deliver the Data.One solution are physical and intellectual/ human.

Concerning **physical resources**, these include facilities to set up the web architecture for data elaboration, communication protocol and management of the computerized information data exchange system. **Intellectual resources** come from the key partnerships established between the city stakeholders, across the city departments and public and commercial sectors. Moreover, as a knowledge intensive solution, the **intellectual & human resources** from the government, monitoring daily maintenance of the portal and provide technical support proved crucial**.**

Key activities

Key activities for the implementation of the solution include: a) the definition of procedures and plans to gain support from government departments to open up their datasets proactively. b) the development and maintenance of the platform, as well as platform management, service provisioning and platform promotion. The individual city department data with different structure, quality and standard have been harmonised, overcoming the following barriers:

- Semantic heterogeneity meaning/interpretation;
- Structural heterogeneity of data structure;
- Syntactic heterogeneity in search & query.

Data harmonization has been carried out according to a decentralised approach, in which data providers have taken care of their own datasets in accordance with the standards elaborated centrally. The procedure for data harmonization and integration was tested during the set-up of the central geospatial Information hub for data exchange within the government departments, in which all the concerned government departments were involved in sharing geo-spatial data.

To support departments in implementing the new policy, the Office of the Government Chief Information Officer has also provided technical assistance and have issued guidelines on the recommended standard data formats, data management life cycle and other detailed technical arrangements. At the same time, an intranet portal has been set up, in order to provide relevant templates and documents for departments' reference. A dedicated team and a hotline has also been set up to provide departments with technical and professional assistance.

Key partnerships

The project is under the leadership of the Office of the Government Chief Information Officer (OGCIO), of the government of Hong Kong and includes all the key governmental departments. Relevant OGCIO advisory Boards and Committees are also involved, as the Digital 21 Strategy Advisory Committee (D21SAC), the Expert Group on Cloud Computing Services and Standards (EGCCSS) and the Advisory Committee on Code of Practice for Recognised Certification Authorities.

Cost structure

The project cumulative cost so far amounts to around €0.6m, primarily variable costs for maintenance of the portal, as well as the cost for obtaining public cloud service. Public funds have been allocated evenly along the past four years, as shown in the following table.

	Year 1 Public	Year 2 Public	Year 3 Public	Year 4 Public
Total operational costs	250,000	100,000	100,000	100,000
of which fixed costs: portal development (e.g. cloud services)	150,000			
of which variable costs: maintenance (personnel)	100,000	100,000	100,000	100,000

"Year 1" is the year in which the solution was initially set-up

Table 2: Cost structure

Barriers/challenges

The key challenge in setting-up the web portal was the creation of procedures for data harmonization, i.e. how to engage city administrations, encouraging departments to take a holistic view and adopt joined-up thinking. Data harmonization process has implied to tackle legal, institutional, and political issues amongst government departments and external data providers.

The provision of geo-spatial information services to the public through the portal has represented a significant trial to test data harmonisation procedures. Despite the adoption and increase in the use of geographical information system (GIS) technologies in both public and private sectors, the advancement in technologies did not necessarily result in major geospatial data accessibility. Therefore, the set-up of the Geospatial Information Hub (GIH) harmonising data has been challenging. The GIH was in fact a geospatial data sharing platform. It was conceived as a government-to-government (G2G) electronic service. Its main focus was to promote horizontal integration, cross-organization cooperation, improve efficiency and most important of all, improve the level of service to the public. One of the successful examples in such a field is the collaboration between Lands Department and Food, Environmental and Hygiene Department in the management of public health services. The integration of information in GIH on the location of mosquito ovitraps in 38 surveyed districts of Hong Kong allows nowadays to use GIH information features (e.g. spatial analysis, trend display, etc) for monitoring and control the spreead of the dengue fever in Hong Kong, after the surge in early 20s.

The Hong Kong experience in dealing with this challenge has stressed the importance of **cultural factors**. The implementation of the GIH has shown that enhancing integration does not simply rely on the technological aspects, but also on cultural aspects. The development and implementation of common standards and a collaborative approach is an endeavour to change institutional culture within the government most notably on data sharing and collaboration. It was found that some data owners in individual departments, who might be sceptical in sharing data in the past, were more willing to share their data for integration to the GIH after seeing the benefits of the common geospatial information platform which can reduce development costs, development time and subsequent data updating efforts.

Another challenge concerns the definition of a proper **legal framework** for the use and re-use of open data. The Data.One case has showed that the definition of clear rules about which data are public, how they can be used and under which condition and liability, is a fundamental step to increase the number of application and data released through the portal.

Replicability factors

Engaging citizens is a key replicability factor. For example, a real traffic information system could not fully realise its potential unless large numbers of drivers actually sign up to receive alerts and information. In order to be successful, the urban portal must engage citizens through social networks and other media, to get ideas and information and assess how much individuals value particular services. In such account, the role of citizen's communities is fundamental. As demonstrated by the Data.One solution, establishing and supporting citizen's communities can facilitate citizen's engagement. The Hong Kong Open Data community, founded in 2013 shows that the role of citizen's community can play a key role in supporting the portal and ensuring feedback and active contribution. Namely:

- Collecting and providing resources about Hong Kong Open Data;
- Organising events for the community to connect, collaborate, share, and understand;
- Liaising with the Hong Kong government and other sectors to facilitate the release and improved quality of Open Data.

Another key factor that can guarantee the replication of the solution, and its success, is the governance structure. The Data.One portal has shown that a city portal must count on a) sound

economic and human resource allocation from the government for maintenance and technical support, b) strategic approach in ensuring data integration (common standard) and streamlining inter-department collaboration, c) effective legal basis for open data use and re-use. This last feature is particularly important to ensure replication in smart cities.

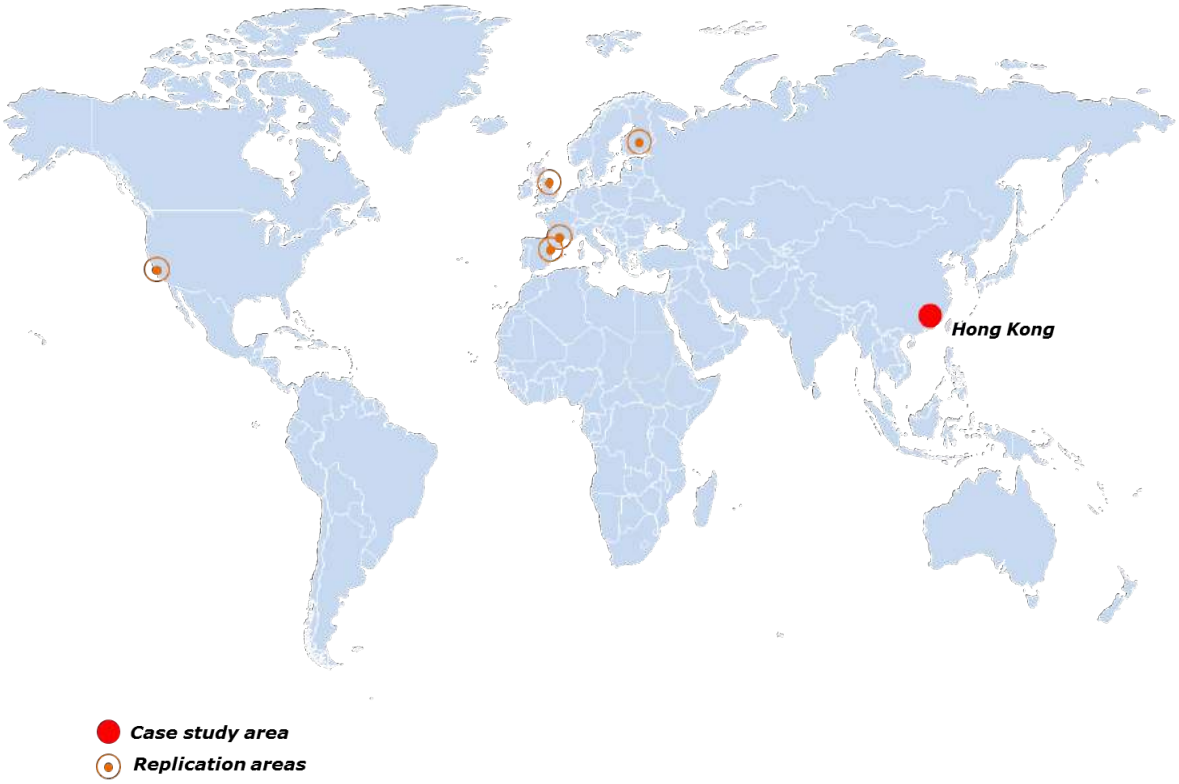

Figure 4: Replication areas of Data.One

	"Replication recipe"
Problem definition	✓ *Stakeholders wishing to implement a similar solution must ensure the coordination among data providers, both internal to the city administration and external, by providing common standards, shared values and collaboration* ✓ *Stakeholders shall also ensure citizen involvement, through communities, preferably based on social network and media*
Infrastructure and financing	✓ *The solution generally must count on public resources, with no revenues from data release. Infrastructure and competences required to develop and implement a portal are generally available*
Governance	✓ *The governance requires a strong political commitment and strategic vision from the municipality/central government side.*

Table 3: Replication recipe

Sources

Interviews / Contact persons	› Russell Tang, System manager – Office of the Government Chief Information Officer;
Literature supporting the research of this case	› Cornell University, INSEAD, and WIPO (2015): The Global Innovation Index 2015: Effective Innovation Policies for Development, Fontainebleau, Ithaca, and Geneva › European Union (2015) Creating Value through Open Data: Study on the Impact of Re-use of Public Data Resources › Hong Kong Special Administrative Region Government Office of the Government Chief Information Officer (2015) Key facts › Transport Department, (2012) Environmental Report › Report on Study on Road Traffic Congestion (2014), Hong Kong Transport Advisory Committee
Internet sources	› https://data.gov.hk/en › http://www.europeandataportal.eu/en/content/creating-value-through-open-data. › https//www.hkmapservice.gov.hk https://btplc.com/Innovation/Innovationnews/miltonkeynes/index.htm
Figures sources	› https://data.gov.hk/en

Intelligent Traffic Solutions

Copenhagen, Denmark

→ Replication potential	○○○○○	→ Economic impact	€€€€€
→ Complexity	⚙⚙⚙⚙⚙	→ Environmental impact	○○○○○
→ Citizens' involvement	●●●●●	→ Social impact	⌂⌂⌂⌂⌂

Assessment based on feedback provided by the solution's representative as well as on the available sources analysed by the study team.

Short description of the case study

		Key facts and figures
Copenhagen Intelligent Traffic Solutions	**Type of solution**	*Cloud based smart mobility platform*
	Project stage	*Implementation of pilots: 2013-2014* *Implementation of full scale solutions: 2015-2017*
	Actors involved	*Public authority, Private Companies, Road Users*
	Roll-out of the solution	*A number of initiatives from the pilot period 2013-2014 are to be implemented in 2015-2017*
	Barriers	• *Solution needs 5G to be reliable* • *Budget is limited for scaling these solutions, financing for the long-term is unclear* • *Security of data is an issue* • *Privacy legislation*
	Implementation best practice city	*Copenhagen, Denmark* *562.000 inhabitants*
	Main technological areas covered	*Smarter and greener traffic management*
	Funding mechanism	*Public Authority Investment*
	Economic, social & environmental impact	• *Significant reduction in travel times (e.g. up to 14% for motorists and up to 16% for cyclists in pilot areas)* • *CO2 emissions reduction* • *Noise reduction*
	Replicability factors	• *Integration across Siloes* • *Data Management Systems* • *Bottom Up Approach – Small Pilots Before Scaling Up* • *Open Standards* • *Strong Cooperation between Cities Both Nationally and Internationally*

Case summary

Copenhagen is known abroad as a modern, green and welcoming city and it is a city which has ambitious goals within the areas of the environment, mobility and quality of life. With a population of about 0.56 Mln people, the city of Copenhagen is the biggest municipality in Denmark. Its economic significance however lies in the Copenhagen metropolitan area, which according to the OECD (Organisation for Economic Co-operation and Development) has a population of 2,390,000 inhabitants[1]. Copenhagen is worldwide famous for it being the "eco-metropole"[2] in the world and it consistently ranks top in many international benchmarks on liveability, sustainability and smart city indexes[3]. Based on ambitious green goals to be achieved by 2025[4], and the expected rate of population expansion, new ways of thinking and developing smart solutions in relation to city planning and traffic management are essential in order to ensure life quality to all residents of Copenhagen.

Copenhagen as part of its green city initiatives has embarked on several strategic intelligent traffic solutions to reduce and more importantly prevent congestion, emissions and increase safety for both vehicular traffic and bicycles. Advances in sensor technology, cloud computing and novel simulation algorithms have made it possible to build traffic models based on large scale data gathering.

One of the projects working towards the aim of future smart mobility solutions is the intelligent data based traffic solution (ITS). The purpose of the ITS programme is to support the goals within green mobility and improve flow, enabling road users to reach their destination more easily, through smarter and greener traffic management for all modes of traffic. The ITS program is a part of the Clima plan 2025. The goal is that the City of Copenhagen is CO2 neutral in 2025. The goal of the ITS program is to reduce the CO2 emission by 25.000 tons per year. Persuading people to go by bike instead of taking their car is one of the most effective methods for reducing CO_2 emissions. So, amongst many other things, the ITS programme deals with how to make cycling and public transport more efficient and attractive. The ITS Action Plan[5] outlines the themes and focus areas that Copenhagen will be working with within Intelligent Transport Systems (ITS) up to and including 2016. These initiatives aim to ensure that the municipality meets the service goals set out in the Traffic Management Plan, which was approved by the Technical and Environmental Committee on 22 September, 2014.

Based on digital technology, ITS is opening up completely new opportunities to control traffic strategically in a way that supports a number of overall goals. The Copenhagen Intelligent Traffic Solutions System for instance allows city officials to track traffic conditions by mapping the positions of city road users and categorizing their patterns, through a smart network of sensors installed around the city, which collect anonymous information from city users combined with GPS

ITS are also a central element in the concept of the Smart City, where data from a variety of sources can be linked and used for new types of solutions and services.

[1] OECD (2009) Territorial Review of Copenhagen - http://www.oecd.org/gov/oecdterritorialreviewscopenhagendenmark.htm
[2] According to the declaration of the 'Eco-metropole of the world' (City of Copenhagen, 2007), Copenhagen has been frequently recognised as a green global leader.
[3] See an overview of Copenhagen's collection of prestigious titles and rankings here: http://www.copenhagencvb.com/copenhagen/prestigious-titles-and-rankings-copenhagen-and-denmark
[4] As part of the "CPH 2025 Climate Plan - A green, smart and carbon neutral city " (http://kk.sites.itera.dk/apps/kk_pub2/pdf/983_jkP0ekKMyD.pdf) , Copenhagen has set an ambitious goal to become carbon neutral by 2025. The ITS programme is one action in the Climate Plan and is expected to contribute to a reduction in CO2 emissions of 25,000 tons per year by 2025. In 2010, transport contributed with 380,000 tonnes CO2.
[5] ITS Action plan https://www.kk.dk/sites/default/files/uploaded-files/ITS%20-%20Action%20Plan%202015-2016.pdf

data from devices and apps. The collected data is based on the positions and behaviour of both car users and cyclists. The software is a cloud dashboard in which actual data is aggregated and used to both assess impacts and estimate future trends, in conjunction with sophisticated mathematical models. These models include the calculations of CO2 emissions, which support Copenhagen's wider goal of becoming a carbon neutral city by 2025.

The intelligent traffic solutions were shaped as part of a public private innovation (PPI) process. In this process, the city administration, in collaboration with universities and private companies, has developed and tested new ITS solutions for the benefit of citizens and users. Lessons learned from these projects, as well as user feedback, have been decisive for the choice of themes.

Five intelligent traffic have been chosen to be part of the implementation phase:

1. **Mobility and Green Transport -** The theme includes initiatives with regard to efficient use of existing infrastructure such as eco driving, green waves for cyclists and an intelligent bus priority system.
2. **Traffic Safety -** Traffic safety will be improved through the establishment of intelligent lighting and data integration between lighting and traffic signals.
3. **The Streets Adapts to the Rhythm of Usage -** This can be achieved on the basis of flexible use of street areas and other new types of intelligent solutions.
4. **Data and Traffic Management -** The establishment of sensor networks for collecting traffic data, a database for collecting real time traffic data and integration of already exiting traffic systems are only some of the potential solutions with the purpose of creating new data integration solutions with a view ofmanaging traffic according to political goals.
5. **Information and Services -** Through open data platforms and dynamic cycle signs with real-time traffic information will be improved.

The innovation at the heart of the intelligent traffic solution is a fundamental shift in business model. Its fundamentally an open innovation approach based on identified key challenges and set up to include key partners from the beginning and to identify innovative ideas and solutions that are then scaled up. The solutions are based on open standards and thus enable the associated system to operate across traffic management systems as well as link with light management. In future more integration could be envisions with smart energy infrastructure.

The 5 solutions currently under development should be seen as building blocks which are part of a modular programme for intelligent traffic in Copenhagen in the future.

The initiative is totally committed to citizens, or more generally road users. The behavior of the citizens is the main source of data in the solution. The solution has been projected with a prevalent focus on cyclists, since Copenhageners are really engaged in becoming a green city, giving a great contribution in environmental issues reduction and city life improvement. The solutions aim at providing "mobility as a service" both by gathering and providing information by the user and useful to the user at the right time as well as enabling better machine-to-machine data flows to enable better city-wide travel and traffic management.

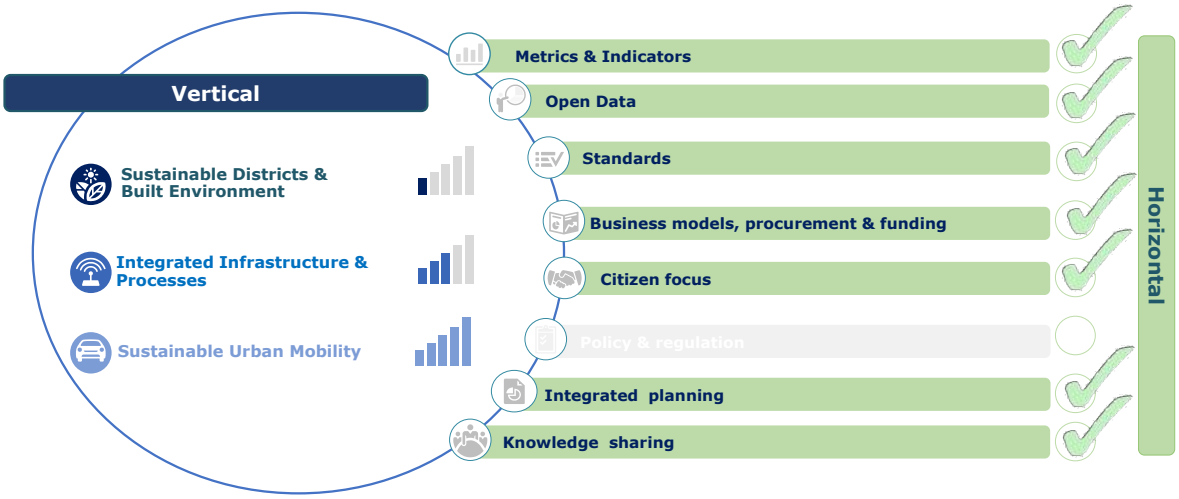

Figure 1: SCC Solution Integration Dashboard

Market analysis

ITS is a combination of information and communication technologies used in transportation and traffic management systems, which improve the safety, efficiency, sustainability of transportation networks and reduce traffic congestion. According to a recent markets and markets report[6], the global ITS market is estimated to reach $33.89 Billion by 2020, at a CAGR of 11.57% between 2015 and 2020. According to a new study by Grand View Research, Inc. the global market for ITS is expected to reach USD 38.68 billion by 2020[7] confirming this estimation. This expected growth is mainly driven by the increasing demand for the expansion of transportation, a rising need for improvement of already existing transportation networks, an escalating focus on road safety, and the growth in the logistic sector[8].

The overall ITS market has been divided into four segments, namely: components, systems, applications, and geographic regions. See Figure 2.

[6] http://www.marketsandmarkets.com/Market-Reports/intelligent-transport-systems-its-market-764.html
[7] http://www.grandviewresearch.com/industry-analysis/intelligent-transportation-systems-industry
[8] http://www.grandviewresearch.com/industry-analysis/intelligent-transportation-systems-industry

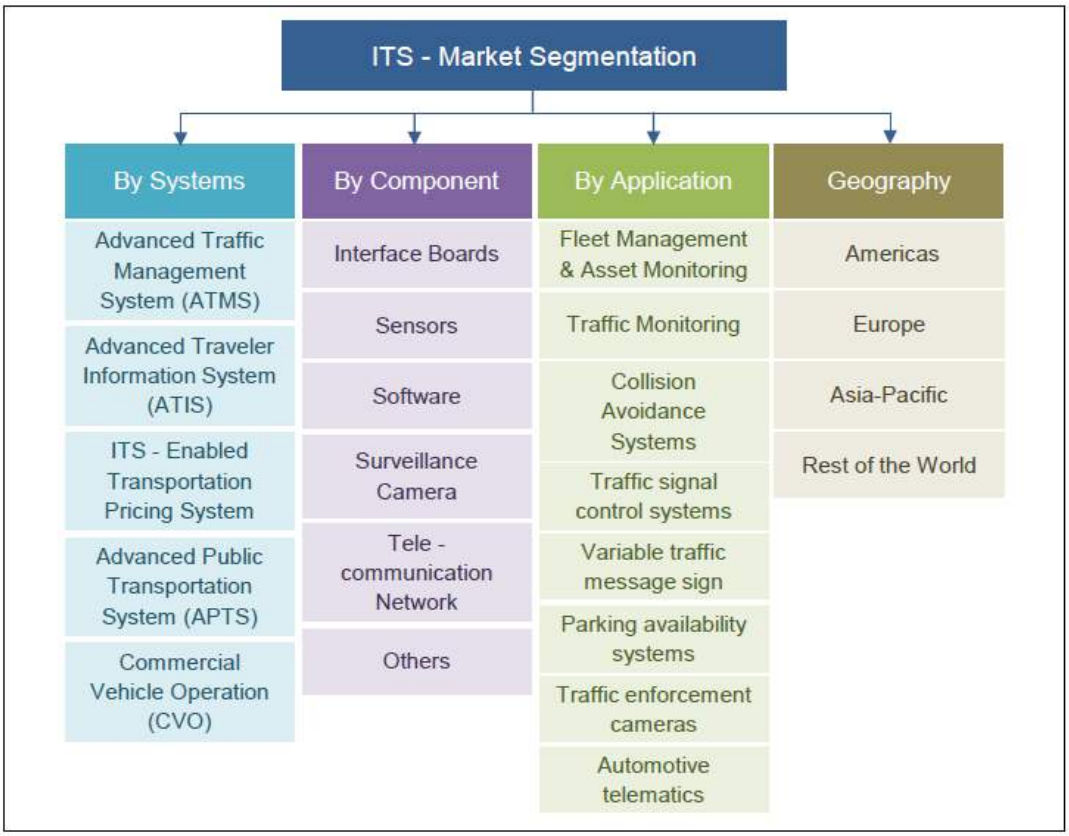

Figure 2: Market Segmentation. Source: MarketsandMarkets Analysis

As illustrated in Figure 2, within the system category, four specific systems can be characterized: advanced traffic management system (ATMS), advanced traveller information system (ATIS), ITS-enabled transportation pricing system, advanced public transportation system (APTS), and commercial vehicle operation systems (CVO). According Grand View Researh, the ATMS market accounted for approximately 38% of the global revenue in 2013 and is estimated to grow at a CAGR of over 12% from 2014 to 2020.[9] This illustrates the huge market potential for traffic solutions, such as the Copenhagen ITS, that addresses the current demand for improved conditions for traffic and transportation management.

Geographically, North America is currently a large market for ITS; however, the market in the Asia-Pacific countries (APAC) is expected to grow at the highest Compound Annual Growth Rate (CAGR) of 14.05% during the forecast period[10]. The European market is further segmented into the U.K., France, Germany, and the Rest of Europe.

However, the market potential for this ITS system cannot be measured only in the direct relationship to estimations of market send in ITS technologies, but should also be considered in the context of future deeper integratedness with for instance smart grid technologies or smart building monitoring technologies.

9 http://www.grandviewresearch.com/industry-analysis/intelligent-transportation-systems-industry
10 http://www.grandviewresearch.com/industry-analysis/intelligent-transportation-systems-industry

Main impacts

The purpose of the ITS solution in Copenhagen is to improve traffic mobility and the safety of all Cyclists, busses, cars and pedestrians. Hence, the system is actually able to perform future scenarios' hypothesis, by matching traffic conditions with variables like weather or road works. At last, the ITS solution's main goal is CO2 reduction and it may reduce traffic noise.

The traffic management plan lays down a number of service goals for individual forms of transport[11]. The initiatives in this action plan will ensure that service goals – the administration's performance indicators in traffic management – are met. Each year, the administration follows up on progress towards meeting these service goals. Collection and processing of traffic data is necessary in order to be able to follow to what extent service goals are being met. This applies both when quick action must be taken if a service goal is not being met, as well as when it comes to assessing averages and trends over a longer period of time. The pilot phases of the intelligent traffic solutions have already been evaluated[12]. Here evidence suggests that the different solutions contributed to optimize response time and making it shorten, thanks to a better capability of reacting to specific traffic conditions. The impact of the solutions is measured according to concrete service goals, which are pictured below.

> The system contributes to a significant traffic optimization and better life quality for each citizen in the city.

Mode of transport	*Service goal – must be achieved by 2018*
Cyclist	• *The average speed on the designated cycle routes will increase from 15.7 kph to 17.3 kph, resulting in the average travel time being reduced by 10%.* • *The number of stops to be reduced by 10%*
Pedestrians	• *In the Inner City, pedestrians must have sufficient green time at the signals to cross the road without having to stop in the middle. Care must also be taken to ensure that pedestrians do not wait too long before getting the green light to cross the road.* • *Outside the inner city, special consideration must be given to pedestrians on the main shopping streets and at busy intersections and particularly in urban spaces where there are many pedestrians*
Buses	• *The average journey time by bus to be reduced by 5-20% during peak hours, depending on the route.* • *There must be a 10% increase in the reliability of the travel time*
Cars	• *The average travel time of the designated road network must not be increased and on specified lines must be reduced by 5%.* • *There should be a 10% increase in the reliability of travel time prediction during rush hour in the direction with the densest car traffic* • *The number of stops on the priority road network must be reduced by 10%*

Table 1: Range of service goals of ITS projects. Source: Technical and Environmental Administration, City of Copenhagen, 2014

A traffic simulation showed that optimisation of traffic signals on one of the main streets in Copenhagen, H.C. Andersen´s Boulevard, can provide up to 14% reduction in travel time for motorists during rush hour in one direction. The number of stops cyclists made on the same stretch of road was also reduced by up to 16%. Bus travel time was also improved in a similar way, especially in daytime at Stormgade / H.C. Andersens Boulevard intersection. Pedestrian traffic safety is also expected to improve following technical adjustment to the signals.

[11] Interview with Mads Gaml, Technical and Environmental Administration, City of Copenhagen (November 24, 2015)
[12] Interview with Mads Gaml, Technical and Environmental Administration, City of Copenhagen (November 24, 2015)

Another test demonstrated that it is now possible to go through some city routes cutting the travel time by 30%. In 2014, The Technical and Environmental Department of City of Copenhagen tested the traffic situation after a football match in Parken, the national football field. The test showed that the time when there is traffic congestion was halved: from about 40 minutes to about 20. The test also showed that it is possible to create intelligent traffic management based on making an early analysis of the traffic situation at that point in time.

And finally, overall, the solution will result in a decrease of noise and air pollution, thus it contributes to reach CO2 emissions reduction target, which is in line with the aims of becoming a carbon-neutral capital by 2025.

Rich Picture Model

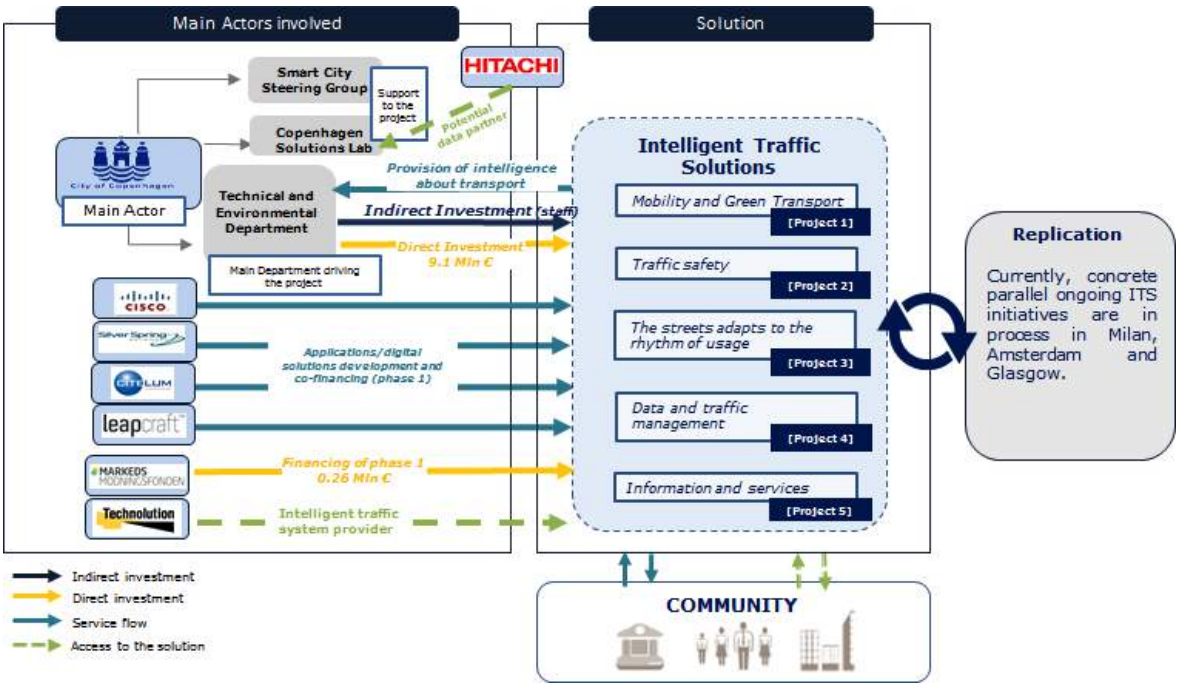

Figure 3: Rich Picture approach of Copenhagen Intelligent Traffic Solutions

As illustrated above, the Intelligent Traffic solution in Copenhagen is part of a fundamental shift regarding "mobility as a service" in Copenhagen. Particularly the method of developing the core project deserves to be highlighted – a bottom-up PPI procedure which was co-financed identified the 5 core themes that have now been turned into projects to be implemented as described above.

Its main success factors can be described as:

- **PPI** – The city administration of Copenhagen has drawn up the CPH Climate Plan 2025 in order to meet its target of being 'carbon neutral by 2025'. This plan contains a large number of regular measures, dealing with energy consumption, energy generation and mobility, including the installation of energy-efficient street lighting and the insulation of older public buildings. Copenhagen assigned an important place to innovation in its climate plan, in addition to 'regular' measures. To achieve such innovation Copenhagen set up a 'catalyst for innovation' in 2013: the City of Copenhagen as a platform – a module to deliver PPI.
- **User/Citizen focus** – all initiatives include a high focus on the citizen/user. This is also included in the procurement processes for these solutions and the contractor in fact won also on the basis of user/citizen involvement.
- **Focus on data** – one of the 5 projects is focussed on unlocking the potential of data to manage traffic better in the future – traffic in this case meaning the wide definition of the pedestrian, particularly the bike user in Copenhagen, busses, cars and trucks. The solutions are supported by close cooperation with the new **traffic control centre** that was recently launched in Copenhagen.

All of these solutions could be further scaled and integrated in future and there is a smart governance structure and parallel key initiatives in place to drive the solution and integrate it further in future:

- **Copenhagen Solutions Lab** - The Copenhagen Solutions Lab will be a new governing body for smart city projects across all sectors in the city and will have focus on creating triple helix partnerships. Copenhagen Solutions Lab will lead the implementation of innovation and smart city development in close collaboration with knowledge institutions and companies as well as citizens[13].
- **Open Data Exchange Platform** – Hitachi is building an innovative big data platform for the city of Copenhagen. The platform is being built in partnership with the City of Copenhagen, the Danish Capital Region, CLEAN (a Danish clean-tech cluster organization), and a consortium of partners. The aim is to take a step further than the already well-known open city data platforms by establishing a city-wide marketplace for the sale and purchase of data between all types of users of the marketplace[14].

[13] Interview with Marius Sylvestersen, CPH Solutions Lab (January 11, 2016)
[14] Interview with Kim Spiegelberg Stelzer, Technical and Environmental Administration, City of Copenhagen (December 17, 2015)

Business Model Canvas

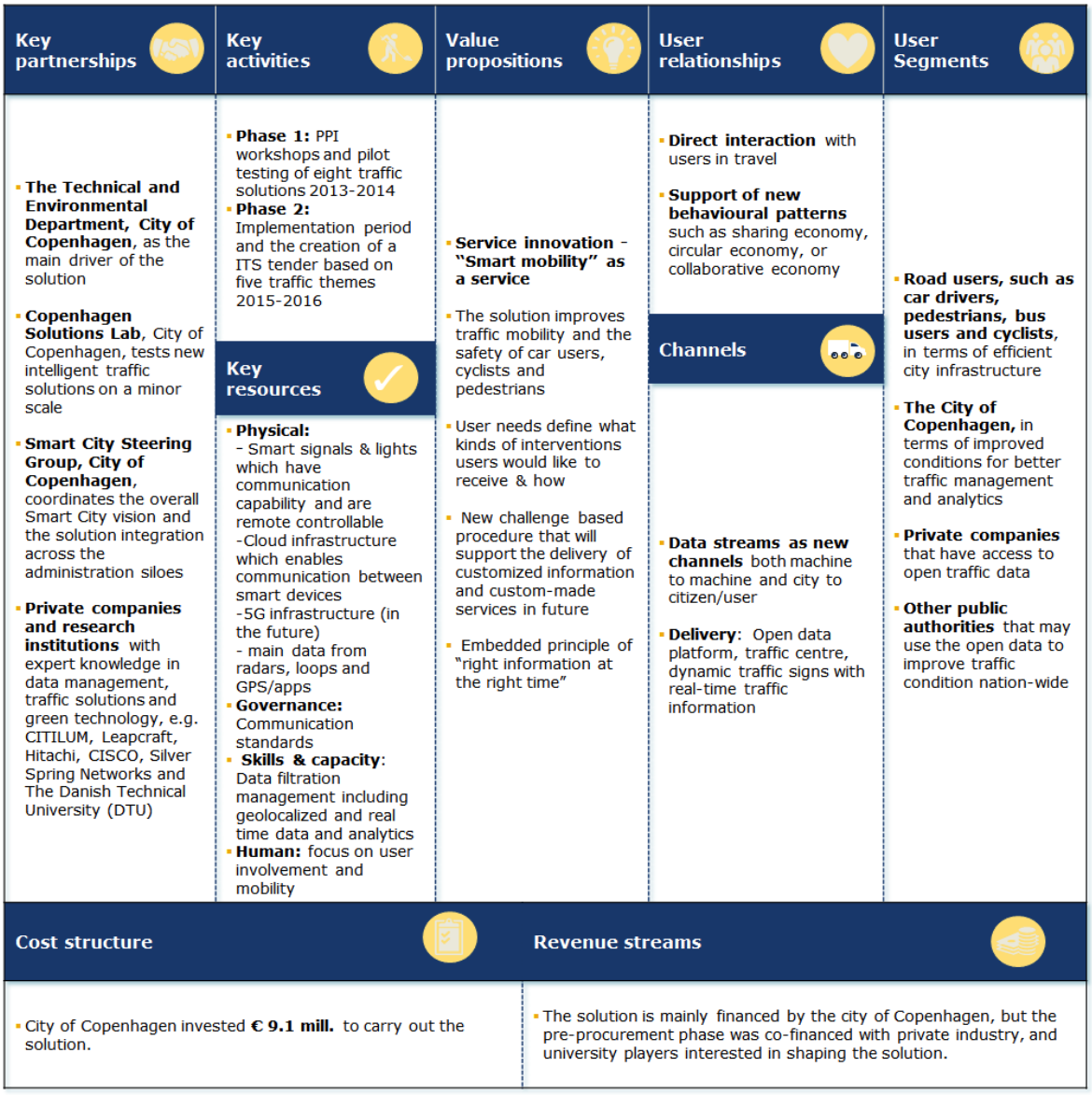

Figure 4: Business Model Canvas of Copenhagen Intelligent Traffic Solutions

User segments

The users of the solution are the different kinds of **roads users** of Copenhagen: motorists, cyclists, pedestrians and public transport users. The users experience an improved infrastructure with reduced travel times, improved safety and high level of traffic service and information. Additionally, **the City of Copenhagen**, and more specifically the Technical and Environmental Administration, gets access to valuable traffic information through the road user data. This data is essential for better traffic management within the City of Copenhagen. **Private companies** and **other public authorities** may use the open data platform to develop new ITS solutions and products as well.

Value proposition

Based on digital technology, ITS is opening up entirely new opportunities to control traffic strategically in a way that supports a number of the overall goals. ITS are also a central element in the concept of the Smart City, where data from a variety of sources can be linked and used for new types of solutions and services. The aim of this IST solution is to move towards offering **- "smart mobility" as a service** in Copenhagen. Whilst this integrates with the overall city ambitions to become more sustainable and reduce the overall level of CO2 emissions, further integration with the smart grid, and/or eco-building technologies could be feasible.

The ITS solution **improves traffic mobility and the safety of car users, cyclists and pedestrians** in Copenhagen. A clear focus is on **citizen centricity** – the user needs define what kinds of interventions users would like to receive & how. The new frontier in citizen centricity in the particular setting of ITS solutions will be what data is used for what purpose and by whom, which the city of Copenhagen is very aware of.

Part of the value proposition inherent in this solution is the **new challenge-based procedure supports the project** which is for instance evident in the PPI procedure which shaped the underlying tender. Also, Copenhagen operates with strong standards such as their open data standards they are also embedding the principle of the "right information at the right time

Channels

Data streams are new channels that are being developed in this solution - both machine-to-machine and city-to-citizen/user. These data streams are processed by the **open data platform**, traffic centre, dynamic traffic signs with real-time traffic information. The concept involves mainly collecting data from radars, loops and GPS/apps along Copenhagen streets, as well as mining anonymized/aggregatd GPS data from devices/apps. data from sensors/apps are processsed, to compute travel times, etc.

User relationships

The City of Copenhagen directly interacts with the traffic users through **traffic data gathering** process. Additionally, in the future, it will be possible to connect **new areas to the data system** such as circular economy, sharing economy and collaborative economy[15].

Revenue streams

The solution does not directly build on a model with revenue streams according to our research to date. The City of Copenhagen finances the ITS solution entirely now that the solution has been implemented. The different ITS projects were tendered for in early 2015 for implementation in 2016-2017.

However, in the pre-tender phase, Copenhagen ran a co-financed public private innovation phase where the private players co-financed the experimentation and definition of the specifications of the final solution. But according to the programme manager of the Copenhagen Solutions Lab, companies are very interested in contributing to solution development and

[15] Interview with Kim Spiegelberg Stelzer, Technical and Environmental Administration, City of Copenhagen (December 17, 2015)

testing because they have the possibility to test and, indirectly, showcase their products, equipment and expertise and potentially refine their business models . In that sense, the companies may well experience establishments of new business models, partnerships and economic advantages through the marketing of their smart city products. Currently, the Japanese technology company, Hitachi, is testing a new data platform including open standards in collaboration with Copenhagen Solutions Lab. The system has the potential in future to combine data from the ITS solution with other types of data. In general the City of Copenhagen does not run a business model in which they make any profit from the solutions (for instance selling data etc) .

Key resources

The **human resource proposition** addresses the issue that the solution is solely dependent on user data and involvement in terms of tracking road users mobility patterns.

The main **physical resources** are mainly technological in nature. They are the implementation of:

- Smart signals & lights which have communication capability and are remote controllable;
- Cloud infrastructure which enables communication between smart devices;
- The system includes data collected from smart network of sensors that are installed around the city. 5G infrastructure (in the future);
- Communication standards;
- Data filtration management including geolocalized and real time data and the relevant analytics.

The **governance resource** most prevalent in driving this solution are the PPI process and the use of strong standards. For instance, the data is open sourced which means that other actors also have access to the data. This is especially in terms of traffic information that, in a broader perspective, is extremely useful in relation to other types of city data and opens up several opportunities for new solutions based on data integration.

New **skills & capacity** that are required by this solution are data filtration management including geo-localized and real time data and analytics. Such skills and capacity will become a key resource for future services for Copenhagen.

The **human factor** embedded in this solution is its focus on user involvement and mobility.

Key activities

The key activities can be divided into a pilot testing period (phase 1) and an implementation period (phase 2).

From 2013 to 2014, eight pilot testing projects were established around the city. During that time, the impacts of the solutions were measures and analysed. Eight ITS themes were tested in the pilot period: 1) Extra lights on the cycle paths – intelligent street lighting, 2) Street life in car park, 3) Better flow in the street, 4) Box senses the street pulse, 5) Buses on time, 6) Smart mobility choice, 7) Parken (the Copenhagen football stadion) emptied in 20 minutes, and 8) Cyclists riding on the green wave. These eight pilot themes were established through seven PPI workshops held by the City of Copenhagen and The Danish Design Centre with the participation of several companies and knowledge institutions in order to get valuable input on how to develop and test new and effective intelligent traffic solutions.

Based on an administrative and political assessment of the results so far, five specific themes and a range of suggested related sub initiatives will be implemented in phase 2 from 2016 to 2017. The five themes are:

- Mobility and Green Transport;
- Traffic Safety;
- The Streets Adapts to the Rhythm of Usage;
- Data and Traffic Management;
- Information and Services.

Key partnerships

The solution is driven by a process including both public and private actors creating a public-private innovation (PPI) process. The main actor driving the solution is **the Technical and Environmental Administration, City of Copenhagen**. In relation to the enrolment of the specific technological aspects of the solution, the City of Copenhagen has partnered up with a big group of companies and knowledge institutions. Each traffic initiative was based on a specific partnership constellation with the City of Copenhagen as the main coordinator. An evaluation of the PPI processes concludes that all the actors, both public and private, categorized these partnerships as positively different compared to other PPI processes due to its high level of transparency, collaboration effort and encouragement among the actors involved, and the experimental character of the work procedure. In general, the PPI process has resulted in a deep insight and understand of the city challenges and needs in the future, valuable access to data, immediate and fruitful feedback from experts, and the recognition of the importance of life-like pilot testing as an integral part of the development process.

Cost structure

Copenhagen City Council has invested almost **€ 9.1 million** to carry out "Copenhagen Intelligent Transport Systems" (ITS) smart solution. This is the investment for the "first wave" of the ITS program. Further investsments are needed of the goal of reducing CO2 emissions of 25.000 tons in 2025.

In the pilot testing phase, project management, tests of solutions, external consultations and the tender process were totally financed by Markedsmodningsfonden, a public fund located under the Danish Business Authority. One of the aims of the fund is to strengthen the public capacity to develop innovative solutions that benefits both the private and the public sector. € 0.26 million was delegated to the ITS project by Markedsmodningsfonden. Based on the case material, there is no information on how much money the private companies involved in the pilot testing phase has pushed into the test solutions.

Budget	
Mobility and Green Driving	*€2.8m*
Traffic Safety	*€0.4m*
Streets Adapted to Circadian Rhytm	*€0.3m*
Data and Traffic Management	*€3.15m*
Information and Services	*€0.5m*
Project Management	*€0.2m*
Total (1015 price levels)	***€7.3m***

Table 2: Budget for the ITS Tender based on each traffic theme. Source: Technical and Environmental Administration, City of Copenhagen, 2014

Based on this, in October 2015, The City of Copenhagen launched a €6.3million investment in a intelligent traffic system made by the Dutch company, Technolution BV. The system covers different traffic features from intelligent street lighting, green waves and better conditions for cyclists and heavy transport. The system will be implemented in 2016- 2017. Additionally, City of Copenhagen is investing €2.8million in the development of another traffic system with the capacity to calculate and create traffic forecasts, and to build up a possibility to integrate other into the system with the aim of improving the traffic and resilience management in bad weather. 5 employees within the technical and Environmental Administration are working full-time on the ITS projects. The costs for project management is approximately €0.2mill. Please see the table below for an overview:

Pilot Testing Phase (2013-2014)	*Pilot Testing*	*External Consultations*	*Tender process*	*Wages*	*Total*
Markedsmodnings-fonden (Danish Business Authority)	*€0.13m*	*€0.07m*	*€0.04m*	*€0.03m*	*€0.26m*
Implementation Phase (2015-2016)	Intelligent Traffic System	System to strengthen data integration	Project management		Total
City of Copenhagen	*€6.3m*	*€2.8m*	*€0.2m*		*€9.3m*

Table 3: Budget for the ITS system distinguished between the pilot testing phase and the implementation phase[16]. ***Source: Technical and Environmental Administration, City of Copenhagen, 2014; 2015***

Finally, not all staff are actually directly financed by the solution under project financing. Some full-time employees of the Copenhagen municipality – for instance the overall programme manager – complement the project funding.

[16] Conversion rate €1 = DKK7,47

Barriers/challenges

Traffic solutions need to be 100% reliable hence both the infrastructure, as well as the co-ordination mechanisms between partners need to be risk-free. Given the innovativeness of these solutions – the solutions are actually built in a "fail fast" way were barriers are identified along the way and in case of wider scaling and roll-out certain contextual barriers may be the reason for a later large-scale roll-out.

For instance:

- Most future ITS solutions will require 5G to be reliable - yet Copenhagen currently is covered with a patchy E to 4G network. The telecommunications market will need to be taken into consideration to address this barrier.
- Security of data will be an issue - whilst there are clear open standard and open data policies in place – security of data for solutions relying more and more on data flows will be a barrier the Copenhagen city government will need to address further.
- The more personalised, custom-made and value-adding future traffic & travel solutions are meant to become the more they may require a fresh look at privacy legislation.

Whilst the nature of this project is bottom-up, challenge-based innovation, this also goes along with **insecure funding** for the long-term future. Phase I, the actual development of the requirements of the solutions, was co-financed by the private partners and the city of Copenhagen. Phase 2, the implementation of the 5 solution projects, will be entirely financed by the Copenhagen municipality. There is an expectation that there will be further financing. The city will finance the operation of the system after implementation, just like we finance roads, traffic lights, etc. The case for this will be based on the business case.

A further barrier mentioned during the interviews was the lack of smart city vision from the national government. Several of the interview persons emphasized, that the Danish cities are the leading smart city drivers, not the national government. On the other side, as one of the interview persons described, the Smart City agenda has been moved to the Ministry of Business and Growth which is one of the leading ministries in Denmark.

Also, even though the cities are the main drivers of the Smart City agenda, in the case of the ITS solutions, the fact that Copenhagen is divided into two administrative bodies, The City of Copenhagen and the City of Frederiksberg (and in the case of Greater Copenhagen even more municipalities), has been a great challenge in terms of providing the citizens with efficient traffic services in the whole city. The ITS solution is driven by The City of Copenhagen which means that the solutions are not implemented in other municipalities (for example Frederiksberg municipality). As one of the interview persons mentioned, cities are still working on their own agendas. However, there is some collaboration going on between the City of Copenhagen and the City of Frederiksberg in order to align data gathering procedures and to implement ITS solutions that cut across the administrative city borders.

> Currently, the vision is to emphasize the use of data in order to improve the overall data management approach in all cities, and not just in the bigger cities.

Replicability factors

The ITS solution has a great potential for replication. There are no place limitations to be identified. In the future all big cities will face major traffic and mobility problems because of increasing urbanisation. Many companies already offer intelligent traffic management systems to ease environmental and climate impacts from the growth in mobility in the cities. Currently, concrete parallel ongoing ITS initiatives are in process in Milan, Amsterdam and Glasgow.

Figure 5: Replication areas of Copenhagen Intelligent Traffic Solution

Five factors can be identified as crucial to the replication potential and rate of success of the ITS solution:

1. In the case of Copenhagen, the establishment of a **Smart City steering group across sectors** and the creation of **Copenhagen Solutions Lab** bring in the opportunity for innovation, coordination, learning, integration and collaboration. This emphasise the importance of a suitable governance structure for the development of smart city solutions[17].
2. **Pilot testing** is a central feature of the ITS solution in Copenhagen. Based on the experience from the involved persons within the administration, the best scalable solutions are initiated within the administrative department. Afterwards, based on a systematic pilot testing period, scaling and integration potentials are evaluated by the Smart City steering group. As one of the interview persons described, at first, city solutions must be smart within its own domain and the data gathering process must be aligned according to standards agreed upon[18]. Afterwards in a much longer perspective, it will be possible to combine data from different administrative domains in order to address issues that cut across administrative siloes.
3. **Strong cooperation both nationally and internationally opens** up the opportunity for replication. The open data platform and the concept of open traffic data is going to be replicated within the Smart City Network in Denmark. Networks also contribute to

[17] Interview with Kim Spiegelberg Stelzer, Technical and Environmental Administration, City of Copenhagen (December 17, 2015)
[18] Interview with Marius Sylvestersen, CPH Solutions Lab (January 11, 2016)

create a common "Smart City Voice" in order to influence the governmental Smart City agenda[19].

4. A **systematic data management structure** is needed in order to further develop the integration potential of the solution. Based on the experience from Hitachi´s engagement in Copenhagen, open data platforms may encourage companies and knowledge institutions to contribute to the creation of new smart city solutions with new and valuable knowledge and investments.
5. The use of **open standards** enables operability and addresses the challenge of vendor lock-in. Copenhagen is committed to open standards to create its smart city infrastructure. In fact Copenhagen is part of the Open & Agile Smart Cities (OASC) initiative, signed by 31 cities from Finland, Denmark, Belgium, Portugal, Italy, Spain and Brazil, aims to kick the use of a shared set of wide-spread, open standards and principles, enabling the development of smart city applications and solutions to reach many cities at once, by making systems interoperable between cities, and within a city. The commitment marks a milestone in the development of smart cities, boosting the digital transformation of cities into engines of growth and citizen satisfaction through co-creation.

"Replication recipe"	
Infrastructure and financing	✓ *Systematic Data Management Structure* ✓ *Open Standards*
Governance	✓ *Smart City Steering Group and The Creation of Copenhagen Solutions Lab - Integration Across Siloes* ✓ *Bottom up approach – Pilot Testing* ✓ *Emerging collaboration between cities both nationally and internationally*

Table 4: Replication recipe of Copenhagen Intelligent Traffic Solutions

[19] Interview with Kim Spiegelberg Stelzer, Technical and Environmental Administration, City of Copenhagen (December 17, 2015)

Sources

Interviews / Contact persons	› Mads Gaml, Project Responsible of the ITS solution, Technical and Environmental Administration, City of Copenhagen (November 24, 2015) › Bahar Araghi, Project Manager of the ITS solution, Technical and Environmental Administration, City of Copenhagen (November 24, 2015) › Emil Tin, Project Manager of the ITS solution Technical and Environmental Administration, City of Copenhagen (November 24, 2015) › Kim Spiegelberg Stelzer, Data Consultant and Smart City Coordinator, Technical and Environmental Administration, City of Copenhagen (December 17, 2015) › Marius Sylvesteren, Manager of Copenhagen Solutions Lab, City of Copenhagen (January 11, 2016)
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Internet sources	› City of Copenhagen, 2014: "26. Midler fra Markedsmodningsfonden til innovationssamarbejde om Intelligente Transport Systemer" http://www.kk.dk/indhold/teknik-og-milj%C3%B8udvalgets-m%C3%B8dematerialе/03022014/edoc-agenda/b83525eb-11fd-46ad-93ad-9a485961df42/45cf8799-3c6a-4689-b751-c29ae1e8f55c › City of Copenhagen, 2015, "Status på København. Nøgletal for København 2015" https://www.kk.dk/sites/default/files/uploaded-files/Nogletalsrapport_2015.pdf › City of Copenhagen; 2015; "Copenhagen Intelligent Traffic Solutions" (https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-intelligent-traffic-solutions) › Copenhagen Data (http://data.kk.dk/) › Copenhagen Solutions Lab (http://cc.cphsolutionslab.dk/) › Grand View Research; 2014; "Intelligent Transportation System (ITS) Market Analysis By Product (ATIS, ATMS, ATPS, APTS, Cooperative Vehicle Systems), By Application (Traffic Management, Road Safety & Security, Freight Management, Public Transport, Environment Protection, Automotive Telematics, Parking Management, Road User Charging) And Segment Forecasts To 2020" (http://www.grandviewresearch.com/industry-analysis/intelligent-transportation-systems-industry)
Figures sources	› cph solutions lab http://cc.cphsolutionslab.dk

Klimastrasse

Cologne, Germany

→ Replication potential
→ Complexity
→ Citizens' involvement
→ Economic impact
→ Environmental impact
→ Social impact

Assessment based on feedback provided by the solution's representative as well as on the available sources analysed by the study team.

Short description of the case study

		Key facts and figures
Klimastrasse solution	**Type of solution**	*Innovative use of electricity, smart meters and charging stations for electric mobility*
	Project stage	*The project kicked-off in 2014 and is expected to continue up to three years with further enhancements.*
	Actors involved	*City energy provider (co-ordinator), City council (policy management), industry and citizens*
	Roll-out of the solution	• *On January 2013 the pilot phase of the project was completed* • *Future plans involve E-bikes, combined with appropriate charging stations.* • *Set up solar power banks, benches, which can simultaneously charge laptop and telephone*
	Barriers	• *Citizen involvement in energy savings behaviour* • *Adaptation to new technologies* • *Industry involvement in development of innovative products*
	Implementation best practice city	*Neusser Straße in Nippes (Cologne district) (33,000 inhabitants)*
	Main technological areas covered	*Information and communication technologies, energy and transport domains*
	Funding mechanism	*€ 1.7 Mln project, funded by grants (from the local energy provider)*
	Economic, social & environmental impact	*16 different local companies have been saving up to 70% of their energy costs by using LED* *The potential related to all shops and offices in the street is approximately 2.216 tons of CO_2 per year, equal to 40% CO_2 reduction emissions*
	Replicability factors	• *Industry and citizens involvement* • *Acceptance and engagement in new technologies use and provision* • *Clear governance structure and policy commitment*

Case summary

The Klimastrasse (Climate Street) project in Neusser Straße in the Nippes district of Cologne (DE) is a project managed by the local energy provider RheinEnergie AG. The project is part of a complex strategy, i.e. over twenty different projects with which the municipality of Cologne aims to show how a future smart City might look. More specifically, the projects are meant to implement the city long term strategy of tackling climate change, as shown by the **SmartCity Cologne platform**, in which several energy related facets of climate change are taken into account: from optimal building insulation and maximum heat efficiency up to the charging stations for electric vehicles, and low-energy street lighting. A broad group of stakeholders is involved in the SmartCity Cologne platform projects: policy makers, private citizens, academia, industry, local business owners and associations.

The common characteristic of the SmartCity Cologne projects is that they aim at supporting industries, small and medium-sized enterprises (SMEs) and local business owners (shop keepers) in the development and use of innovative energy-saving technologies, and citizens in suggesting intelligent ideas and solutions.

In general, all the projects get funding by benefits from **RheinEnergie AG,** the local energy provider dealing with electricity, water and natural gas supply. RheinEnergie AG is the subsidiary company of the GEW Köln AG, part of the holding Stadtwerke Köln, owned by the city of Cologne. Some bigger projects where industries are involved get also funding from both sides.

The Climate Street project in Neusser Straße provides the opportunity to test new products and services reducing energy consumption. Funded with €1.7m grants by RheinEnergie AG (€ 600k of whichh has been allocated to the smart meters roll out), the Climate Street project is an example of a community-embedded demonstrator or test bed for smart city solutions. It also aims at promoting collaborations between private companies. This should ideally promote long-term partnerships, development of innovative ideas and new business models for the future.

The key intervention areas of the Climate Street projects are the following:

- Optimized building insulation (roof, facade, windows, etc.);
- Renewable energy (photovoltaic);
- Innovative use of electricity (LED street lighting, smart meters);
- Intelligent energy management for the home (smart home for heat, light, electricity, security);
- Implementation of additional measurement technologies for better monitoring of power grids;
- Charging stations for electric mobility (car and e-bikes);
- Installation of sensors of environmental data and visualisation for the public.

The project started in 2014, with a preliminary pilot phase carried out in January 2013, when the Bookstore Neusser Straße realized the first step: the existing lighting in the bookshop was completely replaced by LED lighting. The Climate Street project, started in 2014, is going to continue through demonstrations for three to five years onward. Concrete ideas have already been developed (see the box).

> Holger Kahl, Project Manager of Climate Street: ”Concrete plans are for example pitches for E-bikes , combined with appropriate charging stations . We agree precisely with the city administration the location. We also want to set up a solar bank , a bench , in which citizens can charge phones or laptop”.

In a nutshell, the Climate Street project involves citizen and industries in energy efficiency behaviour and products, coordinating demonstrations and innovation projects, promoting climate protection, sustainability and efficient use of energy. Benefits are expected for everyone

involved in the city life: awareness in rational use of energy, cost savings products and support for climate change targets.

The Climate Street project, as depicted in the following figure, covers all three vertical/technological priority areas of the EIP-SCC Strategic Implementation Plan. The Climate Street features in fact charging stations for cars along with a plan for future alternative means of transportation such as the electric cycles (Pedelec), integrating in such a way sustainable mobility with built environments. Sustainable district & built environment and integrated infrastructures are also addressed through the use of smart meters and building insulation. Integrated planning, policy and regulation, citizens focus and business model are the horizontal priorities involved in the project. Policy and regulation and integrated planning are ensured by the important commitment of the local policy makers (the city of Cologne in fact steers the initiative). Citizens focus is a consequence of the local scale of the initiative, which involves the inhabitnats of part of the Neusser Straße in Koln. Pilot and test beds in the implementation of new technologies for energy savings stimulate local businesses in setting-up their own business models.

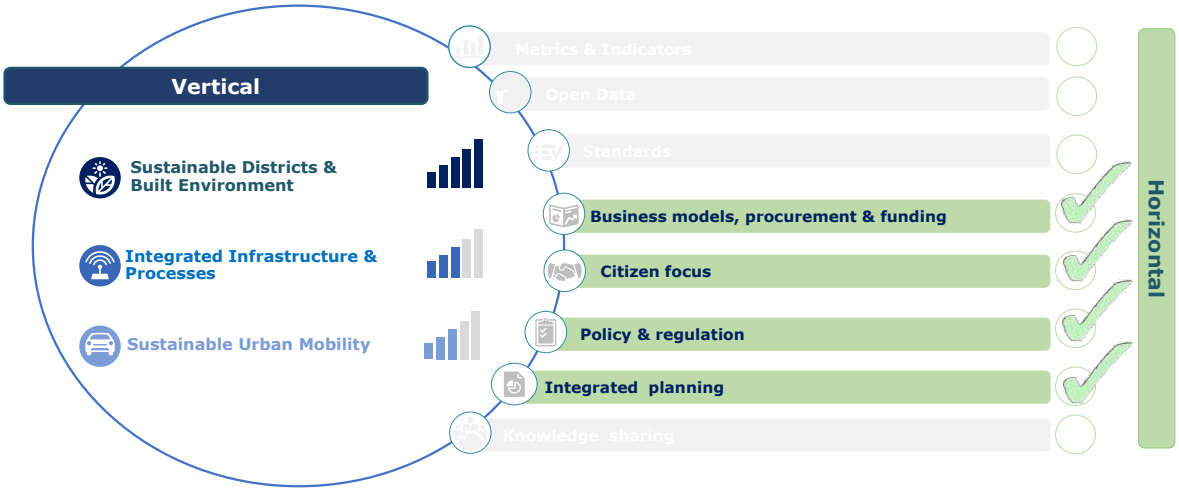

Figure 1: SCC Solution Integration Dashboard

Market analysis

The Climate Street project focuses on the development of sustainable streets and neighbourhoods. This is a market segment with significant examples in European cities, e.g. the Utrechtsestraat case in Amsterdam, i.e. a street located in the city centre filled with shops, cafés and restaurants. In the Utrechtsestraat case, as in the Cologne Climate Street, energy-saving devices, such as LED lights, have have been implementated. The market for LED appliances is growing. According to a McKinsey report[1], the global LED lighting market is expected to grow from € 7 Bln in 2010 to € 40 Bln in 2016[2]. The impacts are significant; it has been estimated that LED lights installed in Utrechtsestraat resulted in 80% less CO_2 emission[3].

Other examples of sustainable streets involve infrastructure created by connecting as many things as possible (in the sense of the 'Internet of Things' – systems, sensors and physical objects). Operational overlay systems are applied to manage communication among interconnected things with minimal direct human involvement. Such "smart streets" can be found in the Barcelona suburb of Sant Cugat (Spain)[4] and in Milan (Italy)[5]. In non-European

[1] McKinsey & Company, "Lighting the way: Perspectives on the global lighting market", 2011
[2] http://www.ledsmagazine.com/articles/print/volume-8/issue-9/features/lighting-market-report-predicts-strong-growth-for-led-lighting-magazine.html
[3] http://amsterdamsmartcity.com/projects/detail/id/9/slug/climate-street?lang=en
[4] http://optimus-smartcity.eu/sant-cugat-del-vall%C3%A8s

contexts, smart lighting applications in the city of San Diego (US) have provided savings of more than $250,000 (€ 227,000) annually in electricity and maintenance costs[6].

The current number of connected things is around 4.9 billion. By 2020 this is expected to reach 25 billion[7]. Applications of the internet of things are developing organically but their impact will depend on acceptance by citizens, businesses and governments, and this is influenced by perceptions of risks and benefits[8].

For smart streets characterised by innovations, e.g. smart meters, new energy-saving technologies, etc., it takes time for citizens to understand potential benefits. The active participation of citizens and companies is in fact a basic pre-condition for market take up of the solution.

Main impacts

Among the solutions of the Climate Street project, the installation of LED lights is one for which ex-post implementation data are available. The Climate Street project installed LED lighting, shifting the old lighting to new energy saving equipment. As a result, 16 business units among shops, public buildings and companies partially or even completely replaced old lighting with power-saving LED lighting. A second stream of installation of LED lights in shops is going to be under way in 2016.

Shifting to LED lighting saved 439,190 kWh of electricity each year, which represents approximately 249 tons of CO_2. This corresponds to an average of 67% savings on electricity. In economic terms, assuming the unitary costs of 13.26 Cents/kWh[9], including excise duties, excluding value added tax, the total gain in the energy bill by business unit amounts to an average of €2,500/year.

Looking at the potential savings, with a current total consumption on the entire street of approximately 8,744,000 kWh of electricity, the estimated share for lighting amounts to about 70% (about 6.121 million kWh).

Considering all the business units in the Neusser Straße, the potential savings (67% of 6.121 million kWh) is 3,915,000 kWh, or about 3.9 gigawatt hours of electricity and about 2,216 tonnes of CO_2/Year. In economic terms they correspond to a saving of about € 512,000/year in energy consumption.

[5] http://milanexpotours.com/milan-expo-project-2015/masterplan/spiga-smart-street-milan.html
[6] http://www.gereports.com/smart-streets-are-made-of-these-san-diego-deploys-americas-first-intelligent-lighting-system/
[7] http://www.gartner.com/newsroom/id/2905717
[8] Government Office for Science, "The Internet of Things: making the most of the Second Digital Revolution", 2014
[9] Statistisches Bundesamt, Wiesbaden 2015, Energy prices - Long-time series from January 2000 to October 2015-

Rich Picture Model

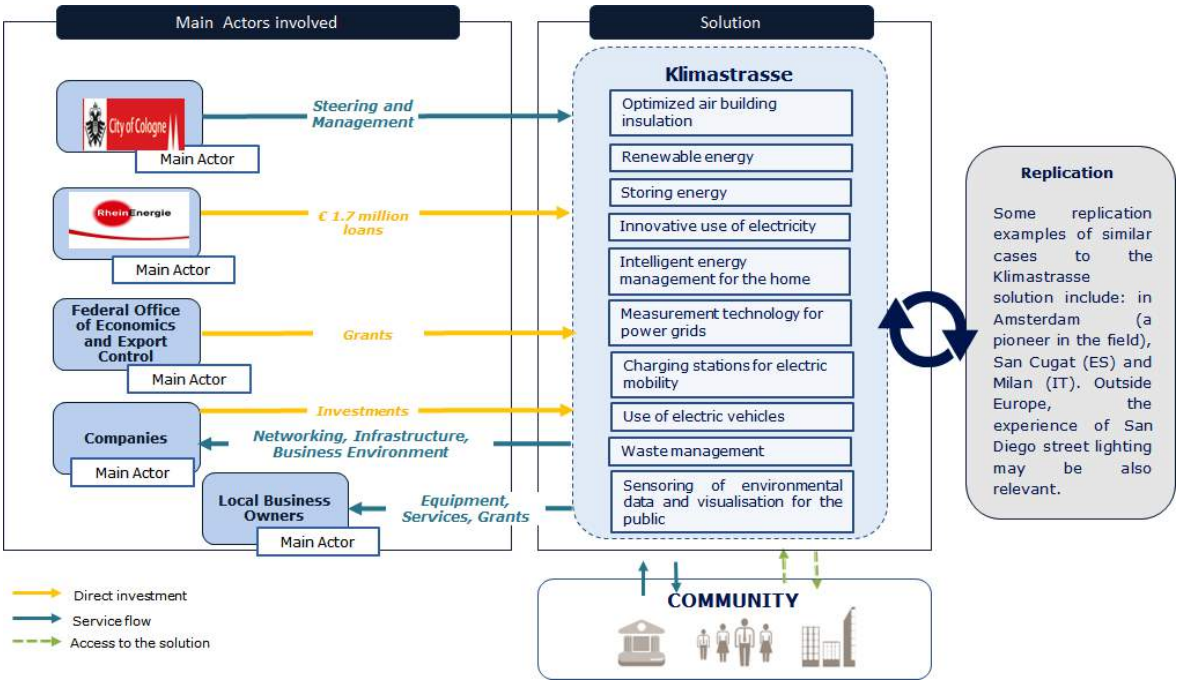

Figure 2: Rich Picture approach of MK:Smart

As illustrated above, the City of Cologne is responsible for steering and management, dissemination and networking activity, supporting the project with staff und its expertise. The political and administrative decision to realize the project "brought a change of heart and shift in consciousness. It rose the awareness starting to invest in measures for climate protection und energy efficiency on the district und city level. This step generated knock-on effects"[10].

The Climate street project is funded thanks to the financial contribution of RheinEnergie AG (grants or benefits). The ACFA (Federal Office of Economics and Export Control) grants are also allocated to the project as part of the Federal program to support switching to LED lights in Germany. Industry also provides economic flows to the project through investments in the solution. In terms of products, there are three main products delivered by the solution:

- **Networking, infrastructure and business environment**, whereby industry can be involved in the project initiatives;
- **Equipment, services and grants** to the business owners, who can benefit from the solutions and innovative products;
- **Training** for citizens, who can be informed on the potential of new products and measurement techniques, in the direction of energy savings

Finally, citizens and industry can have access to the project solutions through targeted initiatives and information campaigns.

[10] Dr Thomas Kreitsch, Coordination Unit for Climate Protection, City of Cologne

Business Model Canvas

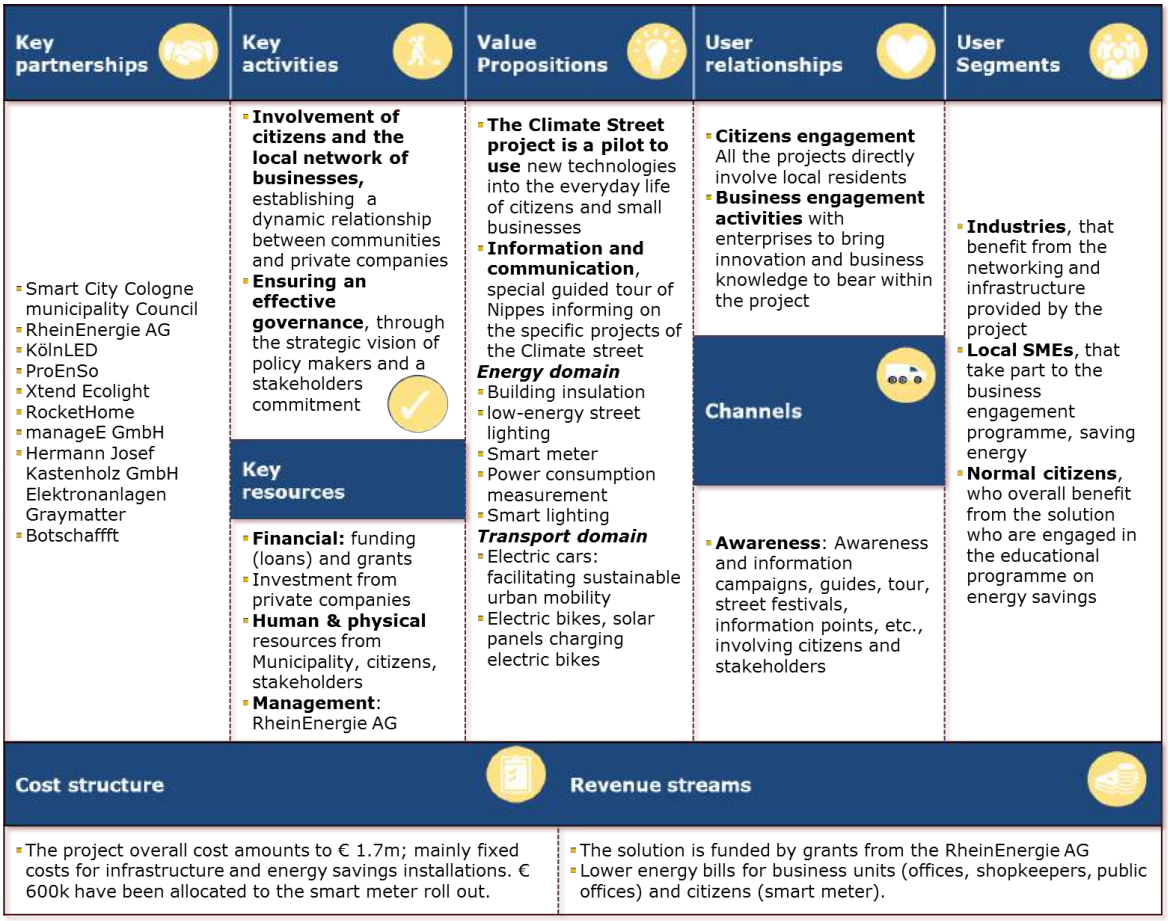

Figure 3: Business Model Canvas of Climate street (Cologne)

User segments

The users of the solution are firstly the inhabitants in the Climate Street, which is a 1.2km stretch of the main road Neusser Straße (about 5 km) in the Nippes district. The scale of the solution is local: 9 private homes and a bookstore for the installation of smart meters, and one charging station for electric vehicles. The installation of LED lights concerns local business owners, public offices and industries.

The following table shows the key users and the corresponding main services provided by the solution.

Key users	Climate Street services
Citizens	Smart meters, charging stations for electric vehicles, and, in perspective, for e-bikes, insulation technologies, awareness on energy savings behaviour and potential savings in every-day life
Industry and local business owners	Solutions and application for energy savings Training for energy saving behaviour

Table 1: Services per key user

Value proposition

The "Klimastraße" ("Climate Street") in the Nippes district of Cologne provides several services and products. They focus on the following solutions:

- Optimized building insulation (roof, facade, windows, etc.);
- Renewable energy (photovoltaic);
- Innovative use of electricity (LED street lighting, smart meters);
- Intelligent energy management for the home (smart home for heat, light, electricity, security);
- Implementation of additional measurement technologies for better monitoring of power grids;
- Charging stations for electric mobility (car and e-bikes);
- Installation of sensors of environmental data and visualisation for the public.

More specifically, the bundle of services and products may be classified under the following three key pillars:

- ***Energy***
  - LED lighting: LED lighting Bookstore Blücherstraße is one of the first projects. The existing lighting in the bookshop has been completely replaced by LED lighting. Further, other shops and public offices did a complete replacement of lighting.
  - Power consumption measurement: Coordinated by RheinEnergie, control and lighting technologies were installed to minimize power consumption of the district town hall. Efficient bulbs contribute as well as on-demand control and use of different power consumers.
  - Smart Home: smart home technologies allowing the control by remote of appliances and smart meters in buildings and shopkeepers can reduce electricity and heating costs by an average of 7%. To test some scenarios and savings in everyday life using modern technologies, the Neusser Straße Smart Home applications have been installed in nine private homes of Nippes Tower and the bookstore.
- **Transport**
  - Electric cars: Electric cars are an energy-efficient and environmentally sustainable alternative to cars which are powered by fossil fuels. In order to promote this renewable alternative transport, 100 charging stations for electric cars have been installed in the context of the electromobility project "colognE-mobile - electric mobility solutions for North Rhine-Westphalia". The "Klimastraße" project has installed one electric vehicle charging station. The charging station, which contains two types of charging points (AC). is branded with TankE, the electric vehicles filling stations network in Cologne, so that everyone can recognize this station among the over 100 others in Cologne. The charging station is listed in every e-mobility register and can be found by everyone who is looking for a charging station around. The electric vehicle charging station has been providing insights concerning user acceptance, usability and user motivation of electric vehicles, which represent relevant information to ensure market take-up of electromobility;
  - Electric bike: In terms of unconventionally fuelled transport means, electric bikes, such pedelec are going to be promoted in the future by RheinEnergie AG. A charging station for pedelecs near the metro station Neusser Str . / Gürtel is going to be set up, provided that all the administrative steps will be completed. The electric bike station will be a trial for the roll out of electric bikes in Cologne. On the roof of the charging station, a photovoltaic system is to be fitted, which saves solar energy in an accumulator, making possible to charge bicycles.

- **Built environment**
  - The project is also testing various sensors from street lamps. At present, a built wireless network monitoring current data for CO2 emissions and for fine dust has been installed. Planned applications will also dealt with noise.

Channels

The "Klimastraße" ("Climate Street") project channels primarily consist of awareness campaigns through which the project solutions are discussed and evaluated.

The **awareness** channels comprise the education, business and community engagement activities.

These are:

- **Information and communication.** In cooperation with the KIO Agency and the RheinEnergie AG a special guided tour of Nippes was developed two years after the start of the project. The Guide provides information about the Nippes district and the specific projects of the Climate street. A city website is also active to deliver project updating.
- **Other engagement activities**. Several initiatives to involve citizens in the innovation process have also been designed, e.g. information kiosks and campaigns inviting citizens to suggest solutions that make energy-saving processes actual in the every-day living.
- **The Climate Street Festival**. The Civic Association "For Nippes" has organized in 2014 and 2015 the project festival to showcase innovative projects and ideas for the sustainable energy consumption and transportation. For citizens and stakeholders of Nippes it has been a way to find out about projects outcomes. The exhibition of new technologies has engaged a wide range of audiences, from local schools to higher education students and businesses.

Climate Street Festival 2015

The Civic Association For Nippes organized in 2015 the 2nd Climate Street festival to showcase innovative projects and ideas for the sustainable improvement of the climate. For citizens of Nippes, there has been the opportunity to find out about projects and options for energy saving technologies.

User relationships

The project provides training activities and initiatives establishing user relationships.

With reference to the **citizen's engagement**, most of the solutions directly involve local residents and need assistance. For example, the installation of smart meter needs to be accompanied by training activities in order to know how to use them, what to do with heat, electricity and security control in the building, etc. Moreover, a citizen Association eV "For Nippes" has been created to raise the opportunity for citizens to suggest solutions, and to work with SMEs in order to bring their ideas to fruition.

On the **business engagement front**, for example, the installation of modern measurement technologies which records the power consumption continuously in the public offices, makes possible to monitor energy consumption, where and at what time how much energy is used exactly, etc. RheinEnergie AG trains the employees of the district town hall in order to check consumption peaks. The aim is to train employees to use the available energy resources as efficiently as possible, in order to avoid unnecessary consumption.

Revenue streams

The solution has been financed by private grants or benefits from the RheinEnergie AG. Accessing financing has been considered of "middle" level of difficulty, due to the innovative features of the solutions.

The project does not feature revenue streams for RheinEnergie AG. The core project activity is to pilot and test new technologies in energy efficiency and sustainable development. (i.e. energy consumption). On the other hand, stores, public offices, can save on energy bills, repaying investment in retrofitting lighting systems. The City of Cologne may benefit in the long term from the use of LED lightings for the city hall of the Nippes district in Cologne, part of the Climate Street project. Industries, as KölnLed and others, involved in the project, can repay investment in the initiative through services and installation of LED lighting.

The project procurement has been conceived as a Pre-Commercial Procurement (PCP), in which the procurement of research and development of innovative solutions is made before they are commercially available, associated with preliminary market consultation followed by innovation partnership with the private sector. The key market consultation instrument was, in September 2012, the organization of a workshop with the regional industry and local companies. At this purpose, the project co-ordinator RheinEnergie drafted an invitation list out of a "business directory" with Cologne and long-time RheinEnergie partners in other projects (e.g. Bayer, Siemens, Alstom). During the workshop the project coordinator illustrated expectations of the Klimastrasse program and the main goals, other than receiving from stakeholders concrete suggestions.

In the preliminary market consultation preceding the project phase, the bookstore Blücherstraße installed energy savings lighting which resulted in a power savings of 67 percent per month. In such a case, it has been estimated that the investment in retrofitting pays for itself in three to four years (see the box).

> "In the bookstore Blücherstraße switching to the LED lighting resulted in a power savings of 67 Percent per month, and the investment in retrofitting pays for itself in three to four years"
>
> Holger Kahl, Climate street project manager

In this respect, it can therefore be said that revenues streams stem from the industries and small local business owners investing in the solution.

Key resources

Apart from the financial resources, described in the revenue stream, another key resources required to develop the solution are human and physical.

Human and physical resources come from citizens, the RheinEnergie, municipality staff and business communities involved in the provision of training, suggestions, and the development innovative ideas. **Management** of the solution benefits from the steering activity of RheinEnergie AG which takes stock of the relevant experience in energy service and product management.

Key activities

For a local-scale project as Klimastrasse, the involvement of citizens and the local network of businesses is fundamental. In terms of key activities to make value proposition and business model viable, there is the establishment of a dynamic relationship between communities and

private companies which is ultimately mutually beneficial. Communities get new smart solutions and companies get valuable feedback on their products.

Furthermore, another key activity is to ensure an effective governance. The Klimastrasse solution is in fact part of the more general SmartCity Cologne strategy, from which all stakeholders in the city may benefit: rational energy consumption, cost savings and support for climate targets; roll out of new technologies and effective business models. Klimastrasse provides benefits for everyone in the city (e.g. shopkeepers and citizens), contributing to changes in lifestyle in the direction of energy savings.

Key partnerships

The project management is under the leadership of the RheinEnergie AG, in coordination with the municipality of Cologne SmartCity platform and projects. The partnership includes industries in the energy sector and consultancy: KölnLED, ProEnSo, Xtend Ecolight, RocketHome manageE GmbH, Hermann Josef Kastenholz GmbH Elektronanlagen Graymatter, Botschaffft.

Cost structure

The project overall cost amounts to € 1.7 Mln. Costs mainly concern the installation of control and lighting technologies to minimize power consumption of the district town hall, smart metering to a sample of households along the street, planned infrastructure for electric bicycle and building insulation, No breakdown in fixed and variable costs is available, however, € 600k have been reserved for the roll out of smart meters.

Barriers/challenges

The key challenge of the Klimastrasse project is the market take-up of the innovative solutions in the field of energy consumption. The lesson learned from the project is that market-take up of smart and innovative solutions implies the collaboration of companies, individuals, organizations and authorities, which should together find own motivations and commitments. Authorities should set up the environment for businesses to find out their own business model; citizens should be involved in testing solutions and suggesting improvements. When dealing with selling new technologies to citizens and businesses there are two main barriers to be tackled:

- **Communication:** efforts are needed to communicate pros and cons of the new applications, e.g. smart meters, new energy savings equipment. Costs and benefits to the customers need to be carefully evaluated and communicated. City officials must collect input from residents and business community, particularly when they are in the final stages of a decision-making process that could lead to a complete takeover either of all the Climate Street solutions, or of specific components.

> "It always takes some time until new technology interspersed . People have indeed only a partial knowledge of what today is already possible"
>
> Holger Kahl, Climate street project manager

- **Technical and financial requirements:** providing innovative solutions inevitably entails a certain amount of risk, whether technical or financial. It is important to carefully consider what those risks might be and to make sure that it is clearly defined who (the public authority or the supplier) is responsible for carrying that risk. The piloting phase before the Climate street project has help substantially to reduce risks.

Replicability factors

Two key replicability factors have been identified:

- Stakeholder participation;
- Citizen & community participation.
- Acceptance in civil society and political backing.

Stakeholder's participation in the context of Climate Street mainly addresses the involvement of the entrepreneurial eco-system, e.g. local business owners and industry. Climate street involved industries and local business owners in the innovation partnership and each stakeholder played a crucial role in the development and implementation of the project; i.e. in the testing phase.

Citizen & community participation is another key factor. In a local project like Climate Street is crucial to include the citizen centric perspective and ensure an active participation and full information. There is a continuous effort in taking the citizen' views in full account in order to ensure that they have a part to play in the innovation solution.

An even more important factor in view of ensuring replication is acceptance in civil society (participation is the tool to get acceptance) and political backing, i.e. to take a decision in setting priorities and legitimize them through political steps.

In the case of Climate Street in Cologne, the governance structure of the project could count on a clear governance structure composed of: a) the steering board at City level and b) the project management carried out by the energy local provider.

All in all, ensuring the full engagement of citizens, industry and political support can be considered the key factors for a smooth replication of the solution.

Similar cases to the Klimastrasse solution are already under way in several streets in Europe and in the US. Cross-cutting insights may come from the replication in Amsterdam (a pioneer in the field), San Cugat (ES) and Milan (IT). Outside Europe, the experience of San Diego street lighting may be also relevant.

Figure 4: Replication areas of Climate street (Cologne)

	"Replication recipe"
Problem definition	✓ *Stakeholders wishing to implement a similar solution shall first manage to engage citizens and local business network in the initiatives* ✓ *A strong political support in terms of long term vision and commitment is also needed*
Infrastructure and financing	✓ *The solution needs to be evaluated as far as potential market take up of the applications is concerned. A piloting phase to test products and innovation is recommended.* ✓ *Installation of smart meters on a sample of households, LED lighting, sensors on street lamp, equipment to monitor energy consumption, infrastructure for electric bicycle and building insulation may require an investment of about € 2 Mln (Neusser Straße pilot street of about 1.2 km).* ✓ *Pre-commercial procurement and preliminary market consultation are needed*
Governance	✓ *The local municipality must act as catalyst of several actors; from infrastructure providers to industry and research.* ✓ *To include a scientific advisory group with academia and research is recommended*

Table 2: Replication recipe

Sources

Interviews / Contact persons	› Holger Kahl, Project management, RheinEnergie AG › Maximilian Metzemacher, Corporate Development, RheinEnergie AG › Dr. Thomas Kreitsch, Coordination Unit for Climate Protection, City of Cologne
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Figures sources	› smartcity Cologne http://www.smartcity-cologne.de/index.php/klimastrasse.html

MK:Smart,
Milton Keynes, UK

→ Replication potential
→ Complexity
→ Citizens' involvement
→ Economic impact
→ Environmental impact
→ Social impact

Assessment based on feedback provided by the solution's representative as well as on the available sources analysed by the study team.

Short description of the case study

		Key facts and figures
MK:Smart city solution	**Type of solution**	*Data hub , that provides an innovation environment to find, use, share, develop and create with data, that is domain agnostic*
	Project stage	*The project kicked-off in January 2014 and is expected to finish in June 2017.*
	Actors involved	*Industry, higher education and city council*
	Roll-out of the solution	*Consortium members are in discussion with a number of UK cities to downscale and upscale the solution via a number of funding programmes. There is also considerable international interest, including the China Centre for Urban Development.*
	Barriers	• *Data securing* • *Competences and resources* • *Internal barriers in public administrations*
	Implementation best practice city	*Milton Keynes (UK)* *(300,000 inhabitants)*
	Main technological areas covered	*Water, energy and transport*
	Funding mechanism	• *€ 22.8 Mln[1] project, funded half by the HEFCE fund and by the other half by contribution from industry and city council*
	Economic, social & environmental impact	*By 2017, and within the pilot programme areas only:* • *20% Water savings* • *2.8% electric consumption reduction* • *50% less traffic congestion* • *40% CO_2 reduction emissions* • *2% gas reduction* • *€ 27 Mln additional GVA* *By 2026: € 187 Mln additional GVA and 500 jobs*
	Replicability factors	• *Responsibility and clear leadership* • *Stakeholder engagement* • *Clear governance structure*

[1] The conversion rate used is this case study is £1 = €1.4.

Case summary

Set up as a "New Town" in 1967, Milton Keynes is a relatively **new city** and today it is one of the fastest growing cities in the United Kingdom (UK). This puts increasing pressure on the city's resources and infrastructure that creates a major challenge for the city: supporting sustainable growth and reduce carbon emissions in line with European and UK targets, without exceeding the current capacity of the water and energy infrastructure.

To face this challenge, the city established in 2014 the **MK Future City Programme**, the programme behind city's smart city projects, which addresses barriers to housing and economic growth and provide the capabilities to enable business and service innovation, including through the integration of multiple city systems. At the centre of the programme is **MK:Smart,** a three and a half year large collaborative initiative that kicked-off in January 2014 and ends in June 2017.

Partly funded for € 11.4 Mln by the Higher Education Funding Council for England (HEFCE) Catalyst Fund with the remaining € 11.4 Mln consisting of matched funding by partners, Mk:Smart is under the leadership of the **Open University** (OU) and includes partners from across the Higher Education, public and commercial sectors.

The main objective, from a policy and industry perspective, are:

- Policy perspective:
  - Address pressure on infrastructure and city systems as the city grows;
  - Improving city-scale location recognition and employment in the city, ultimately bringing benefits for its citizens;
  - Increasing replication and city's profile in order to attract investment.
- Industry perspective:
  - Draw a technological blue print;
  - Draw a replicable business model to pick up and reuse.

The project aims to demonstrate how data gathered from public and commercial partners in the project through the city's sensored infrastructure and other sources can provide innovative analysis tools that would help to better manage transport, water and energy infrastructure. Central to the project is a state-of-the-art **MK Data Hub**, which supports the acquisition and management of vast amounts of data relevant to city systems from a variety of data sources. These include data about energy and water consumption, transport data, data acquired through satellite technology, social and economic datasets, and crowdsourced data from social media or specialised apps.

Moreover, MK:Smart comprises education, business and community engagement activities, including:

- An integrated programme of business engagement;
- A smart city education programme;
- A citizen innovation programme, including a city digital platform for smart city idea generation.

Although the initiative is relatively new, it has already been recognised as an exemplar, having received technical and project awards at a national and global level. In June 2015, at the TM Forum, MK:Smart was awarded the accolade of Best New Catalyst; in October 2015, MK:Smart was the winner of the 2015 VMworld Europe User Awards, for being one of the most innovative virtualisation and cloud-related IT project. In November 2015, MK:Smart was awarded the British Computer Society (BCS) Information and Technology (IT) innovation project of the year. In November 2015 MK:Smart was a finalist in the World Smart City Congress Project of the Year Awards.

> For "its work in helping transform Milton Keynes into a futuristic city where technology is used to enhance public services […]" the Best New Catalyst project of the year go to MK:Smart.

As far as this study is concerned, this project is relevant because, as depicted in the following figure, it covers all the three vertical/technological priority areas of the EIP-SCC Strategic Implementation Plan and most of the horizontal/transversal ones. As mentioned above, the project involves an (open data) Information and Communication and Technology (ICT) infrastructure (MK Data hub) and includes applications and digital solutions in the energy, transport and water domain. Moreover, through the business engagement and education programme, there is a clear citizen focus in it and knowledge sharing is ensured.

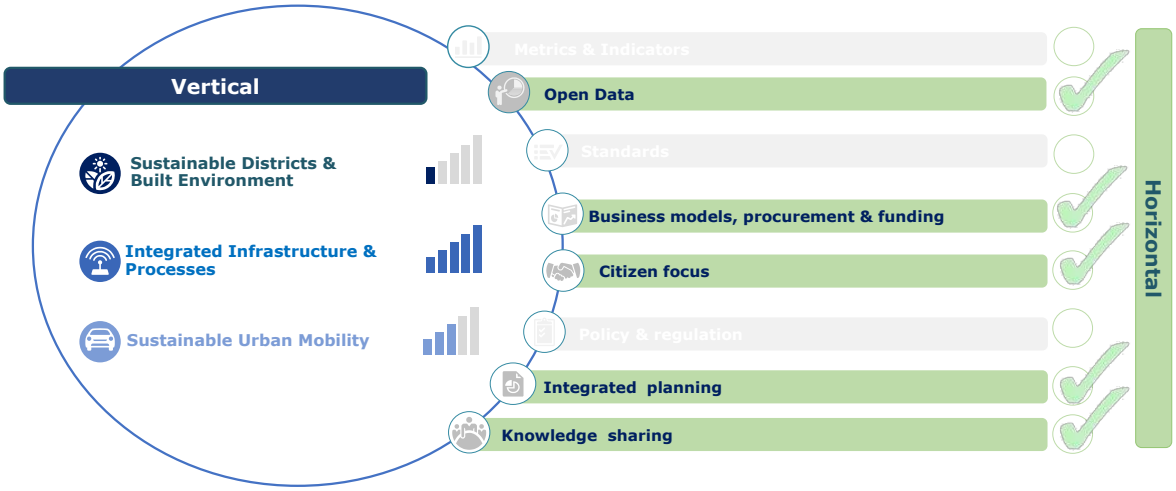

Figure 1: SCC Solution Integration Dashboard

Market analysis

Milton Keynes is one of the fastest growing cities in the UK and is still predicted to grow significantly over the coming years: its economy has a Gross Value Added (GVA) of € 10 Bln and it could reach € 16.4 Bln by 2026[2]. Such growth has the potential to increase employment at the rate of over 2,600 jobs per year, or an additional 42,000 jobs by 2026.[3] This growth could outstrip the capacity of the city's transport and water infrastructures. As an example, traffic on the roads is predicted to grow by up to 60% and due to the potential impacts from climate change on the region, a reduction of regional water availability of 29 Mln litres per day by 2025 is projected. Against this background, the project looks at how the predicted population increase in Milton Keynes can be accommodated within existing energy and water consumption limits (i.e. with a 0% increase) and to investigate how energy and water management systems can benefit from smart sensor technology.

The project focuses on the development of technology to help Milton Keynes overcome the potential barriers to growth.

The main smart city solution deployed by MK:Smart is MK data Hub, an Internet of Thing (IoT) Platform. Berg Insight[4] considers it as an emerging solution that will have a mainstream adoption in 5 to 10 years (i.e. 2020-2015); it estimates that total revenues for third party IoT platforms will grow at a compound annual growth rate of 32.2 percent from € 450 Mln in 2014 to € 2.4 Bln in 2020. Moreover, as companies, organisations, governments and individuals adopt IoT, the number of connected things is forecasted to grow from 1.7 Bln at the end of 2014 to 6.6 Bln in 2020. According to interviewees, solely in the UK, the future potential market

[2] Oxford Economics (2012) Oxford Economic Narrative.
[3] Milton Keynes Council (2011) Core strategy – Employment Technical paper.
[4] Berginsight (2014) IoT Platforms and Software. Sweden.

size could be approximated to €1.4 billion by 2018 though a recent IDC report suggesting the UK market could be nearer €28 billion.

This phenomenal growth is enabled by continuously declining costs of sensors and hardware, communication, data processing and system integration.

Main impacts

By year 3 of the project and within the pilot programme areas only, the MK:Smart project is expected to demonstrate the possibility to deliver up to 20% in water savings, a 2.8% reduction in electric consumption, 50% less traffic congestion, 40% reduction per head of population of CO_2 emissions and 2% less gas reduction. Also, the estimated prize from full solution deployment is a capital saving of at least € 150 Mln.[5]

Moreover, the economic assessment of the MK:Smart proposal predicts that the exploitation of open data and growth of smart technology by Small and Medium-Sized Enterprises (SME) will deliver €27m of additional GVA and 105 jobs to the economy by the end of the funding period (i.e. June 2017), rising to €187.8m and almost 500 jobs by 2026 (i.e. 12 years after the project commencement). This means that by investing € 22 Mln, the city will have a return for its economy of more than eight times[6] by 2026.

Further economic benefits are associated with new business stimulation (estimated in €8.5m by 2017 and € 37 Mln by 2026) due to the Apex Suite in Central MK and the alleviation of pressure from infrastructure, due to the applications and digital solution developed thanks to the MK Data hub.

[5] According to BT website.
[6] €187.8m (GVA by 2026) / € 22m (project cost).

Rich Picture Model

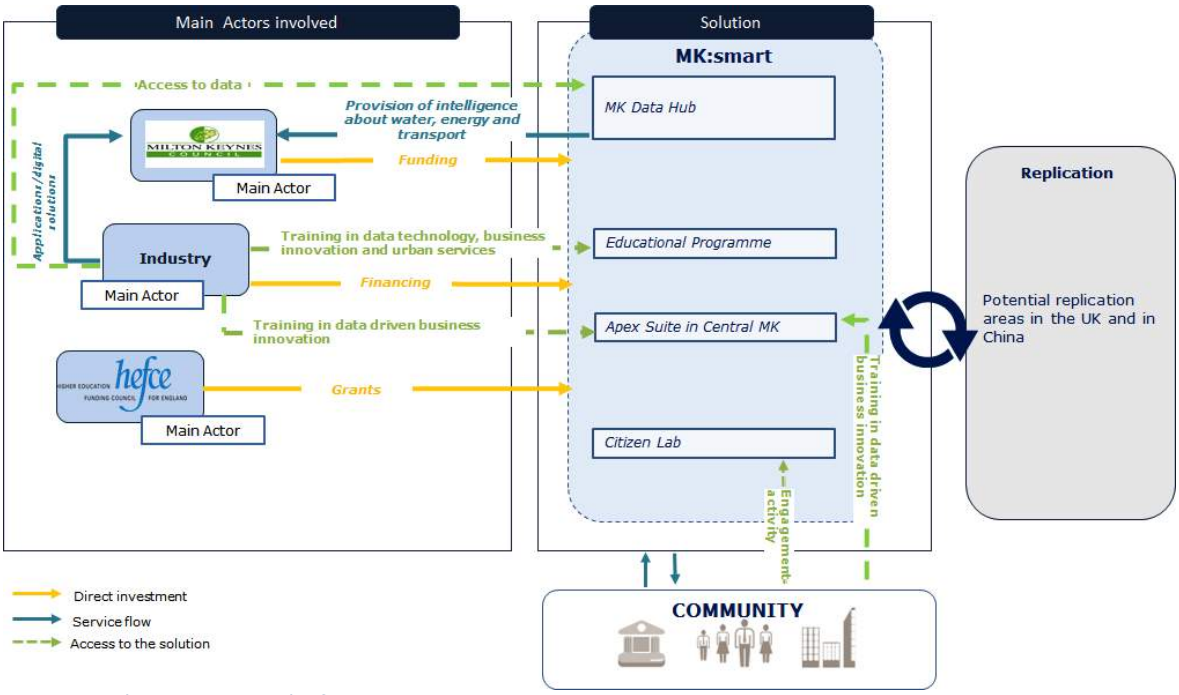

Figure 2: Rich Picture approach of MK:Smart

As illustrated above, MK:Smart was born thanks to the financial contribution from industry, City Council and HEFCE fund. There are four main products delivered by the solution. The core one is the **MK Data hub**, through which industry can have access to data to develop applications and platforms for the benefit of citizens and the City Council. Moreover, knowledge and training is provided to business and citizens through two other key project elements:

- The **Apex Suite in Central MK** through which industry and citizens can have access to training in the field of data-driven business innovation;
- The **smart city education programme**, through which citizens can have access to training covering digital technologies, business innovation and urban services.

Finally, citizens can engage in the project through the **Citizens Lab** and the **web portal**.

Business Model Canvas

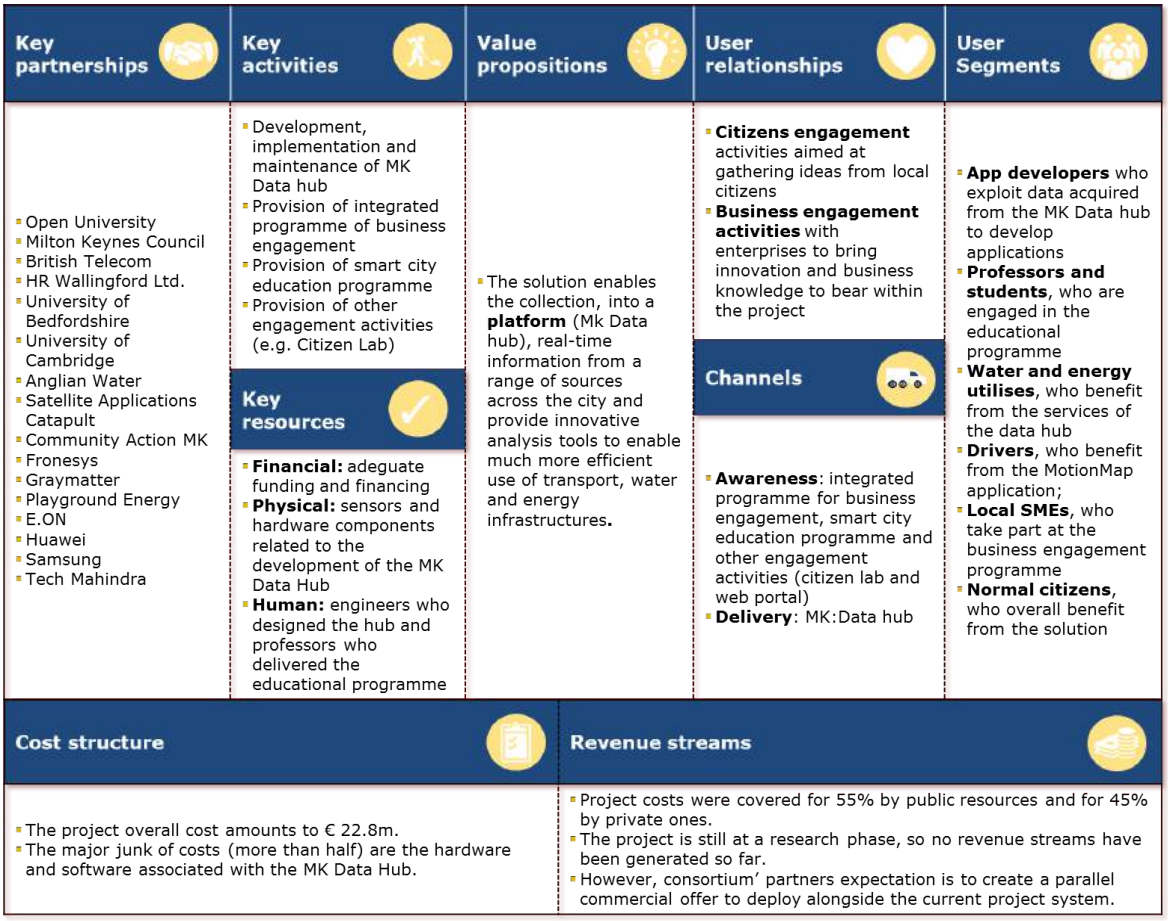

Figure 3: Business Model Canvas of MK:Smart

User segments

The users of the solution are potentially all Milton Keynes citizens who however interface with it differently: app developers use data as raw materials for developing applications; professors and students from all level of education engage with the project through the smart city education programme; water and energy utilities leverage on the applications developed to better monitor and manage their infrastructure; drivers use the transport application to find faster parking spaces; normal citizens engage through the Citizen Lab and the web portal; and finally, local SMEs are key component of the Apex Suite in Central MK.

Value proposition

The solution enables the collection, into a platform (Mk Data hub), of real-time information from a range of sources across the city and provide innovative analysis tools to enable much more efficient use of transport, water and energy infrastructures.

Central to MK:Smart is the **MK Data Hub**, a state-of-the-art data acquisition and management infrastructure which opened in October 2015 at the University of Bedfordshire's Milton Keynes Campus, supporting the collection, integration and use of large amounts of large-scale city data

relevant to how the city functions, including: local and national open data resources; data streams from both key infrastructure networks (energy, transport, water) and other relevant sensor networks (e.g. weather and pollution data); satellite data; and data crowdsourced from social media or through specialised apps.

MK Data hub encourages third parties to build applications that make use of the data under protocols (e.g. terms of use, pricing, etc.) governed and owned by Milton Keynes Council within the MK Data Hub, and citizens to adopt those applications to optimise their use of the city's resources. In other words, by having access to anonymised data in the Data Hub, it allows project partners and independent and commercial developers to develop new approaches and applications that address city challenges.

Milton Keynes has made a move to overcome the problem by requiring that all public sector data should go into a single repository.

Much of the functions of the MK Data Hub are centred around smart open Application Programming Interfaces (APIs) to re-deliver the data in a common, homogeneous and convenient way for the developers of data-intensive applications. These data and APIs are used to inform analytics at different levels of detail to support intelligent planning and usage of resources across city systems.

Moreover, for each of the three key pillars – energy, water and transport – MK:Smart is leading experimentation with:

- **Energy**
  - Open Energy Map: collects, collates and analyse Milton Keynes energy data from various sources and catalyse them into a Map that empowers local communities and business to better understand energy trends in their areas.
  - Electric Vehicles: collects data about driving behaviour of Electric Vehicles (EVs) in Milton Keynes to understand real-world energy demand of EVs and devise energy management strategies to minimise electricity consumption.
  - Electricity Demand Shifting: develops, working with households with solar PV micro-generation, digital tools to help people maximise self-consumption of locally generated electricity by shifting demand to periods of peak generation.
  - Smart Grid Dynamic Demand Response: develops novel data-driven approaches to enable people and communities to manage their energy consumption during peak demand periods in order to decrease the growth in energy demand that threats the stability of electric grids in the current infrastructure.
  - Smart lighting: deploys sensors that relay visibility data to a luminaire segment controller, enabling street lighting to be remotely dimmed or brightened to optimise illumination.
- **Water**
  - Water strategy: identifies steps for reducing the city's water footprint and support sustainable growth.
  - Water resource information system: improving citizens understanding of water supply and demand in the city and to communicate the benefits of sustainable consumption to households and businesses.
- **Transport**
  - MotionMap, a service that continuously describe the real-time movements of people and vehicles across the city, and will include embedded timetables and estimates of congestion and crowd density in different parts of the city of Milton Keynes;
  - Innovative parking space optimisation pilot project: a pilot project which deployed sensors to manage the use of short-term parking spaces at Milton Keynes railway station. By detecting the arrival and departure of a vehicle, the sensors send information wirelessly to lamppost mounted solar-powered repeaters. These

aggregate the data and transmit it over the internet to the MK Data Hub where is processed and the resulting analysis made available on the Milton Keynes Council public information dashboard, as well as via a browser that displays bay status via an overlay to Google maps. This provides valuable information about parking availability and parking duration, which can be used by the city council to adjust parking stations and in the future could also be used to aid parking enforcement.

Channels

There are different channels through which the project can be accessed. In particular, channels can be segmented into: awareness and delivery.

Concerning **delivery**, the channel through which the solution is deployed is the MK Data Hub whilst **awareness** channels comprise the education, business and community engagement activities.

These are:

- **An integrated programme of business engagement**, aimed at supporting businesses that wish to take advantage of the innovation capabilities developed in MK:Smart. A key component of this activity is the **Apex Suite** at University Campus Milton Keynes (UCMK), which provides training in data-driven business innovation and the digital economy, as well as hands-on support for business development and demonstration facilities.
- **Other engagement activity** to involve citizens in the innovation process, not just through an outreach programme, but also by engaging the community in innovation-centric decision-making processes through the establishment of a **Citizen Lab** and a dedicated **web portal** (ourMK.org).
- **A smart city education programme** engaging a wide range of audiences, from local schools to higher education students and businesses, including a global Massive Open Online Courses (MOOC), hosted on FutureLearn. This programme provides advanced training covering digital technologies, business innovation and urban services to empower students and practitioners with the skills and competences needed to participate in the creation of a smart city.

User relationships

Many are the relationships established with the main users targeted, being them both citizens and industry.

On the **citizens engagement front**, a series of workshops aimed at gathering ideas from local citizens, relating to how smart cities work and function, are held in cooperation with the Community Action MK and SME based in Milton Keynes (Graymatter). Moreover, a citizen engagement platform (i.e. ourMK.org) has been developed including the opportunity for citizens to work with SMEs in order to bring their ideas to fruition.

On the **business engagement front**, UCMK has been engaging with businesses to see how they can bring innovation and business (technical and commercial) knowledge to bear within the project. This includes University's Business and Management Research Institute (BMRI) Big Data team and members of staff from the Institute in Research in Applicable Computing (IRAC), who are working closely with SMEs to develop solutions to some of the challenges present in the smart city arena. Additionally the MK:Smart initiative aims to educate citizens and businesses on sustainability. In particular, Data Sensing and Analytics Teaching Kits in local schools are distributed, a Postgraduate Certificate in New Enterprise Creation at UCMK is about to be set up, and an educational programme for businesses and business students is about to be produced and delivered.

Moreover, the Memoranda of Understanding signed between Tech Mahindra Ltd., the OU and Milton Keynes Council developed a bid programme that turn the best ideas presented by the industry and the governmental sector into concrete projects through the awarding of a small amount of money. Ideas are judged by an online community through the web-portal OurMK.org.

Revenue streams

Overall, c. 55% (c. € 12.5 Mln) of project cost were covered by public resources, whilst the other part is from industry. MK Council has provided a €850,000 value in time money contribution (i.e. cash and work force), and it has already set-aside an additional €700,000 for two years after project completion, for maintenance and other costs. The City Council programmed to sustain the project through the additional revenues of the developing money the council gets as the city grows. Whilst, BT, the biggest industry contributor, contributed with around € 4.3 Mln. From a cost structure perspective, the project is interesting because a small portion of City Council budget was able to catalyse a considerable amount of financing from other financial sources (i.e. industry and state funding).

As for the **revenue streams**, due to the agreement of the research project, any form of money exchange by data providers and end users will not be allowed during the research period; therefore, at least during the research phase of the project, no revenue streams will be generated.

However, before the research project ends, through the development of a sustainability project roadmap, consortium' partners expectation is to create a **parallel commercial offer** to deploy alongside the current project system. This commercialisation phase is expected to take place by the end of 2016; by then, industry players believe to have outcomes that would justify the investment, in order to have by 2017 the Return on Investment.

In this respect, two main Business Models are currently under discussion:

- **Offer MK Data Hub as a platform** and take a trading commission on whatever trade happen across the data hub (in this case, public administration and industry are part of the value chain, and would share revenues).
- **Offer MK Data Hub as a management service** and take a service management fee (in this case, the city put in place its own infrastructure and the platform would be operated by an industry player).

In both cases, the MK data hub is going towards becoming a **market place/trading environment** where data providers and end users can meet, and where data are traded as assets. In this way, data providers would be facilitated to publish their data set into an environment where they can assign terms and conditions and privacy policy to them. Eventually they can assign value to that data stream and get revenues from it.

Apart from this, an "indirect revenue" that the project will generate is the stimulus to the economic activities. Probably, due to the project, more companies will be attracted to move their head offices in Milton Keynes.

Key resources

The key resources required to develop the solution have physical, intellectual/ human and financial nature.

Concerning **physical resources**, MK:Smart includes the sensors spread around the city to collect water, energy and transport data as well as the hardware components of the MK Data Hub. **Intellectual resources** are the key partnerships established between the partners across the Higher education and public and commercial sectors. Moreover, as a knowledge intensive solution, crucial were the **human resources** involved and particularly the role played by BT'

computer engineers who put in place the technological solution, the role of higher education professors who deliver the Smart city education programme and who is involved in the **Apex Suite in Central MK.**

Key activities

Key activities include the development and maintenance of the platform, as well as platform management, service provisioning and platform promotion. Other key activities include the development and delivery of the integrated programme of business engagement, of the smart city education programme as well as of other engagement activities, such as the Citizen Lab.

Key partnerships

The project is under the leadership of the OU and includes partners from across the Higher education and public and commercial sectors. Together with OU, other key project partners are:

Milton Keynes Council, the owner of MK Future City programme, in which MK:Smart is embraced;

British Telecom (BT), the largest commercial partner in the programme, in charge of:

- Leading on the deployment of sensor devices for different applications across the city, working closely with sensor manufacturing partners;
- Designing, developing and delivering the data hub, which allows the exchange of information.

Other partners include: HR Wallingford Ltd.; University of Bedfordshire; University of Cambridge; Anglian Water; Satellite Applications Catapult; Community Action MK; Fronesys; Graymatter; Playground Energy. Whilst associated partners are: E.ON; Huawei; Samsung; Tech Mahindra.

Cost structure

The project overall cost amounts to € 22.8 Mln. The major junk of costs (more than half) are the hardware and software associated with the MK Data Hub. Other costs include: maintenance, personnel, marketing and communication campaigns.

Barriers/challenges

One of the key challenge of MK:Smart is the securing of data the initiative relies on. The hub acquires data from diverse sources and store it across numerous data stores, including MySQL, Progress and Microsoft SQL Server. Furthermore, the data stores are made accessible through a Storage Area Network (SAN).

Moreover, with the initiative continually evolving and uncovering new sources to draw data from, MK:Smart main challenge was to find an heterogeneous and scalable recovery management solution, able to both back up and recover data over a SAN.

However, barriers/challenges were not only of technical nature. A challenge is convincing data owners to release their data and helping them to understand the benefit of sharing and of integrating them into single solution. In this respect, sometimes data are kept within organisational silos and therefore the benefits of new data sources are limited by a focus on specific projects, such as traffic management, meeting carbon commitments and improving transport information. A major effort will be required by public administrations, to overcome their **internal barriers** within different departments and to take a cross-dimensional view enabling them to commission integrated smart-city services.

A final barrier is due to the fact that as MK:Smart has been initially conceived as a research project in which the formalisation of a business plan had not been the priority for the consortium, placing a financial value to it would be challenging. This means that this solution could not be acquired through public procurement yet. However it is expected that a commercial offer will be available during 2016.

Replicability factors

A key replicability factor is capabilities and resources. MK:Smart involved higher education, industry and the Council, and each of the three category of actors played a crucial role in the development and implementation of the project. A similar project, if the capacities existing in a territory are sufficient, could be relatively inexpensive. If cities want to undertake similar projects, they shall firstly map the existing capacities and resources, also financial ones.

Stakeholders are another key factor. In the case of MK:Smart, a key role was played by the Director of Strategy of Milton Keynes Council, who had responsibility and clear leadership and played an enabling role which convened players from the industry and higher education together in order to facilitate project take up, and make easy access to business. Also, a similar project shall take citizen's views in order to ensure that they have a part to play in the innovation solution. To this end, similar projects shall focus on citizen's service needs rather than on technology, and should connect technology to the problem. Depending on the issue the city is trying to address, technology should be engaged and not oppositely.

Another factor that could guarantee replication of the solution, and its success, is the **governance structure**. In the case of MK:Smart, the project could count on a clear governance structure composed of: an executive board, a technical expert group and work package leaders (i.e. water, transport and energy).

Moreover, an additional key replication factor (valuable for all research projects of this type which are particularly "close to the market") is to think about the long term sustainabity as well as the commercialisation plan of the solution since its very early stage of implementation, without postponing the decision to when the research project is close to its end.

The replicability factor of the project is something that also consortium partners count on. In fact, as Professor Tim Blackman, from the OU, said "this exciting project will not only directly benefit Milton Keynes but will also demonstrate ways forward for other cities right round the world." For some respects, this is already happening, as shown in the following picture.

Figure 4: Replication areas of MK:Smart

The city has engaged a number of other UK cities in developing projects and funding bids that seek to replicate or draw upon the data hub functionality. During 2015 the city has hosted delegations from the National Development and Reform Commission of China and the China Centre for Urban Development. MK:Smart has been the main focus of discussion.

Concluding, it could be argue that a city wishing to implement a similar project would need to consider the following:

- Importance of an eco-system of partners across sectors to ensure holistic solutions are developed and access to funding streams maximised;
- Allowing time and capacity to broker connections between solution providers and problem owners;
- Striking balance between strategic focus on known city challenges and allowing open innovation of new service and commercial models.

"Replication recipe"	
Problem definition	✓ *Stakeholders wishing to implement a similar solution shall first understand the issue and secondly how the technological solution could address it* ✓ *Stakeholders shall also first map the available resources in the territory in order to identify what the project can leverage on*
Infrastructure and financing	✓ *The solution could be relatively inexpensive if the territory already embraces skilled people and with key competences required to develop and implement a data hub*
Governance	✓ *The solution shall implement a governance structure which could include, inter alia, an executive board, a technical expert group and work package leaders.* ✓ *This also include the appointment of a single interlocutor who could act as facilitator and convene all the key actors together.*

Table 1: Replication recipe

Sources

Interviews / Contact persons	› Alan Cox, Director – Satellite Applications Catapult Services Ltd; › Alan Fletcher, Business Development Manager – Open University; › Geoff Snelson, Director of Strategy – Milton Keynes City council; › Paul Garner, Head of Future Business Technology Research Practice – BT Technology, Service & Operations.
Literature supporting the research of this case	› Milton Keynes city council (2014) Milton Keynes Future City programme › Mathieu d'Aquin, Alessandro Adamou, Enrico Daga, Shuangyan Liu, Keerthi, Thomas, and Enrico Motta (2015) Dealing with Diversity in a Smart-City Datahub, The Open University, United Kingdom › Jose J. Cavero Montaner, Gerd Kortuem, Stefan Foell (2015) Smart community energy initiatives in Smart Cities: Learning collectively about energy, The Open University, Milton Keynes. › Gerd Kortuem (2015) Demystifying big data and the internet of things: realising energy savings in the future smart infrastructure, Open University
Internet sources	› http://www.mksmart.org › https://connect.innovateuk.org/documents/3130726/3794125/Feasibility+Study+-+Milton+Keynes+Council.pdf/3ec3cf6d-3445-43e4-a11d-5db9b67f0616 › http://www.mksmart.org/wp-content/uploads/2015/05/Motion-Map-for-news-image.jpg › https://btplc.com/Innovation/Innovationnews/miltonkeynes/index.htm › https://futurecities.catapult.org.uk/documents/6697210/0/Milton+Keynes+BT+Internet+of+Things.pdf › https://btplc.com/Innovation/Innovationnews/miltonkeynes/index.htm
Figures sources	› MK:Smart website http://www.mksmart.org/

NICE GRID
Carros, France

Assessment based on feedback provided by the solution's representative as well as on the available sources analysed by the study team.

Short description of the case study

		Key facts and figures
Nice grid	**Type of solution**	*Smart Grid*
	Project stage	*Kicked off in 2011 and concluded in Jan 2016*
	Actors involved	*Industrial partners, energy suppliers, Network Operators, manufacturers and SMEs*
	Roll-out of the solution	*Nice Grid project covers a test zone impacting from around 8 industrial customers, for the islanding, to 1500 customers, for the reduction of power demand.* *Part of the solution has been replicated in Philadelphia (The navy Yard)*
	Barriers	• *Strong customers engagement;* • *Lack of regulation;* • *Economic barriers* • *Lack of standards for storage*
	Implementation best practice city	*Carros (France)*
	Main technological areas covered	*Electricity, ICT*
	Funding mechanism	*European Commission and French government funding as well as private financing*
	Economic, social & environmental impact	• *Bill saving around € 15-30 per residential costumer during summer;* • *Overall increase in consumption from solar energy of +5%;* • *10% energy load reduction during winter*
	Replicability factors	• *Strong citizen participation* • *Private-public funds to start up;* • *Wide spaces necessary for large equipement* • *Standards and regulation needed;* • *Business Model not profitable in Nice Grid pilot*

Case summary

Nice Grid is one of the 6 pilot demonstration sub-projects developed within the "Grid4EU" project, funded by the European Commission with the objective of laying the groundwork for the development of "tomorrow's electricity grids". The total cost of the project amounts to € 54 Mln of which € 25 Mln are provided by the European Commission (EC) making it the biggest Smart Grid project funded by the EC.

In addition to the EC, Nice Grid, developed in the city of Carros, (Provence Alpes Côtes D'Azur area, French South East), has been also funded by the French government and ADEME (French Agency for Environment and Energy Management).

Nice Grid aims at addressing the network management issue of this area with a particular focus on the energy supply and demand balance.

> The ambition is to study the whole Smart Grid concept and especially the smooth integration of Distributed Energy Resources (DER) into the local Low Voltage (LV) grid.

Specifically, the pilot is testing programmes of dynamic load management covering the following use cases:

1) Management of decentralised PV panels' mass production and improvement of network flexibility;
2) Reduction of peak demand;
3) Encourage resident to adopt smarter habits according to network state;
4) Islanding[1] of a Low Voltage Network area.

Each of these solutions will be treated in a particular test zone impacting from around 12 customers for the islanding to 1,500 customers for the reduction of power demand.

Demonstrator functions	***Test sone no 3 MV and LV zones***	***Test zone no 2 Several LV zones***	***Test zone no 1 1 LV zone***	***Targeted customers number***
Reduction of peak demand	*X Action zone: MV + LV*			*1500*
Massive PV integration		*X Action zone: LV*		*550*
Islanding			*X Only LV*	*12*

Figure 1: Test zones and demonstrator functions (Source: Grid4EU project, October 2012[2])

Many homes, businesses and plants are equipped with solar panels with a total generation capacity of 2 to 3 MWp.

Adding storage capabilities to a power distribution system creates "energy reserves" that can be available when needed. In the Nice Grid project the excess of energy produced during the day by the PV cells is stored in lithium-ion batteries installed at various points of the power grid.

As of January 2016, all equipments are installed and the system is fully operational. Seven business customers have been on board since 2013, others were recruited over the summer of 2014: one with remote systems control and three smaller companies using manual control.

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[1] Islanding refers to the condition in which a distributed generator (DG) continues to power a location even though electrical grid power from the electric utility is no longer present.

[2] "D6.1_ DEMO 6_ Initiation of the demonstration" (http://grid4eu.blob.core.windows.net/media-prod/6606/Grid4EU_dD6.1_DEMO6_Initiation_of_the_demonstration_v1.0.pdf)

Companies in Carros have agreed to implement demand response at Nice Grid's request in the summer and winter. In winter the request comes with one day's notice, and then companies offload a portion of their electricity consumption, but in summertime companies get just one hour's notice.

The EDF customer volunteers have become true producer consumers, or "pro-sumers", by generating and storing their own electricity or by shifting their usage patterns.

The first SAFT[3] home battery was installed in October 2014. It stores some of the electricity generated during daylight hours for use at night. The battery will be managed and controlled remotely by the Nice Grid.

In addition to customer side installations, Nice grid continues to be rolled out on the ERDF (the French Distribution System Operator) power distribution network. Three energy storage systems, of various power levels ranging from 33 to 250 kilowatts, are running on the grid.

In 2 residential neighbourhoods of Carros, two 10 foot shipping containers to host each a 33 kW Socomec converter and a set of SAFT lithium ion battery modules capable of storing up to 106 kilowatthours of energy have been installed.

> "We are going to build a communication network on top of the power grid, and together these two systems will allow various smart devices to link up with an innovative telecommunications solution…."

This power storage system makes it easier to leverage solar power in the summer. To control batteries, Nice Grid has installed a dedicated BPL4 infrastructure.

In the commercial district of Premiere Rue, a 250 kW / 620 kWh storage system has been set up to test islanding. The islanding system used involves temporarily disconnecting the Premiere Rue district form the main grid and powering it solely using solar panels and a power storage unit. The disconnection is done by the islanding circuit breaker. At the Carros primary substation, where the distribution grid interfaces with the power transmission grid, another storage system has been in place since January 2014. This power storage system can feed up to 1 megawatt into the distribution grid for as long as 30 minutes, enough to power 500 homes during wintertime peaks in electricity consumption. The main idea is to smooth out power demand peaks during winter.

To optimize the flow of electricity in the city of Carros, a special software named **NEM** (Network Energy Manager) has been developed with the aim is to manage the flexibilities required by network entities and aggregators[5]. NEM's architecture enables to design a new model of interactions between energy actors (consumers, commercial aggregators, TSO and DSO) in order to balance generation & consumption in this first megawatt-scale European smart solar district. NEM thus compares power requirements and solar generation forecasts, and identifies pressures on the power grid. It then activates various aggregators that use multiple approaches to optimize the flow of electricity according to the time of day.

For example, in the summer, when a district generates more solar power than it consumes, Nice Grid offers to store the electricity or shift the usage periods of certain electrical devices to align their energy demand to the moment in which it is generated. This grid power management

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3 Industrial specialist in designing and manufacturing Lithium-ion high-tech batteries for industrial clients (see paragraph "Key partnership")

4 Broad Band Power Line

5 The "aggregators" are responsible for the aggregation and dispatching of the DERs that belong to their respective portfolios. An aggregator is a company that acts as a collector of available consumer loads and distributed small-scale production offering these distributed energy resources to the actors in power who need them.

system also makes it possible to reduce Carros' overall electricity consumption in the event of winter consumption peaks or technical issues on the grid.

It is worth noting that NEM requires solar power output forecasts for its calculations. ARMINES is in charge of providing that and, through its PERSEE research center, has developed advanced solutions to forecast solar power system generation and is also working on new ways to manage distribution grids, via a Network Battery Aggregator (NBA), managing network batteries and preparing flexibility options for NEM. This technology handles the uncertainties of renewable power generation.

The figure below shows the level of integration of Nice Grid. The solution includes technologies and services combining two of the three vertical/technological priority areas of the EIP-SCC Strategic Implementation Plan: Sustainable Urban Mobility, Sustainable District & Built Environment and Integrated Infrastructure and Processes.

In addition, several enabling factors have been leveraged to allow the successful development of the technologies illustrated above:

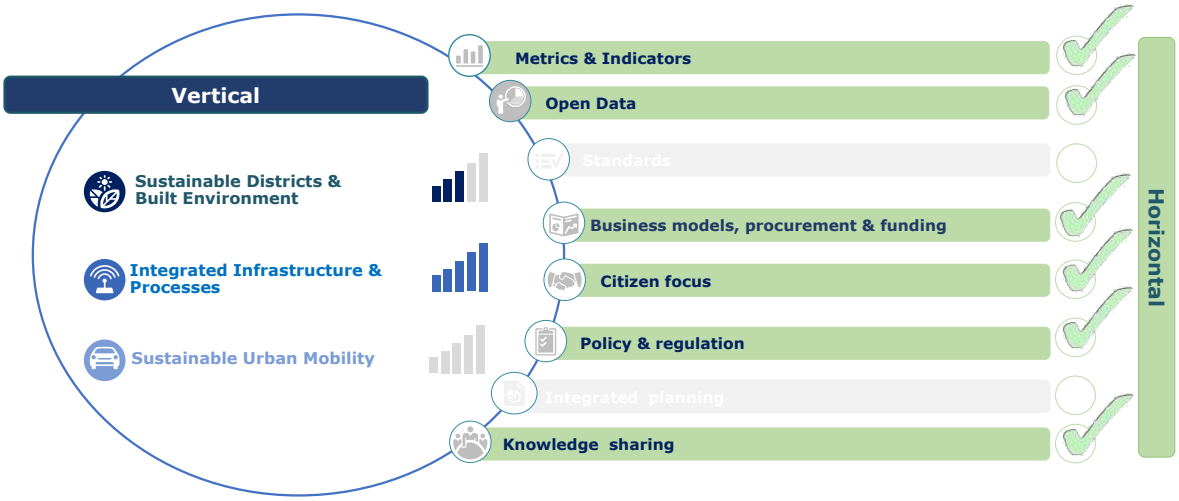

Figure 2: SCC Solution Integration Dashboard

Market analysis

Further to EU and national laws, France has been working intensively for many years on the development and roll-out of smart grids. The smart grids sector, being one of "the 34 Schemes of the New Industrial France" launched by the government in 2013, is seen as a key element in boosting the French economy under the so-called "Third Industrial Revolution".

A number of experimental projects have already been implemented or are currently under development in various French cities, each oriented to a specific technology of smart grids and Nice Grid is on the top of the list.

Moreover, since March 2010, "Linky" smart electricity meters have progressively been installed in 225,000 households in Lyon and Indre-et-Loire on a trial basis. Following the success of the Linky trials, France plans to replace 35 million traditional electricity meters with smart electricity meters over the next six years. ERDF has already ordered 3 million smart meters from six companies for the mass roll-out that started December 1st 2015.

Main areas of focus outlined by France's smart grids roadmap include:

- In the medium term, assisting the roll-out of smart grids through the concentration of support services, such as research and training, within a specific geographic zone in France with a view to develop a skilled labour pool for smart grids.

- The longer-term goal of creating a platform, "Open Innovation", aimed at bringing together smart grid operators and suppliers for the purpose of supporting the sector's competitiveness.

France is also planning to reform current regulations to aid the development of smart grids, including:

- Preparing an evolution of the thermal regulation RT2012 so as to strengthen the flexibility of the electricity system.
- Establishing a consistent and effective legal framework for the management of and access to the mass data exchanged between the different parties in the sector.

According to France's smart grids' roadmap, the sector may create 10,000 new jobs (compared to the existing 15,000 jobs) and its turnover may exceed € 6 Bln by 2020 (compared to € 3 Bln in 2015, half of which came from exports).

The government's timetable for the roll-out of smart meters envisages 95% of French households being equipped with Linky smart meters by the end of 2020. According to the Energy Regulation Commission, the total cost of this is estimated at 7 billion euros. France plans to create a "Smart Grids Team of France" in the near-future to promote the sector and coordinate the parties concerned.

Main impacts

The evaluation of the actual impacts of the pilot case was carried out during the project and the results concerning the environmental, economic and social impact are described below.

Environmental impacts

Winter participants reduced, on peak demand days, their power consumption by 21% on average, between 6:00 and 8:00 PM. Summer participants adapted their consumption to the local energy production. Time of Use pricing with "Solar Bonus[6]" in summer days allowed customers to consume an additional 20% of locally-generated PV energy (load shifting).

In households which tested the "Smart Water Tank" offer (thermal storage through the water tank during the afternoon in summer days), a difference of 56% on average was recorded in their consumption between a solar day and a "normal" day between the hours of 12:00 noon and 4:00 PM (load shifting).

For companies, feedback shows that the winter load reductions in the region of 10% were possible without employees experiencing the slightest discomfort and without company organisation being significantly modified. This lack of inconvenience is a positive factor as far as acceptability is concerned. Taking all companies together, load reductions were considered to be part of the fight against unnecessary use of energy, a fight which required a better understanding of how equipment uses energy, how the buildings work and greater awareness from the employees.

Economic impacts

The tariff designed for participating customers allow them to save around 15 to 30 € per customer per summer. However this was decided from the beginning to incentivize participation of residential customers. An in-depth description of recruitment procedures is desribed in paragraph "Users Relationship".

From the network point of view, the use of Nice Grid solutions at the LV scale seems relevant provided they are deployed at producers' premises. Activation of Nice Grid flexibilities to all distributed residential producers has a significant impact on the LV profile:

[6] French incentives scheme for the use of solar energy

- By addressing the (surplus) output at source;
- By solving the issue of the constrained phase;
- By allowing for the development of real-time local servo controls based on the effective; measurement of sunshine or voltage (e.g. to store at each second only the surplus power generated).

However, they prove less efficient when a majority of customers are absent from their homes, and therefore do not consume or do not store power. Other drivers might then be necessary, such as a feed-in reduction of solar power.

Social impacts

For experimenters, financial opportunities coexist with the wish to participate in collective efforts, to act as good citizens and contribute to improving the security of supply. The unpredictable nature of alerts was not perceived as a major constraint or an obstacle to postpone power consumption. The presence of someone at home and the ownership of programmable appliances were also factors facilitating participation.

In the long run, participants appreciate the opportunity to reflect on and to prepare for difficulties in energy supply, by identifying in advance the levers to use and the technical and organisational solutions to implement.

Above and beyond the load reductions, companies noted a certain number of positive effects from their participation in Nice Grid, in particular their integration into a network, a better understanding of their energy consumption and a closer working relationship with their energy supplier.

Moreover, participation in the experiment was directly valorised with regard to external communication, particularly in relation to customers who are sensitive to environmental issues. The company involved in the project asked for a dedicated logo "Engaged in Nice Grid" to use it as a marketing vehicle for their own businesses.

Rich Picture Model

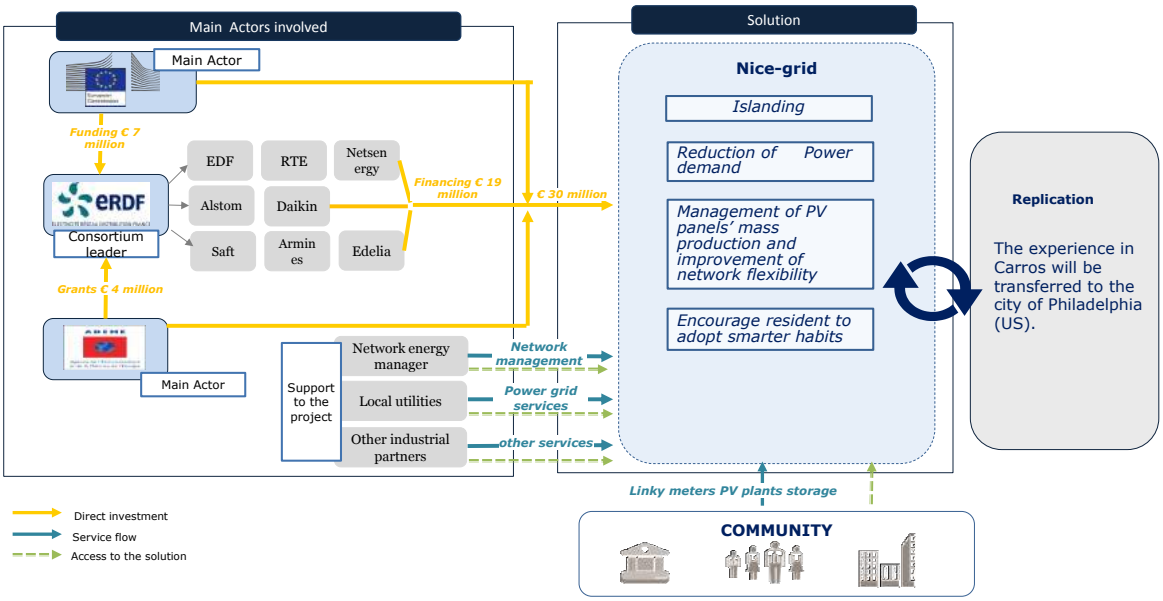

Figure 3: Rich Picture approach of Nice Grid

In the Nice Grid project, volunteer citizens have free access to the provided services (Linky meters, PV plants, etc). All the services are provided by the Nice Grid consortium, funded by EC, and ADEME.

Business Model Canvas

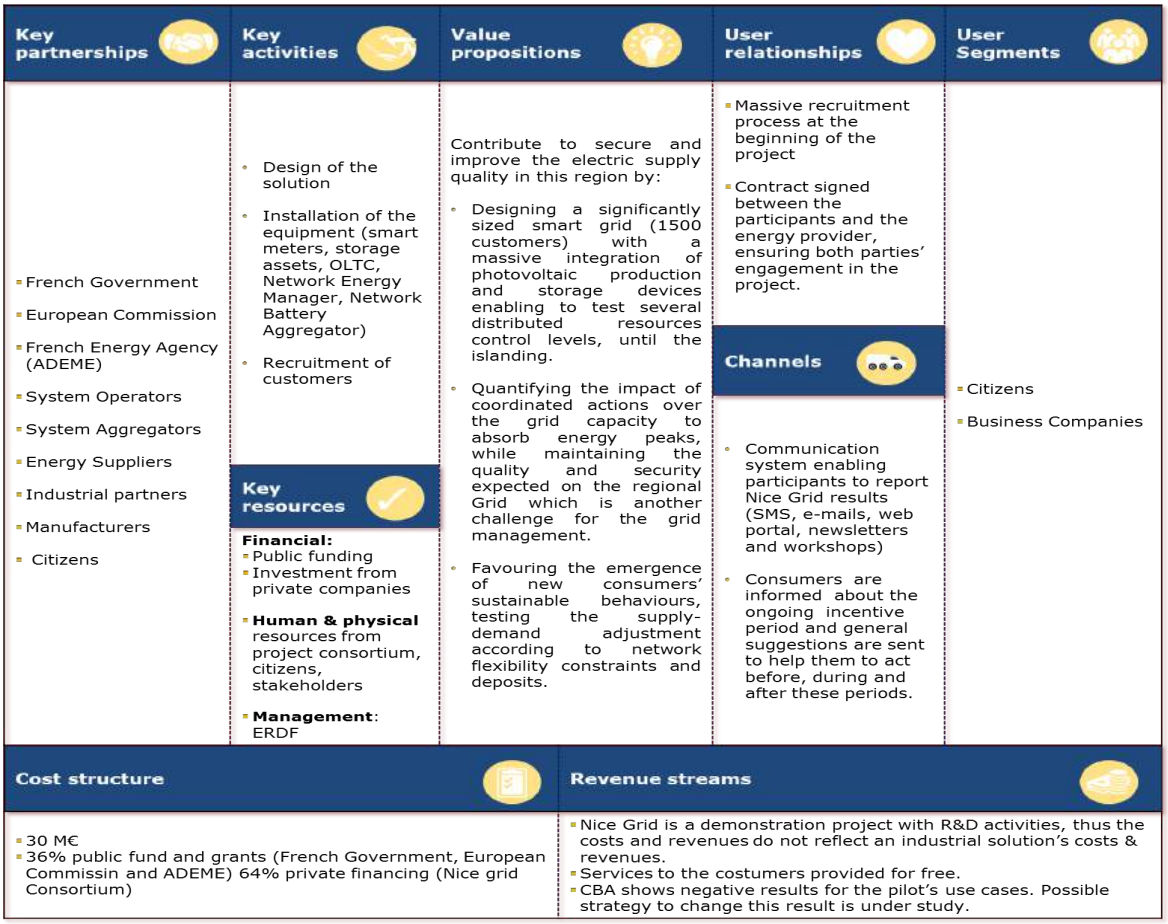

Figure 4: Business Model Canvas of Nice Grid

User segments

The local residents, who volunteer to participate to the Nice Grid project, contribute to the harmonious integration of solar-generated energy in their local grid system. Their participation is important to enable more effective management and control of the demand for electricity and thereby reduce greenhouse gas emissions. Whether residential users, business owners or operators of apartment buildings, these volunteers will no longer be just consumers, but "pro-sumers".

> "You can always save money on things that consume a lot of electricity, like ironing and drying clothes. Also, being able to use the system between midday and 4 pm means we can adjust our needs to match the solar power we generate right here at home."

Private customers were excited about the project. 2,300 Linky smart meters, the building blocks of the smart grid, were deployed in the town of Carros between May 2012 and February 2015. Around 300 customers have become active participants in the Nice

Grid experiment (217 households shedded their consumption in winter, 76 households shifted their power consumption in summer and 12 businesses also answered to load management requests) and installing equipment such as solar panels, batteries, or control devices.

Value proposition

Studies carried out by RTE have shown that 60% of the impact of a load reduction at a primary substation in Le Broc-Carros, near Nice, was passed on to the bulk transmission line through which transit the largest volumes of electric current in the PACA region. Indeed, as the region only produces 10% of its electric consumption, the local production is highly insufficient to meet the demand, thus, significant part of the consumed electricity is imported from other regions.

Therefore the PACA area is exposed to the risk of load shedding for about 1,500 hours per year, mostly in winter and summer.

Nice Grid project should contribute to secure and improve the electric supply quality in this region by:

- Designing a significantly sized smart grid (2300 customers) with a massive integration of photovoltaic production and storage devices enabling to test several distributed resources control levels, until the islanding. This is the core of the project, because one of the main issues are the voltage constraints generated by the massive introduction of RES in to the grid. The main role of the Network Energy Manager (NEM) is to manage and provide information to the customers on what to do during this period of constraints.
- Quantifying the impact of coordinated actions over the grid capacity to absorb energy peaks, while maintaining the quality and security expected on the regional Grid which is another challenge for the grid management.
- Favouring the emergence of new consumers' sustainable behaviours, testing the supply-demand adjustment according to network flexibility constraints.

Nice Grid is testing programmes of dynamic load management covering the following use cases:

- **Islanding:** During 5 hours, a MV/LV substation is disconnected from the network. This type of operation can be run either in anticipated way ("scheduled islanding") or unforeseen ("unforeseen islanding"). In both cases, synchronisation at the end of islanding proceeds without any interruption of supply for the customers.
- **Reduction of peak demand:** The goal of this operation is to reduce the power demand in the network. It can be used on Distribution System Operator (DSO) and/or a Transmission System Operator (TSO) request to prevent electrical constraints on the network, to help supply demand balance and to prevent customers from power outages. Different levers can be used to achieve this goal such as flexibilities related to customer appliances or battery placed in customer premises, the network batteries and industrial customers.
- **Management of massive decentralized PV generation on the low voltage grid:** A massive insertion of DER on the LV network may induce localized network constraints (voltage, current). The targeted solution in this use case is to trigger consumption and storage, in an anticipated way, near the constrained points in order to prevent network reinforcement, over-voltage and prevent from PV inverter disconnections (to maximize PV production).
- **Encourage resident to adopt smarter habits according to network state:** Nice Grid brings together residential customers whose homes are equipped with smart meters and, in some cases, solar panels and/or individual batteries, and business customers who chose to take part in the experiment. In summer, consumers take an active role in the "electricity systems of tomorrow" in several different ways: by shifting their consumption to coincide with abundant power generation, or by storing energy

when it is being produced in order to use it later (if the consumer is also a renewable energy producer), allowing consumers to make the most efficient use of renewable resources. In winter, consumers (individuals, companies and local authorities) can also reduce their electricity consumption to help manage power consumption peaks. Through their participation, experience and suggestions, Nice Grid project participants help make their neighbourhood more energy-efficient.

The roles, stakeholders, responsibilities, business models, within the tested Smart grids operations are quite different from those homogenous utility-based models of present power grids, mainly because of the distributed character of such systems involving new types of stakeholders, the **commercial aggregators**.

Commercial aggregators are responsible for the aggregation and dispatching of the DERs that belong to their respective portfolios. Through a coordination of various dispatchable flexible assets within the electrical installations of participating prosumers, it is hence possible for the aggregator to provide services as if the distributed assets were a single entity.

The technical infrastructure that is deployed in the project allows for local load management through the following actions: industrial demand response, residential storage management, residential load shifting, grid storage charge and discharge.

The Aggregators can manage various assets such as the water heating system of residential houses, the public lightning or manufacturing facilities, or small electrical batteries located in households.

In the Nice Grid configuration, there is one aggregator per sector or kind of resources:

- One commercial aggregator for residential DERs (including residential batteries), also said "B2C aggregator";
- One commercial aggregator for tertiary / industrial DERs, also said "B2B aggregator";
- One aggregator for grid -connected low voltage network batteries, or Network Battery Aggregator (NBA).

Channels

Energy storage systems and smart meters are installed in the homes of volunteer participants. By giving energy users the opportunity to manage their power consumption and budget, Nice Grid intends to turn passive consumers into active "pro-sumers" (producer-consumers).

This means that residents, during critical periods for the electric grid, are expected to change their electric consumption habits by stopping, moderating or postponing some of their electrical device uses and therefore to activate their flexibilities. When the network state is under constraint, **residents are informed about the ongoing incentive period and general suggestions are sent to help them to act before, during and after these periods**. Consumption, PV production information (with weather data: sunshine, temperature, etc ...) and storage data will be available to improve the impact of residents' actions and ensure that their efforts work in their favour.

Moreover, participants are inspired to own the project through a communication system enabling them to report Nice Grid results. Two types of communications are performed:

- **Individual communication through SMS**, e-mails and a web portal called "Visibilité Conso", available since summer 2013. SMS and e-mails provide information before the load-shedding or load-shifting takes place and give the opportunity to override the request (i.e. not to participate). These communication channels are also used to thank the individuals for their participation/involvement. The web portal is a consumption monitoring display that presents consumption for overall use, in euros and kWh, hour by hour, day by day and month by month. This portal enables participants to perform a day-to-day, month-to-month or even year-to-year comparison.

- **Community feedback through "Carros Info",** the quarterly newsletter and the website were ready at the end of the first experiments (mid-year 2014). A meeting in the showroom was also organised at this time to reinforce the commitment of participating consumers and enrol new ones. These communications aim to add meaning to the project through community results. Moreover, an open data website called NICE VIEW has been set up to display for example the percentage of load shedded of experimentation days during the winter or to show in real-time the local production and generation in each solar district.The households engaged in the experiment appreciated being able to receive feedback on the results obtained at individual and collective levels. Consumption reports and information on the collective results of the experiment were made available on the "Visibilité Conso" site; this was very much appreciated and echoed the wish expressed by households to be part of a collective action shared between the various stakeholders.

User relationships

Recruitment

As customer recruitment's process is often long and difficult in this kind of demonstrator, this activity started just after the validation of the general specification and the choice of the testing area. It lasted until the middle deployment and experimentation phase.

The Nice Grid project has been started with a sociological assessment of the expectations of Carros inhabitants regarding their electricity supply.

One of the main reasons that prompted the citizens to participate in the project is that the implementation of the Nice Grid project would prevent the construction of new high voltage lines passing through the city. Thus, the avoided visual and environmental impacts have been one of the main motivations for customers to be involved in these experimentation.

The customer recruitment's process consitesd in encouraging customers to be involved in the experimentation and accept to install some new in-home devices.

Statements about the motivation to participate in the first load shedding experiment from resdients in Carros:

"(her) If it could help…"

"(him) I know very well that we are at the end of the power line, and they don't want to install a big power line, Thus, if it could fix, we are not against… "

(her) We thought: It does not cost anything to make it.

(him) I thought: if everybody could make stuff like that, we would have less big power lines in the middle of fields...

(her) It is true that we don't like having a high-voltage line above the house. Moreover, according to what they say, it appears to make disturbances… "

- From May 2012 to October 2012, community gatherings were held to provide information on the deployment of smart meters.
- From September to October 2012, communication in local publications about the deployment of smart meters was organized to reach most Carros residents.
- In May-June 2013, the first enrolment campaign of the project took place. A teaser campaign was first implemented through posters in the designated solar precincts. Initially, communications did not focus on specific rational aspects of the project, but rather conveyed the overall benefits of the project: innovation, sustainability and territorial anchoring.
- Then, to inform inhabitants of the identified solar areas about the launch of the load-shifting experiment in summer 2013, brochures were distributed, doors open days organized and promotional posters put up.

To educate consumers about the project, a booklet comprising a description of the offers and a "prosumer guide" was handed out to participants of open door days.

In September-October 2013, the second enrolment campaign of the project, started the load-shedding experiment lasting from December 2013 to March 2014. This campaign targeted all inhabitants of the city equipped with a smart meter.

To address the specific needs of business/industrial participants, the recruitment process was engaged through a visit by a representative from the energy retailer and a technical expert to present the experiment, both of whom stayed in touch as key contacts to support the participating companies.

These participant awareness-raising processes were supported by a broad awareness and education commitment to the local community and local, national and international press coverage.

Customer recruitment focused on a qualitative research that met the roles defined in the use cases and which was played in the different electric network level. All awareness and education activities were based on the analysis of sociological studies realized during former similar projects in southern France and ad hoc interviews conducted prior to experiments.

With regard to consumer participation in the project, a contract has been signed between the participants and the energy provider, thus ensuring that both parties' engagement in the project was secured. Participants can opt-out throughout the duration of the project without incurring any extra cost. Recruitment is also possible up to the beginning of the last experiment.

Winter experimentations

In winter, two experimental solutions were offered by EDF to volunteering residential customers:

- Electric heating control via the Linky smart meter, designed to switch off or cut down the heating system for a short time during peak periods without impacting the participant's comfort.
- Behavioral Load Management: In the winters 2014 and 2015, households who significantly decreased their power consumption between 18.00 and 20.00 pm (during 20 peak demand days) received gift-vouchers in reward for their efforts.

In addition, the following solutions were offered by EDF to participating businesses and local authorities:

- Controlled Load Management offer via remote control of their energy uses (heating, HVAC, domestic hot water, etc.) and/or processes (steam ovens, refrigeration units, furnaces, etc.), together with remote consumption tracking.
- Behavioral Load Management offer controlled manually following load management requests.

Following the recruitment campaign, 217 volunteer households (out of an eligible population of 1.700) and 12 industrial customers (i.e. all of the approached businesses with subscribed power above 250kW) participated in the experimental trial in Carros during the winters 2014 and 2015. 40 households even accepted to have electric heaters controlled by the smart meter LINKY and dedicated devices during peak periods.

Summer experimentations

In Summer, three experimental trials were offered to residents of "solar districts" in the town of Carros to attempt to balance output and demand and optimise the solar resource. These offers are adapted to various consumer profiles, enabling all residents to participate according to their consumption habits and electrical appliances.

- Solar Bonus offer: During the 40 "Solar Days" in summer 2014 and 2015, indicated by alerts sent on the previous day via text and/or e-mail messages, EDF invited its volunteering customers to shift their electricity consumption during "Solar Hours" between 12.00 and 16.00 pm. At the end of each summer, EDF sent the customer a gift-voucher for a tariff equivalent to the off-peak tariff for their power consumption during Solar Hours.
- Smart Domestic Hot Water Tank (DHW): As a complement to the previous offer for equipped consumers, the system provides for optimum remote control of the hot water tank based on the local solar power output, without any impact on comfort.
- Smart Solar Equipment offer includes the generation of solar PV power via panels installed on the roof and energy storage in a battery.

76 households participated in the summer trials in 2015 in the seven solar districts (i.e. 15% of eligible households[7]).

Concerning the commitment of customers, all of the households involved in summer experiments "played the game" by preferentially using their appliances between 12:00 noon and 4:00 PM. Overall, these offers were very well received by the households. They effectively led to the expected increase in flexibility in organizing household chores, in particular by allowing them to shift the use of appliances such as the dishwasher, the dryer or the iron onto two time slots (night-time off-peak and daytime off-peak) instead of one.

Certain households neglected the appliance management and preferred these SOH[8] to charge their phones or to turn on the swimming-pool pump and filtering system. In winter, load curve analysis showed that whilst curtailment levels fell from one season to the next, households reacted well to demands for less flexibility.

User relationships beyond their participation

B2B[9] participants asked for a specific tagline to highlight their participation in the project. In response to this requirement, Nice Grid created a dedicated logo "engaged in Nice Grid" ("engagé dans Nice Grid"). Participants can use it to communicate their engagement will. They have the permission to use this logo in all of their communications (annual reports, presentations, signature of letters, email, etc.).

For B2B participants, a business club of participating companies was created to foster synergies and discussions and share best practices.

Regarding the participants that would like to opt-out, a dedicated action framework has been realized to understand their concerns and to address them:

- Dedicated public presentations of the project open to all citizens, and in particular opponents of the project, have been organized
- Invitation in the showroom for groups of residential opponents to have the opportunity to discover, touch and play with the actual components of the project (meters, relays, batteries, etc.). This way of handling opposition has enabled:
    - Opponents to change their minds about the project, even to become supporters,
    - A participatory dynamic to be created in the city of Carros, thereby facilitating customer recruitment and project implementation

Revenue streams

[7] *Eligible household: resident of one of the solar districts fitted with Linky smart meters*

[8] *State Of Health* which represents the long term capability of the battery.

[9] Business to Business

€11 million of project cost were provided by the French government and the European Union. Moreover, approved by the Commissariat General aux Investissements, the project received:

- €4 million in refundable advances and grants from the ADEME, the French environment and energy agency;
- €7 million from the European Commission.

The remaining 19 M€ were provided by the partners of the consortium. Each partner provided financial, human and physical resources (equipment) for an amount proportional to its role in the project.

Nice Grid is a demonstration project with R&D activities, thus the costs and revenues in the demonstration does not reflect an industrial solution's costs & revenues. However, a CBA was conducted within the project following the methodology from JRC to evaluate prospective industrial cost & revenues for industrial solution. This method uses a "global society value" and, thus, does not present a business model for each involved actor.

The project was designed for the benefit of integrating DER in Low Voltage Grid more cost efficiently. The flexibilities provided by the different aggregators (B2B, B2C or batteries) are meant to maximise the local use of electricity, thus avoiding constraints and additional investments into the grid.

During the experimentation, customers did not pay for the service. In the opposite, there was some rewards to involve them further for the purpose of the experimentation. In the CBA, potential revenues at customer level are related to the savings on the grid investments thus, it is not an additional benefit. All in all, if the business model was profitable, the impact on the customer bill could be of two different types:

- Avoiding possible increases in electricity bill due to additional investments on the grid if the measures to improve the flexibility were not applied.
- Bill saving due to the introduction of load shedding;

The use cases designed in the project cover only about 15% of the year (in term of days of activation of the different flexibilities, more or less 55 days/year), which corresponds to the period when voltage constraints could occur due to a massive introduction of DER into the grid. This makes the CBA of the project's use cases negative as the benefit related to the selected days do not cover the complete costs of the solution implemented. If additional use cases were designed (for example the use of Electric vehicles) with added benefits, the conclusions of the CBA could change. Thus, a necessary requirement to make the business model profitable is to integrate the solution with other type of measures.

Key resources

The key resources required to develop the solution are of physical and intellectual/human.

Concerning the physical resources, Nice Grid includes sensors, meters and generation facilities (PV and Energy Storage) involving directly or indirectly 1500 costumers of which 220 households participated to the winter trials (2014-2015) and 76 to the summer ones (2015). Also 12 business company joined the test.

Key activities

As outlined above, the key activities necessary for the development and implementation of Nice Grid were:

- Design of the solution;
- Installation of the equipment (smart meters, storage assets, OLTC, Network Energy Manager, Network Battery Aggregator);
- Recruitment of customers.

In particular, continuous customers' involvement processes and communication activities are crucial for the maintenance of the services. These activities were successful and during the duration of the project more than 7,000 people in less than 2 years visited the project showroom, including 1,500 foreign visitors.

The following picture further illustrates the level of integration of the solution and summaries the key activities.

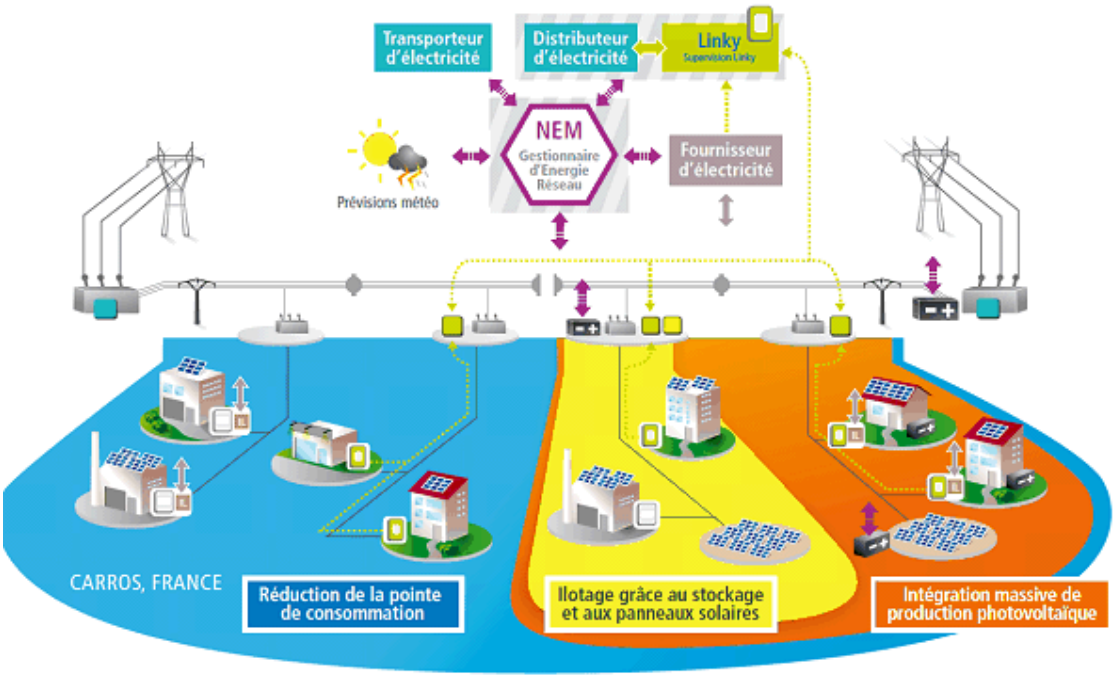

Figure 4: The different dimension of integration of the solution

Key partnerships

The Nice grid project is led by ERDF with the collaboration of a consortium made up of industrial partners, energy suppliers as well as other actors working on the implementation of the demonstrator. A contractual engagement lays the foundation for the relationships between the various stakeholders.

At the highest level, a legally binding agreement has been signed by all members of the Nice Grid Consortium to clarify the role of each party and build a strong and effective partnership.

Knowledge-sharing is key for this demonstration project. Partners regularly exchange on their findings and even wrote common publications.

The role of each partner within the project is described below:

- ERDF has brought its Distribution System Operator expertise whatever is the technical object (medium voltage or low voltage: protection and remote control), the activity (Designing and engineering development of Grid and connections, operations, metering…) or the purpose (services to consumers, connection distributed generation facilities). ERDF is also the demonstrator leader.

- The historical energy supplier, **EDF SA** has collaborated with EDF R&D centre. The latter provided technical expertise in renewable energies (laboratory test for PV, research on optimal storage associated to PV…), software intelligence (Research on PV control algorithms…), IT technologies, energy efficiency technologies, and simulation tools enabling to evaluate and extrapolate the demonstrator results. EDF SA subsidiary EDELIA provided incentives offers, in tariff offer field and in services enabling consumers to remotely control their energy needs. Furthermore, EDELIA provided its skills relating to the remote and dynamic management of electricity consumption. EDELIA design, develops, integrates devices to offer load shifting services.
- Two main industrial partners:
    - **GE Grid Solutions**, is specialized in Electricity Grid and provided the following specific skills:
        - Software in the Smart Grid field.
        - R&D skills for the design, specification and prototyping of innovative solutions, particularly in power electronics and energy management systems.
    - **SAFT** is an industrial specialist in designing and manufacturing Lithium-ion high-tech batteries for industrial clients. SAFT provided its expertise in modelling systems: thermal and electric storage, batteries performance, size, behaviour (charge and discharge) and life cycle
- The French Transmission System Operator: RTE worked on the adaptation of the market rules in order to integrate better the capabilities offered by the Smart Grid, respecting the security of the electricity network functioning. RTE also analysed, with ERDF, load shifting incentives / consumption and mobilization capacities associated, according to various parameters.
    - Equipment manufacturer and SMEs:
        - DAIKIN, is a manufacturer of air conditioning equipment, refrigeration and heating for the residential, commercial and industrial sectors. DAIKIN group adapted and developed, from existing technologies, load shifting solutions for variable refrigerant volume air conditioning and heating.
        - NETSEENERGY designs, sales and operates remote energy services. This company sets up two-way communication systems in service sector and industrial buildings. In the framework of Nice Grid project, NETSEENERGY made available its assets to minimize the cost relating to the implementation of communicating boxes in service sector and industrial buildings in Carros.
- A community research actor, ARMINES who is an important actor of the French research community. Its role has been to make available its centre for energy and processes (CEP, called now PERSEE) of MINES-ParisTech. The CEP will work on the following topics:
    - Short-term production forecasting models of renewable power generation
    - Modelling and management of electricity system such as "micro-Grid" integrating smart energy systems enabling to control the intermittent renewable production (wind energy and PV), storage means and electricity market signals.

ERDF, GE, EDF SA and Armines are also partners of the Grid4EU project.

Cost structure

The Nice Grid project estimated costs amount to €30 million. It included both fixed and variable costs. It included both fixed and variable cost (e.g. personnel, hardware and software infrastructure, maintenance, etc.)

Barriers/challenges

The main challenge of Nice Grid is to facilitate the integration of Distributed Energy Resources into the grid by limiting the voltage constraints that consequently occur using cost-effective solutions. To this end, the Nice Grid project aims at implementing and testing a distributed energy resource management system, supporting hierarchical operation and control for a microgrid with high concentration of photovoltaic generators.

Demand response programmes will be successful and sustainable **only with strong customer engagement**. Commercial aggregators play a key role to guarantee it. That can only be done if customers perceive an interest, and trust the relationship they have with their supplier. For them, "demand- response", "load- shifting", "aggregation" are terms without any meaning, especially in the residential area. Accepting a battery installation that will take a place in the garage or in the basement is not straightforward.

Indeed, a key and critical piece in Nice Grid was around customer enrolment in the project. Specific offers have been designed, that push forward how they can benefit from the proposed schemes, in terms of possible bill reduction, of new opportunities (for instance, to run certain tasks in "solar off-peak period"), and also, in the fact that they will make a better use of their own solar production (for customers equipped with PV panels).

In any case, customers should remain in control of what happens in their premises and can always escape from any automatic process. Impacts on comfort, if any, are clearly stated. Full transparency in terms of information is ensured: display with load consumption and information of forthcoming off-peak or on-peak period, regular feedbacks and explanations on the bill, but also global results achieved by the experiment.

These assumptions were deliberate choices made in the project: **demand response is not only a technical challenge,** it is also a social challenge that relies on confidence, transparency and benefit for all stakeholders. Leaflets, meeting with customers, hotline were implemented, and very positively received.

For what concerns the barriers encountered during the implementation of Nice Grid, it must be mentioned the *lack of regulation* for what concerns some specific devices used in the solution, for example batteries, for which there is no regulation for what concerns usage, standards and ground footprint.

Last but not least, the economic barriers are not negligible as most of the equipment used to implement the solution are expensive and the results of the CBA shows that it is not possible to make the business model of this solution profitable without finding other use cases for these devices, which work only during the constraints period.

Replicability factors

From a physical and structural point of view, the measures undertaken by Nice Grid are potentially replicable in any European large or medium city having the possibility to generate electricity from renewable sources. Nonetheless the business model has not yet proved to be profitable. This means that the solution as it is been designed for the Nice Grid case is not replicable in other cities unless to carry out other pilot cases, that imply public grants, or to integrate it with other final electricity uses to make the investment more profitable (but, in this case, ad hoc CBA have to be carried out).

Other factors to be considered in case of replication of this solution are:

- The necessary presence of suitable spaces to accommodate bulky devices, often also unattractive, as in the case of storage equipment;
- The presence of standards and regulation for the technologies involved;

- And, most important, the necessity to involve, motivate and inform citizens, without which the system is bound to fail. To this end the massive recruitment process adopted is a necessary requirement for the replication.

As for this last point, the involvement and participation of the city could help not only from an organizational point of view but also to generate trust from the citizens in the development of the solution. It is important that the final users feel their selves firstly "citizens" rather than consumers and the city could play a key role in this. In the Nice grid trial, the City of Carros was not officially involved as partner of the solution but it provided a precious contribution to the Nice Grid consortium in ensuring that the people would understand the real benefits of the integration of renewable energy sources in the municipality.

A more holistic and integrated approach is then one of the main challenge to replication. The experience accrued during the development of this pilot case will be transferred to the city of Philadelphia (US) in order to open a Microgrids center for educational, research and operative scopes (see below a brief outline of this initiative).

Figure 5: Replication areas of Nice Grid: Philadelphia (USA)

The replication of Nice Grid in Philadelphia, US:

One of the world's leading managers of electricity networks agreed, in summer 2015, to open a research centre in partnership with Pennsylvania State University ("Penn State") at the Navy Yard, reinforcing its emergence as a smart-energy campus.

GE Grid, a unit of GE which is also partner of Nice grid project, will open the Microgrid Center of Excellence at the Navy Yard in South Philadelphia. The centre will be involved in the deployment of new technologies related to "microgrids," which are localized electrical systems that can operate autonomously from the regional power grid.

The GE project will operate out of the Department of Energy-funded GridSTAR Center at the Navy Yard, a smart-grid education and research centre that is part of Penn State's architectural engineering department. Alstom said it will assign four engineers to the centre.

Penn State officials hope the partnership will lead to new research opportunities for professors and new teaching opportunities for students. "We have a new emphasis on developing new knowledge, and getting that knowledge into the marketplace," said Neil A. Sharkey, Penn State's vice president for research. "So having a partner like Alstom, that's what that's about."

Alstom's energy units, including its power generation and grid business, has been acquired for $17 billion by General Electric Co.

Alstom employs about 125 engineers at its power-electronics offices near Philadelphia International Airport.

> "We are looking for ways to put into real-life practice the things that are working for us in the laboratory, I don't want people to think this is all future, pie-in-the-sky stuff."
>
> Michael Atkinson, President of Alstom Grid North America

The Navy Yard, which developed its own power-distribution system as a military installation, currently has a peak electricity load of about 30 megawatts, and that is expected to double in seven years with the continued redevelopment of the area.

The microgrid project seeks to reduce the Navy Yard's dependence on the regional power network with locally generated power, on-site energy storage, and conservation measures

"Replication recipe"	
Problem definition	✓ *Municipality and stakeholders wishing to implement a similar solution shall first understand the issue and secondly how the technological solution could address it.* ✓ *Citizens engagement processes must be addressed with the proper attention before and during the implementation phase*
Infrastructure and financing	✓ *The solution requires very large investments. The price for the offered service should be initially low (or even free) to attract citizens in the initiative.* ✓ *Other final electricity uses must be found in order to make this kind of solution profitable (to amortise the initial investment)* ✓ *suitable spaces to accommodate bulky devices are necessary requirements for implement this kind of solution;*
Governance	✓ *The solution shall adopt a governance structure, which could include, inter alia, an executive board, a technical expert group and work package leaders.* ✓ *Strong leadership is required of the coordinating authority, backed up by an equally developed cooperation culture animating the participating stakeholders.* ✓ *Proactive and continuously fostered citizen participation is another key requirement.* ✓ *Standards and regulations are required for the battery and the battery management equipment*

Table 1: Replication recipe

Sources

Interviews / Contact persons	Adel JARIFI - ERDF - Direction TECHNIQUE
Literature supporting the research of this case	McKinsey, The Smart grid opportunity for solutions provider, 2010
Internet sources	http://www.grid4eu.eu/overview.aspx http://grid4eu.blob.core.windows.net/media-prod/6606/Grid4EU_dD6.1_DEMO6_Initiation_of_the_demonstration_v1.0.pdf https://birdandbird.files.wordpress.com/2015/06/smart-grids-market-summary_france_06-15_v4.pdf http://articles.philly.com/2015-06-04/business/63009915_1_navy-yard-research-center-penn-state https://hal.inria.fr/hal-01112769/document
Figures sources	http://www.nicegrid.fr/

LYON SMART COMMUNITY

Lyon, France

→ Replication potential	3	→ Economic impact	4
→ Complexity	5	→ Environmental impact	3
→ Citizens' involvement	1	→ Social impact	3

Assessment based on feedback provided by the solution's representative as well as on the available sources analysed by the study team.

Short description of the case study

Lyon smart community – confleunce project

	Key facts and figures
Type of solution	*Smart Districts*
Project stage	*The project is structured into 4 tasks, implemented from 2012 to 2016.*
Actors involved	*Public Authority, Industry*
Roll-out of the solution	*The solution is progressively scaling through different components implemented in wider areas of the city of Lyon.*
Barriers	• *Technical, legal and administrative complexities in the implementation* • *Many partners may set up barriers for the overall project management* • *Timing and user involvement*
Implementation best practice city	*Confluence District in the city of Lyon, France*
Main technological areas covered	*Smart Meters, Traffic and Mobility Infrastructure, Data Management*
Funding mechanism	*Public Investment and private co- investment: NEDO funds with 50 mill. EUR; Grand Lyon / SPL Confluence make direct and indirect investments in the project; all industry partners have R&D partner contracts and co-fund*
Economic, social & environmental impact	*Expected impact:* *> 20% energy efficiency improvement over low energy buildings* *> 80% of electrical vehicle usage from PV generation* *> 10% energy savings by engaging users*
Replicability factors	• *Direct (in this case public) investment* • *Strong political leadership* • *Strong emphasis on inclusiveness of the local community* • *Strong governance set-up* • *Clear vision to become a smart and sustainable region*

Case summary

The City of Lyon is the third biggest city in France, with approximately 1.5 Mln inhabitants. The region is characterised as the second most attractive city for business in France, and 1,500 new companies are founded each year. Lyon has a proven track record as a European **city of innovation**, as demonstrated by the number of patent applications, inter-company collaborations and teaching and research centres, as well as by its total expenditure on research and development. The city also boasts 126,000 students, 10,000 researchers and 500 public and private laboratories. The Smart City agenda of Lyon is well developed and known around the world and currently include around 40 smart city projects in the city area.

The **Lyon Smart City Community demonstration project** is part of Greater Lyon's broader aim: becoming an international example of clean-tech and an even smarter sustainable city/region. As part of this major multi-dimensional project to transform Lyon into a smart city, an urban redevelopment project is underway in the Confluence district of Lyon.

The decision to redevelop the Confluence district as a "model city that can expect sustainable growth" was made in 2005. Initiated in the mid-1990s, the Confluence redevelopment project in Lyon has gained much attention by its central urban location, size and ambitions. The 150 hectare Confluence district is located on the most southern part of the peninsula making up Lyon's urban centre. Its name comes from its geographical location – at the confluence of the Saône and Rhône rivers and lies in the direct continuation of the city's central axis. The area was run down and neglected as well as disconnected area, inhabited by the socially marginalised and poor. Set to ultimately double the size of the city center, the Confluence project is one of the largest brownfield redevelopments in Europe.

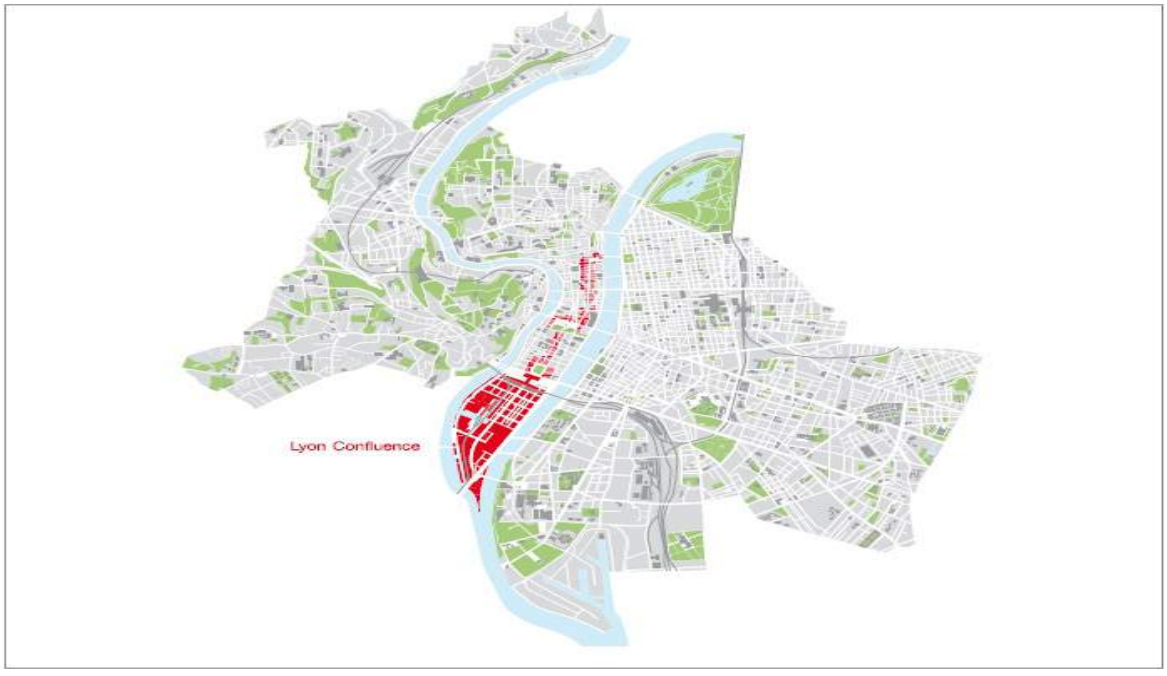

Figure 1: The Lyon Confluence area in 2011. Source: SPLA

By 1999, the Greater Lyon authority established a public company to develop the Confluence district. Divided in two main development phases and areas (Saône and Rhône embankments), it covers the entire district over a 15 years time span. The renovation of existing social housing and the development of a green link along the Saône embankment are also included within the project. Once the redevelopment is complete, 16,000 residents are projected to live in the neighborhood. Promoting the establishment of a mixed-income community and encouraging mixed-use development are integral parts of the project. An effort has also been made to ensure that the neighborhood is practical for its residents, including space for both offices and

shops, cultural attractions, and entertainment venues. This reinforces the goal of environmental sustainability, encouraging residents to walk and not rely on their cars, while also fostering a community life.

In 2005, the European Commission's Directorate General for Energy launched the Concerto initiative aimed at demonstrating that energy-optimisation of districts and communities as a whole is more cost-effective than optimizing each building individually. The project began in 2005 and supported 22 projects all over Europe. Within the project, Grand Lyon participated in a huge urban regeneration programme called RENAISSANCE from 2005 to 2010. In Confluence, 3 big buildings were constructed with respect to the specific criteria laid down for energy efficiency and the use of renewable energy sources derived from CONCERTO specifications. The goal of the project was to build a neighbourhood in which 80% of heating and 50% of electric consumption in common areas of housing buildings, and 30% of electricity produced for air conditioning in office buildings come from renewable sources of energy. The buildings were finished in 2010.

In December 2011, a partnership was agreed between the Japanese New Energy and Industrial Technology Development Organisation (NEDO) and the Greater Lyon metropolitan administration for the implementation of a joint demonstration project in Confluence and the related deployment of technologies supporting its environmental and energy ambitions. This project aimed at demonstrating the potential of new technologies to support energy optimization of districts and communities. This was supported by various projects underway, and the general city leadership to turn the greater Lyon area into smart Lyon.

The idea of **Smart Lyon** is built around four main ideas:

- The taking into account of the environmental challenges and energy constraints;
- The main actors functioning as a network - local authorities, citizens and businesses;
- The movement away from ownership to usage - participation of users in the design of products and services;
- The inclusion of new technologies (information and communication, robotics, intelligent transport systems etc.) To facilitate working as a network, encourage changes in energy use and support and encourage behavioural change and usage patterns.

In line with these ambitious goals, the Lyon Smart Community demonstration project was initiated. The project, which includes homes, buildings and transportation in an area of roughly 150 hectares, involve the active adoption of solutions such as solar power generation and establish management technologies for its effective use under the theme of "a sustainable city through renewable energy utilization and management systems."

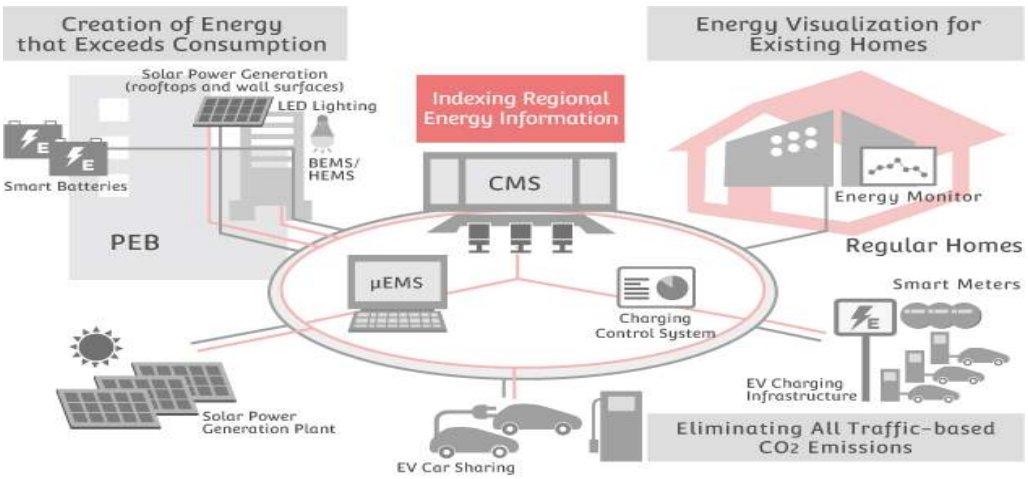

Figure 2: The Lyon Smart Community Project. Source: Toshiba Corporation

Especially, the establishment and use of ICT-systems to control and optimise infrastructure and energy consumption in terms of both communication, data management and mobility, will play a major role in the project.

In 2011, Grand Lyon and NEDO signed an agreement regarding the roll out of the project. The correspondence and agreement between the two main partners, Grand Lyon and NEDO, can be described as a perfect match of visions and interests between industry, national governments and local authorities: Grand Lyon wanted to structure and monitor their smart city approach and accelerate the city development, and, at the same time, NEDO was looking for an experimentation place in Europe to test new technology solutions and support the Japanese companies.

> Lyon Smart Community aims to make the area its flagship district in terms of energy efficiency, and the district will be the first ever sustainable and zero emission.

The Lyon Smart Community project includes the implementation of four demonstration tasks, which are being implemented from 2012 – 2016 (see below).

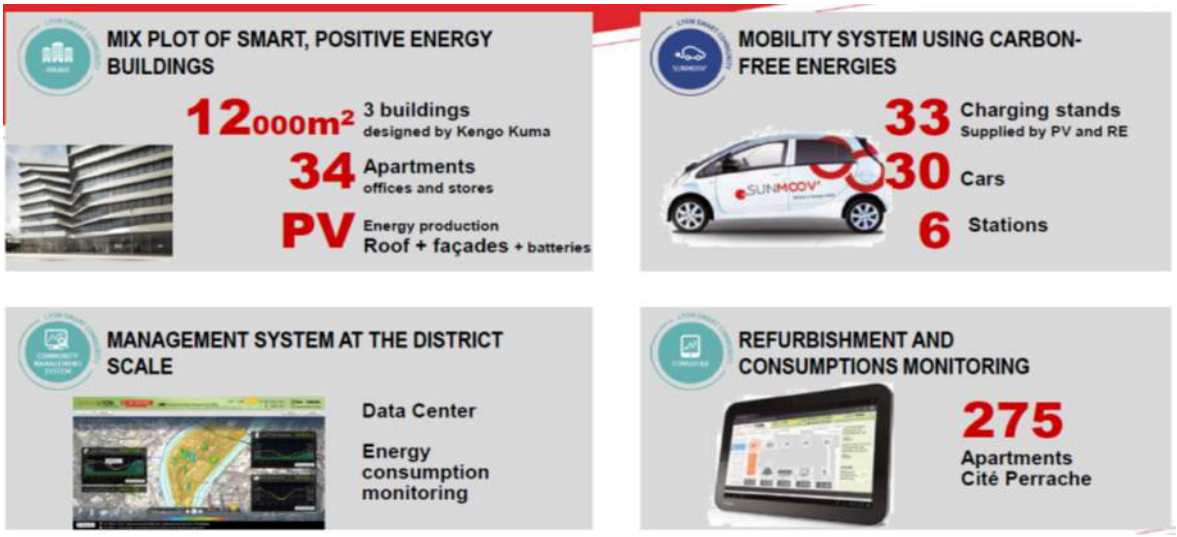

Figure 3: Figure Explaining the Four Demonstration Tasks. Source: Lyon Advertisement Campaign 2015

The four demonstration tasks are:

1) **Mix Pilot of smart, positive Energy group of Buildings (task 1):** Positive-energy buildings are built on the last part of the mosaic surrounding Place Nautique. This will be a group of mixed use landmark buildings in terms of energy efficiency and the use of renewable energies. The buildings will capture sun light using solar panels, and a cogeneration plant is also planned to be established in the area. The district includes shops, offices and living dwellings.

2) **Mobility system using carbon free-energies / fleet of electric vehicles for a car-sharing scheme (task 2)**: To restore life in the district without making a bigger pressure in the existing infrastructure conditions a fleet of electric vehicles in a car-sharing scheme will be established. This serves as an innovative, energy sufficient mobility solution for a variety of car users, such as firms and local residents.

3) **Refurbishment and consumption monitoring / ICT system on a micro level: installing energy monitoring systems in homes (task 3):** In terms of renovating existing buildings in the Confluence District the GRAND LYON HABITAT, a local social housing body, has created an eco-renovation plan with the aim of providing 275 homes on Cité Perrache with energy monitoring systems. Part of this task are also a number of actions aimed at raising awareness and promoting behavioural change of the inhabitants.

4) **Management system at the district scale / data analysis system to monitor energy use by the demonstration as a whole (CEMS) (task 4)**: The Community Energy Management System (CMS) will gather a large and diverse quantity of data from a range of locations, and, furthermore, the system will aggregate this data with other information from systems set up by Grand Lyon as part of its sustainable smart city programme. The data collection makes it possible to analyse the production of renewable energy and types of energy use, as well as weather conditions, etc.

On the operational side, the four demonstration projects are being run by NEDO and its operational partner, Toshiba, with the support from SPL Confluence, the community agency of Confluence. From 2016, Grand Lyon will take over all demonstration projects from NEDO.

At the heart of the Lyon Smart community demonstrator is a data management system - **the Community Energy Management System (CMS).** The CMS gathers real-time information from a range of sources located within the Confluence District. The data centre has the capacity of integrating different types of data with the purpose of improving innovative energy analysis and management. CEMS aggregates all data gathered from the district with other information from systems set up by Grand Lyon as part of its "Grand Lyon Smart City" programme, such as weather readings and air quality. Based on this approach, CEMS provides both management and forecasting. It uses detailed measurements of overall energy use throughout the Confluence district in order to give urban stakeholders a global view – facilitating planning in terms of energy resources and requirements.

CEMS comprises a number of aspects:

- Identifying the indicators that are most relevant for the Lyon Smart Community district;
- Collecting and aggregating measurement data from various buildings, infrastructures and energy production sources;
- Analysing and formatting the results, and at last;
- Simulating and planning future energy consumption.

> "Lyon Smart Community is a very special project in the smart city portfolio of Grand Lyon. The main objective is to undertake research in terms of technology, organizational and behavioural innovation."
> Emilie Gerbaud, Project Manager for the Smart Lyon Community Project, Grand Lyon

As far as this study is concerned, this project is relevant because, as depicted in the following figure, it covers all the three vertical/technological priority areas: Sustainable Urban Mobility, Sustainable Districts & Built Environment, and Integrated Infrastructure & Processes. Based on the development of efficient ICT systems and data management strategies on both a micro and a macro level, the solution improves urban mobility and the built environment by creating better conditions for energy savings and CO2 emission reductions.

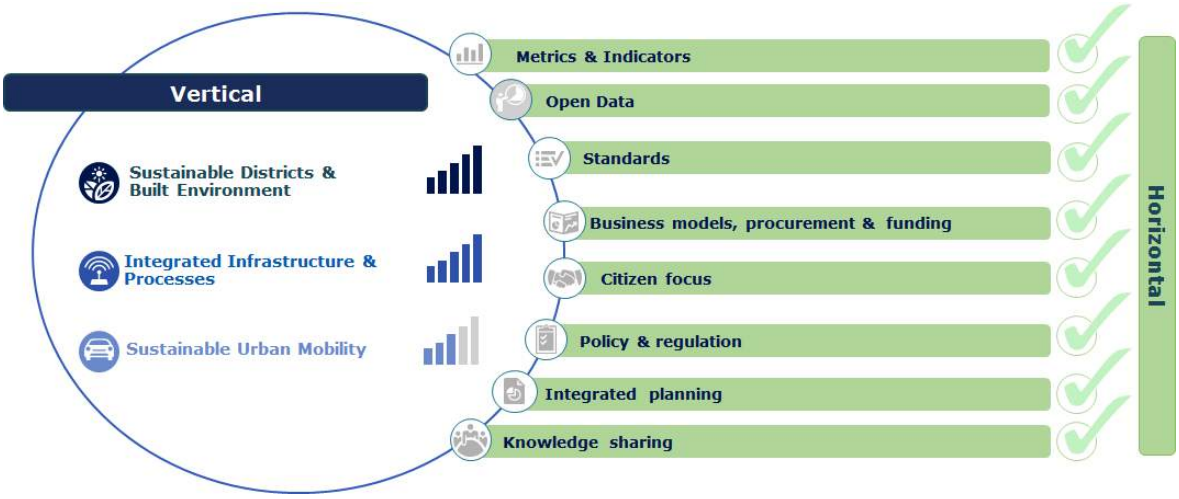

Figure 4: SCC Solution Integration Dashboard

Market analysis

The market for this integrated solution is not easily described as it spans multiple engineering traditions, technology as well as service markets. For instance, at task level this solution includes household monitoring equipment, smart building technologies, car sharing or intelligent transport system technologies and associated electric vehicle infrastructure as well as associated services with both as well as underlying data management systems and approaches. Taking a more macro approach, the situation is further complicated by the fact that this was a demonstrator project, hence the market conditions should be seen as R&D investment in real-life conditions.

There is a specific market for such set-ups and some cities opt for living labs, whilst others opt for smart streets or smart houses depending on their industry strengths and partnerships in place.

The market analysis house Frost & Sullivan expects the smart cities market to be worth a cumulative $ 1,565 trillion by 2020[1]. This cumulative market calculation is based on the assumption that the market will be split into the following segments: smart governance and smart education (24.6%), smart security (13.5%), smart energy (15.8%), smart infrastructure (13.1%), smart mobility (8.7%), smart healthcare (14.6%), smart building (9.7%).

Main impacts

Greater Lyon recently launched its Innovation Strategy as well as a Digital Policy with the following objectives:

- Turn Greater Lyon into a territory of innovation through creativity and digital technology;
- Support the development of infrastructures, the basis for all digital projects across the urban area;
- Reinforce coordination between all players involved to ensure a common goal and high visibility, in order to develop a digital identity that enhances the attractiveness of the Lyon urban area;
- Encourage the emergence of new uses, enabling Greater residents to enjoy a higher quality of city life together;
- Offer innovative, optimised urban services so that resources and flows within the urban area can be managed more effectively;
- Encourage the development of innovative projects with a digital aspect by promoting experimentation and supporting current initiatives; and
- Incorporate digital technologies and associated innovations in all major urban projects and public policies within the Lyon urban area.

At an **economic level:**

- Encourage business creation and support the emergence of the jobs of the future in the digital economy and in the green economy; and
- Attract investment in the area of the city of tomorrow, within the context of strong competition from other cities.
- Using synergy developed within the project, partner companies can provide high-level commercial offers on an international scale, which can be extended to other European cities. At an urban development level: finding new ways of thinking about the way the area is managed.

In terms of **sustainability:**

- Promote changes in energy use (production / distribution / consumption); and

[1] Mega Trends briefing: Strategic Opportunity Analysis of the Global Smart City Market, Frost & Sullivan http://www.egr.msu.edu/~aesc310-web/resources/SmartCities/Smart%20City%20Market%20Report%202.pdf

- Offer new transport solutions in areas that have more and more constraining factors.

With respect to the **environment and energy**:

- The project plans a yearly savings of 200,000 tons of CO_2 by 2020 for the Lyon urban area;
- Private and professional users will spend less time on transportation through information technology and the optimization of network use.

Emphasis on **Research and Development**:

- Greater Lyon actively encourages technological, organisational and social innovation in business.
- Lyon has a proven track record as a European city of innovation, as demonstrated by the number of patent applications, inter-company collaborations and teaching and research centres, as well as by its total expenditure on research and development.

In concrete figures the expected impact of Lyon Smart Community are:

1. Achieve more than 20% energy efficiency improvement over other low energy buildings;
2. Achieve more than 80% of electrical vehicle usage from PV generation;
3. Achieve more than 10% energy savings by engaging users with energy visualization systems;
4. Achieve the EU "20-20-20" policy in the Lyon Confluence District, 5 years ahead of time.

Concerning the case of LYON SMART COMMUNITY, as a particularly young project, it is impossible yet to evaluate the benefits of its implementation beyond its expected outcomes.

It is important however to put forward that the technological input by NEDO/ Toshiba will be accompanied by taking into account social elements, particularly in the case of affecting behavioural and energy consumption patterns. Beyond demonstration, there is a need for successful implementation through community adhesion: to create a smart community, it is important to study how a social system functions, including not only energy supply and demand and the introduction of renewable energy, but also various lifestyles.

However, even though impact assessment in relation to the goals mentioned above have not been carried out due to the very short time period, some impact assessments has been made in order to assess the solution efficiency, the scaling potential and the need for further integration into existing city services in the City of Lyon.

Impact assessment of the four projects are planned by both Grand Lyon and Toshiba. The assessments are based on data and results collected in the first phase of implementation, the experimentation phase. As an example, an impact assessment of the car sharing scheme showed 2 key issues: 1) the dimensioning of the service had not been right - the loop system was less adapted to the consumer than the one-way car sharing scheme and 2) that it was a question of phasing the different tasks - essentially the car sharing scheme was launched before a critical mass of inhabitants had actually moved into the district. This meant that the service as it was evaluated as financially not sustainable. Gran Lyon is now considering to change the system into a one way system which is more flexible and suitable in terms of CO2 emission reductions. An evaluation of the eco-renovation project also showed that citizen involvement is crucial for citizens to actually use the technological equipment installed in the buildings.

In a longer perspective, and with the establishment of the data management system (task 4), it will be possible to evaluate the environmental impact of the different intelligent solutions due to the integration of data from different domains (traffic, heating, energy etc.). As a mechanism for evaluating the project's effectiveness objectively, a management system covering region-wide energy information (Community Management System) will be introduced simultaneously. Because this project is still in its development phase, the data integration potential is not fully investigated and discovered.

Rich Picture Model

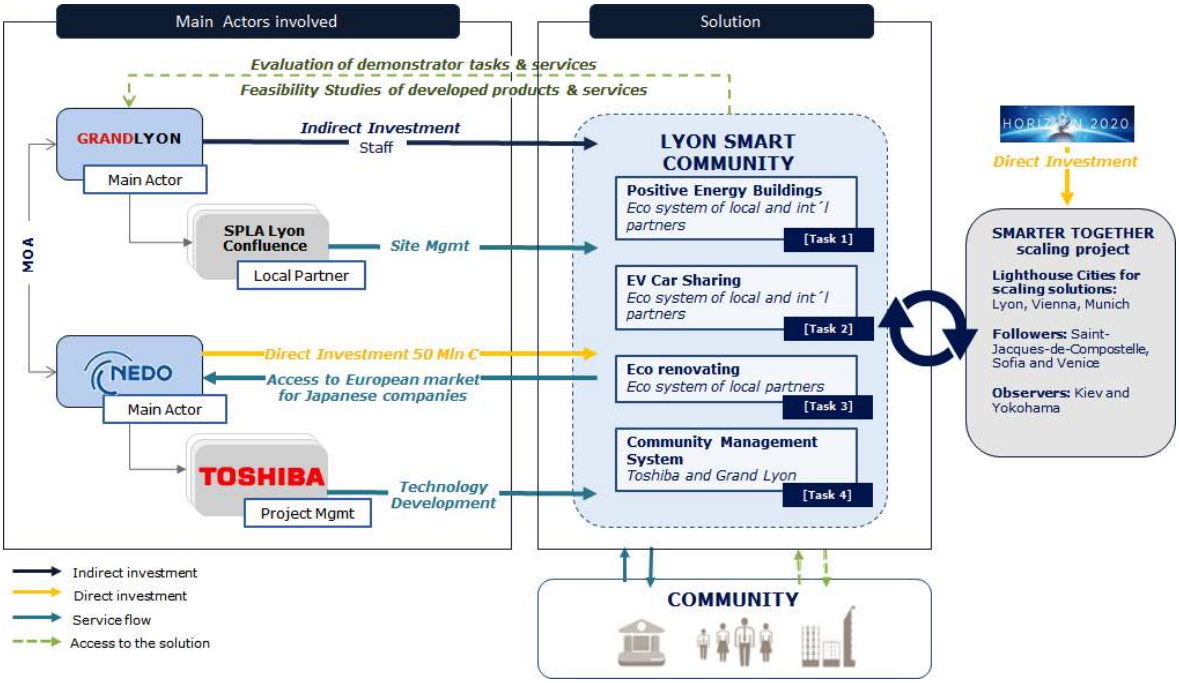

Figure 5: Rich Picture approach of Smart Lyon Community

As illustrated above, the Lyon Smart community is a multi- task, large scale demonstrator. Essentially the pilot projects are embedded in a brown-field redevelopment of a smart district.

The key elements Lyon Smart Community delivers are:

- **Large-scale, multi-phase experimentation** and development of core infrastructure for (greater) smart Lyon with the aim to test key elements to move towards a zero emissions district/city;
- Strong emphasis on **local partnerships, creation of skills, capacity and new business opportunities** for local business partners;
- Focus on **transformation of daily life at community level (of businesses and citizens)** supported by training, awareness raising and residential energy monitoring (real time data services);
- Integration of multiple **data points in underlying data center** to develop new data-based services.

Business Model Canvas

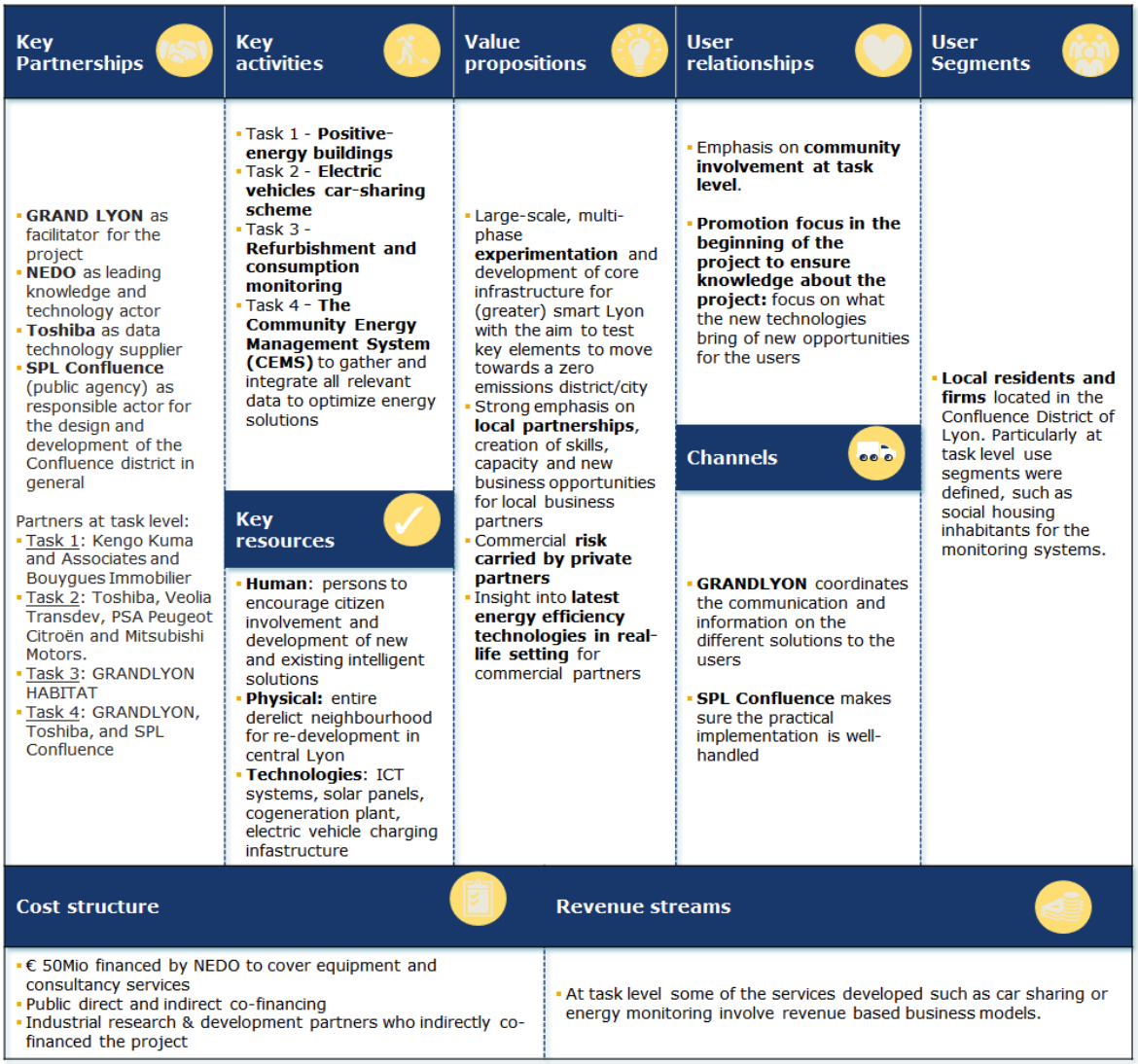

Figure 6: Business Model Canvas of Smart Lyon Community

User segments

The users of the solution are the population of Lyon, and, especially, the population located within the Confluence District. The users include **local residents and firms** situated in the area. Each task had different key user groups. For instance task 3 included home measurement tools of water, electricity and gas, which was aimed at the social housing segment in this district.

Value proposition

Lyon Smart Community is a large-scale, multi-phase experimentation project and development of core smart infrastructure for (greater) smart Lyon with the aim to test key elements to move towards a zero emissions district/city.

For Lyon, this project is part of a larger regional redevelopment plan which includes a specific emphasis on energy efficiency. Lyon Smart Community is one of many projects aiming to boost

Lyon's territorial attractivity and create employment (particularly in emerging sectors/activities), whilst at the same time fostering its sustainable development policy at both district and metropolitan level. In other words, the project includes a strong emphasis on local partnerships, creation of skills, capacity and new business opportunities for local business partners, whilst the commercial risk is carried by private partners.

For Lyon, the partnership with NEDO is a mean to prepare for an energy transition. By managing the interface with local stakeholders and facilitating the project's development, it is supporting knowledge transfer and enhancing local expertise as well as supporting the generation of insight into latest energy efficiency technologies in real-life setting for the commercial partners.

Finally, despite a planned 235 000 m² of new housing capacity throughout Confluence, particular attention has been given to social diversity in this reinvested and valuable territory.

Channels

First of all, **Grand Lyon** informs the users of the different sub-projects. Grand Lyon also runs assessments in order to evaluate and incorporate the user perspective in the implementation of the four tasks. Second, because **SPL Confluence** is in charge of the practical implementation of Lyon Smart Community, they coordinates the work of various contracting authorities in relation to the construction work and has the responsibility of the total brand of the Confluence area in terms of business location and housing.

User relationships

This demonstrator is very community focussed and therefore a variety of measures are being undertaken to engage citizens and local businesses and to get commitment to the energy transitions. However, overall the project is a demonstrator for technical solutions not innovative community involvement. Whilst the citizen and the community is at the heart of this solution the mix of tools used to raise awarness, to engage the citizens and to inform the citizens are elaborate but classical. An article about the Lyon Smart community project mentions the community engagement as a particular success factor. Marshall[2] argues that a **permanent consultation** was established within the local network of inhabitants and associations. This serves mainly to adapt planned developments but also to create within the community a strong membership to the project. This "**participative democracy**" was based on a Grand Lyon participation charter[3] which promotes transparency, dialogue and common decision making.

The interviewees pointed to a situation in which citizens and businesses are informed about the benefits of the new solutions in a pragmatic way by showing how the projects benefit them in both their everyday and working life. Particularly from the NEDO perspective the citizens were important as users of new services. What was particularly important was the critical mass to reach sufficient amounts of data to calculate CO2 emission reductions. For example, in the case of the eco renovation project and the installation of energy monitoring systems, it was essential to explicitly showcase the economic and energy saving potential for the residents. Interviewees suggested that a lesson learnt was that citizens needed to be engaged more consistently and according to their needs to effect behavioural change. Overall however, from the perspective of Grand Lyon, the general feedback from the users have been very positive. Hence, adjustments are made in order to meet the needs of the users, as for example in the case of the car sharing system and the eco-renovation project. Further, there may be more experimental approaches to

[2] Marshall, Thomas; 2012; Informationen zur Raumentwicklung, Heft 5/6.2012 "Lyon Confluence: from smart grid to Smart community?"

[3] www.grandlyon.com/Chartede-la-participation.1376.0.html

changing citizen behaviour to come as the data management system will be upgraded from a closed system to an open system in the course of the "smarter together" project.

Revenue streams

The biggest investor and key success factor to the success of making this large-scale demonstrator happen is NEDO, who committed **€ 50 mill**. into the project. Based on the official agreement, NEDO covers in particular the supply of technologies. The funding from NEDO has mainly been used in the beginning of the project where a lot of technological equipment was installed in the Confluence District.

Grand Lyon has a commitment to the project in terms of supporting and facilitating the implementation of the project, but they are not contributing to the direct project costs. Instead, Grand Lyon contributes with human resources such as project managers, providing the testing grounds, and technical services at city level for instance or by lawyers for instance. This is conceived as another extremely important success factor in the implementation process as particularly the capability of Grand Lyon to address barriers or challenges in the process at technical or legal level has ensured implementation success to date.

Each task has an associated eco-system of partners, most of which have entered into a R&D partner contract and can be expected to be subsidizing the project with technical expertise and project management time. There are no estimates available about the co-investment of the partners.

NEDO will hand over the whole project (equipment, technology etc.) to Grand Lyon after the project period which means that Gran Lyon will get all the equipment for free, e.g. the CMS system. In a broader perspective, Grand Lyon can **brand themselves** as a city that attracts foreign investments in the field of green technology and data management.

At task level, services have been developed that have revenue stream based business models such as car sharing of EV cars or energy monitoring for consumption or energy efficient buildings technologies.

A replication phase has already been set up. **The "Smarter Together" project will be based on Horizon 2020 funding** – a European co-funding investment scheme. So far project has successfully brought together public and private investment in partnership, but not all phases of the grand plan have been funded. City officials say they are taking it one phase at a time, but they are confident all the cash will be secured at each stage of the process.

Overall, reports point to investment figures of over € 1bn[4] of investments made to regenerate the entire confluence region. This figure is likely to include real estate development as well as multiple projects that have been secured in parallel.

Key resources

Key resources are of human, physical and technical nature. The **human resources** reflect the ongoing effort by staff from Grand Lyon, NEDO, SPL Confluence, Toshiba, and the participating private contractors and companies to continuously empower and encourage the development of intelligent solutions to improve the life within the Confluence area. It also includes efforts to encourage citizen involvement and development of new and existing intelligent solutions for example the engagement of actors to co-creation through open data sharing.

[4] See for instance http://www.ibtimes.co.uk/lyon-smart-city-confluence-project-toshiba-nedo-523358

The **physical key resource** is the existence of the derelict neighbourhood for re-development in central Lyon and therefore an appropriate test site.

Also, the Lyon project entails several **technologies as key resources as it is an experimental demonstrator**. The range of new ICT systems are essential resources that makes creates the foundation for data integration and management. Additionally, solar panels, a cogeneration plant, and electric vehicles are some of the resources that make up an essential part of the solution.

Specifically **new energy solutions** are an integral part of the community development:

- Solar panels and a cogeneration plant: the purpose is to optimize energy consumption the newly established energy positive buildings.
- Electric Vehicles: The use of electric vehicles reduce the consumption of fossil fuel in general. Furthermore, the vehicle scheme has been designed to serve a variety of users. Firms will be able to use the fleet during the day for occasional business trips, while local residents will be able to benefit from car-sharing for leisure activities. In that way, both firms and residents take advantage of the vehicle scheme
- Energy Monitoring Systems: an array of energy sensors and a display unit will be installed in homes in the district, allowing each resident to monitor how much electricity, water and gas they are using in real time, and take action to optimise their consumption.

Key activities

The key activities is the implementation of the four tasks: smart, positive energy Buildings (task 1), mobility system using carbon free-energies / fleet of electric vehicles (task 2), energy monitoring systems in homes (task 3), and the CEMS to monitor energy use by the demonstration as a whole (CEMS) (task 4).

In **the experimentation phase** from 2012 to 2016, the four demonstrations will be tested in the real environment of Confluence.

At the moment, the project is going into its **post experimentation phase** where the impacts of the four solutions and the scaling and replication potential must be evaluated in order to find out how and to what extent the solutions can be used in the broader service provision in Lyon. From Grand Lyon´s point of view, a lot of decisions are now going to be made in terms of long time planning and integration.

The car sharing scheme system (task 1) and the eco renovation project (task 3) has ended, whereas the Hikari buildings (task 2) and the CEMS system (task 4) will enter the post experimentation period in the beginning of 2017. In the post experimentation phase, Grand Lyon will be in charge of the four demonstration projects. As mentioned above, in the post experimentation phase, evaluations of task 2 and 3 will be done by both Grand Lyon and Toshiba.

A new phase for the project just been started. Through the **European H2020 project, "Smarter Together"**, Grand Lyon will continue to explore the potential of smart city service development in terms of new technologies and functionalities in collaboration with the cities Vienna and Munich. The project period is from 2016 to 2020.

Key partnerships

The main actors are **Grand Lyon** and **NEDO**, the New Energy and Industrial Technology Development Organisation of Japan. NEDO is a public agency with the aim of promoting Japanese industry on a national and international level. Additionally, NEDO supports research and development as well as the dissemination of energy, environmental and industrial technologies.

The partnership between Grand Lyon and NEDO is therefore based on an agreement made by one French local authority and one national Japanese authority, which in a broader perspective is very unusual compared to other smart city solutions. The picture below shows the relationship between the main partners and their role in the Lyon Smart Community from the Toshiba perspective, also using a rich picture approach:

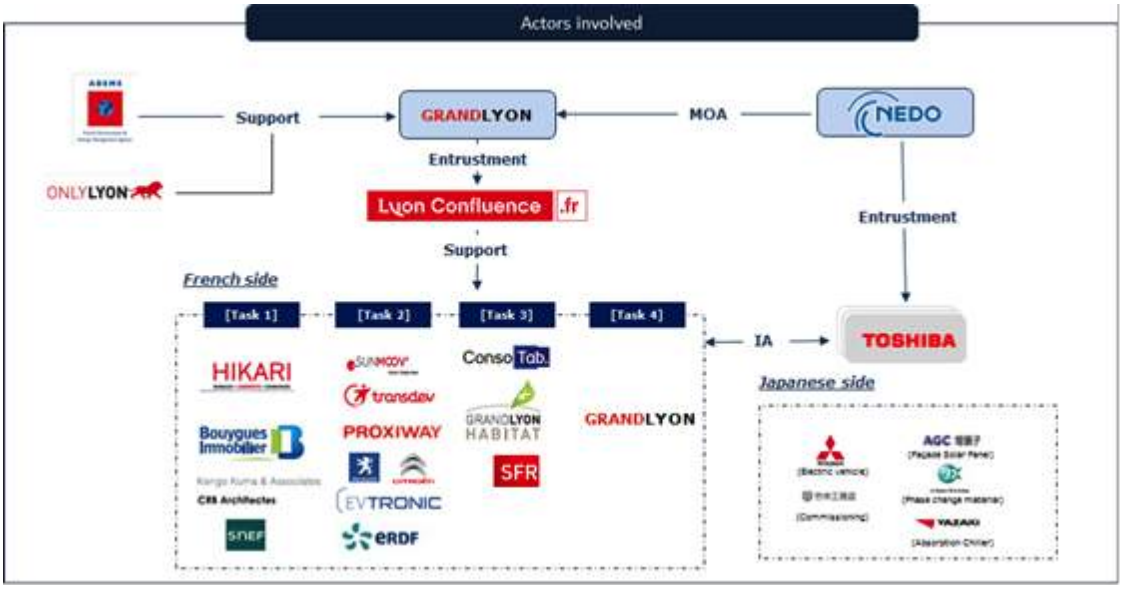

Figure 7:The Relationship among the various partners. Source: Toshiba Corporation

The Lyon Smart Community project is the first smart community project in Europe for NEDO. From NEDO's point of view, the aim is to use the Lyon Confluence district as a "demonstration" to experiment and test new and emerging energy technologies in a European market. Grand Lyon serves as facilitator for the project, notably by arranging local partnerships. Grand Lyon has an operational partner, **SPL Confluence,** that is in charge of the practical implementation, coordination and development of the four tasks within the Confluence district. SPL Confluence is a local public redevelopment agency. GRANDLYON has a 89% stake in SPL Confluence. Grand Lyon and SPL Confluence are in charge of some administrative tasks in the experimentation phase, such as collecting the necessary legal, political and administrative approvals and documents in order to implement the tasks.

> "It was a perfect matching of visions and interests between industry and local authorities that lead to the establishment of the Smart Community Lyon." Christoph Debouit, Project Coordinator, NEDO Europe

NEDO chose **Toshiba** as the main operational coordinator of the four tasks in terms of the choice of technology suppliers for each task. Toschiba was appointed on the grounds of an open call for tender. NEDO funds Toshiba to implement the projects.

Based on an assessment made by Toshiba, the main stakeholders are joined by a range of other private partners in the establishment of the tasks. This 'ecosystem' of organisations includes a whole range of entities, of various sizes and with diverse backgrounds and expertise.

Each task is constituted of an ecosystem of local and international private and public partners – 30 partners in total. SPL Confluence and Toshiba are involved as the main actors in all tasks. The following companies are the main actors within each task:

- Development of Positive Energy Buildings: Property developer **Bouygues Immobilier** (in cooperation with SLC Pitance) from France has the main responsibility for the establishment of positive energy buildings in the district. **Kengo Kuma and Associates**, a Japanese architectural firm, will design the buildings.
- A fleet of electric vehicles for a car-sharing scheme: The **Toshiba** consortium supplied the appropriate technology in partnership with **Veolia Transdev** through its subsidiary Proxiway, which specializes in car-sharing. **Easytransic** supplied the charging

infrastructure. Electric vehicles from **PSA Peugeot Citroën** and **Mitsubishi Motors** were used for the solution.

- Energy monitoring systems in homes: The social housing body, **GRANDLYON HABITAT**, is the main actors driving the eco renovation project and the installation of energy monitoring systems in 275 homes together with Equitia who implement the outreach to the community in terms of awareness raising and training.
- Data analysis system to monitor energy use by the demonstration as a whole: **GRANDLYON**, **Toshiba and SPL Confluence** are the main actors creating the data management system.

Cost structure

There is no aggregated information about the total project cost that is publically available. What is known is that NEDA provided € 50 Mln and that Grand Lyon has a commitment to the project in terms of supporting and facilitating the implementation of the project, providing the testing ground and technical expertise but that they are not contributing directly to the project funding. However it is worth noting that Grand Lyon's human contribution is conceived as an extremely important factor in the implementation process in order to ensure implementation success. In relation to this, in 2012, Grand Lyon established a small team of one full time project manager as well as part-time technical reference persons per task to specifically focus on and support the Lyon Smart community project. The team is placed within the innovation directorate. In addition, Grand Lyon pays Confluence to project manage the implementation of the tasks and the relationship with Nedo and Toshiba. Confluence in itself of course is in charge of the development of the district and covers the actual renovation and creation of buildings including the smart eco-friendly building from a separate budget.

Further private co-funding was leveraged through the negotiation of business contracts led by Toschiba in 2011. This was part of Toschiba's remit to identify and assign relevant partners. Toschiba itself had been appointed technology & project managing partner following an open tender procedure by NEDO. In other words, the partner negotiation was a B2B negotiation, believed to include further R&D investment from the other partners – in technology or human resource costs by partners, particularly in the car sharing task and the energy monitoring task. Final contracts presumably also shared risks. However no information about these contracts were made available to the team. The negotiation phase with partners according to interviewees took about a year. The project kicked off in 2012 with full partners in place.

Barriers/challenges

In the experimentation phase, several **technical complexities** did occur. This must be seen as a natural part of implementing rather abstract solutions and technologies in to a real-time environment.

Additionally, NEDO, Toshiba and the private companies faced challenges in relation to **legal and administrative rules** within Greater Lyon, for example in terms of the legal and material ownership of equipment and public space. However, these challenges were handled by Grand Lyon and SPL Confluence in a very satisfactory way.

Further on, **the timing of the implementation** of the specific tasks influenced the way in which the solutions were used. The e-car sharing system was the first task to be fully implemented but due to the long construction period of the new positive energy buildings. This caused a rather insufficient use of the car sharing system because residents and firms were not established within the area yet due to lack of buildings. Grand Lyon will be looking into adequate car-sharing business models with its partners and are using the experience from this pilot and the subsequent lessons learnt.

There is a question about the **optimal size of demonstrators** and **how many partners to involve**. The interviewees mentioned that multiple partners participating in the construction and development of each task have been on the one hand a challenge in terms of the overall project management as many partners had their own business interests creating a situation in

which a lot of interests had to be handled. At the same time, interviewees pointed out that the project enjoys exactly the right kind of partner mix which is the key to success of this project. In hindsight, interviewees mentioned that they would **prioritize business model innovation and the development of sustainable business models** in such demonstrator projects in future and highlighted that evolving emerging business models require co-ordination and flexible set-up structures of the projects themselves.

At last, and from a citizen point of view, the spread of information on the overall purpose behind the solution and the potential user benefits is of crucial importance to the rate of success and goal achievement. The solution needs to be meaningful for the users. The experiences from the ecorenovation project illustrates that **citizen may interpret new intelligent technology as disturbing and strange rather than profitable and efficient** if they are not aware of the potential benefits by the active use of the solution components.

Replicability factors

All interviewees stated clearly that the purpose of this project was experimentation and demonstration in the quest to develop sustainable services and solutions based on the type of technologies and learning gathered in this project. Hence, replicability in this case has to be looked at in three dimensions:

1. **Aspects or sub sections of the solution / tasks are being replicated with similar partner structures elsewhere.** According to NEDO, feasibility studies are carried out in Malaga in Spain and Manchester in United Kingdom, where parts of the overall solution are being replicated. NEDO has very strict guidelines that do not allow the direct replication of the same technologies/project set up, hence other financers would have to invest in the success of this project for a direct replication.

2. **The actual solution will be scaled both across other districts in Lyon but also across a set of partner cities** in a follow-up European Commission funded 24 Million EURO project. Vienna and Munich (as well as Saint-Jacques-de-Compostelle, Sofia, and Venice as follower cities and Kiev and Yokohama as oberver cities) have joined Lyon as part of the "Smarter Together"-project.

3. **The industry partners themselves (and as interviewees pointed out this is industry partners of all sizes) have replicated their parts of the solution or have further developed products & services based in this pilot from the beginning of the project**. For instance Toschiba used its experience with the Lyon pilot to build the smart city service market in France as well as use the project as a gateway to Europe. Veolia Transdev as another example is a partner in the car sharing scheme and has used this pilot as a test bed for the development of its multi-modal mobility and transport products and services[5].

[5] http://www.transdev.com/en/multi-modal-offer/transport-modes/

Figure 8: Replication areas of Smart Lyon Community

Hence, what have been the success factors for replicability in the Lyon Smart community project?

A very important factor was the **initial funding of the innovation fund NEDO** and the willingness of **other private partners participate as R&D partners** in the project. National, international and particularly local private companies were very much encouraged to invest and participate in the Lyon Smart Community, especially in the construction of the positive energy buildings and e-car sharing scheme (task 1 and 2). If this would not have been achieved, then the project would not have been possible.

A second success factor emerged as crucial during the process of the project. This is the importance of the development **sustainable business models of any new service** developped as part of such demonstrators and the openess of partners to develop new services learning from the demonstator too. In the latter case, the car sharing task is an example of a service that is still working on the sustainable business model, and regardinginstallation and implementation of smart energy monitoring devices and services, interviewees mentioned that this is currently installed by a variety of technicians for each utility and lacks a single point of contact. This could in future be streamlined.

A third and extremely crucial to a project like this is the existence of political visions and will to transform existing city structures to become a smarter city. Based on the interviews, money and financing is important, but what mostly matters is the political will at the local city level. From NEDO´s point of view, the project could have been implemented in any other city, but the city of Lyon had **a strong political commitment and already demonstrated its achievements in a large number of smart projects** and also brought necessary will and courage to participate in such a project. The political level in Grand Lyon was fully committed to the smart and sustainable agenda and the purpose behind the Lyon Smart Community, and when problems occurred they quickly made decisions in order to solve the problems.

Finally, Grand Lyon has **a clear smart and sustainable vision for the metropol region of Lyon**, which includes actively encouraging technological, organisational and social innovation in

business[6]. Lyon has a proven track record as a European city of innovation, as demonstrated by the number of patent applications, inter-company collaborations and teaching and research centres, as well as by its total expenditure on research and development. This long term vision was one of the convincing factors from a NEDA perspective.

At the same time it is important to mention that the concrete business model behind the Lyon Smart Community is rather unusual due to the fact that it is a national agency from another country providing a large part of the funding of a smart city project located. In this regard, the project is very special and the funding structure is very different compared to other smart city solutions. This may influence the potential for large scale roll-out of the Smart Lyon Community because this constellation would probably not be seen as the most cost-efficient way of investing in smart city solutions in other contexts and in fact NEDO has the guiding principle that it will not invest in an exact replication project. In the case of Lyon, the partnership reflects a perfect match of interests between Grand Lyon and NEDO, but, in a broader perspective, it will probably be very few Smart City-partnerships that will be based on a similar seed- financing structure. This does highlight though that the role of national innovation funds may be of crucial importance to experimental large-scale pilots for integrated solutions for smart cities which may allow the development of particularly cross-sectoral solutions.

	"Replication recipe"
Infrastructure and financing	✓ *Public investment* ✓ *Indirect co-financing by industry partners* ✓ *Risk-free see financing, and burden of risk during implementation period on private partners*
Broad innovation	✓ *Technology innovation* ✓ *Focus on sustainable business models for the services*
Governance	✓ *Strong political leadership to transform at local level* ✓ *Strong emphasis on inclusiveness of the local community (both businesses and citizens)* ✓ *Strong governance set-up of the smart city team, which straddles the political and the administrative part of the city governance structure and sits within an innovation directorate* ✓ *Clear vision to become a smart and sustainable region (including a hub for R&D, solutions and products & services)*
Multi-phase roll out	✓ *Size is an interesting factor for the pilots for such integrated solutions – this may just still fit the "start small, fail fast" category* ✓ *What works in the different tasks will be scaled both to further geographical areas within Lyon and in different cities as part of a follow-up EU financed project called "smarter together". As part of this scope the services will also be revised or expanded.*

Table 1: Replication recipe

[6] Read an interview (19. May 2015) with Karine Dognin-Sauze, Vice-president of the Lyon City Council and in charge of innovation, smart city and digital development here http://www.digitalforallnow.com/en/greater-lyon-area-smart-metropolis-innovation/

Sources

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Figures sources	› http://www.pluzzy.com/assets/skin/smart_01.jpg

SMART MELIT

Toyota City, Japan

→ Replication potential

→ Complexity

→ Citizens' involvement

→ Economic impact

→ Environmental impact

→ Social impact

Assessment based on feedback provided by the solution's representative as well as on the available sources analysed by the study team.

Short description of the case study

		Key facts and figures
SMART MELIT	**Type of solution**	*Intelligent city services*
	Project stage	*Project kicked off in 2010 and ended in 2014*
	Actors involved	*Public authorities, academia, transport operators*
	Roll-out of the solution	• *Smart Melit is still in the pilot phase but promising economic benefits of the investment are emerging* • *It has been partially replicated (Ha:mo service) with success in the cities of Grenoble and Tokyo.*
	Barriers	• *Costs of innovative devices and services, necessity of public investments to start up the solution.*
	Implementation best practice city	*Toyota City (Japan)* *421,000 inhabitants*
	Main technological areas covered	*ICT, energy storage and transport*
	Funding mechanism	*Government funding + Private financing (around € 170 Mln)*
	Economic, social & environmental impact	• *40~65% CO2 reduction among households (with respect to reference households without Smart Melit devices);* • *43% CO2 reduction in transport. The overall CO2 saving is around 31% within the whole verification area (in relation to the state before implementation).* • *Energy efficiency improvement through BEMS/HEMS[1] and Energy Cost reduction through Multi-tariff model.*
	Replicability factors	• *Strong city governance able to coordinate the high number of high level stakeholders to involve* • *Strong citizen participation* • *Public or private-public funds to start up* • *A national policy/strategy for the development of electric vehicles*

[1] HEMS= Home Energy Management Systems; BEMS =Building Energy Management Systems

Case summary

The environment city's model goal adopted in Toyota City was to become a Hybrid City2. Accordingly, an association was formed to promote the implementation of the environment city's model and to work in synergy with other implemented low carbon energy and social systems solutions. The so-called Smart Melit (Smart Mobility & Energy Life in Toyota City) is the headline project undertaken by the association with the aim of achieving a low-carbon society by reducing energy use in residential, commercial and public buildings, and by facilitating sustainable urban mobility.

In this framework, the project scope is to pave the way for the development of a sustainable home environment in ten years' time, with the introduction of renewable energy and more extensive use of various energy-saving and energy storage devices.

The Smart Melit project is a multifaceted solution covering and integrating the following areas:

- ***Information and Comunication Techology (ICT):*** The Smart Melit solution integration relies on smart management through a data centre, which manages energy consumption and production (in households and non-residential buildings), as well as traffic at city level (mobility).

- ***Household,*** through*:*
    - EDMS (Energy Data Management System): it collects data and gives guidance to household about how to consume less energy (BEMS - Building Energy Management System and HEMS - Home Energy Management System). The systems also show the energy price (Yen/kWh) every 30 minutes to users;
    - Implementation of distributed energy production systems (PV, biomass, recycled heat).

- ***Energy Storage:*** The implementation of energy storage systems allows the use of green energy produced by households in Electric Vehicle (EV) batteries. Smart Melit has also the aim to monitor the storage of the electricity generated by the solar power systems installed at convenience stores and other commercial facilities in stationary storage batteries, and then to use it to recharge the storage batteries mounted on home collection and delivery vehicles.

- ***Transport:*** ITS uses collected data to give guidance on:
    - Car sharing;
    - On-demand Public transport;
    - Parking;
    - Driving options;
    - Implementation of battery charging stations for EV, Private Hire Vehicles (PHV), Full Cell Vehicle (FCV) (buses).

Furthermore, the solution integrates incentives aiming at raising awareness amongst citizens on how to consume energy in a smarter way, providing support for action and enabling to control the energy use through terminal services at each individual home. This makes it possible to offer a ready-to-use, individual menu of low-carbon activities adapted for the living environment.

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[2] A Hybrid City can be defined as a sustainable community that emphasizes civic engagement, social justice, environmental soundness, and economic diversity. It is based on an understanding of factors that over the ages have lured people to cities and of qualities of life people seek when they move to the countryside and to small towns. The "hybrid city," attempts to combine the best of cities-diversity, density, innovation, opportunities for economic mobility, and access to means for human development-with the best of village or small-town life-cultural wisdom, frugality, conservation, resource efficiency, a sense of scale and place, self-reliance, and a sense of community and connectedness.
https://www.nae.edu/Publications/Bridge/EarthSystemsEngineering7311/HybridCitiesABasisforHope.aspx

The figure below shows the level of integration of Smart Melit. The solution includes technologies and services that are part of the three main areas: Sustainable Urban Mobility, Sustainable District & Built Environment and Integrated Infrastructure and Processes.

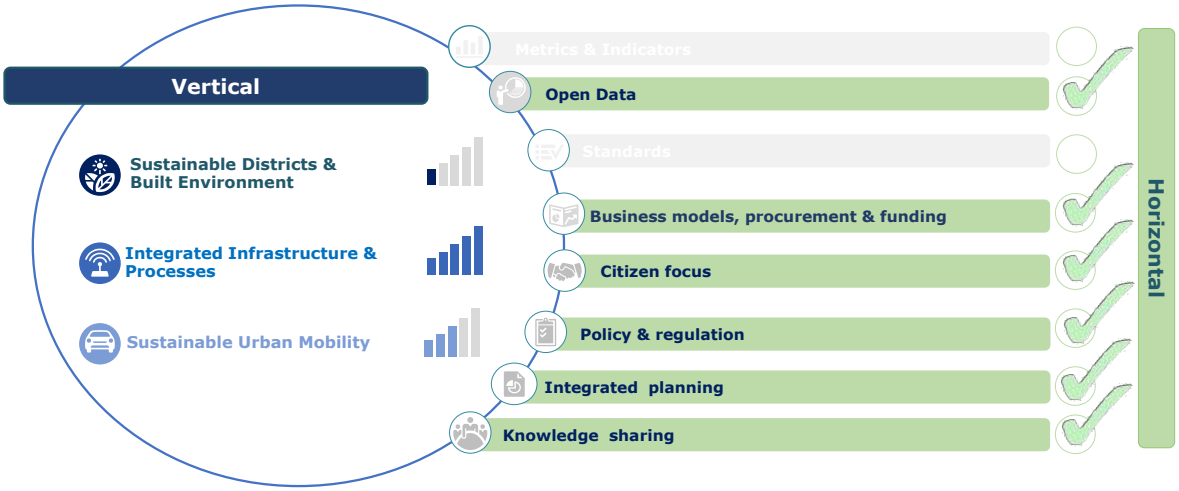

Figure 1: SCC Solution Integration Dashboard

Market analysis

Perspectives of the Demand Side Management programmes

In the context of Smart Cities in Japan, the implementation of an open ICT platform is an innovative initiative that aims to promote the benefits of cloud applications for the collection, analysis and delivery of scattered and heterogeneous data on mobility and energy to citizens and stakeholders.

In particular, Toyota City is experimenting home energy management systems and demand-response programmes for energy consumption, development of wired and wireless broadband networks and intelligent environments using sensors for real-time information processing and alerts, development of e-services for the business community of each district and training services for the involvement of end-users, businesses, and organizations in e-content development and social media use.

In recent years, Japan has turned the attention toward demand-side management. Now a strong, government programme is driving the HEMS and BEMS markets out of the research lab and into the product development and deployment stages.

> With 50 million homes in Japan, the HEMS market alone will be worth well over $2.3 billion by 2015, and the BEMS market will be significantly larger.

The rapid evolution of HEMS and BEMS technologies is influenced by three main factors:

- A mature transmission grid;
- A pressing need to reduce energy demand;
- And the opportunity to become a world leader in a new technology market.

The Japanese power grid is one of the most efficient grids in the world. Thanks to this, Japan has been able to shift its focus toward optimizing energy management in the past few years which has become a crucial issue after the Fukushima Daiichi nuclear disaster in March 2011, which led to a strong need for demand-side management technologies and the Japanese government anticipated its demand-side management and energy efficiency project timelines from 2020 to 2015.

Thus, the market for Energy Management System (EMS) products has been growing for the past few years, and Japanese firms are preparing to capitalize on the opportunities both domestically and abroad. EMSs are the next step in the logical progression from supply-side management to demand-side management.

Japan has only 17 minutes of blackout time annually (138 minutes in the U.S.), an incredibly low 5.1% line loss rate thanks to a $100 billion transmission grid build-out in the 1990s, an average of 41.3 % thermal efficiency in its thermal power plants (34.1%in the U.S.), and nearly 100% penetration of digital substations.

By the numbers, Japan's energy consumption is around 25% of that of the U.S., which is the second largest electricity consumer in the world after China. Japan, like the U.S., spends around 30% of its electrical energy on the residential sector, aiding in the growth of the domestic HEMS market. Moreover, the commercial & industrial (C&I) market includes office buildings, stores, manufacturing plants, and other large load sources (typically over 15 kilowatts to 50 kilowatts of peak demand) and, by far, it could be considered the largest market for EMSs, of which a large part is BEMS.[3]

Electric Vehicles and charging stations market perspectives

Japan holds the third place in the world for the size of the fleet of plug-in EV after United States and China as of August 2015.

Over 121,000 plug-in electric vehicles have been sold in Japan through August 2015, since 2009. During 2012, global sales of pure electric cars were led by Japan with a 28% market share of total sales, followed by the United States with a 26% share. Japan ranked second after the U.S. in terms of its share of plug-in hybrid sales in 2012, with a 12% of global sales. A total of 29,716 highway-capable plug-in EV were sold in the country in 2013, representing a 0.55% market share of the 5.3 million new automobiles and kei cars sold during 2013.

As of December 2012, Japan was the country with the highest ratio of quick charging points to EV (EVSE/EV), with a ratio of 0.030 as of December 2012. The country's charging infrastructure included 1,381 public quick-charge stations and around 300 non-domestic slow charger points. The Japanese government has set up a target to deploy 2 million slow chargers and 5,000 fast charging points by 2020.[4]

The increase in the number of EV charging stations is one of the major trends witnessed by the Japanese market. The number of EV charging stations is expected to grow significantly during the forecast period. According to the report "Global Grid-to-Vehicle (V2G) Market 2015-2019"[5], V2X technology (where "X" stands for to "Grid, to Home or to Building") enables the use of EVs as distributed storage devices, with the stored power being utilized to feed the system in situations of peak load or for usage in homes or offices. Furthermore, the report states that the low availability of V2G supply during periods of peak demand poses a challenge for the market. Peak load management and demand response are key functions of the V2G technology, making the availability of a sufficient number of EVs to fulfil the demand a major concern for market growth. In Smart Melit, the V2X functions are used through the management of BEMS and HEMS platforms.

It is worth noting that a wide deployment of charger points at national level requires a careful analysis on the impact of this suplementary electricity demand on the whole country energy

[3] https://www.greentechmedia.com/articles/read/The-Fast-and-Furious-Japans-Race-to-Energy-Management
[4] http://www.hybridcars.com/one-million-global-plug-in-sales-milestone-reached/
[5] Technavio, April 2015

system. Nonetheless, the outcome of different studies and pilot projects on this subject6 underline that if the battery recharging is made overnight or, at lest, not during peak hours, its overall impact on the electricity demand is absolutely sustainable. More importantly, this means that a significantly greater proportion of a country's electricity can follow to be generated by base-load plants and hence at lower average cost. In terms of figures, a LGi Consulting7 pubblication estimates the EU EV stock around 12 millions of vehicles up to the 2020 (the 2013 IEA Global EV Outlook, 2013 roughly estimates this stock around 8 millions). Considering a 25 kWh typical EV battery, the total EV storage capacity of this stock will be around 300 GWh. According to the IEA forecasts, the total electricity generation in the OECD EU countries is estimated to be 9.205 GWh/day. This means that the EV storage capacity represent 3,25% of the daily electricity production if the whole batteries stock is recharged in one day.

Main impacts

The test has involved 227 detached houses including 67 newly built smart houses in two areas within the city boundaries. It is worth noting that these houses have been tested by collecting data during the everyday life of citizens (from September 2011 to March 2015). It was the first time that such data collection method was used in Japan.

Headline results include:

- A 49.1% average reduction of CO2 emission, and a 64.9% reduction in the most *eco-conscious* households (optimization of the energy by HEMS and FC controller);
- A further 4% emission reduction by EDMS (Energy Data Management System) for the whole verification area.

For what concerns transport, a 43% CO2 savings has been estimated, specifically composed of:

- 180kg-CO2/year/person reduction by TDMS (from private vehicle);
- 108.7kg-CO2/year/person reduction by EV sharing system.

Beyond these environmental impacts, Smart Melit led also to the commercialization of PHV/FCV and of Smart House equipped HEMS, Li-ion battery, etc. Furthermore, it has contributed to foster a better and more conscious use of energy in communities.

[6] See i.e. Electric Vehicle Charging Station, Xcel Energy, May 2015 (http://www.xcelenergy.com/staticfiles/xe-responsive/Admin/Managed%20Documents%20&%20PDFs/CO-DSM-2014-EV-Pilot-Evaluation.pdf or http://www.triplepundit.com/2016/02/electric-vehicle-chargers-grid-devils-energy-angels/

[7] EV-smart grid integration, January 2015, LGiConsulting

Rich Picture Model

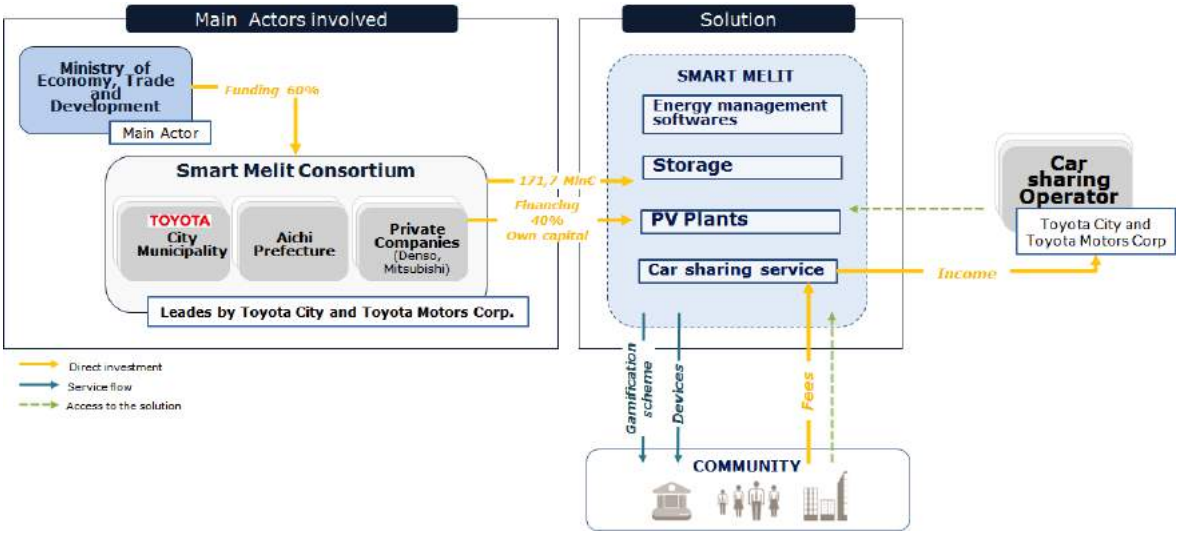

Figure 2: Rich Picture approach of Smart Melit

In the SMART MELIT project, citizens have free access to the provided services (real time information systems to advise on the household energy consumption and the mobility needs), with the exception of the car sharing service for which they need to pay a commercial fee. Applications like the Gamification Scheme increase the willingness of citizens to proactively participate. This powerful set of services has the potential to develop business based activities but requires the implementation of a background technological structure (e.g. energy storage system, recharging station of EV, PV plants and smart grid system).

Each partner of the Consortium received subsidies from the Ministry equal to 60% of the cost of the interventions carried out by them, thus the contribution of each private entity within Smart Melit solution depends on their role in the solution. All partners contributed with their own capital (recourse to lending was not necessary).

Business Model Canvas

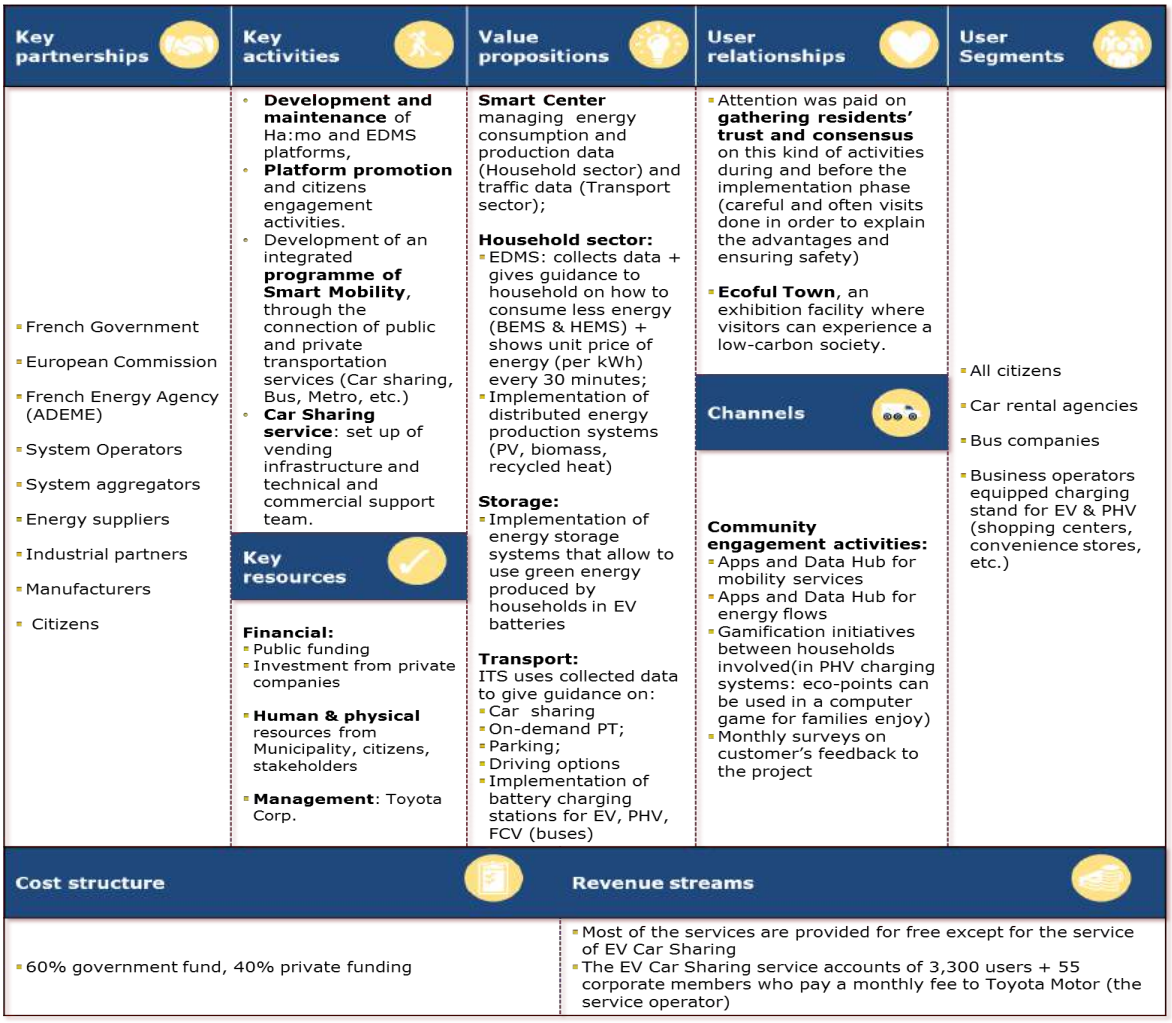

Figure 3: Business Model Canvas of Smart Melit

User segments

Smart Melit's strategy is built around the engagement of citizens, the main users of the solution, to actively change their behaviour related to energy consumption and transport.

With ITS, which comprises the Harmonious Mobility Network transport support system (Ha:mo NAVI) and the Traffic Data Management System, citizens have the opportunity to enjoy real-time public transport information, be informed about available parking spots and available electric vehicle for car-sharing (Ha:mo RIDE). They are empowered to drive in an eco–friendly way, avoiding traffic congestions and using environmentally friendly transport solutions, such as on-demand bus services and car sharing.

Furthermore, the Smart City solution enables them to track and control the energy consumption in their households thanks to the Energy Data Management System (EDMS) platform. Hence, by providing information on consumption patterns and energy prices, the project is able to raise awareness on energy efficiency among the general public. By making the economic benefits visible, users are guided in adjusting their day-to-day activities according to the electricity

supply and demand conditions of the region. Ultimately, it allows consumers to monitor their energy consumption and, as a consequence, not only reduces their carbon footprint but also increases their satisfaction. The active involvement of citizens is further encouraged by the gamification aspects included in the PHV charging system. Points accumulated by charging (distributed according to amount and location) can be used in a computer game that is for the families to enjoy. In this framework, many actors are involved and benefit from the Smart Melit services: Car rental agencies; Bus companies and Business operators equipped with charging stands for EV & PHV (e.g. shopping centers, convenience stores, etc.).

Value proposition

The value proposition of Smart Melit can be summarized in the following main objectives:

- Optimize the energy and transport infrastructures of the entire community;
- Provide services at an affordable price for citizens;
- Achieve a low-carbon society by reducing energy use in residential, commercial and public buildings, and by facilitating sustainable urban mobility.

To achieve these objectives, interventions were made in the following three areas:

- Energy Management in residential and building sector;
- Storage infrastructure;
- Car Sharing and mobility apps.

Energy Management in residential and building sector

Smart Melit is a low-carbon society verification experiment project that uses the EDMS to reduce regional carbon production and equalize electricity consumption. The EDMS forecasts regional electric power supply and demand and uses solar power systems for local production and consumption of green electricity to reduce CO2 emissions.

The EDMS operated by Toyota Motor Corporation to balance regional electricity supply and demand, serves 227 detached houses including 67 newly constructed smart houses in two areas within the city (Higashiyama-cho and Takahashi-cho). The HEMS and the BEMS are operated at these homes/ buildings, which are also equipped with solar power systems or household batteries.

The EDMS gathers electricity usage data and other information from the HEMS and BEMS in each home and building and makes forecasts on the amount of electricity that will be supplied by solar power systems and on the required electricity consumption in the region based on weather information, residents' behaviour forecasts, and other factors. As an example, if the system determines that on a rainy day the amount of electricity generated by solar power will be less than the regional electricity demand, it raises the virtual electricity price (EDMS unit price) to encourage residents to limit their consumption through energy-saving behaviours. In contrast, if the system forecasts an excess of electricity supply on a sunny day, the EDMS unit price is lowered to encourage demand during that period.

> The objective is to effectively use green electricity produced by solar power systems in the region in order to reduce CO2 emissions throughout the region and cut peak electricity demand.

Storage Infrastructure

Smart Melit seeks to evaluate the storage of the **electricity generated by the solar power systems** installed at convenience stores and other commercial facilities in stationary storage batteries, to use it **to recharge the storage batteries mounted on home collection and delivery vehicles.** The purpose is to operate the electric compressors that run the refrigerators and freezers of these vehicles without coming into contact with them. The project is also implementing initiatives to reduce CO2 emissions by **converting the electricity stored in the shops' stationary storage batteries into hot water with heat-pump water heaters for the shops' internal use.**

Figure 4: Non-Contact Charging System Recharging a Collection and Delivery Vehicle Operated by Yamato Transport Co., Ltd. (Photograph by: Naoki Morita)
Source: SCP

A specific area of the parking lot of the Seven Eleven Toyota Uenomachi convenience store (located in Toyota City) is surrounded by a white fence that is locked under normal circumstances. This area is a special recharging spot reserved for the sole use of collection and delivery vehicles operated by Yamato Transport Co., Ltd. The collection and delivery vehicles that collect goods from this store twice every day, stop at this spot and have their mounted storage batteries recharged.

A pad capable of transmitting electricity without direct contact is installed on the surface of the parking lot. The driver of the collection and delivery vehicle parked in the prescribed location pushes the "Start Recharge" button on the control panel to begin transmitting electricity to the coil on the surface power transmission pad. **Electricity then flows to the coil on the power receipt pad installed on the bottom of the collection and delivery vehicle so that the vehicle's storage batteries can be recharged without direct contact.** The efficiency of this system is very high, ranging from 90 to 95% depending on the distance between the two coils (on-board and off-board).

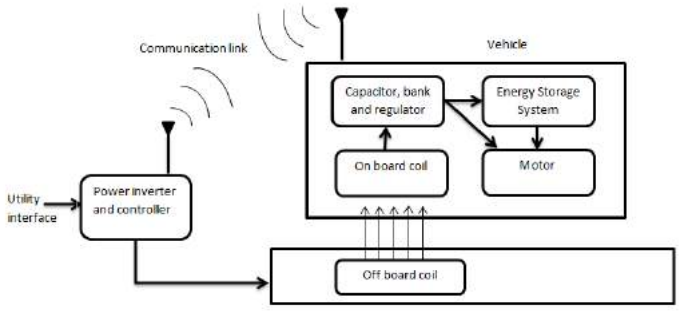

Figure 5: Components of a wireless charging system (Quelle: CU-ICAR – Clemson University International Center for Automotive Research, http://www.cuicar.com)

Car Sharing and mobility apps

Ha:mo (Harmonious Mobility Network) is a new urban transport support system for which verification testing began in October 2012 as part of the Smart Mobility & Energy Life in Toyota City Project.

Ha:mo aims at reducing CO2 emissions and achieving comfortable mobility by optimally and efficiently combining private car and public transportation. The current verification testing involves two services:

- Ha:mo NAVI, is an app for smart phones. The app provides information on car navigation, available Park and Ride (P&R) and parking lots, departure and arrival times for trains, buses and other public transport, and connection routes as part of the Smart Melit experimental project on low-carbon society carried out in Toyota City.
- Ha:mo RIDE, a car-sharing system that uses ultra-compact EV (COMS) for urban short-distance transport (the "last mile").

The system in the Ha:mo Ride Support Center monitors in real time current locations with the use of a GPS (Global Positioning System), remaining charge capacities, recharger connection conditions at stations, and the status of the electricity supply, etc. With the exception of the staff in charge of monitoring, the system is basically capable of unmanned operations.

The Multi Modal Navi route guidance system (Ha:mo NAVI), which supports low-carbon and seamless movement, provides guidance information via smartphones when users are traveling, such as: guidance on route navigation, available PR (Park-and-Ride) parking lots, and times of departure and arrival and transfer routes for trains, buses and other forms of public transport. Routes connecting cars with trains, buses and other forms of public transport can be searched for with a single operation. This service is linked in with Ha:mo Ride, allowing users not only to visualise the transport options available along the route, but also to be linked to the Ha:mo RIDE reservation page of the car sharing service.

Channels

Smart Melit leverages different channels for promotion. An intense campaign of community engagement activities was undertaken, including:

- Apps and Data Hub for mobility services;
- Apps and Data Hub for energy flows;
- Gamification initiatives among the involved households;
- Monthly surveys for customer's feedback.

User relationships

Before and during the implementation of Smart Melit, local authorities sought to win the trust and consensus of residents by carrying out frequent visits and meetings to explain the benefits of the project and ensure that citizens became aware of the importance of obtaining data on personal energy consumption and behaviour, thereby reducing their energy costs and carbon footprint and increasing their satisfaction.

Revenue streams

60% of project costs were provided by public funds and the remaining 40% from private companies.

Each partner of the Consortium received subsidies from the Ministry equal to 60% of the cost of the interventions carried out by them, thus the contribution of each private entity within Smart Melit solution depends on their role in the solution itself. All partners contributed with their own capital (recourse to loans was not necessary).

All services of Smart Melit are provided for free, with the exception of the car sharing service, which requires a user fee. These services required strong technological and infrastructural investments provided by private and public organizations. The R&D investments made by private companies intended to open new business opportunities and new markets, whilst public funding sought to facilitate the new markets and provide support for the innovation risk borne by private companies. Public funds furthermore pursued long-term economic and social return due to reduced environmental externalities and boosted job creation.

> By measuring the savings achieved by the users participating in the Smart Melit demonstration, DENSO Corporation was able to place the service on the market at a price lower or equal to the savings generated.

A concrete example of the benefits afforded by from these investments comes from DENSO Corporation[8], which used the results of the demonstration project to develop a new HEMS called "Naviehe" that went for sale in December 2014. Thanks to the initial funding provided by the Japanese Ministry of Economy Trade and Development, which allowed for the development of the background technological infrastructure, DENSO Corporation was able to launch on the market an information service with an investment that was 60% cheaper than the initial one.

The efficiency and commercial viability of the car sharing service (Ha:mo RIDE) was assessed by placing the service into operation (1 October 2014) with a payment system based on the time of vehicles use. For COMS (ultra compact EV) units, the rate was 200 yen (about 1.6 euro) for the first 10 minutes, and 20 yen (approximately EUR 0.16) for each additional minute.

Key resources

The key resources required to develop the solution are of physical and intellectual/human nature.

Concerning the **physical resources**, Smart Melit includes sensors, meters and generation facilities (PV and Energy Storage) installed in 227 households and in 2 commercial buildings and distribution centres monitored through HEMS and BMS. There are also 30 EV charging stations installed for the Car Sharing service, plus the charging points installed in customer's premises for PHV. For the Car Sharing service, a total of 207 vehicles are available for users. **Intellectual/human resources** were spent to establish and run the key partnerships bringing together the partners across the higher education, public and private sectors. Moreover, **crucial** was the role played by DENSO Corporation and Toyota engineers, who put in place the technological solution for Ha:mo and EDMS platforms, as well as that of the Aichi Prefecture, who delivered the Smart city solution thanks to community engagement and Toyota Ecoful Town promotion.

Key activities

Key activities include the development and maintenance of Ha:mo and EDMS platforms, as well as platforms management, service provisioning, customer service, platform promotion and citizens engagement activities. Other key activities include the development and delivery of an

[8] DENSO Corporation is an international manufacturer of automotive components and integrated systems, headquartered in Kariya, Aichi Prefecture, Japan.The company is known for developing and manufacturing various auto-parts including but not limited to: Gasoline/Diesel Engine Components, Hybrid Vehicle Components, Climate Control Systems, Instrument Clusters, Air-Bag Systems, Pre-Crash Radar Systems and Spark Plugs. Moreover, Denso also develops and manufactures non-automotive components such as Household Heating Equipments, Industrial Robots and QR Code

integrated programme of Smart Mobility, through the connection of public and private transport services (Car sharing, Bus, Metro, etc.), the result of the joint effort of Toyota Motors and the local public transport company. The Car Sharing service was set up in conjunction with the operation of a vending infrastructure and technical and commercial support team.

The figure below provide an illustration of the key activities implemented in Smart Melit.

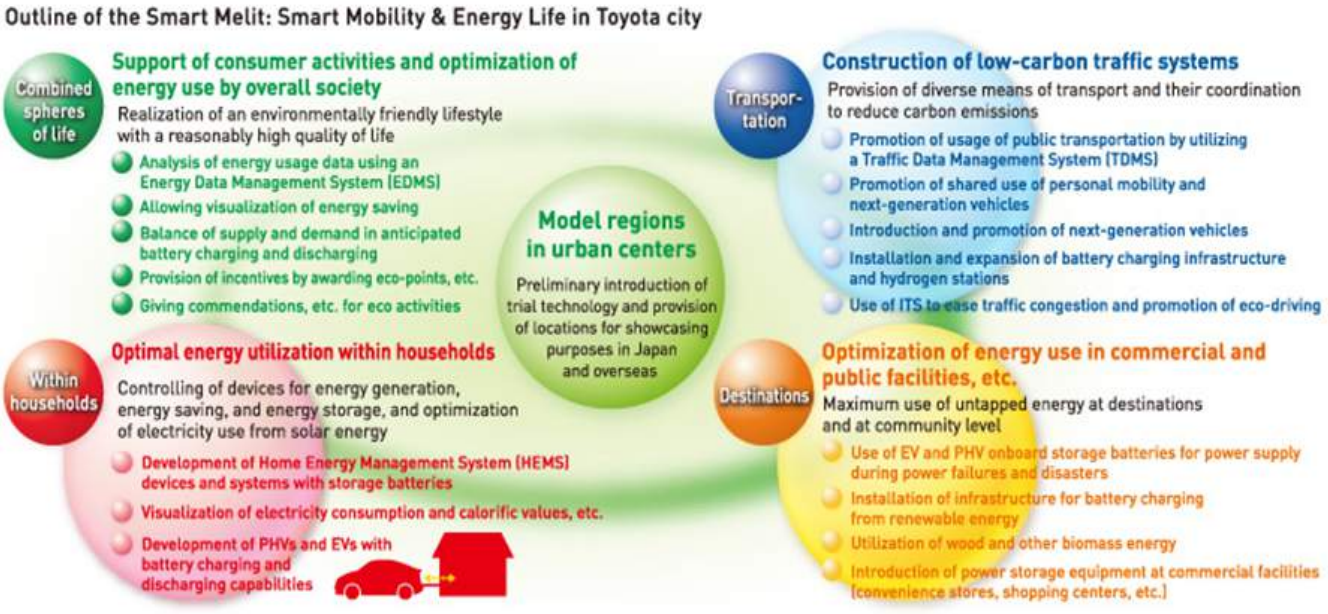

Figure 6: Key activities of Smart Melit - Toyota-global.com

Key partnerships

The project is lead by Toyota Motors and Industries Co. and includes 50 partners from the public and private sectors, with notable roles played by the Aichi Prefecture and Toyota City Municipality. Other key project partners are: Nagoya University; AISIN SEIKI CO., LTD.; ENERES Co.,Ltd.; KDDI CORPORATION; Circle K Sunkus Co.,Ltd. ; Sharp Corporation; Shinmei Industry Co.,Ltd.; Sumitomo Electric Industries, Ltd.; SECOM Co.Ltd.; Systems Engineering Consultants Co., Ltd.; Chubu Electric Power Co., Inc.; DENSO CORPORATION; TOSHIBA CORPORATION; TOHO Gas Co., Ltd.; Toyota Chamber of Commerce and Industry; TOYOTA SMILE LIFE INC.; Toyota Tsusho Corporation; TOYOTA HOME; Dream Incubator Inc.; Central Nippon Expressway Company Limited; Nagoya Railroad Co., Ltd.; Development Bank of Japan Inc.; Hewlett-Packard Japan, Ltd; Hitachi, Ltd.; FUJITSU LIMITED; Mitsubishi Corporation; YAZAKI Corporation; Yamato Transport Co.; Ltd.Yamaha Motor Co., Ltd.

> At first the initiative started with less than 20 organisations. Other members joined following the invitation from one or more members of the consortium.

The Consortium is chaired by Toyota City though each entity carried out verification tests regarding their own fields.

Beyond the implementation of the tests, other activities of the Consortium include:

- Planning, promotion, and coordination of verification testing for low-carbon society systems
- Coordination with various related agencies and organizations
- Provision of information and PR activities outside the council

- Other activities that are required to achieve the purpose of this council

The Consortium met regularly during the duration of the project and even later; Smart Melit finished in March 2015 but a "post Smart Melit council" was newly established, leaded again by Toyota City and made up of the main members of the former council.

Cost structure

The overall project costs amount to about 171.7 M€.

Project Cost	2010	2011	2012	2013	2014	TOTAL
€ Mln	20.3	46.9	43.0	32.8	28.2	~171

Table 1: Smart Melit Cost[9]

A list of the major intervention and the related cost is provided in the table below:

Intervention	Companies	€ Mln
Implementation of HEMS	Denso, Toyota Motor Corporation, Toyota Home, Chubu Electric Power, Toho Gas, Sharp, KDDI, Toyota Smile Life, Mitsubishi Corporation	44.7
Add PHV - FC promotion business subsidy to the subject of low-emission vehicles	Toyota City, Toyota Motor Corporation	7.5
New-generation cars (PHV100 units, FC10 units)	Toyota City, Toyota Motor Corporation	3.5
Next-generation busses (FCHV 1 units, HV 3 vehicles)	Toyota City, Toyota Motor Corporation	20.4
On demand PHV busses	Toyota City, Toyota Motor Corporation	0.2
Charging equipment installation in public facilities	Toyota City	0.1
Introduction of next-generation vehicles charging and power storage equipment to the effective energy utilization consumers. (tertiary buildings)	Mitsubishi Heavy Industries, Mitsubishi Corporation, Toyota City, commercial facility (convenience store, supermarket)	6.9
Storage batteries, BEMS and commercial vehicles for commercial facilities. Research and development of EV and PHV. Demonstration and validation of cooperation system	Denso, Toyota Tsusho Corporation	8.1
Hydrogen station installation	Toyota City, Toho Gas, Toyota Motor Corporation	4.7
Development of mobile support systems that utilize sensors information	Toyota City, Toyota Motor Corporation	0.3
Provide information on charging infrastructure	Toyota City, Aichi Prefecture, Toyota Motor Corporation	0.2
BRT (Bus Rapid Transit) introduction	Toyota City, Toyota Motor Corporation	9.7
Common IC card (for public transport), Park & Ride discount system	Toyota City, Toyota Motor Corporation	2.2
Promotion of TDMS (Transportation Demand Management System)	Toyota City, Toyota Motor Corporation	0.2

[9] Note: the cost breakup per cost item was not provided by the interviewed people as they considered this information confidential and then not to be disclosed.

Intervention	Companies	€ Mln
Private mobility verification project	Toyota City, Toyota Motor Corporation	0.5
Car sharing and next generation cars	Toyota City, KDDI, Toyota Industries Corporation	2.7
Effective use of car energy storage battery (emergency power supply)	Toyota City, Circle K Sunkus, Toyota Industries Corporation, Toyota Motor Corporation	0.2
Effective utilization of energy (EMS)	Toyota City, Toho Gas	3.1
Research, development and demonstration of Energy Demand Management System (EDMS)	Toyota Motor Corp., Fujitsu, Toshiba, other	35.4
Consumers behavioural change (according to incentives) verification	Toyota City, Toyota Motor Corporation, Dream Incubator, Mitsubishi other demonstrated participation companies	2.7
Environmental learning	Toyota City	2.1
Smart Melit district maintenance	Toyota City, Toyota Motor Corporation, Toyota Home, Chubu Electric Power, Toho Gas, other construction companies, etc.	16.3
TOTAL		**171.7**

Table 2: Cost by type of intervention

Barriers/challenges

Smart Melit successfully implemented innovative services thanks to strong project management, continued coordination among services providers and proactive participation of motivated final users. Such level of seamless collaboration and participation is typically a challenge in initiatives of this scale.

All the services developed within Smart Melit are continuing to work outside the project, under the leadership of Toyota City. Moreover, incentives are provided by the city to citizens for purchasing the HEMS (50,000 yen per citizen) service, Plug-in Hybrid Vehicles (150,000 yen per citizen) and Fuel Cell vehicles (335,000 yen per citizen).

Undeniably, the delivery of the services were made possible by an average investment of about 0.6 M€ per household. Even if a scaling factor and a price learning curve can be predicted, it remains a huge investment hardly manageable by the public or private sectors alone.

The cost might be the single most formidable barrier to replicability and scalability of this solution.

It must be said that this high costs include large investments in R&D for the pilot implementation. In case of scale up to a larger number of users the additional unit investment would be much lower.

On a more specific level, Smart Melit experimented the illustrated innovative battery recharging systems by using a fleet of electric commercial vehicles owned by a distribution company. The pilot case proved that the technology works, but in order for it to be replicated at a wider scale it would require that this type of vehicles were made widely available in the market, and this at least in Europe is still far from being a reality.

Replicability factors

From a physical and structural point of view, the measures undertaken by Smart Melit are potentially replicable in any European large or medium city having the possibility to generate electricity from renewable sources. From a technological point of view, the individual

technologies used by Smart Melit are generally well known and experimented, with a few exceptions as illustrated in the narration. What is innovative in Smart Melit is the ability to integrate these technologies, providing useful services to the public and at once reducing the carbon content of the city energy system.

It is nonetheless worth mentioning that a solution like this entails some implication for what concerns the EU countries legislation and regulatory framewok. This in particular refer to the elecricity storage devices, the smart grids implementation and the trade off between the data to be collected by the smart meters to improve the energy efficent behaviors and the privacy issues. The charging station for the electric vehicles do not really interact with the national policies as they only serve a local car sharing service and a local good distribution network. It is clear that if these were designed to serve private vehicles, overarching policies and national strategies should have to be carefully considered.

For what concerns smart grids, it is known that they still have to face rigidity in the regulation and regulatory draw-backs as these systems have to be develped in a still highly regulated environment and are exposed to the risk of changes in political priorities, which can severely affect the Return on Investment calculations and undermine investor confidence. The storage systems are moreover at a preliminary standardization stage, which hinders the opening of the markets to free competition.

As for the privacy issues, during the deployment of smart meters, citizens' concern arise concerning utilities invading privacy. Likewise, health problems have been reported from exposure to wireless signals broadcasts, although no scientific evidence for this has yet been found. For what concerns the privacy issues still does not exist, neither at EU nor at Member State level, a clear, specific, regulatory framework to which to refer, apart the more general legislation concerning the handling of the personal data. Some countries like Germany or UK have issued guidelines containing suggestions on how to handle this problem, but the lacking of a precise law framewok may hinder the developemnt of these devices and/or limit the type of data they are able to communicate to the grid operator. Also, the lacking of a standardized data security regulation could delay deployment, since protection again cyberattacks is a recognized challenge in any advanced IT system.

Apart from these important policy considerations, it is important to stress that the holistic and integrated approach of Smart Melit is the main challenge to replication, so much so that to date it has been (partially) replicated in two cities, Tokyo and Grenoble. The factors that would allow replication correspond to the economic and organizational barriers most likely to be encountered in Europe:

- The high initial investment required for the deployment of:
    - Storage devices;
    - Vehicle charging devices smartly connected to the network (V2X = Vehicles to Grid / Building / Home systems);
    - PV plants and related connections.
- The strong leadership and high level of governance needed to manage and synchronize the large number of technologies and stakeholders involved.
- The necessity to involve, motivate and inform citizens, without which the system is bound to fail. To this end incentives such as the gamification scheme can prove effective and easily replicable.
- The need for a (possibly long-term) national policy for the promotion of EV. The lack thereof would considerably limit the impacts of the solution and stifle the effectiveness of the investments.

Finally, a solution of this ambition needs to undergo a phased deployment, with an initial small scale implementation, i.e. on a pilot district of the city, and a subsequent extension to larger scale. This however only when experience, skills and structural investments have been secured.

The replication of the Ha:mo RIDE service in Grenoble, France

Replication of the Ha:mo RIDE service has recently been attempted outside Japan.

A project began in Grenoble, France, in October 2014, with Toyota Motor partnering with the city of Grenoble, the regional government of Grenoble Alpes Metropole, the business Cite Lib, and Electricite de France (EDF), responsible for installing an adequate charging infrastructure.

Financed by the funds"Ville de demain", "City of Tomorrow", set up to support new urban mobility models and innovative forms of public transport which are based on renewable energies, the electric car sharing has been chosen as a solution to reduce pollution in the French city.

The Car sharing service will be managed by the company Lib Cité already offering modal interconnection services to other French cities while the fleet of vehicles is provided by Toyota Motor Company (70 vehicles). Toyota will also provide its One-Mile Mobility Management System, a multimedia management system that allows users to learn about positioning and usability of charging points, parking lots and vehicles through apps on smartphones.

The Ha:mo RIDE solution was selected to play a large role in this strategy. The service is to connect with the route searching system of Station Mobile, the traffic information centre operated by the Grenoble Alpes Metropole regional government. Users can use their smartphones to find stations and vehicles available for use and get real time traffic information. The system aims to lure membership, by offering discounted fees to people with public transit commuter passes. Verification is set to run for three years, during which 35 units of the COMS and 35 of the i-ROAD will be made available at 17 stations in the city.

The replication of the Ha:mo RIDE service in Tokyo, Japan

Thanks to the experience carried out in Toyota City the Ha:mo service has been tested also in Tokyo. The Tokyo trial started in April 2015 and lasted in September whilst the service has officially started in October 2015.

The trial includes a combination of two services: i-Road and Park 24's Times Car Plus service, which allows members to make use of a fleet of share-cars at any time of day. The scheme has also incorporated elements from Toyota's Ha:mo urban transport template, which has also been adopted for the Grenoble project.

During the test, usage data and user feedbacks have been gathered to assess ease of use, changes in user activity patterns and public receptiveness to new mobility systems of this type.

The focus of the test was on i-Road being used for one-way trips to businesses, shops and sightseeing locations. Users could pick up their vehicle from the Times Station at the Yurakucho ITOCiA shopping centre and later return it to any of five central locations.

Park 24 offers the service to Times Car Plus corporate members and some individual members as well. A web page gives details of availability and take reservations. Users are required to undertake an i-Road training course before driving the vehicle. The service cost 412 yen (about 3.5 €) per 15 minutes and the maximum usage period is two-and-a-half hours. Park 24, which operates a network of car parks across Japan, created Times Car Plus to make public mobility even more convenient. The service has around 430,000 members and offers a wide range of cars for rental.

Figure 7: Replication areas of Smart Melit: Grenoble (FR), Tokyo (J)

	"Replication recipe"
Problem definition	✓ *Municipality and stakeholders wishing to implement a similar solution shall first understand the issue and secondly how the technological solution could address it.* ✓ *Municipality and stakeholders shall also first map the available public and private resources in order to identify what the project is able to leverage.*
Infrastructure and financing	✓ *The solution requires very large investments. The price for the offered service should be initially low (or even free) to attract citizens in the initiative.*
Multi-phase roll out	✓ *The solution shall adopt a governance structure, which could include, inter alia, an executive board, a technical expert group and work package leaders.* ✓ *Strong leadership is required of the coordinating authority, backed up by an equally developed cooperation culture animating the participating stakeholders.* ✓ *Proactive and continuously fostered citizen participation is another key requirement.*

Table 3: Replication recipe

Sources

Interviews / Contact persons	› Hitomi TANAKA, Model Environment City Division, Toyota City
Literature supporting the research of this case	› Tecnavia, 20015, Global Grid-to-Vehicle (V2G) Market 2015-2019 › The Smart Grid in Asia, 2012-2016: Markets, Technologies and Strategies (GTM Research), EIA › Jose Pontes (2014-01-30). "Japan December 2013" › International Energy Agency, Clean Energy Ministerial, and Electric Vehicles Initiative (April 2013). "Global EV Outlook 2013 - Understanding the Electric Vehicle Landscape to 2020" › Jeff Cobb (2015-09-16). "One Million Global Plug-In Sales Milestone Reached" › Mark Kane (2014-01-30). "Nissan LEAF Sales In Japan Up 17% in 2013
Internet sources	› http://www.toyota-global.com/sustainability/report/archive/html2013/society/future/pdf/sr13_p45.pdf › http://jscp.nepc.or.jp/article/jscpen/20131218/377527/index3.shtml › http://www.ruoteperaria.com/news/1275-stazioni-di-ricarica-prosegue-impegno-toyota.html › http://www.globaldenso.com/en/ › http://jscp.nepc.or.jp/article/jscpen/20150528/445244/index.shtml › http://www.teitanso-toyota-city.com/en/conference.html › https://en.wikipedia.org/wiki/Plug-in_electric_vehicles_in_Japan › http://www.meti.go.jp/committee/summary/0004633/masterplan002.
Figures sources	› cph solutions lab http://cc.cphsolutionslab.dk › http://www.cuicar.com › http://jscp.nepc.or.jp/en/toyota › http://www.toyota-global.com/sustainability/report/archive/html2012/society/mobility/

Urban Platform

Barcelona, Spain

→ Replication potential		→ Economic impact	
→ Complexity		→ Environmental impact	
→ Citizens' involvement		→ Social impact	

Assessment based on feedback provided by the solution's representative as well as on the available sources analysed by the study team.

Short description of the case study

		Key facts and figures
Urban Platform solution	**Type of solution**	*Open data interoperable city ICT architecture*
	Project stage	*The project started in 2012 with the deployment of Sentilo (the sensor layer). The tendering phase of the City Os (the second layer of the solution) is now on, complete go live of the solution is planned for April 2017.*
	Actors involved	*Barcelona City Council, private technological services provider, public and private services, citizens*
	Roll-out of the solution	*"Sentilo", the sensor platform is running beside the metropolitan area of Barcelona also in Terrassa, Reus, Cambrils, Tarragona and Dubai.*
	Barriers	• *Need of strong political will* • *Involvement of the government, residents, and the business community* • *Data silos and ownership* • *Contracting phase with the tech firms*
	Implementation best practice city	*Barcelona (Spain)* *(1.6 Mln inhabitants)*
	Main technological areas covered	*ICT architecture which provides a transversal platform that interconnects the entire city*
	Funding mechanism	*Public (municipal) funding/private financing*
	Economic, social & environmental impact	*Among others:* • *Transparency and citizens engagement through the Open Government platform* • *Cost reduction, minimizing duplicity of data and increasing system resilience* • *Elimination of departmental silos*
	Replicability factors	• *Strong need of senior-level political support* • *Strong coordination across the various city departments* • *Solution build with open source software and creation of a supporting community* • *Design of a blueprint of the solution* • *Ensure a competitive dialogue with ICT service providers*

Case summary

Barcelona is seeking to efficiently provide city services at multiple levels to all citizens by harnessing information and communications technology through the development and implementation of the Barcelona Smart City Model. The model identifies 12 areas under which Smart City projects are initiated: environmental, ICT, mobility, water, energy, waste, nature, built domain, public space, open government, information flows, and services. Currently, the city has 22 major programmes and 122 separate projects that fit into one or more of these 12 areas, covering all areas of city management.

Among the 22 major programmes aforementioned, there is the Barcelona Urban Platform, through which information can be collected, managed and communicated in a common way, making it easier to share and manage city data and services.

The Urban Platform project is under the jurisdiction of Barcelona City Council policy and strategic vision and it has been developed through the public-private collaboration between the City Council and technological ICT providers (Cisco, IBM, Accenture, Cellnex Telecom, Abertis, Indra, etc.) allowing the development of functional technological applications to improve the efficiency of services received by citizens.

Enabling the gathering, use and dissemination of information by many sensors distributed around cities it supports the Barcelona City Council take decisions in real time, in order to meet the needs of governing the city and improve the quality of life of its citizens.

This platform has the capacity to acquire and process information concerning the running of the city quickly, effectively, efficiently and in a sustainable manner. Its smart systems allow it to analyse and relate events so it can produce simulations and anticipate any problem that might affect the city (including emergency situations).

The Urban Platform provides an IT architecture model of the city, which is replicable and open sourced:

1. A bottom layer, collects the raw data produced by the city, and is formed by four groups of different kinds of data with their own logic and management:
    - A sensors and actuators platform called Sentilo (currently providing measures for 2,200 parameters);
    - The City Council's information systems data (people, procedures, etc.);
    - Data from the city's information systems (infrastructures, mobility, etc.);
    - Data from Social Networks and Web 2.0.
2. A City Operating System (City OS), the intelligence component of the Urban Platform, based on three elements:
    - A City Model that pilots the City Operating System;
    - A universal repository where all historic information of the city is stored;
    - A manager of information treatment processes that, based on the City Model, applies intelligence to the set of stored information.
3. A top layer formed by applications and control centres aimed at visualising the data and finding useful applications for it.

The three layers and their links are illustrated in the picture below.

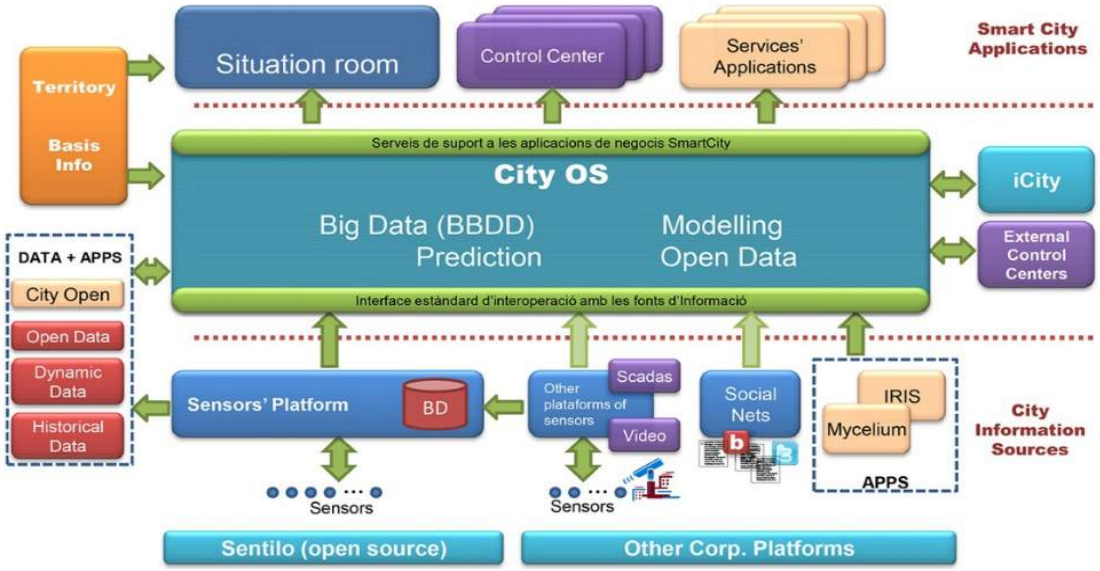

Figure 1: the ICT architecture of Urban Platform

The Urban Platform, as well as many other programmes, relies on the city Telecommunications Network to transfer information. This network integrates all of the city's Fiber Optic and Wi-Fi networks into one. In addition to being the corporate municipal network used by the City Council departments, the Telecommunications Network is also providing free Wi-Fi connectivity to citizens, with more than 500 access points already in operation throughout the city.

At the moment Barcelona is working on pilot projects on the sensor layer of the solution which cover various measuring purposes such as sensors for trash containers (to reschedule waste collection routes more efficiently), sensors on the street (to measure the use of parking spaces), environmental sensors (to measure noise), humidity sensors (to manage the irrigation system of public parks of the city) and urban sensors (to read gas, water and electricity use in municipal buildings), allowing information sharing and providing added value to citizens.

Currently, the Urban Platform solution is not fully developed and introduced, the first layer (sensors) is completed, while the second layer (the City OS) is terminating the tendering phase and the third layer will come afterwards, the full go live of the solution is expected for April 2017.

As far as this study is concerned, this project is relevant because, as depicted in the following figure the Urban Platform, being a transversal solution, covers all the three vertical/technological priority areas of the EIP-SCC Strategic Implementation Plan (Sustainable Urban Mobility, Sustainable District & Built Environment and Integrated Infrastructure & Processes) and many of the horizontal/transversal ones. As mentioned above, the project involves a strong citizen focus promoting the concept of civic innovation by the use of the Open Government platform and providing open source data. Furthermore the solution enhances knowledge sharing among the several involved stakeholders, providing metrics and indication for an integrated city planning and management. The adoption of an innovative procurement model such as the competitive dialogue (a detailed focus will be presented in the following pages), the funds sharing among Barcelona City Council and the private ICT companies makes this solution very interesting. In addition the Urban Platform in Barcelona has been constructed to be, when full operative, a future point of reference in setting new standard of city management.

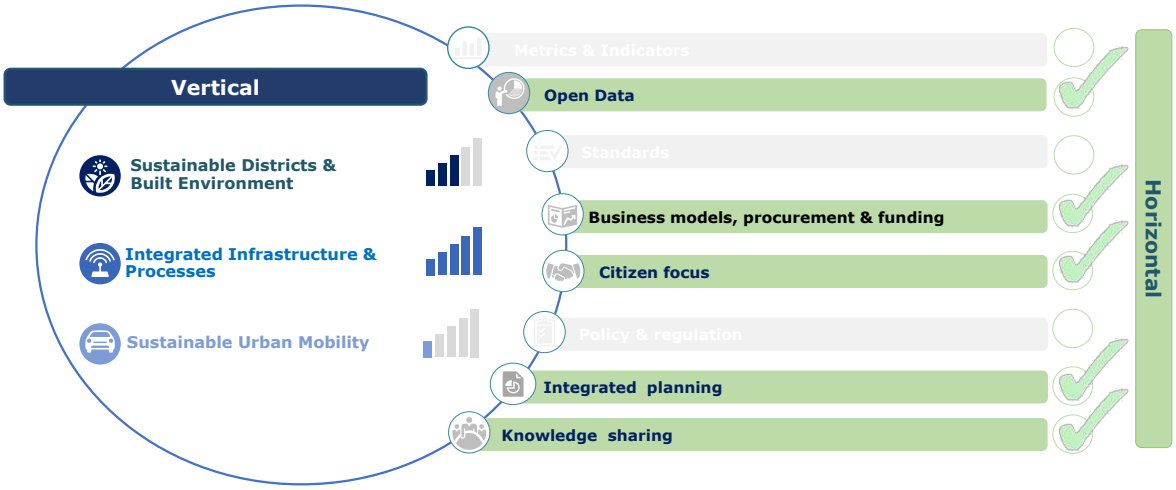

Figure 2: SCC Solution Integration Dashboard

Market analysis

Many cities around the world will, with all probability, implement a City Platform on which most smart city applications and services will run. This platform will be the main backbone for many existing sector systems (like energy efficient buildings, smart grid, intelligent transport systems, e-health systems) and many new applications and systems specifically designed for the city.

According to Navigant Research, the global smart city technology market is expected to grow from $10.4 Bln in 2015 to $ 27.4 Bln by 2023[1], creating a widespread interest in smart city programmes and an expansive market opportunity. New projects will be added: smart grids, networked LED street lights, urban mobility, climate action plans, open data platforms, water management and government service applications for smart cities. Considering that Urban Platform is a transversal core ICT solution for the implementation of many smart city services it is possible to foresee a huge market for this kind of solutions.

The technological city partners see this project besides the great impact it will have in Barcelona, also as an investment constituting a reference that can be marketed and sold to other cities for both experience and knowledge on this sector and setting them in a leading position in the market.

Main impacts

Barcelona seeks to become a self-sufficient, hyper-connected, zero emissions city. ICT is key to reaching this goal as it enables the city to manage resources efficiently and reduce the impact of urban infrastructure on the environment. With the urban platform, the city can also captures information in real time, allowing for quicker decision making and response times.

The urban platform installation will help the city save energy and reduce pollution thanks to sensors monitoring water levels for irrigation, garbage containers, parking, people flow, energy efficiency in city buildings, civil works, etc. Moreover, the intelligence processes engine will make it possible to provide contingency plans for situations such as heavy snow or urban flooding.

> "If we can pull this off, I assure you it will be a revolution". Julia Lopez - former Head of IT International Office - Directorate for ICT Strategy and Smart Cities - Barcelona City Council

[1] https://www.navigantresearch.com/research/smart-city-tracker-4q15

Urban Platform has been designed to support as many urban needs as possible, enabling many and different services both public and private as well as from third parties, from this will results several social, environmental and economic impacts.

At the moment, being the solution not fully developed and introduced, there is only a qualitative assessment of the multiple positive future impacts that Urban Platform being a transversal and multipurpose application could have and enable in Barcelona's Smart City scenario.

These are listed below:

Social	• The platform enables **"GO" (Open Government) a programme geared towards citizen engagement** which features a web platform aiming to bring transparency of the municipal government to citizens and publishes all data publicly. **GO promotes the creation of services based on public information** allowing citizens to communicate with municipal representatives and give their opinions, assess municipal policies and become involved in the different participatory processes established in the city, on any topic that affects it. • Thanks to the use of an intelligent process engine that connects different events in real time, **emergency situations can be anticipated** and responses from different **services coordinated** in a more efficient and expedited way
Economic	• Barcelona plans to create **47,000 new jobs through its Smart City effort** • Connections with IT industry made through Barcelona's pilot programmes - with both smaller entities and industry leaders - will help the city to **define suitable technological partners for funding and implementation of the long-term Barcelona Smart City goals** • **Implementing remote irrigation control** for the city's green spaces; including 77 remote controlled fountains and two networks that provide hot water in 64 buildings • Barcelona is **saving $58 million annually using smart water technology**, and that the city has increased **parking-fee revenues by $50 million** annually utilizing smart parking technology • The deployment and maintenance of sensors and processes that **deliver information using a unified catalogue will bring a cost reduction**, **minimizing duplicity** of data and infrastructure and helping in the **elimination of departmental silos** and improve the resident experience in Barcelona
Environmental	• **Reducing the negative impacts of the city on the environment**. For example, the Self-Sufficient Buildings project supported by Urban Platform monitors the energy within City Council's buildings, allowing to know the building consumption in real time, detecting deviations in order to correct them. • Obtaining data related to noise pollution levels as part of the **Strategic Noise Map** and urban laboratory activities, in many cases related to the Mobile World Lab project • Urban platform allows **energy monitoring in municipal buildings**. In addition, Barcelona worked with utilities to create a programme to achieve greater energy efficiency, **deploying more than 19,500 smart meters** in the Olympic Village • The city's smart transportation initiative includes deploying **orthogonal bus lines and zero-emissions mobility options**, which include more than 500 hybrid taxies, 294 public electric vehicles, 262 recharging points, 130 electric motorbikes, and 400 private electric vehicles

Table 1: Foreseen impacts of the Urban Platform solution

In addition with these, Barcelona City Council and its ICT providers will work with a variety of global and local partners to develop and test new city services through field pilots in Barcelona.

- **Pay per light**: a pay per use model for city lighting in which the city pays for lumens as opposed to fixed infrastructures;
- **Self-sufficient city blocks for energy**: develop self-sufficient energy blocks in cities by determining net consumers and producers and trading energy; develop a holistic map of energy usage in a city;
- **Energy monitoring of public buildings**: develop a real time analysis of energy consumption and monitoring for the 2,000 public buildings in Barcelona;

- **Improve rain water use**: maximize the collection and use of phreatic water and rain water in the city;
- **Smart bus network**: develop network model for tracking new bus routes in the city and provide real time bus information to citizens;
- **Smart Parking for the city**: integrated parking solution for the city that incorporates sensors to provide real time visibility into open parking spaces in the city. Create new business models relating to public parking;
- **The Internet of the neighbourhood**: promotion of social interaction by managing new relations between citizens, things and spaces, through the use of embedded information systems.

Furthermore the city has set out the following goals to be achieved by 2020, in which the Urban Platform will play a pivotal role:

- 20% reduction of total energy consumption from municipal services;
- 20% water consumption reduction;
- 15,000 additional sensors installed in the city;
- 30,000 consumption energy measures installed in 100 municipal buildings;
- 1,000 measures to remotely control irrigation in municipal parks;
- 1,000 environmental measures in civil works;
- 5,000 parking spaces monitored.

Rich Picture Model

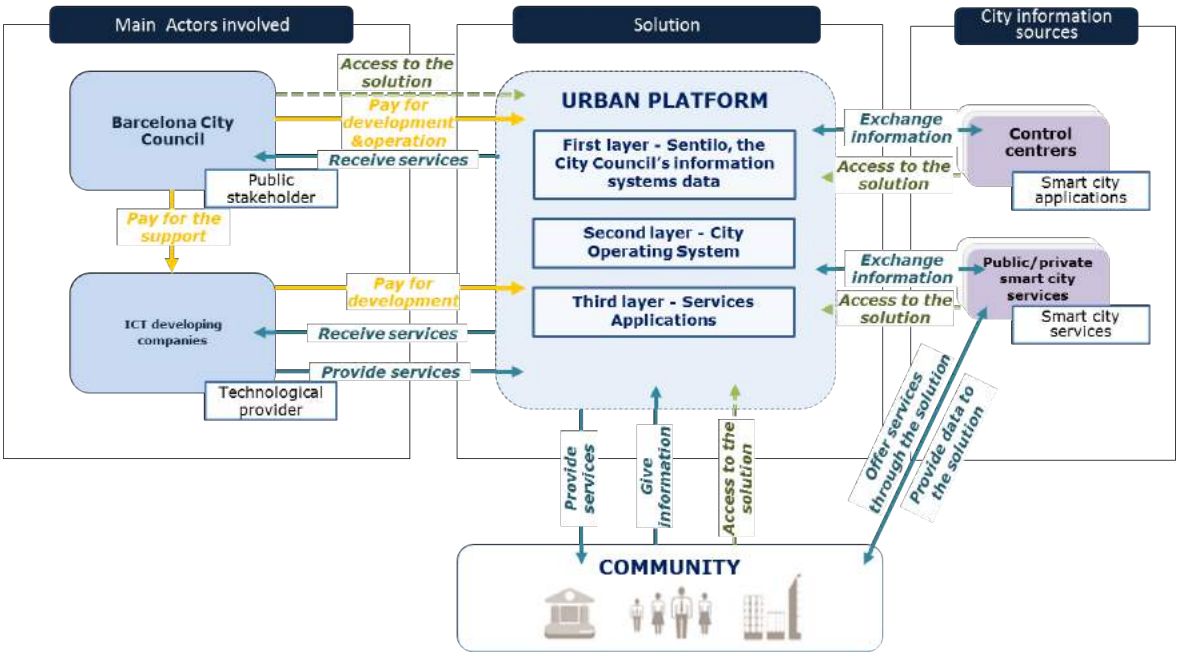

Figure 3: Rich Picture approach of Urban Platform

As illustrated above, Barcelona Urban platform is a holistic transversal solution for the entire city. The solution is funded by Barcelona City Council, that intend in this solution a relevant pillar for Barcelona smart city deployoment, with an economical support of the ICT solution developing companies which see this solution as a laboratory to gain experience on this kind of solution with the aim to replicate it in other cities. Both the Barcelona City Council, the ICT developing companies have access to the solution as well as Control centers and Public/private smart city services which provide monitoring and controlling services on several city management topics (citizen engagement, energy, transportation, etc.). A very relevant role is played by Barcelona Community, which accessing to the solution exchanges in both directions information, providing data and accessing to the offered services.

As described, the Urban platform acts as a pivotal role, collecting, managing and distributing data and information from and to several actors, such as: city environment, citizens, public and private service providers and control centres.

Business Model Canvas

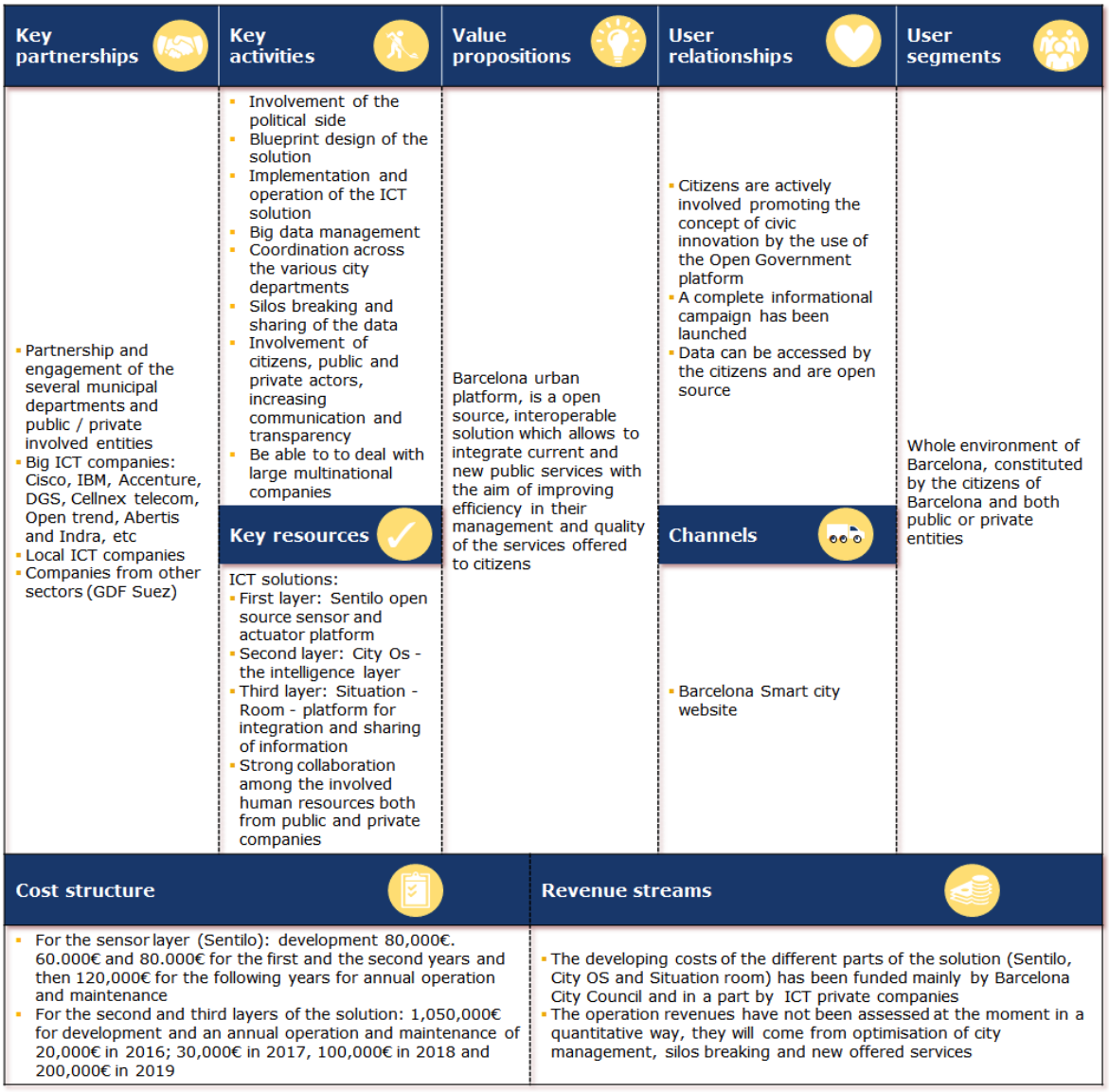

Figure 4: Business Model Canvas of Urban Platform

User segments

The final users of this holistic implementation of services is the whole environment of Barcelona, constituted by the citizens of Barcelona and both public and private entities which will offer new services or improve the existing one.

Value proposition

Barcelona urban platform allows to integrate current and new public services with the aim of improving their efficiency and quality. Barcelona Urban platform is an ICT architecture that provides a single, transversal platform that interconnects the entire city. The project was

proposed to create a sustainable city model that can manage different resources in an efficient way, including water, public services, temperature regulation, CO2 emissions, civil works, humidity and energy efficiency. The urban platform will allow to integrate current and new public services with the aim of improving the resilience of the systems, the efficiency in their management and quality of the services offered to citizens.

The urban platform project is structured in three technological layers that will be fully open source, interoperable and could connect with other cities in Europe and in Spain:

- **The first layer** consists of sensors (raw source data) that have been deployed throughout the city in conjunction with the various projects. Currently, this platform is being used for smart water, smart lighting, and smart energy management projects, as well as others. The city plans to expand use of the sensor network in coming years. The city's sensor platform is called Sentilo (www.sentilo.io) and was developed specifically to aid the city in bringing all of its sensor data together and manage them. Barcelona has made the Sentilo platform fully open source and provided it for download from the web so that other cities or organizations can use it for similar purposes;
- **The intermediate or second layer** of the technology architecture is the City OS (the intelligence component), a platform created by the Barcelona city government to aggregate and analyse all data gathered from various city applications. This includes modelling for data analytics, predictive analytics applications and big data management. This initiative is still in development, and there is a tender out for bid;
- **The third layer** made by the applications (City Council and third parties as output information providers) of the "urban platform" is the sharing of data and analytics provided by the City OS with both clients within the city government and external data users. This will enable both public and private sector development of applications to improve city services and operations, along with helping to produce a better educated administration and citizenry.

Channels

Being a transversal infrastructure, the most used tool the city planner use promoting the several new offered services is the Barcelona Smart City website, (http://smartcity.bcn.cat/en/), which presents all information about the Smart City concept and the several services aimed to the end users being implemented in Barcelona.

User relationships

During this process, Barcelona aims to actively involve the citizenship in a participative way, thereby promoting the concept of civic innovation. Several are the service/project already available to the citizens that will be enabled by the future go live of the Urban Platform. The full list could be read here: http://smartcity.bcn.cat/en/projects. With this purpose in mind, a complete informational campaign has been launched in order to guarantee that every citizen understands the aim of the strategy and the projects it contains, as well as how they can get involved with many of them.

The city uses its data to engage city residents in the Smart City process. Already in function are the city's open government platforms (http://governobert.bcn.cat/ca/) which brings citizens and public servants into closer contact and provides transparency into government operations. Also the Open Data/Open API projects, such as OpenData (http://opendata.bcn.cat/opendata) which allows citizens to access data collected and processed by the Urban platform or the ICity project which aims in the development of services of public interest by third parties (developers, small and medium enterprises, etc.) interacting with the open city' information system (http://www.icityproject.eu/).

Revenue streams

Barcelona City Council has not prepared a specific business plan, not considering it crucial for this kind of project, as the Urban Platform is considered a basic infrastructure ITC tool.

The developing costs (Sentilo, City OS and Situation room) has been payed mainly by Barcelona City Council and by private technological companies that were interested in participate and learn from this project gaining experience and visibility on the market.

The project receives municipal funds and private funding. Private companies are investing in the development of the platform as Barcelona City Council will not cover 100% of the platform cost.

Focus on the procurement process of City OS platform

To achieve the most appropriate City OS platform and given the lack in the market of any product that fully meets the expectations, Barcelona City Council has opted to open a competitive dialogue with companies to jointly innovate and develop the requirements for setting up this system.

The competitive dialogue procedure for developing the City OS was carried out in stages. The process began in April 2013 and 23 enterprises applied to it, some of which were presented individually and others by forming Joint Temporary Ventures. This process continued with the final presentation of 13 candidates[2]. During the next stage, the procurement body evaluated the documents received from the various bidders and invited six candidates - the ones with the highest scores - to take part in a dialogue stage. The six competing companies at this stage where: Abertis Telecom and Accenture in joint venture with other companies, T-Systems, Cofely (GDF Suez), Capgemini and Schneider (also in joint venture with other companies), IBM, and Indra.

This was followed by the opening of the development stage, an interaction with candidates to determine and establish the most suitable solution or solutions for meeting the needs of the procurement body.

Once the prior stages had been completed, the procurement body called on the candidates to present their final tenders, based on the specific solution or solutions presented during the dialogue stage. The candidates presented their tenders, which were evaluated under the initially established contract-awarding criteria, ending with the proposed contract award in April 2015.

The tender for obtaining, developing and maintaining this system has a maximum budget of 1,700,000 € (VAT included) for a period of three years. The winner of the tender has been CIMO (Collaborative & Innovation for Municipal Organizations) the joint venture formed by Accenture, Sl, Tradia Telecom, Sa, CNS and Cofely Sinovia Spain (the latter two are part of the group GDF Suez)[3].

Key resources

The Urban Platform solution, being structured on different layers, relies on core ICT resources, which constitute the physical resources of the solution:

- Sentilo, the sensor layer;
- City OS the intelligence component;

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2 https://www.linkedin.com/pulse/barcelona-awards-its-contract-city-os-operating-joaquim?forceNoSplash=true

3 http://blogs.elperiodico.com/masdigital/afondo/barcelona-adjudica-city-os-el-sistema-operativo-de-ciudad

- Applications and control centres, third layer of the solution.

The first resource, is constituted by **sensors network**, collecting from the environment the raw source data, named Sentilo ("Sensor" in Esperanto) an open source sensor and actuator platform designed to fit in the Smart City architecture of any city looking for openness and easy interoperability. Sentilo is built, used, and supported by an active and diverse community of cities and companies that believe that using open standards and free software is the first smart decision a Smart City should take. As seen before, in order to avoid vertical/silos solutions, Sentilo is designed as a cross platform with the objective of sharing information between heterogeneous systems and to easily integrate legacy applications. Sentilo is the piece of architecture that integrate the applications that are developed to exploit the information "generated by the city" and the layer of sensors deployed across the city to collect and broadcast this information.

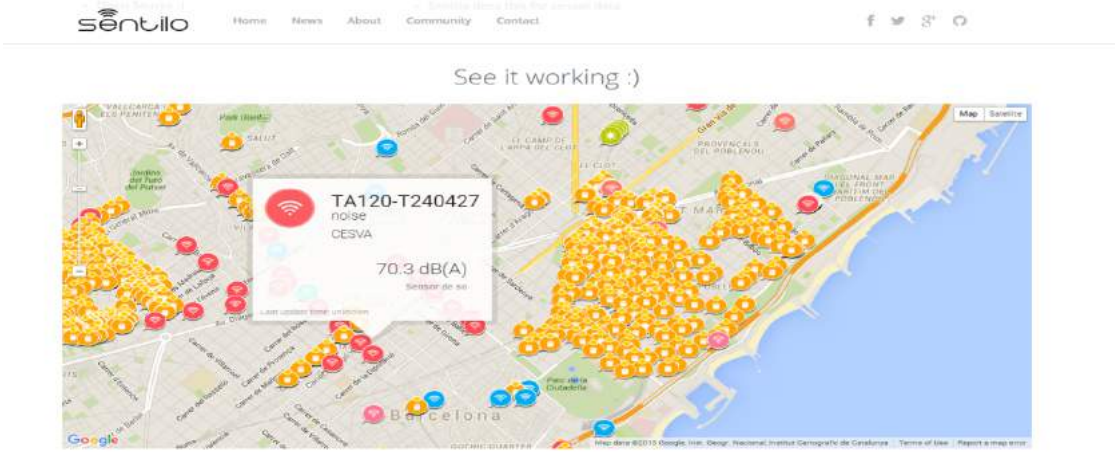

Figure 5: Sentilo - the sensor layer

The main objective of the Sentilo platform is to provide a functional, open, interoperable, easily expandable platform for any city in the world that requests it, sharing public investment in its development based on open-source software. The open-source software model also means that cities have no need to depend on specific providers in strategic areas such as access to the sensor network and actuators spread round their streets and squares. The Sentilo community aspires to become a meeting point in which cities and companies can work together to improve the platform, provide support and develop business using Sentilo.

At March 2016, only in Barcelona city, 1,800 Sentilo physical devices are connected and up to 780 Million transactions have been processed.

The second key resource is the **intelligence layer** of the Urban Platform solution, City OS is the technological platform of services and solutions able to acquire and process information fast, efficient, reliable and sustainable of the different systems (sensors, applications, control centres, etc.) scattered throughout the city and in heterogeneous formats. This platform has business intelligence to relate, combine, complete, process and store events. It will possible to build and run city processes, generate and send parts or warnings to other applications or control centres. It has the ability to foresee and anticipate any emergency to help coordinate resources more quickly and efficiently and to support decision making in real time. Barcelona is using the experience of technological companies, to, together, define and build the City OS. The best suited method to such needs is CCPP (Contract collaboration between the public and private sectors), that allows competitive dialogue. At the moment, the City of Barcelona is closing the tendering phase for the City Os layer, the deployment of this part will take one year, so the full operativity of Urban Platform solution is foreseen for April 2017. This operating system will sit atop the city's established network of sensor technology (Sentilo) to collate and analyse data that is collected across the network. The city sees this layer as the key to unlocking IoE benefits associated with data analytics and predictive modelling.

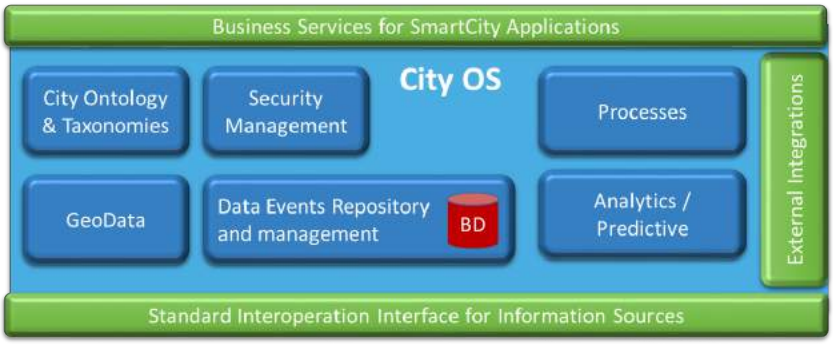

Figure 6: Architecture of the second layer the City Os

Part of the third resource is the **Situation Room** which is the Platform for integration and sharing of information about the city and its services. It is a centre that will control centres across the city, not management services integrated into it. Its goal is to have a tool to improve governance.

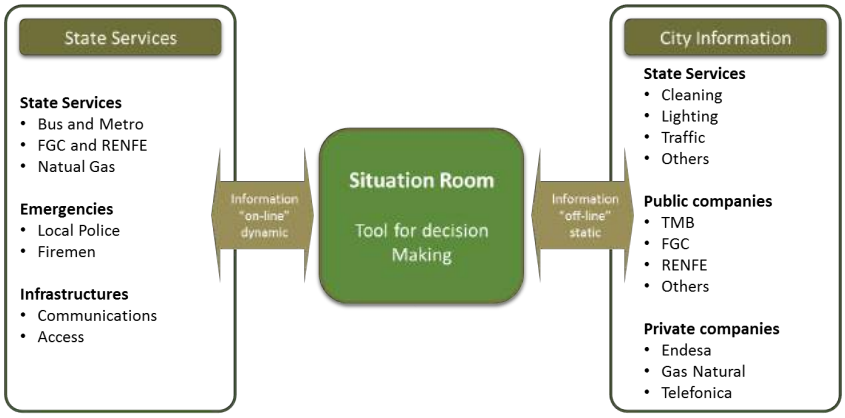

Figure 7: Architecture of the Situation Room part of the third layer

A very relevant role has the **human resources** both from public than from private companies which have to work together in a strong commitment and collaboration on a visionary, long and complex ICT integrated project like this one.

Furthermore, another key resource is represented by the **funding model** shared by Barcelona City Council and the ICT private companies which look at this project as an investment to gather experience in the new smart city market.

Key activities

For the Urban platform application, the key activities are:

- Strong involvement of the political support being this activity crucial for the development of the projects;
- Design of a blueprint of the solution;
- Implementation and operation of the ICT infrastructure which being a complex system needs a strong involvement and coordination across the various city departments and private actors allowing to cut through various layers of city bureaucracy and bring departments together;
- Big data management
- Strong coordination across the various city departments and private actors;

- Encourage silos breaking in order to let data sharing and circulation among the several actors enabling integrated and holistic management;
- Involvement of citizens, public and private actors and a strong increase of communication and transparency;
- Implement a competitive dialogue purchasing process along with the ICT technological providers in order to define the most appropriate solution;
- City has to adapt in dealing with large multinational companies that may not be accustomed to working at the municipal level.

Key partnerships

Considering the transversal entity of the Urban Platform, there is a strong partnership among the several municipalities and government entities in Barcelona, with the involvement of many actors such as the Barcelona City Council, the ICT Architectures Manager of the Institut Municipal d'Informàtica, the office of Smart City strategy for the city of Barcelona, the ICT International Office for Urban Habitat of Barcelona and many others.

The Barcelona City Council has sought strategic relationships with worldwide technology leaders in order to convert Barcelona into a laboratory for experimentation and innovation.

Partnering with key technology firms has been a crucial part of developing Barcelona's Smart City capabilities, recognizing that all these developments cannot be done only by the city. A strong and well-thought-out public/private partnership approach have been followed in which accounting for both large and small private sector participants.

"When governments and businesses work together in partnership, there is unique opportunity for innovation and growth." John Chambers - Cisco Chairman and CEO

Several ICT companies are collaborating with Barcelona City Council on this project, supporting the deployment of various components of this complex solution. To mention some: Cisco, IBM, Accenture, DGS, Cellnex Telecom, Opentrends, Abertis and Indra and many other local ones. Also GDF Suez, results to be a partner in this project regarding the energy sector.

Regarding Sentilo, (the sensor layer), the key partners for the deployment of the solution are, besides the municipal and government involved entities, the independent operator of wireless telecommunications and broadcasting infrastructures Cellnex Telecom and the open-source software development company openTrends.

With regards to the deployment of second layer of the solution (City Os), the identified key partners, winners of the competitive dialogue tender has been the joint venture formed by Accenture, Sl, Tradia Telecom, Sa, CNS and Cofely Sinovia Spain (the latter two are part of the group GDF Suez). Private companies have agreed with the approach of reducing their revenues from licenses while maintain or increase the revenues obtained from selling services. Also, as a result of the project, private companies know that they will achieve a sound knowledge of the platform and will reach a leading position in the market.The partnership and the engagement of the several municipal departments and public/private involved entities result to be really relevant.

Cost structure

The full costs of deploying the solution are:

- For Sentilo layer: 80,000€ for the development (20,000€ in 2012; 40,000€ in 2013; 20,000€ in 2014) and an annual operation and maintenance of 60,000€ and 80,000€ for the first and the second years (2013 and 2014) and then 120,000€ for the following years;

- Regarding the second and third layers of the Urban Platform: development 1,050,000€, (20,000€ in 2014; 30,000€ in 2015; 300,000€ in 2016; 400,000 in 2017; 300,000 in 2018) and an annual operation and maintenance of 20,000€ in 2016; 30,000€ in 2017, 100,000€ in 2018 and 200,000€ in 2019. All the costs are showed in the table and graph below.

Total cost of the solution (Mln/€)	***2012****	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***Total***
	20	100	120	150	440	550	520	320	**2,220**

** November 2012*

Table 2: Cost structure of the solution

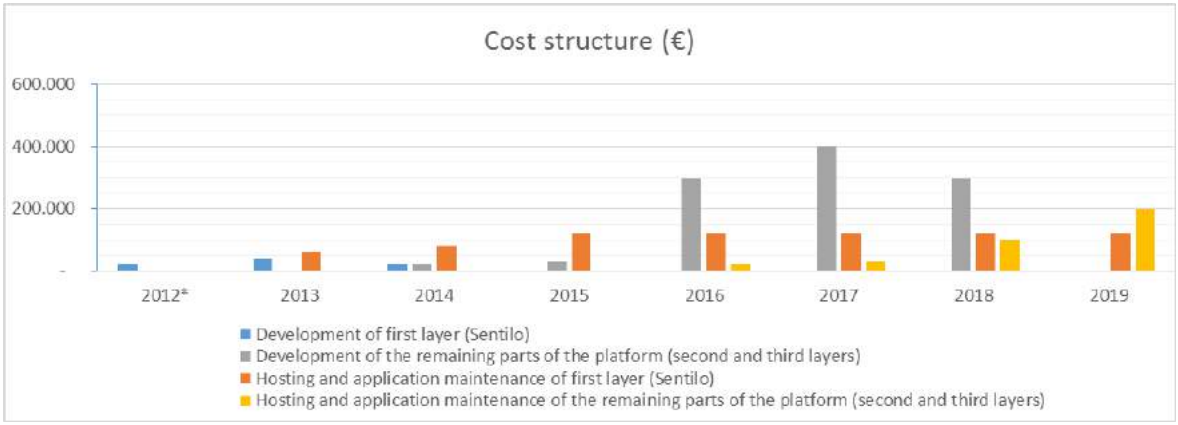

Figure 8: Cost structure of the solution

Barriers/challenges

Considering such a big and long project as the Urban Platform, the main barriers/challenges in the implementation of this initiative have been to set clear objectives, define the vision and map out the many steps necessary to attain the goals of managing such big amount of data. Being a long and visionary project, the main barrier results to be political, for this reason the involvement of top-down political leadership to ensure full support to this project results to be a key factor explaining the technological vision and complement this with visions from other cities that are developing in the same field, as well as having a leadership structure to coordinate the different aspects of the project. There is a strong need in strategizing early on, defining the potential roadblocks that can be foreseen and identifying the needed resources before challenges arise.

Another aspect which played a key role in this initial organizational formation, is the strong involvement of the government, residents, and the business community in developing, shaping this city's technological initiatives and designing a communication plan.

Another important aspect is the data management, the handling of such amount of data that need to be collected, analysed and managed requires strong competences. Regarding the data management one big barrier in this project is about change management and in particular regarding the break of data silos and data ownership of the several different control centres both public than private in Barcelona in order to let them share and circulate data among the platform. In this case the main way to overcome this barrier is to explain to the different stakeholders the problems of silos maintenance.

Another key aspect is the contracting phase with the tech firms in the competitive dialogue to ensure an optimal definition of the solution to implement and to maintain the system architecture open and not linked to proprietary technology. On many occasions, the contracting phase has led to finding new, sustainable business models, for instance: come on board to the Urban Platform project, considering it as an learning experience, they can present and sell in other municipalities and not only rely on added revenue coming from future software upgrades.

Replicability factors

The Urban Platform in Barcelona has been constructed to be a future point of reference for scaling both experiences and knowledge to other cities, it is a model that aims to transform the way cities are designed, built and renewed in order to ensure economic, social and environmental sustainability. At the moment the solution is not replicated in other cities because it is not fully developed yet.

Regarding "Sentilo"[4], the sensor platform which results to be currently already full deployed, this is running beside the metropolitan area of Barcelona also in Terrassa[5], Reus[6], Cambrils, Tarragona[7] and Dubai[8].

Industry sources point out that Spain is a leader in smart city solutions (other projects are ongoing in Madrid[9], Valencia, La Coruña, Pamplona, etc.[10]) as the government, through the

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4 http://www.diba.cat/documents/16833958/59604047/DB013-Sentilo+SC+Expo-1+0.pdf/ce05da38-7e79-49ed-a243-9649fec4eaa1

5 http://www.socinfo.es/contenido/seminarios/0508smartcities7/AytoTerrassa.pdf

6 http://www.cic.es/reus-continua-avanzando-en-su-innovacion-como-smart-city/

7 https://www.tarragona.cat/lajuntament/tramits-i-serveis/contractacio/aprovacio-de-projectes/2014/142-14/142-14

8 http://www.sentilo.io/xwiki/bin/view/Sentilo.About.Project/Partners

9 http://www-03.ibm.com/press/fr/fr/pressrelease/44347.wss

10 http://thegreatiproject.com/smart-city-use-cases/

Spanish Network of Intelligent Cities (Red Española de Ciudades Inteligentes - RECI[11]) of which nearly 60 cities are part, Cloud4Cities[12] with about 10 municipalities and Red.es[13] is driving projects and collaborating to build this market.

Several are the replicability factors that are needed in such big and long project:

- There is a strong need of senior-level political support which results to be crucial in the ability to develop Smart City projects;
- The top-down political desire and willingness to examine and create a Smart City vision is vital to successfully implementing this kind of solutions;
- Increased government transparency is also a critical component in this strategy, helping city officials communicate and explain why they are developing new smart applications or publicly sensitive solutions. This is helpful in gaining public support for projects, especially in a difficult fiscal environment;
- A strong coordination across the various city departments result to be very important too, key to success to this can come the top-level support from the mayor, which could help to cut through various layers of city bureaucracy and bring departments together. Take a tailored approach to encourage different public sector areas and departments to participate in the project. This include consolidating and streamlining projects already in motion before the blueprint for the Urban Platform project. Consider how to connect the different city affiliated "networks" (e.g. transportation, energy and technology);
- The solution should be built using an open source software and afterwards establish and support a community around it;
- The design of a blueprint of the solution results to be a strong need;
- Being Urban platform a data driven solution there is a strong need to gather as many data as possible with their historical database, in order to allow data analysis, simulation and predictions;
- Implement a competitive dialogue purchasing process along with the ICT technological providers in order to define the most appropriate solution for the city;
- The city had to adapt to dealing with large multinational companies that may not be accustomed to working at the municipal level.

[11] http://www.redciudadesinteligentes.es/

[12] http://premio.okfn.es/cloud-barcelona-cloud4cities/

[13] http://www.red.es/redes/

Figure 9: Replication areas of Urban Platform

"Replication recipe"	
Political will	✓ *Strong need of the senior-level political support which results to be crucial* ✓ *Top-down political desire and willingness to examine and create a Smart City vision*
Planning and coordinating	✓ *Promoting and coordinating Urban Platform application development throughout the city organization* ✓ *Consider how to connect the different city affiliated "networks" (transportation, energy and technology) in order to break the silos of information* ✓ *Build an open source platform and create a community to support it* ✓ *Strong need of a blueprint design of the solution* ✓ *Take a tailored approach to encourage different public sector areas and departments to participate in the project* ✓ *Store as many data as possible with an historical dataset*
Build partnership / define new business models	✓ *Build strong partnerships with technological providers* ✓ *Adapt to dealing with large multinational companies that may not be accustomed to working at the municipal level* ✓ *Ensure strong competitive dialogue in order to define along with the technical providers the best suitable solution and be resolute on a strong open data vision of the system architecture* ✓ *Define along with technical providers new sustainable business models*
Communication, transparency and trust	✓ *Increase government transparency* ✓ *Actively involve the citizenship in a participative way*

Table 3: Replication recipe of Urban Platform

Sources

Interviews / Contact persons	• Jordi Cirera Gonzalez - Project Manager - Barcelona City Council • Pere Comas Guerri - ICT Architectures Manager en Institut Municipal d'Informàtica – Barcelona City Council • Yolanda Gordo - Technical Manager for Barcelona City Os • Raluca Ciungu - Barcelona City Council • Gloria Grau - Project Director and Business Consultant for Sentilo application
Literature supporting the research of this case	• IoE-Driven Smart City Barcelona Initiative Cuts Water Bills, Boosts Parking Revenues, Creates Jobs & More http://www.cisco.com/c/dam/m/en_us/ioe/public_sector/pdfs/jurisdictions/Barcelona_Jurisdiction_Profile_final.pdf • Barcelona Smart City https://d3gxp3iknbs7bs.cloudfront.net/attachments/2ed95a00-a771-4271-b461-6c57f5b099c2.pdf • Cisco collaborates with Barcelona to support '2020 vision' for sustainable urban management and economic growth http://newsroom.cisco.com/press-release-content?type=webcontent&articleId=5918850 • EIP Integrated Infrastructure Urban Platform Open Briefing Pack • https://eu-smartcities.eu/sites/all/files/Urban%20Platform%20-%20Open%20Briefing%20Pack.pdf
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