Deliverable 2.1 SWOT analysis report of the refined concept/baseline

SINFONIA

"Smart INitiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy"

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EXECUTIVE SUMMARY

The main purpose of this work is to provide a background through the advice and support for the first phase of the SINFONIA integrated project implementation. This first step is crucial for the successful deployment of the SINFONIA smart city project.

The European Union set several targets to address the unprecedented energy, climate, economic and social challenges in 2020, 2030 and 2050. For example, by 2020, the European Union aims at a decrease in greenhouse gas emissions of 20% from 1990 levels. The energy demand covered by renewable energy sources is expected to be 20%. A 20% drop in primary energy consumption is to be accomplished by upgrading energy efficiency as well (EC, 2013A).

The primary energy use in Europe accounts for around 1800 [Mtoe/a] (Pezzutto et al., 2014). European cities account for approximately 70% of the primary energy consumption and this portion is expected to rise up to 75% by 2030 (EIFER, 2015).

In this framework several concepts for the development of European Union cities are under discussion and test. One of the most supported by the European Commission is the “Smart Cities and Communities” that focuses particularly on the creation of sustainable and efficient urban areas by addressing urban challenges (e.g. optimization of resources use). The smart cities holistic approach concerns mainly energy, environment and information and communication technology (Mosannenzadeh and Vettorato, 2014). A distinct sub-domain of the smart city concept can be identified for the energy topic: the smart energy city.

The main target of the SINFONIA project is the transformation of existing urban areas into smart energy districts. This transformation process develops in a very complex framework in which multiple actors are involved at multiple spatial and temporal scales.

This work defines two objectives in order to support the process:

1) To define its framework components through the clarification of the terms “smart city” and “smart energy cities” and their structures;
2) To analyse the transformation process and its structure through the strengths, weaknesses opportunities and threats (SWOT) methodology in order to provide a decision support system for cities to list and rationalize potential obstacles to implementation and opportunities to be caught.

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1) SMART (ENERGY) CITY DEFINITION

A conceptual framework is designed in order to define a smart city and smart energy city. The conceptual framework is developed mainly through an extensive literature review. Scientific literature sources are investigated through a keyword analysis used to extract relevant data from selected sources (Onwuegbuzie et al., 2012).

The literature on smart cities is investigated in three main areas: (i) academic, (ii) industrial, and (iii) governmental literature (Mosannenzadeh and Vettorato, 2014). The investigation suggests various tendencies in each area due to different interpretation of the term “smart” and different interests behind its use.

Based on the aforementioned research techniques, we propose a conceptual framework for smart cities, which identifies various subsector of the smart city concept (see Figure 1).

The three rings show, respectively, the objectives (yellow ring), the domains (blue ring) and the stakeholders (green ring) of smart cities, while the boxes (in purple) refer to main principles of smart cities creation.

Based on a framework we propose a definition of the smart city: *a smart city is a sustainable and efficient city with a high quality of life, aiming to address urban challenges (mobility improvement, optimization in the use of resources, improvement of health and safety issues, social development progress, economic growth support, and participatory governance) by the application of information and communication technology in its infrastructure and services, collaboration between key stakeholders (citizens, universities, government and industry), integration of its domains (environment, mobility, governance, community, industry and services), and investment in social capital* (Mosannenzadeh and Vettorato, 2014).

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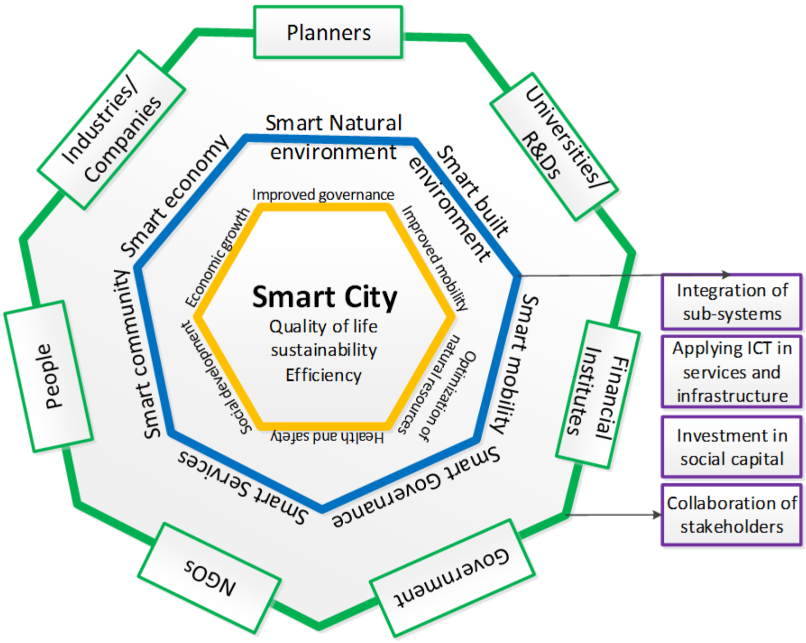

FIGURE 1 - A CONCEPTUAL FRAMEWORK TO DEFINE SMART CITIES (MOSANNENAZDEH & VETTORATO, 2014)

Smart energy city (SEC) is a sub-domain of smart city aiming to maximize sustainability, self-sufficiency and resilience of energy systems through an extensive integrated, participatory and innovative approach. Thanks to the rational use of information and communication technology, these objectives are reached while ensuring affordability, adequateness and competitiveness of energy services in the framework of a low carbon and integrated development. See Figure 2:

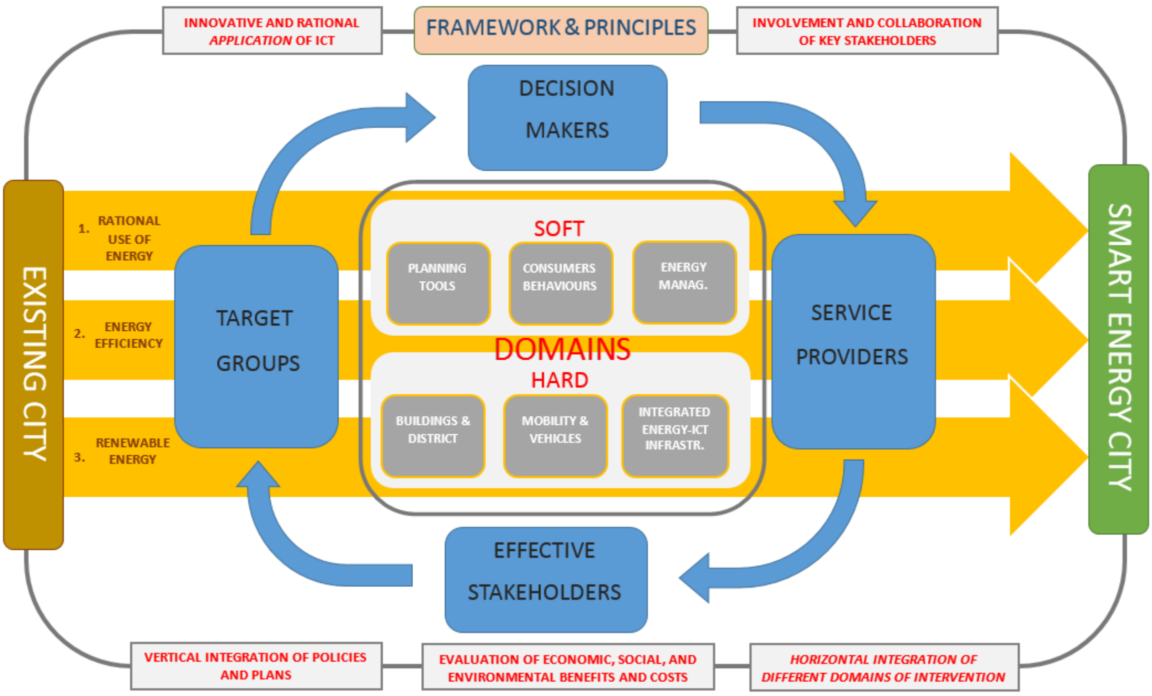

FIGURE 2 - A CONCEPTUAL FRAMEWORK TO DEFINE SMART ENERGY CITIES

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For further information, see the ANNEX (chapter 1: DEFINITION OF SMART CITY).

2) SWOT ANALYSIS

Second and core task of the present work consists in the elaboration of a SWOT (strengths, weaknesses, opportunities and threats) analysis, suitable for the concept proof and baseline revision with regard to the SINFONIA project. The SWOT analysis is divided into two parts: one named “SMART CITIES BASELINE SWOT”, focusing on the lessons learnt from the past experiences of smart city project implementation; and “SINFONIA SWOT”, focusing on specific implementation activities foreseen the project.

The reason why the two SWOT analysis are led separately is the need to learn from previous experiences (i.e. already completed and ongoing smart city projects). Such analysis provides valuable information regarding the modality for the implementation of smart city activities. In particular, the most valuable insights are the potential difficulties (barriers: weaknesses or threats) as well as factors enabling the successful implementation of the smart city project.

Overall, the SMART CITIES BASELINE SWOT provides a comprehensive **list** of **barriers** (weaknesses and threats) and **drivers** (strengths and opportunities), regarding smart city project activities already accomplished. It also provides the most relevant and important barriers and drivers in terms of their impact level. The impact level was evaluated quantitatively in cooperation with the experts already involved in the implementation of the smart city projects. Their input were collected through a questionnaire and direct interviews. The questionnaires and their outcome were used to carry out the present research and can be found in chapter 7 (QUESTIONNAIRE AND GLOSSARY) in the final part of the report. For further details, see the ANNEX (subchapter 2.1: SMART CITIES BASELINE SWOT METHODOLOGY).

For the purposes of the SWOT analysis, strengths were considered as advantages in the implementation of a smart city project. Weaknesses are the elements hindering the implementation, while opportunities are factors that can be caught during the implementation of a smart city activity. Finally, threats are defined as external factors, which might put at risk a smart city project (Pahl and Richter, 2009), (Mind Tools, 2014).

Gathering data with regard to prior smart city undertakings and extrapolating respective strengths, weaknesses, opportunities and threats, it is possible to draw a clear picture concerning the difficulties and favourable issues encountered during the transformation of already existing European cities into smart cities.

So far, based on the SMART CITIES BASELINE SWOT analysis, the main conclusion is that there is a certain level of difficulty in implementing smart city projects in Europe due to issues outside the project implementation activities (opportunities and threats). In contrast, matters handled within the project are successfully dealt with, favouring the creation of smart cities (see Figure 3).

The impact analysis of internal and external factors affecting the implementation of previous or ongoing smart city projects shows that the most important ***strengths*** are **public participation, marketing application for awareness and involvement, and cooperation and trust between different stakeholders.** This result highlights the importance of information exchange when carrying out smart city activities. Secondly, the main ***weaknesses*** or shortcomings of the projects turn out to be **communication between project participants and the public, lack of expertise, awareness and methods for designing new technologies and implementing innovative solutions, and lack of cooperation and trust between different stakeholders**. Once more, the exchange of data confirms it importance. The main ***opportunitie****s* are the **existence of affordable and mature technologies suitable for local conditions, environmental issues, and political commitment over the long term**. Hence, in this case the technical and environmental related aspects prevail. Finally, the ***threats*** with the highest impact values, are the **availability or lack of subsidies, requirements from the European Commission concerning reporting and accounting, and complex ownership structure**. These threats are all connected to legislation.

Figure 3 summarizes the main results of the SMART CITIES BASELINE SWOT analysis, listing the factors with the highest impact values in each of the sections (strengths, weaknesses, opportunities and threats).

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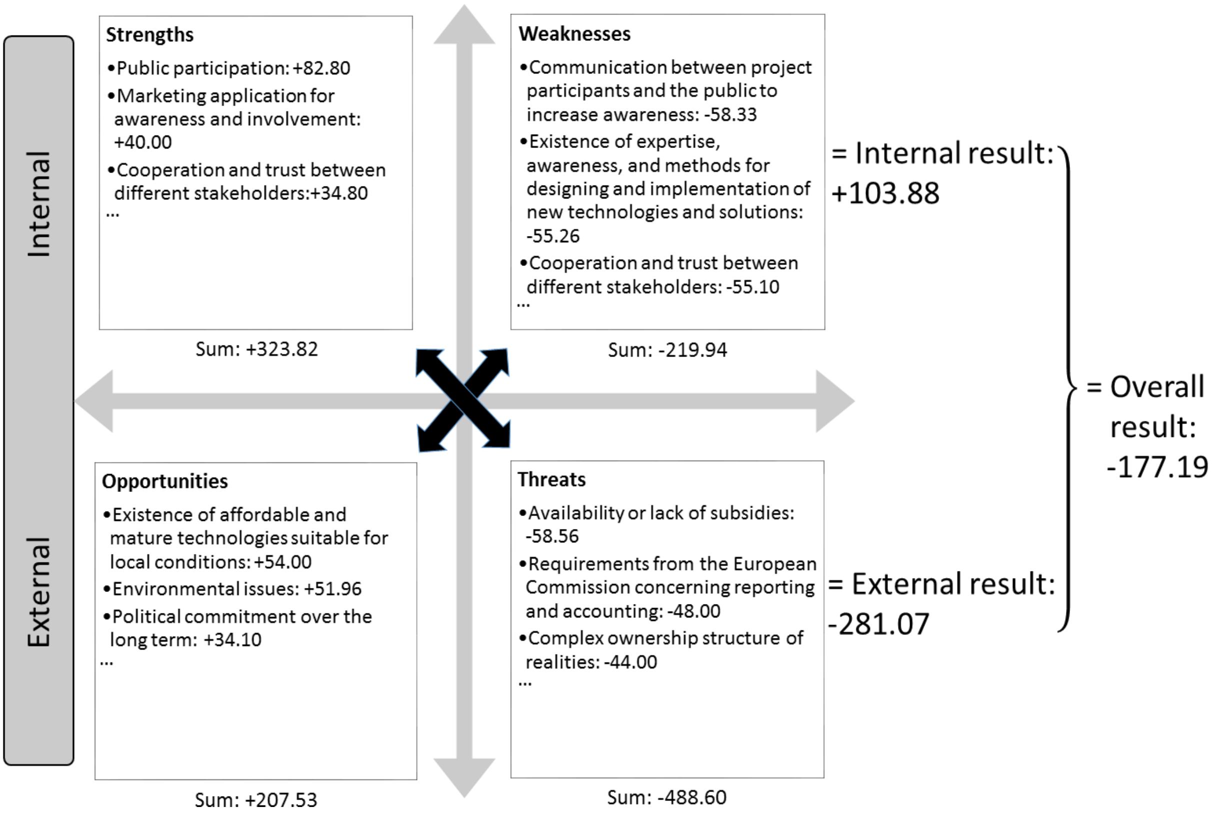

FIGURE 3 - SCHEME OF THE MAIN SMART CITIES BASELINE SWOT RESULTS

The final SWOT matrix entails barriers and drivers, which have not been mentioned in previous scientific literature (e.g. European Commission requirements in terms of reporting and accounting). These barriers highlight the importance of creating an appropriate context for stakeholders' cooperation in all phases of the project (planning, implementation, monitoring etc.).

On the other hand, experts stated that a number of barriers or drivers, which are mentioned in existing scientific literature, are not relevant to the projects analysed.

The most useful driver for overcoming barriers presented in the final SWOT matrix is public participation. As this factor is characterized also by the highest impact value, this issue turns out to be the key driver of the entire SMART CITIES BASELINE SWOT analysis.

The SMART CITIES BASELINE SWOT provides a general understanding of internal and external drivers and barriers in European smart city projects. It is helpful for new smart city projects, because it presents risks and opportunities that can occur. This SWOT provides also a number of important considerations for decision-makers, useful for the initiation and evaluation of smart city activities. Moreover, the SMART CITIES BASELINE SWOT is applicable to further analysis of specific smart city projects and was used as a basis for the SINFONIA SWOT. For further information, see the ANNEX (subchapter 2.2: SMART CITIES BASELINE SWOT RESULTS).

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Based on the knowledge acquired in analysing the previous and ongoing smart city experiences, it is possible to develop an ex-ante assessment of the SINFONIA project. This assessment can bring the most important possible barriers and drivers to the attention of project partners (mainly the work-package leaders and local municipality representatives). By analysing the local energy master plans and SINFONIA´s description of work (DoW), it is possible to understand the expected synergies and the contribution of the SINFONIA project to the implementation of energy strategies concerning both pilot cities of the project: Bolzano and Innsbruck.

In this case, the strengths, weaknesses, opportunities and threats are defined by the following rules:

- Positive aspects:

- Strengths are elements of the project itself, which provide a positive input to the question: "How is SINFONIA designed to be successful?
- Opportunities are elements outside the project, which provide a positive answer to the question: "Could the given issue help SINFONIA to reach its targets?

- Negative aspects:

- Weaknesses are elements of the project itself, which provide an answer to the question: "What limits will SINFONIA probably encounter due to its design?
- Threats are elements outside the project, which provide a positive input to the question: "Could the present issue reduce the chance of SINFONIA to reach its targets?"

The given analysis is supported by a detailed review of the following documents, carried out by work-package (WP) leaders and municipal experts:

- Description of work of the SINFONIA project
- Background analysis concerning the state of the art (local energy master plans) of the pilot cities:

- Sustainable energy action plan (SEAP) for the pilot city of Bolzano (Vaccaro et al., 2014)
- Energy development plan for the pilot city of Innsbruck (STADT INNSBRUCK, 2011)

For further details, see the ANNEX (subchapter 3.1: SINFONIA SWOT METHODOLOGY)

The most relevant factors of the SINFONIA project are identified in accordance to the number of times they occur in the SWOT analysis. This inquiry indicates the following three factors to be the most important: the combination of different financial schemes, costs of materials, construction and installation, and payback time.

The most important strengths of SINFONIA relate again to the existence and combination of different financial schemes, and public participation. The most relevant weaknesses lie mainly in individuals' behavioural attitude: inertia, energy efficiency related values - which may hinder change -, and principal-agent relationship. The major opportunities are: public acceptance of technologies, share of valuable data between different departments and partners, and availability of subsidies. Again, the concept of information exchange emerges. Finally, the major threats are related to economic and financial issues such as materials, construction and installation costs, payback time, risk and financial instability.

Figure 4 summarises the major findings of the SINFONIA SWOT investigation, listing three factors with the highest impact values.

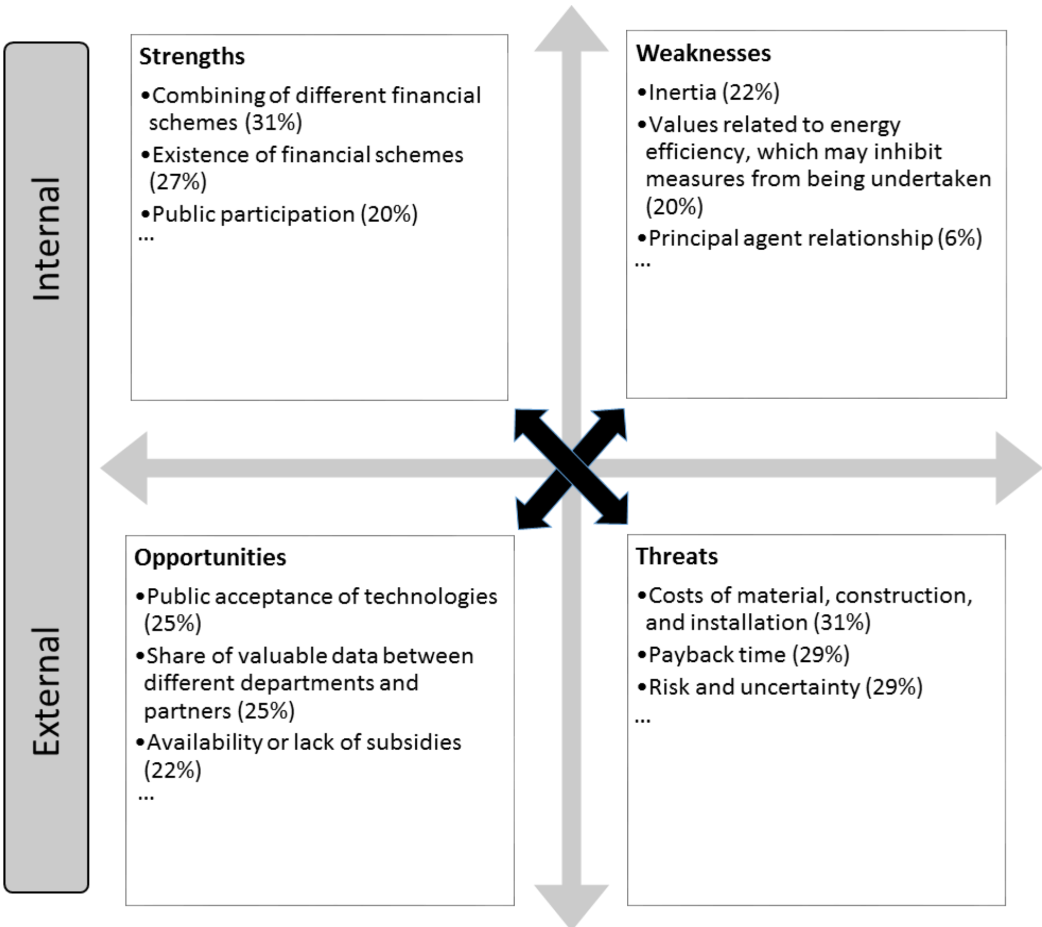

FIGURE 4 - SCHEME OF THE MAIN SINFONIA SWOT RESULTS

The analysis of SINFONIA results, suggests that the project consistently supported the implementation of the cities energy master plans. The cross checking of SINFONIA activities and these of the energy master plans shows an overlapping of about 60% for both Bolzano and Innsbruck. This means that the SINFONIA project can provide a relevant contribution to both pilot cities in the implementation of the activities foreseen in their energy plans.

This investigation provided relevant knowledge about the cities (targets, scenarios etc.) and their strategies (e.g. areas of interventions), but a more detailed revision of baseline conditions (energy and emission inventory and implemented actions) of both energy master plans is needed. For further information, see the ANNEX (subchapter 3.2: SINFONIA SWOT RESULTS).

Smart city projects are complex activities, which entail multiple actions in a diverse context. The SWOT analysis can therefore be a useful technique to assess the state of the project and to gather relevant information. A SWOT TOOL is developed as well, to capitalise on the work carried out within the SMART CITIES BASELINE SWOT investigation. A software application consisting of a set of questions and possible answers is created. By answering yes, no or not known to each question, the application allows the elaboration of a 2 X 2 SWOT matrix, containing the first step of a SWOT analysis. Since the questions derive from more than 400 barriers and 300 drivers occurred during past and ongoing smart city projects in Europe, the tool represents also a useful checklist of possible barriers and drivers. This enables the individuation of strengths, weaknesses, opportunities and threats identified by the operator and should be followed by further depth analysis as described in the subchapter 4.1.3 (HOW TO USE THE RESULTS OF THE SWOT TOOL). The SWOT TOOL is very easy to use in order to be accessible to all actors interested in smart city projects. Given the wide spectrum of users and scale of applicability, necessary simplifications have been introduced. The tool should therefore be considered as a preliminary analysis technique. For further details, see the ANNEX (subchapter 4.1: SWOT TOOL METHODOLOGY).

The application of the SWOT TOOL for Bolzano and Innsbruck in the framework of the SINFONIA project shows the possibility of creating synergies for solving problems as well as for enforcing these factors, strengthening the implementation of the smart city project. The two SINFONIA pilot cities have the chance to learn from each other: indeed, in a number of cases, weaknesses and threats for one city turned into strength and opportunities for the other. For further information, see the ANNEX (subchapter 4.2: SWOT TOOL RESULTS).

Finally, the SMART CITIES BASELINE SWOT represents an outstanding tool for decision-makers (e.g. European Commission) intending to transform already existing European urban areas into smart cities. While the assessment provided by the SINFONIA SWOT ANALYSIS is of interest mainly for the two pilot locations of the SINFONIA project, the SWOT tool can be used by all European Union cities, aiming to become smart.

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ANNEX

The entire following section of the present document is part of the ANNEX. Within this, the reader will find the detailed information given above in the executive summary of the report. In this summary references are provided to each chapter, in order to obtain a deeper awareness of the specific topic addressed in the document.

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1. DEFINITION OF SMART CITY

Main aim of the SINFONIA project is the transformation of existing districts located in the pilot cities Innsbruck and Bolzano (IBK & BZ) into smart cities (SCs) neighbourhoods. Hence, the focus of the given project is the smart city (SC) itself. Therefore, first of all the term “smart city” is clarified.

The present chapter sheds light into this concept. The topic “smart city” or “smart cities” joined more and more attention in recent years (EIP-SCC, 2013), (Washburn and Sindhu, 2010). Smart cities claim to heal urban challenges. These challenges vary from a high rate of urbanization as well as to urban competitiveness and a rise of citizen expectations in terms of urban services, and infrastructure quality (Washburn and Sindhu, 2010), (Chin, et al., 2010). Smart cities aim to exploit recent urban advancement, including progress in the field of information and communication technology (ICT) (Lee et al., 2013), (Mosannenzadeh and Vettorato, 2014). Thus, transforming urban areas towards SCs is argued to be a promising policy for urban governments. However, “labelling” cities and policies as smart is still subject of doubt for a number of scholars (Hollands, 2008).

A brief review of literature on SC definition shows that there are still many open questions (Sinkienė et al., 2014), (Chin, et al., 2010), which refer to following issues:

- The necessity of SCs creation (Why?)
- The main aspects of SCs (What?)
- The key actors in SCs (Who?)
- The ways to create SCs (How?)
- The right place and time to set up SCs (Where and when?)

A conceptual framework for SCs is provided by answering following questions: why is it necessary to transform? What are the main domains for intervention? Who are the key stakeholders involved? Where to transform? When to transform? And finally, how to transform (Mosannenzadeh and Vettorato, 2014)?

The following definition of SCs is structured in five sections. First, it is explained how the definition is provided (1.1). Then the carried out literature review is exposed in detail (1.2). Next, the keyword analysis is performed and a conceptual framework for SCs is shown (1.3). After, the concept of smart energy city (SEC) is explained as well (1.4). Finally, the results are given (1.5).

1.1 HOW TO DEFINE SMART CITIES

A conceptual framework is exposed to answer the question concerning the definition of SCs. The base for the conceptual framework is an extensive literature review. This review and a keyword analysis are chosen for investigating and interpreting scientific literature sources. A number of 37 scientific literature sources are analysed.

The literature on SCs is investigated in three main areas: (i) academic, (ii) industrial, and (iii) governmental literature (Mosannenzadeh and Vettorato, 2014). The investigation indicates various tendencies in each area due to different interpretation and interests of the term “smart”.

A keyword analysis is used to extract relevant data from the investigated literature (Onwuegbuzie et al., 2012). This results in a conceptual framework for SCs, which identifies various subsector of the SC concept.

1.2 STATE OF THE ART: AN OVERVIEW ON THE SMART CITY DEFINITION IN LTERATURE

The term “smart cities” has been used by many urban actors in a number of different fields of study (EIP-SCC, 2013). However, this definition is not settled yet (Sinkienė et al., 2014). The key word analysis done by Mosannenzadeh and Vettorato (2014) illustrates that there is a disparity of keywords applied in SC definition (Mosannenzadeh and Vettorato, 2014).

Scientific literature sources cover a wide range of SC topics and scales. A number of definition are very detailed, while others are very general, such as introducing the analysed term like cities that apply an advanced knowledge and technology to address urban challenges (Winters, 2011), (Glaeser and Berry, 2006), (Canton, 2011). Definition provided in this domain consider social and technological innovation as the core of SCs (Kanter and Litow, 2009), (Lazaroiu and Roscia, 2012), (Odendaal, 2003), (Marsa-Maestre et al., 2008), (Batty et al., 2012), (Nam and Pardo, 2011), (Sinkienė et al., 2014), (Lee et al., 2013). Also the important role of citizens is emphasized in the SC concept (Giffinger et al., 2007), (Coe et al., 2001), (Allwinkle and Cruickshank, 2011). Monitoring tools and strategies are considered as an important field too (Hall, 2000), (Harrison and Donnelly, 2011).

Industrial literature covers publication by corporation such as IBM, ORACLE, and ARUP. Definition provided in this domain cover more practical characteristics of SCs. IBM defines SCs as systems of systems, exploiting technology to optimize resources and transform urban core application by making them instrumented, interconnected and intelligent. Instrumented means to make systems measurable by digitalizing them and making them produce data. Interconnected refers to the creation of a communication between different systems in order to transfer information to each other. Intelligent implies the generation of informed decisions based on recognized and predicted behavioural patterns through the application of data (IBM, 2009).

The governmental domain includes publication of public authorities such as the European Commission (EC) as well as urban municipalities. This domain focuses on the urban planning concept "smart growth". The latter mentioned term emerged in the early 90s as a response to US urban sprawl and supports compactness, mixed-use of land as well as walkability in order to make urban development cost effective, predictable and fair (Herrschel, 2013). It supports community collaboration in making development decisions (EPA, 2014). The definition provided by this domain has therefore a tendency towards European policies such as energy efficiency (EE) and greenhouse gas (GHG) emissions as well as financial management and administration of SCs (Mosannenzadeh and Vettorato, 2014).

With this regard, "The Smart Cities Stakeholder Platform" (SCSP) has been initiated by the EC, aiming to identify and distribute relevant knowledge on SCs to both, policy makers, and practitioners (EC, 2014A), (EC, 2014B). The publications of this platform have an influence on practice of SCs. For example, the publication "Ten year rolling agenda", states that SCs are meant to increase the quality of life of city-dwellers, enhance the efficiency and competitiveness of local and EU economy, move towards the sustainability of cities by improving resource efficiency, and meet emission reduction targets. The latter mentioned document recognizes the infusion of ICT in urban sectors and the integration of systems on various scales (from residential to national) as the main objectives of SCs (Egenhofer and Saritas, 2013).

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1.3 KEYWORD ANALYSIS OF THE DEFINITION FOR SMART CITIES

The definition of SC is investigated in a more detailed way through a key word analysis. This analysis is done in two parallel steps: (i) an analysis based on three main domains of academic, industrial, and governmental literature. Furthermore, (ii) an investigation towards the already before mentioned six questions: why, what, who, where, when and how? The key words are derived and their frequency is counted based on the before indicated categories and groups. Different keywords with similar meaning are grouped together (e.g. IT - information technology -, ICT and “artificial intelligence” are assembled to ICT).

- Why is it necessary to transform toward SCs?

The drivers for development of SCs lie in the recent rapid growth of urbanization as well as advancement and transformation in technological, economic and governmental aspects of urban life. In this regard, SCs aim to exploit advancement as an opportunity to transform urban life. Cities, as the place for accumulation of both, physical and human capital, attract business activities to be the centre of global competitiveness. This is accompanied not only with cities’ increasing power and freedom due to global governmental transformation from nation-state models to more multi-level political governance, but also with improvement in technology costs reduction, which provide citizens and decision makers more possibilities to create, communicate, and anticipate urban functions (IBM, 2009) (Berst, 2013).

Smart cities seek to address urban challenges such as shortage of natural (energy, water etc.) and non-natural (housing, healthcare etc.) resources, inadequate and deteriorating infrastructure (such as energy infrastructure, roads, and schools), price instability of energy sources, climate change and higher citizen expectations regarding economic, and social urban functions (Washburn and Sindhu, 2010).

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The result of the key word analysis concerning SC literature shows that academic literature keeps a holistic approach, stating that SCs aim to improve sustainability through enhancing governmental, community/social and environmental aspects of urban life. On the other hand, industrial literature emphasizes on the economic function of the city: competitiveness - while mentioning that it should be combined with sustainability including efficiency, sustainable environment, and community/social development. Finally, governmental literature is mainly concerned with global challenges including topics like economic growth, quality of life, energy, sustainability, health, safety, mobility, and environment. See following Table 1 and Figure 4:

TABLE 1 - KEYWORD ANALYSIS: WHY SMART CITIES? (MOSANNENZADEH AND VETTORATO, 2014)

ACADEMIC	INDUSTRY	GOVERNMENTAL	TOTAL
Improved governance Community/social development Sustainable environment	Economic growth Sustainability Efficiency Sustainable environment Community/social development	Quality of life Economic growth Sustainable environment Sustainability Improved mobility Health Safety Energy	Economic growth Sustainable environment Sustainability Quality of life Improved governance Community/social development Efficiency Improved mobility Health Safety

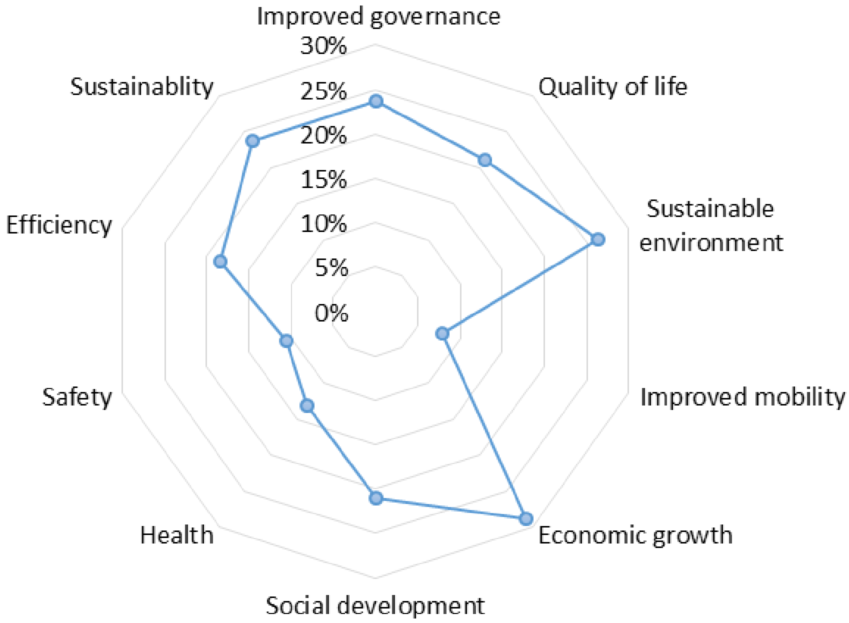

FIGURE 5 - KEYWORD ANALYSIS: WHY SMART CITY?

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As visible in Figure 5, within the considered 37 sources, the terms economic growth and sustainable environment appear most often (in more than 25% of the cases). All other topics entailed in the chart above follow up to improved mobility, characterized with a presence level of less than 10%.

- What are the main domains of SCs?

Main domains of SCs are the major place of attention and investment for stakeholders (Mosannenzadeh and Vettorato, 2014). In this sense, economy, population, environment, governance, mobility, and building are the six main domains of SCs presented by Giffinger et al. (2007) (Giffinger et al., 2007). IBM (2009) defines the SCs´ main domains (systems) as people, business, transport, communication, water, and energy (IBM, 2009). Universal aspects, built environment, energy, telecommunication, transportation, water and wastewater, health and human services, public safety, and payments are presented by Berst (2013) as SCs´ main concerns (Berst, 2013). See Table 2:

TABLE 2 - KEYWORD ANALYSIS: WHAT? (MOSANNENZADEH AND VETTORATO, 2014)

ACADEMIC	INDUSTRY	GOVERNMENTAL	TOTAL
Economy Environment Community Governance Infrastructure	Transportation Energy Building Services	Transportation Energy Building	Services Transportation Community Governance Energy Building

Table 2 shows the most frequent keywords on SCs’ main domains subdivided in academic, governmental and industrial literature. Again, academic literature presents a more holistic, general, and long-term overview, while industrial and governmental literature is practical and short-term oriented. This means that the main domains are considered as urban sectors, being directly affected by urban decision-makers. These sectors include transportation, energy, and building.

The most frequent keywords in general are services, transportation, people, governance, energy, and building. On a second level, we can find terms as health, safety, mobility, environment, education, economy, infrastructure and water. Further analysis of these keywords based on relation between different urban systems and sub systems, government, mobility, services, community, economy, natural environment and built environment are introduced as seven main domains of SCs (Mosannenzadeh and Vettorato, 2014).

In more detail, the keyword analysis results represent governance as an organizational and administrative function of the city. Mobility concerns soft and hard networks and infrastructure including transportation networks and internet. Services represent health and safety. Community represents people, citizens and neighbourhoods being able to innovate and create. Economy concerns economic functions of the city such as a market of SCs. Natural environment mainly regards water and energy and finally built environment represents primarily the building sector (Mosannenzadeh and Vettorato, 2014). See Figure 6:

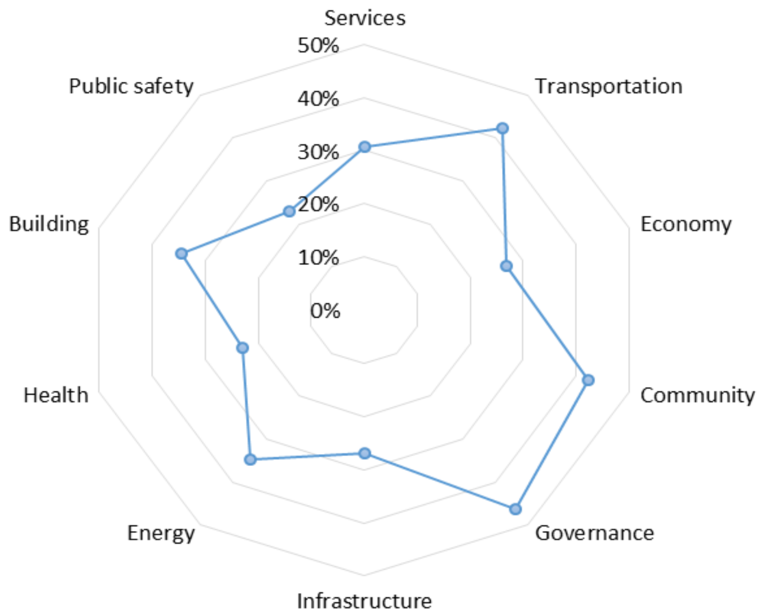

FIGURE 6 - KEYWORD ANALYSIS: WHAT?

Like shown in Figure 6, within the analysed 37 documents the term governance, community, and transportation appear most often (in almost 50% of the cases). All other items entailed in the graph above follow up to the term health, characterized with an emergence of less than 30%.

- Who are the key stakeholders involved in SCs?

A stakeholder is any group or individual, who affects or is affected by SC activities. Accordingly, the key stakeholders of SCs are those, who are actively involved and affected by the creation of SCs. Leydesdorff and Deakin (2011) indicate university, industry, and government as main stakeholders of SCs (Leydesdorff and Deakin, 2011). University function as producing organized knowledge, industry activities as creating economic wealth and government tasks as controlling reflexively are mentioned. This definition is later developed by Lombardi et al. (2012), through adding civil society as the fourth main stakeholder (Lombardi et al., 2012). Aoun (2013) introduces business, local stakeholders, and city leadership as the core SC stakeholders (Aoun, 2013). In more detail, governments, private investors, industry suppliers, NGOs (Non-governmental organizations) and associations, utilities, planners, and developers are different stakeholders involved in SCs. Their collaboration is crucial when creating the analyzed type of cities. The latter indicated collaboration is also mentioned by the CONCERTO initiative (EC, 2014A). It suggests that policy makers have to bring all stakeholders together in order to be successful. These stakeholders are mentioned as investors, local authorities, material suppliers, designers, urban planners, developers, energy utilities, contractors, engineers, tenants, and owners (Bahr, 2013).

As visible in Table 3, the academic keyword analysis indicates four groups as key stakeholders of SCs: companies/industries, people, government and university. In addition, the industrial literature names especially NGOs, investors, planners and developers and contractors (Mosannenzadeh and Vettorato, 2014).

TABLE 3 - KEYWORD ANALYSIS: WHO? (MOSANNENZADEH AND VETTORATO, 2014)

LITERATURE	REFERENCES	PEOPLE	COMPANIES	GOVERNMENT	BUILT INFRASTRUCTURE	UNIVERSITY	PRIVATE INVESTORS	NGOS	PLANNERS	INDUSTRY SUPPLIERS	UTILITIES	CONTRACTORS
Academic	Cosgrave et al. (2013)	*	*									
	Yavonaf et el. (2009)	*	*	*								
	Leydesdorf et al. (2011)		*	*		*						
Industrial	Lombardi et al. (2012)	*	*	*		*						
	Aoun (2013)		*	*	*		*	*	*	*	*	*

Governmental literature indicates stakeholders in a very precise manner. For example, the SCSP introduces mayor/politician, city administration, utilities, energy service companies, network operators, developers, architects, planners, construction companies, industries, component manufacturers, renewable energy (RE) industry, ICT companies, financial institutions, research and development (R&D) institutes and universities, inhabitants as SCs stakeholders (Egenhofer and Saritas, 2013).

As a conclusion, people, government, companies/industries and universities are the four main actors in creating SCs. In addition, other groups of stakeholders including planners, developers, financing organizations and NGOs aid to develop the treated kind of cities. However, each group of stakeholders could be divided in smaller sections. For example, government includes national, regional, municipal, and other administrative authorities (Mosannenzadeh and Vettorato, 2014). See Figure 7:

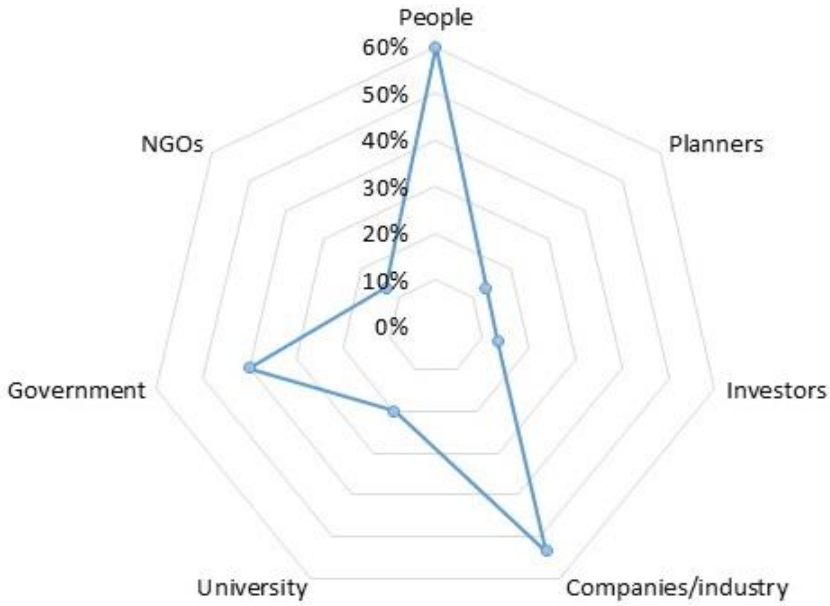

FIGURE 7 - KEYWORD ANALYSIS: WHO?

Figure 7 shows that within the considered 37 sources, the term people appears most often (in around 60% of the cases). All other topics entailed in the chart above follow up to planners, investors, and NGOs, characterized with a presence of slightly more than 10%.

- How to transform towards SCs?

The most important part of conceptualizing SCs may lay in answering the question of how to transform towards them (Mosannenzadeh and Vettorato, 2014). By scientific literature, application of ICT are stated as having the most dominant role in developing SCs (Lee et al., 2013), (Odendaal, 2003), (Glebova et al, 2014), (Nielsen et al., 2013). However, there is a consensus that ICT is not merely enough and it should be combined with governmental, social, economic, and environmental improvement (Hollands, 2008), (Komninos et al., 2011), (Pol et al., 2012), (Giffinger et al., 2007).

The prominent role of ICT application in infrastructure and services to develop SCs is confirmed by the keyword analysis (Mosannenzadeh and Vettorato, 2014). Although different academic, industrial, and governmental literature sources are generally unanimous on the main ways to move towards SCs. A tendency towards more application of instruments is noticeable in industrial literature, while governmental literature has a tendency towards proactivity and importance of measuring urban systems by metrics´ elaboration (IBM, 2009), (Kanter and Litow, 2009).

Concluding, ICT application in urban services and infrastructure is the core strategy, which makes SCs different from other city concepts. However, this strategy has to be combined with other ones, including investment in social capital and community development (Anastasia, 2012), collaboration of stakeholders, and integration of SC domains (Mosannenzadeh and Vettorato, 2014). Moreover, creation, measurement and management of data and knowledge in all treated domains and of all stakeholders, as well as data communication via an interconnected and comprehensive urban network is crucial to create integrated-collaborative urban development (Li et al., 2013), (Anastasia, 2012), (Gui and Roantree, 2012). See Table 4 and Figure 8:

TABLE 4 - KEYWORD ANALYSIS: HOW? (MOSANNENZADEH AND VETTORATO, 2014)

ACADEMIC	INDUSTRY	GOVERNMENTAL	TOTAL
Technology/ ICT (mainly in infrastructure & services) Collaboration Integration (interconnection) Data gathering/knowledge Social capital	Technology/ ICT (mainly in infrastructure & services) Collaboration Social capital	Technology/ ICT (mainly in infrastructure & services) Collaboration Social capital Proactivity Metrics	Technology/ ICT (mainly in infrastructure & services) Collaboration Integration (interconnection) Data gathering/knowledge Social capital

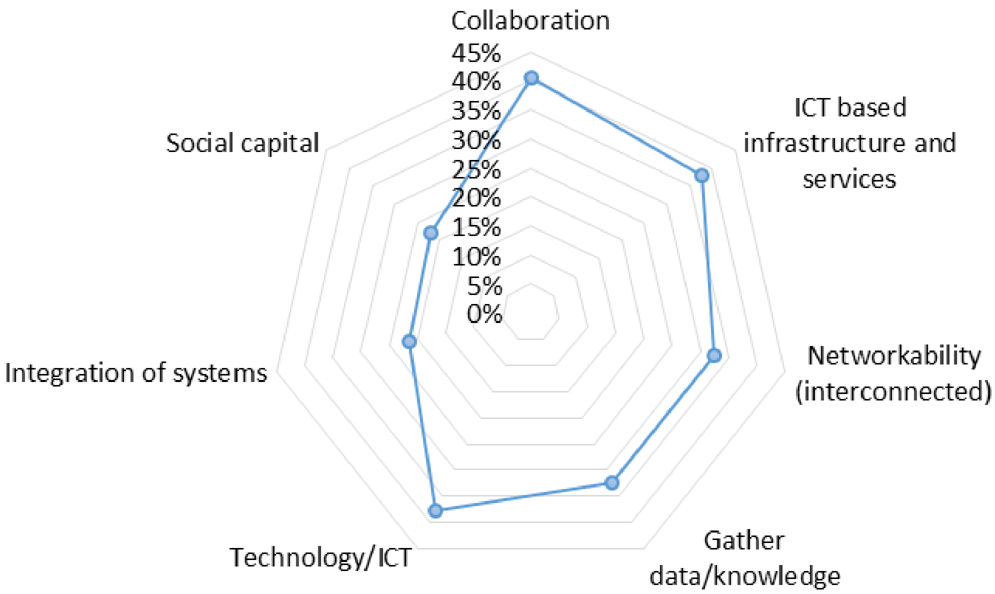

FIGURE 8 - KEYWORD ANALYSIS: HOW?

As visible in Figure 8, within the analysed 37 documents the term collaboration appears most often (in more than 40% of the cases). All other items entailed in the graph above follow up to the item integration of systems and social capital, characterized with a presence of slightly more than 20%.

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- When to transform towards SCs?

The result of the keyword analysis shows no specific time indication for the development of SCs (Mosannenzadeh and Vettorato, 2014). However, future is the most frequent time reference in literature, implying a lack of time as restriction for SCs´ development (Canton, 2011), (Komninos et al., 2011), (Hall, 2000), (Aoun, 2013).

- Where to transform towards SCs?

Literature implies that smartness is a continuous urban development, which can be applied in every city (Aoun, 2013), (Shneider electric, 2014). However, many factors have a role in hindering or accelerating transformation towards smartness - e.g. existing policy frameworks for SCs, existence of experience in implementation of energy interventions and high level of social acceptance of innovative technologies can lead a city to a more successful smart development. Smart cities can have different dimensions from a single city or town to a region, a network of cities, a country or a global dimension (Dameri, 2013).

1.4 TAXONOMY OF SMART ENERGY CITY

The smart energy city (SEC) is a central element of the smart city concept (Nielsen et al., 2013). Optimization of energy sources is one of the main objectives of SCs. In addition, energy is one of the main domains of the analysed term (Mosannenzadeh and Vettorato, 2014). The EC defines higher EE as one of the main components of SCs and communities (EC, 2015B). Thus, smart energy cities (SECs) are considered as one of the main components of SCs.

Even if a series of definition for SECs can be found in literature - e.g. by (Chai et al., 2013), (Eng et al., 2011) and (Nielsen et al., 2013) - there is no consensus on the exact concept of SECs (Nielsen et al., 2013). One of the most recent and important scientific definition is provided by Nielsen et al. (2013): "…The smart energy city is highly energy and resource efficient and is increasingly powered by renewable energy sources; it relies on integrated and resilient resource systems, as well as insight-driven and innovative approaches to strategic planning. The application of information, communication and technology are commonly a mean to meet these objectives. The smart energy city, as a core to the concept of the smart city, provides its users with a liveable, affordable, climate-friendly and engaging environment that supports the needs and interests of its users and is based on a sustainable economy..." Based on this statement and with respect to the definition of SCs provided by Mosannenzadeh and Vettorato (2014), we define a SEC as follows:

A SEC is a sustainable, resilient and efficient city with a high quality of life. A SEC aims to address urban energy challenges, which include increasing EE, a rise of share concerning local renewable energies, intelligent use of energy, and development of low carbon energy systems. The main domains of intervention for a SEC are hard domains on one hand (building and districts, transportation and mobility, energy networks and infrastructure) and soft domains (collaborative planning tools) on the other hand. The key stakeholders of a SEC include decision makers (politicians, city administration, financial institutions, developers, housing companies, R&D institutes and universities), service providers (utilities, energy service companies, network operators, industries, component manufacturers, ICT companies, construction companies and consultants) and target groups (owners, tenants, citizens and farmers). The principles of a SEC are an innovative planning approach, application of ICT in energy infrastructure and services, collaboration between key stakeholders on different spatial scales, integration of hard and soft domains and social inclusion. A SEC is part of the SC, meaning that it is affected by economic, environmental, and social domains and influences these domains in a sustainable way.

1.5 RESULTS

A conceptual framework of SCs is suggested and shown in following Figure 1. The first ring (in yellow) visualizes the objectives of SCs. The second ring (in blue) shows the main domains of the analysed type of cities. The third ring (in green) indicates the main stakeholders and the boxes (in purple) refer to the main principles of SCs creation. Each city can transform towards smartness in time.

Thus, *a SC is a sustainable and efficient city with a high quality of life, which aims to address urban challenges (mobility improvement, optimization of resources use, melioration of health and safety issues, social development progress, economic growth support, and participatory governance) by the application of ICT in its infrastructure and services, collaboration between its key stakeholders (citizens, universities, government and industry), integration of its main domains (environment, mobility, governance, community, industry and services), and investment in social capital* (Mosannenzadeh and Vettorato, 2014).

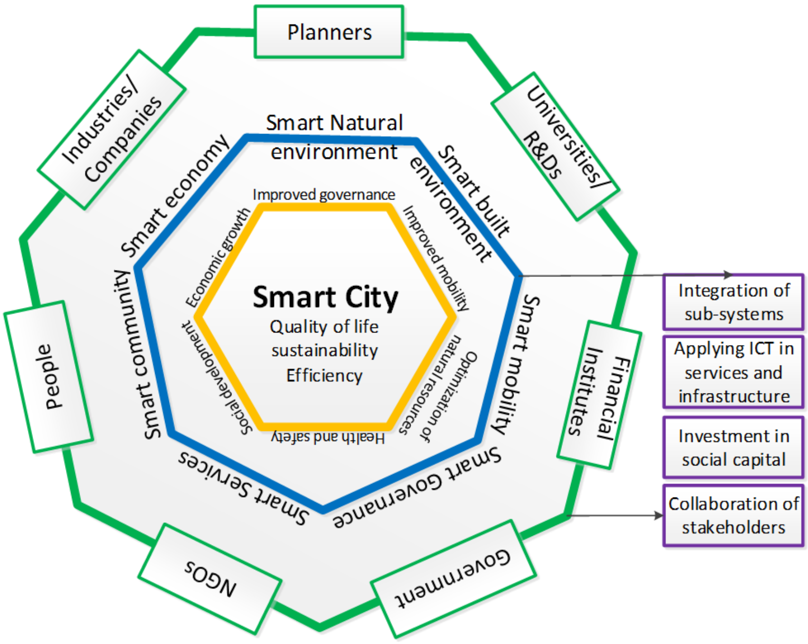

FIGURE 1 - A CONCEPTUAL FRAMEWORK TO DEFINE SMART CITIES (MOSANNENAZDEH & VETTORATO, 2014)

In addition, location issues such as spatial scale, size of the city and area of development has to be considered as well as the time scale and total budget of the transformation towards SCs. It is important to consider application of ICTs to improve the functionality of urban services and infrastructure, integrated planning and implementation and the collaborative work between stakeholders as SCs development principles (Mosannenzadeh and Vettorato, 2014).

Summing up, to analyse SCs we need to at least recognize the following 10 macro criteria entailed in following Table 5:

TABLE 5 - TEN MACRO CRITERIA IDENTIFIED TO ANALYZE SMART CITIES

MACRO CRITERIA
1.) Scales
2.) Goals
3.) Sectors
4.) Stakeholders
5.) Spatial scale
6.) Involvement level
7.) Duration
8.) Size of the area concerning the intervention
9.) Total budget
10.) Technologies applied

The issues exposed in Table 5 above are further investigated and explained in subchapter 3.1.1/3.2.1, SINFONIA´S MOST SIMILAR SMART CITY PROJECTS and 7.3 (GLOSSARY FOR SMART CITIES).

2. SMART CITIES BASELINE SWOT ANALYSIS

As already mentioned in the INTRODUCTION section of the present document, there is a need to learn from previous experiences (already completed and still ongoing SC projects). By doing so, it is possible to avoid already carried out missteps in running SC activities. On the other hand, it is also possible to identify these factors, which brought the analysed projects considerably forward. The latter named projects provide valuable insights regarding how to carry out SC undertakings.

Performing the present SMART CITIES BASELINE SWOT, a list of barriers (weaknesses and threats) and drivers (strengths and opportunities), regarding SC project activities already accomplished so far are provided. Estimations concerning the impact level of the before named barriers and drivers are generated. Therefore, in the present case a quantitative investigation is carried out. Having at disposition a consistent number of experts regarding already completed and ongoing SC projects, it is possible to perform a quantitative SMART CITIES BASELINE SWOT investigation.

Gathering data with regard to prior SC undertakings and extrapolating from these respective strengths, weaknesses, opportunities and threats (SWOTs) it is possible to draw a clear picture concerning which were the difficulties and favourable issues encountered during the transformation of already existing cities into SCs in Europe. Therefore, the following SMART CITIES BASELINE SWOT consists of elements, which are characterized by a certain generality – fitting into an investigation, which aims to analyse the highest amount possible of past and ongoing SC activities.

Within the next coming text sections, first the applied methodology to generate the SMART CITIES BASELINE SWOT is provided (2.1 SMART CITIES BASELINE SWOT METHODOLOGY). Afterwards, the results of the latter mentioned investigation follow straight within the subchapter 2.2 (SMART CITIES BASELINE SWOT RESULTS). Questionnaire and respective contents to carry out the present research are located within chapter 7 (QUESTIONNAIRE AND GLOSSARY) in the final part of the given document. The reader is invited to consult the latter mentioned questionnaire as well, in order to understand in depth the given inquiry.

2.1 SMART CITIES BASELINE SWOT METHODOLOGY

In the present subchapter, the explanation concerning how the above mentioned SMART CITIES BASELINE SWOT is created, follows in various parts. The first one entails information on the data collection regarding SC projects in Europe (2.1.1). Then, it is exposed how barriers and drivers of the latter mentioned projects are gathered (2.1.2). Next, the proceedings to weight the effectiveness of the barriers and drivers categories is given (2.1.3). Finally, it is described how the final SWOT matrix of the present analysis is obtained (2.1.4).

2.1.1 SMART CITY PROJECTS AND THEIR LOCATIONS

An extensive investigation is carried out to identify the highest amount possible of already completed and ongoing SC projects in Europe. Such projects are encountered in the FP6 (Sixth Framework Programme) and FP7 (Seventh Framework Programme) “CONCERTO initiative”, FP7 “Smart cities and communities initiative”, “Amsterdam smart city” undertakings as well as SC activities funded by singular EU member states (or regions/provinces etc.) and/or private corporations (EC, 2012A), (EC, 2012B), (EC, 2014A), (EC, 2014B), (Amsterdam smart city, 2015), (Climate and Energy Fund, 2013). Following paragraphs shed light into the characteristics of the latter mentioned project groups:

CONCERTO (Demonstrating on a large scale how to reduce their consumption of fossil fuels by substitution with renewable energy sources and by demand management) is an initiative of the EC, carried out within FP6 and FP7. These undertakings respond especially to the high energy consumption of building (approximately 40% of the entire EU´s energy use), their huge part on CO2 emissions (around 33% of Europe) and that about three quarter of the energy utilization within the EU28 occurs in cities. In addition, the part of GHG emitted by cities in the EU, equals to the latter mentioned amount. Moreover, EU´s cities are characterized by an enormously unexploited potential of cost effective energy savings. The CONCERTO projects aim to prove that the optimization of communities and districts is more cost effective from an energetic point of view, than intervening building by building. In order to reach the latter mentioned aim, all significant stakeholders have to cooperate in an appropriate way and integrate various technologies in a smart manner. The CONCERTO initiative especially aims to prove the implementation of renewable energy sources (RES) within cities, new technologies ready for application, EE actions, development of sustainable districts and building, transparency of energy at city level as well as economic assessments. CONCERTO projects demonstrate that in case of adequate planning, communities and cities can be transformed into sustainability and EE pioneers. The communities and cities of the CONCERTO initiative are characterized by an important part of its energy use derived by RES, district heating and cooling (DHC) systems, smart grids, energy management systems and cogeneration. An extraordinary important feature of CONCERTO projects is the local optimization of utilized innovative technologies to consider the particular characteristics and opportunities of local conditions (e.g. climate, political issues and cultural aspects). Recommendations for policy makers and employees in the energy sector derived from the CONCERTO experience are particularly important for the “European Innovation Partnership on Smart Cities and Communities”.

The latter mentioned partnership aims to create whole cities energy smart. The CONCERTO projects help the EU to reach its 20-20-20 targets. Until 2020, a decrease in EU greenhouse gas emissions of 20% from 1990 levels is foreseen. Moreover, a 20% drop in primary energy consumption with respect to projected levels of 1990 has to be accomplished by upgrading EE as well. An increase of energy use produced from RES up to 20% is aimed too. The CONCERTO projects are defined itself as “Energy solutions for smart cities and communities” (EC, 2012B), (EC, 2014A) (EC, 2014B).

The FP7 Smart cities and communities initiative projects belong to the SET (Strategic Energy Technology) - Plan Smart Cities and Communities Initiative. Within this initiative, different European cities elaborate innovative measures to support the implementation of low carbon technologies. Related projects address a large range of energy related topics such as energy networks, EE and renewable energy (RE) generation and further other issues of the urban area, such as heating and cooling (H&C), electricity, water management, waste, and transportation (especially green mobility). Two further thematic areas treated by the Smart cities and communities projects are public private partnership (PPP) and energy-efficient building (EeB). Core areas are given by strategic sustainable planning and screening of city plans, large scale systems for urban area, heating and/or cooling supply and nearly zero energy building (nZEB) renovation for cities and districts (EC, 2012A).

Amsterdam smart city (ASC) projects are carried out by the homonymous innovation platform (ASC), which takes care of the metropolitan area in Amsterdam. The latter named projects address residents, businesses, knowledge institutions, and the municipality to propose and implement innovative solutions for the urban area of Amsterdam. The ASC projects support sustainable economic growth and promote the establishment of new markets. The latter mentioned undertakings are performed in close collaboration with the inhabitants of the Dutch capital city. The core aim is to improve the liveability of the city itself. Building, streets, neighbourhoods as well as the entire city are subject of the latter mentioned projects. Amsterdam Smart City is active since 2009 and nowadays counts more than one hundred partners (Amsterdam smart city, 2015).

Moreover, there are a number of SC projects initiated and founded individually by different EU28 member states (their regions, provinces etc.) as well as private corporations. For example, “Austria's Smart Cities and Smart Urban Regions” projects supported by the “Austrian Climate and Energy Fund” and the “SC Vizze” project, funded by the private enterprise SEL AG (Südtiroler Elektrizitätsaktiengesellschaft - South Tyrolean Electricity company jointed-stock company – Jsc.) in Italy (Climate and Energy Fund, 2013).

In fact, the borders between the latter mentioned project groups are floating, and characterized by a number of similarities. Moreover, the above indicated project assemblies respect the SC term extensively exposed in previous chapter 1 (DEFINITION OF SMART CITY).

In order to find the highest possible amount of completed and ongoing SC projects, an extensive research is undertaken, especially by collecting open access information (solely reliable scientific sources are used). Furthermore, data are retrieved by project partners of the FP7 SINFONIA work package (WP) 2 (Design & specifications of scalable/replicable refurbished district templates) as not all SC undertakings are reported by open access fonts (e.g. the before mentioned SC Vizze project). With regard to the data gathering from open access provenance, especially following fonts are used:

- The CONCERTO initiative (EC, 2014A)
- Market Place of the European Innovation Partnership on Smart Cities and Communities (EC, 2014C)
- Amsterdam smart city (Amsterdam smart city, 2015)

On the other hand, regarding the information uptake from project partners please see the list of the SINFONIA WP2 participants in the APPENDIX, DOCUMENT INFORMATION, located at the last page of the given report.

A database is created, entailing all collected SC projects. Within this database, each undertaking is specified by respective cities or locations (regions, valleys etc.) in which SC project activities are carried out. Following Figure 9 visualizes the scheme of the latter mentioned listing manner:

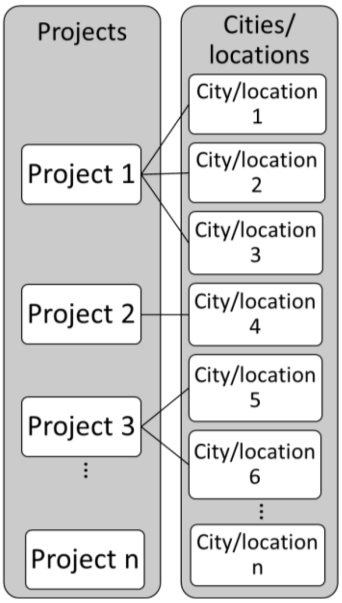

FIGURE 9 - SCHEME OF THE PROJECTS LIST WITH RESPECTIVE CITIES/LOCATIONS

2.1.2 BARRIERS AND DRIVERS OF SMART CITY PROJECTS

As already mentioned above, the core of the present analysis consists into an elaboration of a SWOT analysis. In order to accomplish the latter mentioned aim, the most relevant barriers (weaknesses and threats) and drivers (strengths and opportunities) concerning the implementation of SC projects at EU level are investigated.

Barriers indicate limits/obstacles, which hinder the successful implementation of SC projects, while drivers refer to factors, which create and encourage activity or give force to the implementation of SC undertakings.

Strengths and weaknesses are defined as so-called "internal factors", while opportunities and threats are part of the "external factors" (Mind Tools, 2014). In the present analysis, internal factors are internal to the analysed SC projects. The latter mentioned factors may include project participants, finance, project tools, and models. On the other hand, external factors are represented by the environment external to investigated SC undertakings. The external factors may include macroeconomic matters, technological innovation, legislation, and sociocultural changes.

Within the present analysis, strengths are issues, which give an advantage for the implementation of a SC project. Weaknesses are elements, which place a SC undertaking at a disadvantage relative to its implementation. Opportunities are factors of a SC activity, which could be exploited to its convenience. Finally, threats are defined as factors of the environment, which could cause troubles to a SC project (Pahl and Richter, 2009), (Mind Tools, 2014).

Starting from the SC projects list described above, for each city/location, incurred barriers and drivers are researched. In order to collect the different barriers and drivers, an extensive research is undertaken, especially by gathering data from open access sources (again solely reliable scientific sources are used). Furthermore, barriers and drivers are retrieved through expert questioning. In this case, experts are intended as project participants, who were or are still involved in at least one SC project.

With regard to the data collection from the web, again especially "The CONCERTO initiative" home page (HP) has been used - as barriers and drivers are already described per city/location of the projects under the link "More detailed" (EC, 2014A). By doing so, it was possible to retrieve barriers and drivers for a number of the latter mentioned projects.

In order to create a balance between barriers and drivers derived from CONCERTO and non-CONCERTO projects, the same amount of experts as CONCERTO projects analysed are asked concerning barriers and drivers encountered during the execution of the SC project/s (only non-CONCERTO ones) they worked in. Hence, the collected barriers and drivers of all investigated undertakings account for 50% CONCERTO and 50% non-CONCERTO ones.

Main reason to generate a database of barriers and drivers given by the same amount of CONCERTO and non-CONCERTO projects is their difference regarding the period of execution, which leads to considerably different barriers and drivers encountered. For example, as the CONCERTO initiative started already in 2005, within this kind of SC projects almost no indications regarding the economic crisis are given. In contrast to that, at the non-CONCERTO projects the economic crisis is indicated as a barrier for the absolute majority of cases.

It has to be stressed, that concerning expert interviews, solely empirical information are considered. Even if ongoing SC projects are analysed too, the retrieved information concern only already occurred barriers and drivers encountered during the projects execution. Experts are asked to provide exclusively the latter mentioned kind of information by phone interviews.

Then, the assembled barriers and drivers are allocated next to their respective projects and cities/locations in the before described database (Figure 9 - SCHEME OF THE PROJECTS LIST WITH RESPECTIVE CITIES/LOCATIONS). From that two databases are formed: one for barriers and the other one for drivers. Following Figure 10 shows the patterns of the latter indicated databases on the example of barriers:

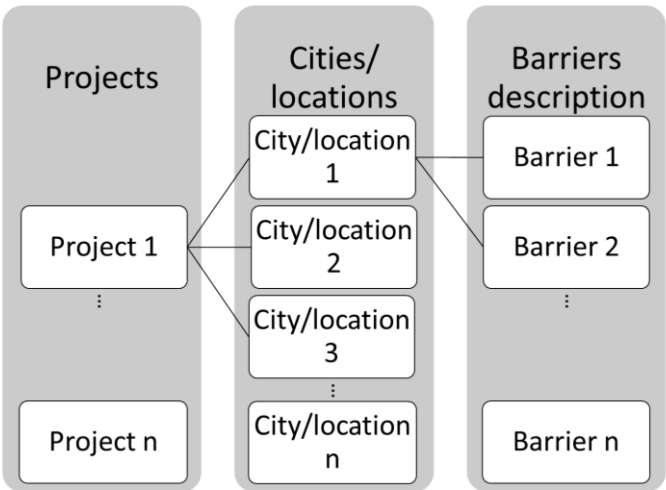

FIGURE 10 - SCHEME OF THE PROJECTS LIST WITH RESPECTIVE CITIES/LOCATIONS AND BARRIERS

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2.1.3 CATEGORIES OF BARRIERS AND DRIVERS & THEIR EFFECTIVENESS

In order to assemble the huge amount of retrieved barriers and drivers, the latter mentioned information are grouped by taking into consideration different categories. These categories are derived from an extensive bottom-up exploratory study. First, a literature review is undertaken to collect common barriers for the implementation of energy projects. The data collection is concentrated on the experience of preceding investigation. Especially the document "Categorizing Barriers to Energy Efficiency: An Interdisciplinary Perspective" published by Thollander, Palm and Rohdin (Linköping University, Sweden) in 2010 is useful for the latter mentioned aim. Also the script "OVERCOMING BARRIERS TO CLEAN DEVELOPMENT MECHANISM PROJECTS" composed by the Organization for Economic Co-operation and Development (OECD) and appeared in 2007 provides interesting insights. The document "Energy Efficiency Governance" written by the International Energy Agency (IEA) and published in 2010 results to be very informative too (Thollander et al., 2010), (OECD, 2007), (IEA, 2010). Then, the most common barriers encountered within the analysed scientific literature (named at least by three different sources) are selected.

Afterwards, the selected barriers are neutralized. Through the latter mentioned step, neutral categories are obtained, which can be used for categorization in the above mentioned barriers´ as well in the drivers´ database. Furthermore, the neutral categories can be considered either as barriers as well as drivers – depending by the different cases (SC projects). For example: Lack of political commitment over the long term (barrier) → Political commitment over the long term (neutral category: barrier or driver). Finally, the obtained neutral categories are grouped into macro categories according to their thematic affiliation (policy categories, administrative categories etc.).

Then, experts are contacted to quantify the effectiveness of the above selected categories on SC projects. Once more, experts are considered as project participants, who were or are still involved in at least one SC project. The above mentioned effectiveness corresponds to the relevance level of the selected categories regarding each analysed project. The interviewees quantified the effectiveness of the categories in relation to the SC project/s they were/are involved in.

It has to be stressed, that the above described effectiveness quantification derives from the perception of the various experts. Hence, the acquired quantifications come from the process to perceive through senses of the project participants. Furthermore, again solely empirical information are considered.

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The utilized questionnaire is attached in the chapter 7: QUESTIONNAIRE AND GLOSSARY (7.1 BARRIERS AND DRIVERS QUESTIONNAIRE). While the fulfilled questionnaire are not enclosed for privacy issues. All expert interviews are carried out by phone, so that incomprehension concerning the posed inquiries can be clarified immediately.

As visible in the latter mentioned questionnaire, the last query is: "Further categories that are relevant to you but have not been mentioned in this questionnaire". By asking so, further categories have been named by interviewees, which are evidenced in the following results section 2.2.3 (EFFECTIVENESS OF BARRIERS AND DRIVERS CATEGORIES). These additions do not exhibit the same number of marks as the other categories. However, practically all effectiveness values result from a different number of weights given, as not all categories are marked by the total number of asked experts. Answers not given by interviews are inserted as empty cells in the respective calculations database. Hence, these do not have any influence on the results calculation.

A sample size of n = 30 filled in questionnaire is collected to derive an effectiveness quantification per asked category. There is no general rule, which states how great a sample should be, to carry out acceptable statistical elaborations. To accomplish the latter mentioned aim, often a minimum of thirty cases is used (Lacy and Riffe, 1996), (Hogg and Tanis, 2005), (Hill, 1998), (Dominutti, 2015). The possible values indication per factor range from -5 to +5, including the value of 0 on a Likert scale:

- -5 equals to a very effective barrier and -1 to a less effective barrier
- 0 = neutral
- +5 equals to a very effective driver and +1 to a less effective driver

To calculate the effectiveness per category, the average of absolute values given by experts is used. Hence, given values by experts are transformed to positive numbers and then their average is calculated. The reason to use the average of absolute values to determine the effectiveness per category, is that in this way the pure relevance of the categories is extracted, not taking into consideration the counter position of positive and negative values (Clapham and Nicholson, 2009).

A consistency analysis is implemented as well, which determines how much experts agreed on the importance of the categories. The interquartile range (IQR) of the weights distribution is chosen to quantify the agreement level among experts (Schenler et. al, 2009), (Stevenson, 2009), (Malczweski, 1999). This metric indicates the difference between the 75th percentile and the 25th percentile of the data. The 75th percentile is the weight under which 75% of all the marks per category lie. The higher the interquartile range, the less is the experts´ agreement level (Lane, 2010).

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2.1.4 FINAL SWOT MATRIX

Next, the two above shown data collections visualized in Figure 9 (SCHEME OF THE PROJECTS LIST WITH RESPECTIVE CITIES/LOCATIONS), 10 (SCHEME OF THE PROJECTS LIST WITH RESPECTIVE CITIES/LOCATIONS AND BARRIERS), and the selected categories (categories and macro categories) are brought together to form a matrix. Within the latter mentioned matrix, the y-axis consists of the projects with respective cities/locations and barriers or drivers descriptions, while the x-axis is formed by the before mentioned categories. The sense of such a matrix composition lies in the possibility to check which category applies to each barrier and driver identified. Figure 11 shows the scheme of the above described matrix on the example of barriers:

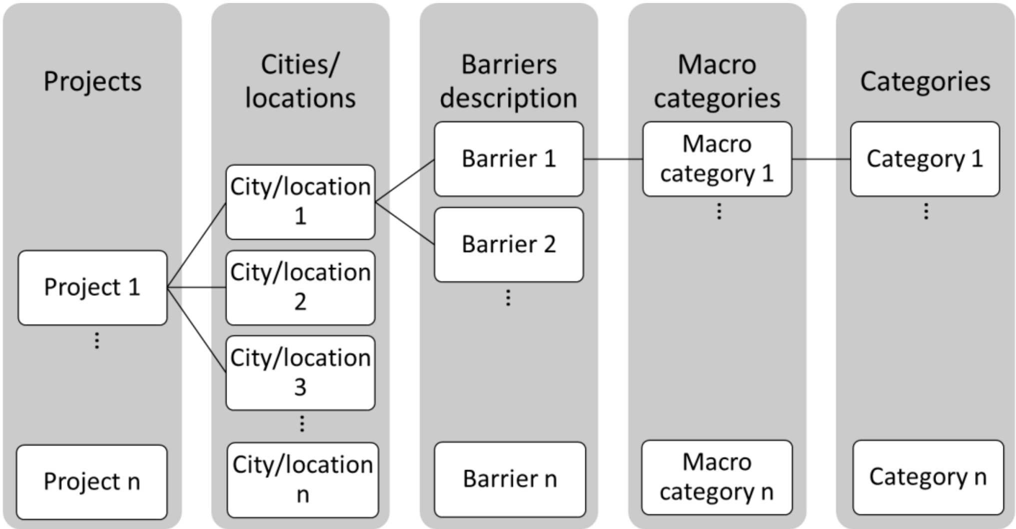

FIGURE 11 - SCHEME OF THE PROJECTS LIST WITH RESPECTIVE CITIES/LOCATIONS, BARRIERS AND CATEGORIES

As the selected categories are able to describe the various barriers and drivers solely in a very general manner, two further sections in the above mentioned x-axis have been added: “Causes” and “Effects”. By adding these new descriptions per barrier and driver it is possible to describe meaningful categories, appropriate for the use within a conclusive SWOT matrix. See Figure 12:

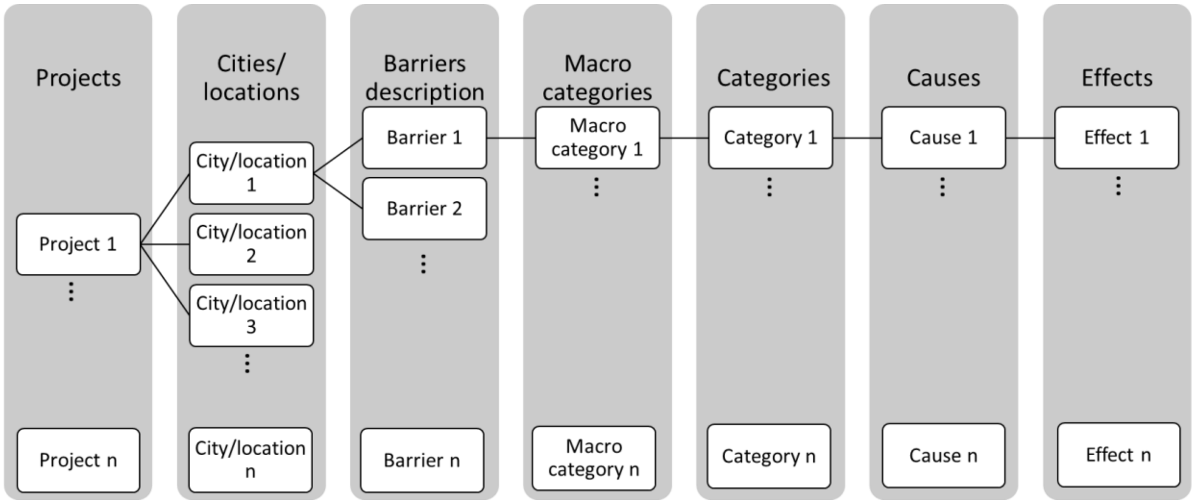

FIGURE 12 - CATEGORIES EVALUATION OF BARRIERS

Next step of the given SWOT analysis consists into the evaluation of the categories. To quantify the impact level of the various categories on past and ongoing SC projects in Europe, a weighting procedure is carried out. Each category is evaluated by a multiplication of its number of appearance within all collected barriers or drivers and its respective effectiveness value.

As already mentioned, this procedure is followed as for the barriers as well as for the drivers' database. Following Figure 13 visualizes the latter described evaluation methodology on the example of barriers:

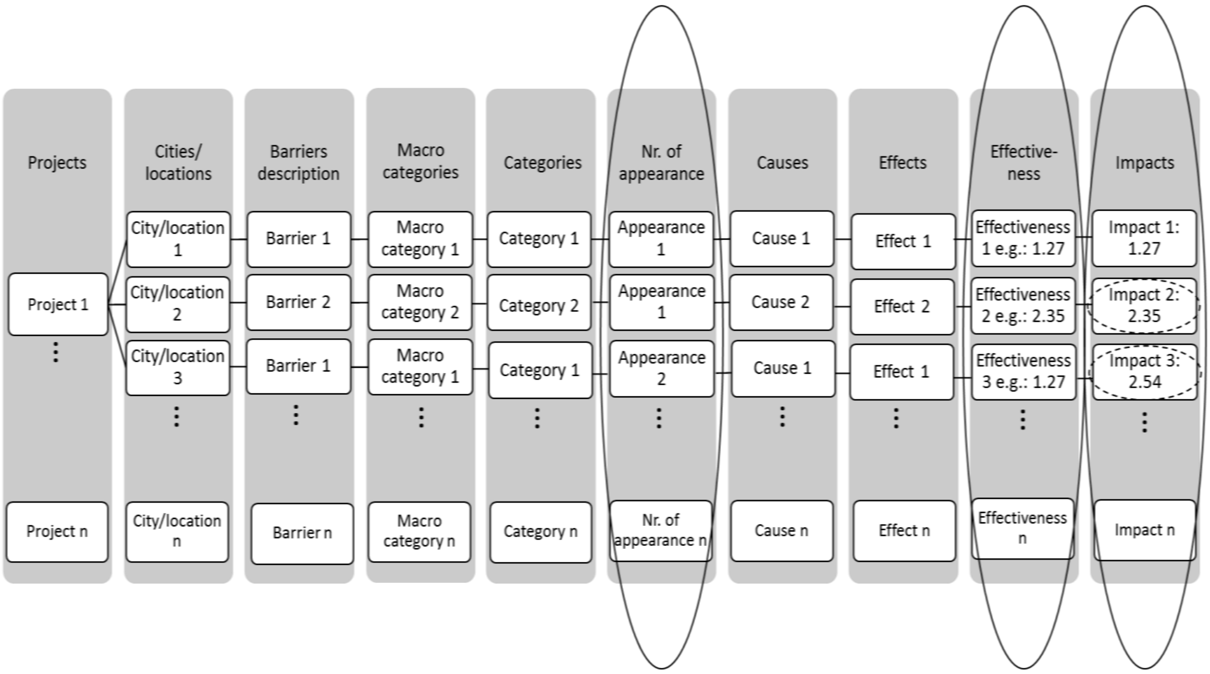

FIGURE 13 - SCHEME OF THE IMPACT CALCULATION FOR BARRIERS

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After, these impact values and respective categories are inserted in the final SWOT matrix, which result from the multiplication of the total amount of appearance per category and their respective effectiveness values. For example, in Figure 13 above, the impact number 2.54 for category 1 (two appearances in total) and the impact value 2.35 for category 2 (just one appearance in total) – both latter mentioned impact values are marked with dashed lines – would be inserted within the SWOT matrix with their respective categories. In contrast, the impact value 1.27 for category 1 would be disregarded as not resulting from the total number of appearance for its category.

The allocation determination of the categories within the SWOT matrix section (either strengths, weaknesses, opportunities or threats) is carried out according to the indication given in subchapter 2.1.2, BARRIERS AND DRIVERS OF SMART CITY PROJECTS, explaining what are internal as well as external factors and which issues belong to the four section.

The allocation of different categories within the four parts of the SWOT matrix (SWOTs) is difficult when the limits of the item´ belonging are floating. In these cases, the attribution to a section rather to another one is carried out by analysing if the categories are more part of one side rather than another one.

Finally, an evaluation methodology is applied to retrieve a quantitative result from the acquired SWOT matrix. After having assigned to each category in the SWOT matrix its corresponding impact value, these numbers are summed up per section (SWOTs). Next, a counter position follows between the internal (strengths and weaknesses) and external (opportunities and threats) parts of the final SWOT matrix. Finally, also the two resulting values of the latter mentioned mathematical proceeding are brought against each other, determining the overall result of the described matrix. For example, according to the illustration given in Figure 13, strengths and weaknesses show a total impact value of +15 and -10 respectively. Thus, the outcome for the internal part of the final SWOT results to be positive: +5. Furthermore, opportunities indicate an impacts´ sum of +2 and the threats are characterized by a total amount of impacts corresponding to -14. Hence, the external section of the matrix shows a negative result: -12. Consequently, the overall outcome of the SWOT matrix emerges to be -7.

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This result represents the final outcome of the matrix, which is able to provide a general indication concerning how smooth or difficult it was until nowadays to carry out SC projects in Europe. In the present example, a certain difficulty in carrying out SC projects at European level so far is indicated. In this case, the final outcome is especially conditioned by the result of the external part of the SWOT matrix.

Following Figure 14 describes graphically the latter mentioned evaluation methodology using randomly selected numbers for the given example:

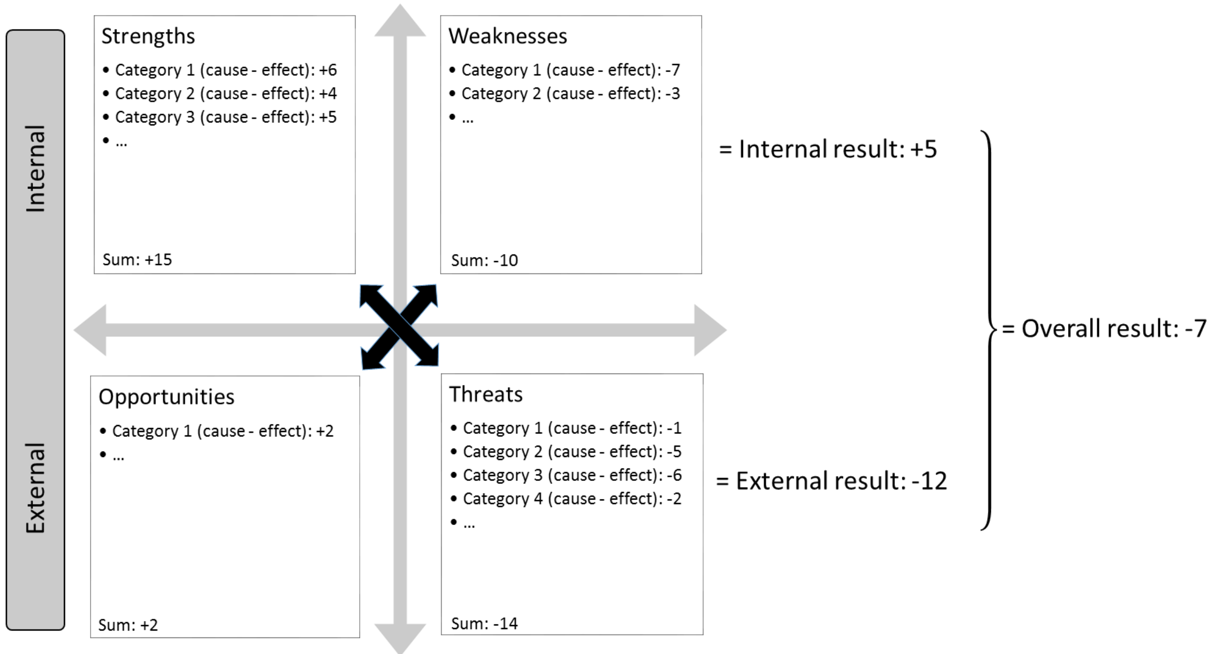

FIGURE 14 - QUANTITATIVE APPROACH OF THE UTILIZED SWOT MATRIX

Within a last step, logical connections are created between categories present in the strengths and threats sections, as well as for these entailed in the opportunities and weaknesses parts. By doing so, advice can be provided, which explain how the present drivers (strengths and opportunities) can be utilized to overcome barriers (weaknesses and threats) connected to them. The above present crossed arrows, in the middle of given Figure 14 indicate the latter mentioned process.

2.2 SMART CITIES BASELINE SWOT RESULTS

Within the present subchapter, the results regarding the above described SMART CITIES BASELINE SWOT methodology are given in different parts. First, the outcome of the data collection concerning SC projects in Europe and respective cities/locations is exposed (2.2.1). Then, the found barriers and drivers of the latter mentioned SC activities are given (2.2.2). The before indicated section entails also the collected categories of barriers and drivers. Next, the results concerning the effectiveness of the before indicated barriers and drivers are shown (2.2.3). After, causes and effects of barriers and drivers´ categories are described and the final SWOT matrix of the present investigation is visualized and interpreted (2.2.4). Finally, recommendations are provided on how to utilize drivers to overcome barriers present in the final SWOT matrix (2.2.5). The latter mentioned subchapter entails also indication by what method certain drivers could be utilized to enforce other positive elements of the respective SWOT matrix. Moreover, it is explained by which means minimizing specific barriers, it is possible to avoid other negatives of the same SWOT matrix.

2.2.1 SMART CITY PROJECTS AND THEIR LOCATIONS

The amount of collected SC projects (already completed and still ongoing ones) accounts for approximately one hundred cases. The CONCERTO undertakings consist of slightly more than twenty cases, which equals to a percentage of approximately 25% on the total number of collected projects. In contrast to that, the residual part belongs to undertakings of the Smart cities and communities initiative, ASC projects as well as SC activities funded by singular EU member states (or regions/provinces etc.) and/or private corporations. The latter mentioned cases consequently correspond to the remaining 75% of the total collected SC projects.

There are a number of differences between CONCERTO projects and undertakings of the Smart cities and communities initiative, ASC projects as well as SC activities funded by the singular EU member states (or regions/provinces etc.) and/or private corporations. The latter mentioned diversities refer especially to organizational characteristics. First, all considered CONCERTO projects show a durability, lasting between three and seven years. In contrast, the residual SC undertakings indicate a lower durability, because a number of projects (more than 10 cases) are characterized by a project duration of one to two years solely. The CONCERTO initiative is characterized by a higher involvement of inhabitants per project. In about 50% of the CONCERTO initiative cases an involvement of 5,000 to 50,000 inhabitants is given, while such a large range is never encountered for the remaining SC activities. The same applies to the size of the projects in terms of area [ha]. The CONCERTO projects register a higher number of cases carried out in huge ranges with 1,000 to 5,000 and 5,000 to 30,000

[ha] respectively. Also the total budget per project appears to be generally higher in the case of CONCERTO undertakings. In comparison to the aforementioned remaining SC projects, the CONCERTO initiative undertakings show a higher number of total budget within the level of 20 to 30 [Mil.€] as well as for the range between 40 to 50 [Mil.€]. In contrast to that, the residual SC projects are characterized by a five times higher number of cases within a level, which shows a total budget ranging from 0 to 10 [Mil.€] (EC, 2014A), (EC, 2014C), (Amsterdam smart city, 2015).

The above indicated around one hundred SC projects are carried out within approximately 150 cities/locations. Hence, each collected SC project consists in average of about one to two places. However, a number of collected SC projects are even characterized by one to seven locations and a singular project (the “PLEEC” project) has more than 10 of them (EC, 2014A), (EC, 2014C), (Amsterdam smart city, 2015). Figure 15 shows the latter mentioned localities within a map of Europe and its surroundings:

FIGURE 15 - SMART CITY LOCATIONS IN EUROPE AND ITS SORROUNDINGS (EC, 2014A), (EC, 2014C), (AMSTERDAM SMART CITY, 2015)

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Like visible in Figure 15, there is a concentration of SC projects in different parts of the EU. An agglomeration of such projects is given in the middle of Europe: Swiss, Austria and northern part of Italy. A high concentration of projects is present also within the Benelux countries – especially in Amsterdam. The capital city of Netherlands is characterized by the highest number of SC activities in Europe: about thirty undertakings are allocated here, which corresponds to around 20% of the total cities/locations taken into consideration. There are also other localities, which appear at least twice, up to a maximum amount of four times: Hamburg, Hannover, Copenhagen and Vienna. Finally, also the border area between Denmark and Sweden registers an agglomeration of the treated SC projects.

2.2.2 BARRIERS AND DRIVERS OF SMART CITY PROJECTS & THEIR CATEGORIES

As already mentioned within subchapter 2.1, SMART CITIES BASELINE SWOT METHODOLOGY, an extensive survey is carried out to retrieve the barriers and drivers related to SC projects and their city/locations. The outcome of the latter mentioned investigation shows an extraordinary high amount of barriers (more than 400) and drivers (not less than 300).

Next, a number of categories are researched through an extensive literature review to assemble the found barriers and drivers into categories. Following Table 6 indicates the retrieved categories (national roadmaps, strategies, and policies for energy goals etc.) and respective macro categories (policy factors, administrative factors etc.) used to analyse the different barriers and drivers of the collected SC projects:

TABLE 6 - CATEGORIES AND MACRO CATEGORIES USED TO GROUP BARRIERS & DRIVERS OF SMART CITY PROJECTS (THOLLANDER ET AL., 2010), (OECD, 2007), (IEA, 2010), (IEA, 2007), (KAMINKER AND STEWART, 2012), (WEC, 2012), (OECD, 2011), (BROWN AND ZHOU, 2012), (LEE, 2010), (ELZINGA, 2013), (PEZZUTTO, 2014), (BIRCHALL ET AL., 2014)

POLICY CATEGORIES
National roadmaps, strategies, and policies for energy goals
Political commitment over the long term

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ADMINISTRATIVE CATEGORIES
Cooperation and trust between different stakeholders
Communication between project participants and the public to increase awareness
Existence of multi-actor/multi-sectorial planning tools
Share of valuable data between different departments
Existence of public-private engagement models
Existence of financing models suitable for the innovation to address stakeholder involvement
Public procurement
Coordination of a large number of tenants
Marketing application for awareness and involvement
Set up of institutions to support the projects
Obligations given to project participants
Public participation

LEGISLATIVE CATEGORIES (IMPLEMENTATION AND ENFORCEMENT)
Transparency of legislation
Consistency of implementation and interpretation of law
Existence of regulatory stability
Development procedures that may inhibit or trigger implementation of SC projects
Local budgetary legislations
Existence of knowledge about future litigations
Effectiveness of regulations for implementation of technologies and solutions
Existence of updated regulation and rules for new technologies
Procedures for authorization of technologies

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LEGISLATIVE CATEGORIES (CROSS-SECTORIAL AND INTERNAL COHERENCE)
Existence of data security and privacy
Tax pressure
Transparency of taxation system
Availability or lack of subsidies
Existence of regulatory incentives for implementation of SC projects
Tariffs regulations

TECHNICAL CATEGORIES
Existence of affordable and mature technologies suitable for local conditions
Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions
Existence of training material
Monitoring

ECONOMIC CATEGORIES
Adverse selection
Principal-agent relationship
Split incentives

FINANCIAL CATEGORIES
Hidden costs
Accessibility to capital
Risk and uncertainty
Up-front costs
Costs of material, construction, and installation
Economic crisis
Existence of financial schemes
Combining of different financial schemes
Stability of costs during project life cycle
Payback time

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OPERATIONAL CATEGORIES
Existence of tried and tested solutions and proven on the ground examples
Complexity of applying solutions with regard to local conditions
Interoperability between systems
Supporting hard infrastructure
Well-defined or documented in detail processes
Existence of performance indicators for technologies implementation

BEHAVIORAL CATEGORIES
Form of information
Credibility and trust
Values related to energy efficiency, which may inhibit measures from being undertaken
Inertia
Bounded rationality
Public acceptance of technologies

As visible in Table 6, the macro category characterized by the highest number of categories is the legislative part, followed by the administrative and financial section. The legislative part is subdivided into two relatively different sections: one referring to the area of implementation and enforcement, while the other one relates to cross-sectorial issues and internal coherence. Following text section sheds light on these two concepts:

a.) Implementation and enforcement

Implementation of legislation refers to the realization of a policy. The latter mentioned concept has to be phased in compliance with the public to be successful. Implementation processes can be complemented by the utilization of media, with the aim to increase respective awareness from side of the public. Implementation and enforcements refers to official instructions that clarify and enforce new policies, which should get integrated into real practice. These instructions are most often fiscal matters (Gerber et al., 1998). Facets of enforcement are closely related to the latter mentioned issue, because without it a legislation could fail its implementation (Stevenson, 2010), (WHO, 2015).

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b.) Cross-sectorial and internal coherence

In contrast to the concept explained in the paragraph above, the term cross-sectorial indicates the relation and affecting of a policy on more areas and sectors. Closely related to that, is the correspondence between various objectives of equal intervention (internal coherence). The latter mentioned term implies a hierarchy of objectives, in which the objectives located at the bottom, contribute in a logical manner towards the achievement of those positioned above, so that a coordination and alignment of strategies and measures for policies application is given (Stevenson, 2010), (Herrfahrdt-Pähle, 2013).

Within following part of the present report, the selected categories visualized by Table 6 (CATEGORIES AND MACRO CATEGORIES USED TO GROUP BARRIERS & DRIVERS OF SC PROJECTS) are explained in detail. Each category is described concerning its meaning and possible negative effects (barriers). If the latter mentioned negative effects are not given, the described categories are assumed to be drivers for SC projects. Like already mentioned above, the categories are divided into macro categories, showing their main domains. Nevertheless, each category is characterized by its own administrative, legal, technical, economic, financial, operational, and behavioural aspects (Weber, 1997).

Policy factors

- National roadmaps, strategies, and policies for energy goals

These refer to supporting policies for achieving the aims of SC projects (e.g. member state plans aiming to reach the EU 20-20-20 targets). The above indicated roadmaps, strategies, and policies are relevant as frame conditions for the successful implementation of the treated type of projects. A lack of such an assistance means also a lack of political support. Ideally, infrastructure projects need to be part of a long-term strategy (up to 10 years) to be economically attractive. If policy support for them is in doubt, investors are likely to remain away (OECD, 2007), (Kaminker and Stewart, 2012), (IEA, 2007).

- Political commitment over the long term

The above mentioned term indicates political support for SC projects during the long term. Inconsistent political assistance, mainly due to changes in local government, can delay or even stop project activities. There are a number of SC projects, at which the previous local government was in favour, while the next one did not approve the projects undertakings. Hence, the latter indicated projects suffered of consistent delays or went even partially stopped (Kaminker and Stewart, 2012), (Pîrlogea, 2011), (EC, 2015C).

Administrative factors

- Cooperation and trust between different stakeholders

The majority of SC projects involve a high number of partners and authorities (Mosannenzadeh and Vettorato, 2014). Due to different timing of project partners and their conflicting interests, cooperation barriers can arise (Golev et al., 2014). Because of the latter mentioned reasons, also a lack of trust and acceptance between collaborates can occur. The consequence is missing interactive and productive collaboration (Goh, 1997), (Cagno et al., 2013).

- Communication between project participants and the public to increase awareness

A lack of adequate understanding and information concerning SC projects to utilizers and inhabitants can lead to an interruption or stop of proper participation. The latter mentioned reasons can cause also an aversion and resistance to the treated projects. Basically, there are two types of obstacles concerning project information: missing availability of information and asymmetric access to them (Sorrell et al., 2000), (Howarth and Andersson, 1993), (Sanstad and Howarth, 1994). The first named type of obstacle is encountered more often in the analysed SC projects (EC, 2015C), (EC, 2014C), (Amsterdam smart city, 2015).

- Existence of multi-actor/multi-sectorial planning tools

The above indicated term refers to the use of tools, utilized for supporting urban energy planners in assessing the best decisions within a complex environment such as SCs. The terms multi-actor and multi-sectorial do not indicate exactly the same objectives, but are closely related one to each other. The denomination multi-actor refers to the actors within SCs, like i.) dwelling occupants, ii.) employees, iii.) drivers etc. On the other hand, the denomination multi-sectorial indicates hard infrastructure facilities such as i.) houses, ii.) industrial production sides, iii.) streets aso. Examples of multi-actor/multi-sectorial planning tools are: EnerGis, SUNtool, CitySim as well as various forms of multiple-criteria decision analysis (MCDA – e.g. social multi-criteria evaluation) (Ouhajjou et al., 2014), (Munda, 2006), (Falquet et al., 2011). If the latter mentioned planning tools are not applied non-optimal decisions can be taken.

- Share of valuable data between different departments

The present category relates to the exchange of relevant information not only between close collaborators (e.g. project partners), but also on a larger scale - as for example consortia of different projects. Closely related to that is the concept of open data (Auer et al., 2007), (Lee, 2010). Transparency and openness of data should help to overcome the barrier of a larger deployment concerning SC projects (Smart Cities Stakeholder Platform, 2015). Through openness and transparency of information, also external consultation activities to projects are possible, which lead to solving problems not adjustable internally. If a share of valuable data between different departments is not given, delays or even a stop of project activities might occur (EC, 2012B).

- Existence of public-private engagement models

The term above indicates collaborations between the public and private sector in SC projects. The present concept refers especially to the active involvement of project participants and the population. The latter mentioned activity is of extreme importance for the successful implementation of projects (IEA, 2010), (WEC, 2012), (OECD, 2011), (Thollander et al., 2010). A number of interviewees argued that if the before indicated undertaking is not carried out, not only missing collaboration can arise as a consequence, but also aversion and resistance to the projects can appear.

- Existence of financing models suitable for the innovation to address stakeholder involvement

In order to accomplish the aims of SC projects (retrofitting, implementation of RES, construction of high performance building, application of innovative technologies etc.) the involvement of stakeholders is crucial, because without it, projects would lack of a real implementation. Moreover, low attention to the involvement of stakeholders during the whole life cycle of the project may lead to miss-placed priorities and a decreased rate of adoption and diffusion of undertaking decisions among target groups, as well as inadequacy of support and acceptance concerning interventions (Painuly, 2001), (Reed, 2008). To involve stakeholders, financing models are helpful, which provide possible solution to finance stakeholders' participation in SC projects (e.g. by providing an acceptable return on investment – ROI – for their efforts).

- Public procurement

The present term refers to the purchase of commodities and services executed by the public sector (Thai, 2008). Public procurement accounts for a relevant function of governments to achieve especially social and economic goals. Well-working public procurement is characterized by transparency and is non-discriminatory. However, a number of barriers can arise when applying public procurement: high time consumption connected to bureaucratic delays, malpractice due to insider dealings etc. (Thai, 2005), (Dutton J., 2007). Therefore, public procurement can delay or hinder the execution of project activities.

- Coordination of a large number of tenants

A large number of tenants (e.g. homeowners and dwelling occupants with renting contracts) characterizes the majority of SC projects. Their coordination is crucial for the success of the projects, as an appropriate use of technologies is desired as well as the collection of the tenants´ feedback concerning the projects interventions etc. (EC, 2012A), (EC, 2014B), (Amsterdam smart city, 2015), (Middlebrook, 1988). Thus, if a coordination of a large number of tenants is not foreseen, a barrier to the projects proceedings could be given.

- Marketing application for awareness and involvement

The given term refers to the communication of values and services related to SC projects. Main purpose of the latter mentioned undertaking is to promote the treated projects type, increase the awareness of the population concerning these and raise the populations´ involvement into SC activities. Television, radio and newspaper communication are used among others to reach the latter mentioned aims. Internet communication technologies are crucial to achieve the before named challenges (Lucent, 2012), (EC, 2015B), (Giffinger et al., 2007).

- Set up of institutions to support the projects

The here described concept relates to the fact, that within a number of SC projects, new institutions (e.g. energy agencies) are set up (EC, 2015B), (Deakin and Al Waer, 2012), (Gamper, 2014). Main reason for the establishment of new institutions within the analysed projects is the creation of an operative unit, which supports the SC project activities. The lack of such an institution could lead to a barrier of the project, as an important support is missing.

- Obligations given to project participants

In order to carry out project activities in a smooth manner and achieve the set goals of undertakings, obligations (e.g. in form of contracts) are given to project participants - for example between stakeholders and tenants. The latter mentioned obligations are also legally binding ones, for which a penalty can incur if not fulfilled (EC, 2015B), (Perrone, 2014), (Potts, 2014). In the case of absence concerning such obligations, certain project activities can go in a wrong way (e.g. monitoring activities fail because of an inappropriate behaviour of utilizers).

- Public participation

Public participation refers to obstacles related to insufficient attention in involving the public and key players of SC projects during the whole life cycle of the undertakings. The latter mentioned barrier, can lead to a minor rate of diffusion and adoption concerning project decisions among target groups, as well as a lack of acceptance and support to project activities (Painuly, 2001), (IEA, 2010), (WEC, 2012). Therefore, problems concerning project implementation can be generated.

Legislative factors (Implementation and enforcement)

- Transparency of legislation

The given term relates to the perceived quality of intentionally shared information from side of the legislator (Schnackenberg, 2014). Transparency of legislation is crucial for the implementation of project activities, as non-transparent and complex laws generate uncertainty and therefore lead to not undertaken investments. Furthermore, if needed transparency is not provided in order to understand which requirements have to be respected, time delays in running project activities can occur as well (Kaminker and Stewart, 2012), (OECD, 2007).

- Consistency of implementation and interpretation of law

The logical coherence among legislation and explanation of its meaning is highly important for attracting investments in SC projects and their execution. Non-consistency of implementation and interpretation of laws represents a barrier for investments, because it either rises the risk of non-compliance or increments the time and resources required to interpret legislation. Moreover, uncertainty concerning laws lead to the risk that projects do not perform as intended, because the legal requests connected to their implementation are not clear (OECD, 2007), (Kaminker and Stewart, 2012), (Dalmau, 2015). Hence, time delays can occur as well.

- Existence of regulatory stability

Ambiguous governmental policies generate uncertainty and lead to unclear investment situation. Thus, investments in projects can be hindered or even stopped (Kaminker and Stewart, 2012), (Painuly, 2001), (IEA, 2007). In addition, the project costs can rise consistently due to shifts in project activities caused by instable regulations.

- Development procedures that may inhibit or trigger implementation of SC projects

The present category refers to urban development plans (including respective procedures and regulations), which can hinder or even stop the implementation of SC project interventions, such as for example energy sanitation of historical building (Zagorskas, 2013), (Ibrahim, 1998), (IEA, 2010), (Elzinga, 2013), (Legambiente, 2013).

- Local budgetary legislations

Local legislation (e.g. on regional or provincial level) with regard to the budgetary situation for implementing activities in line with SC projects (e.g. restrictions for foreign investments) can inhibit or stop the implementation of project measures. Thus, unfavourable legislation for innovative technologies (e.g. restrictions related to building aesthetics) are given (Painuly, 2001), (IEA, 2007), (Kaminker and Stewart, 2012).

- Existence of knowledge about future litigations

Future regulatory instability or imminent uncertain governmental policies create insecurity and result in unclear investment situations. Therefore, the latter mentioned ambiguity can hinder or even stop investments in SC activities. In addition, the costs of the project could increase too, as unexpected payments arise (Kaminker and Stewart, 2012), (Painuly, 2001), (IEA, 2007).

- Effectiveness of regulations for implementation of technologies and solutions

Conventional regulatory systems are not always appropriate for the implementation of innovative technologies such as smart grids and photovoltaics (PV) (Luthra et al., 2014). The latter mentioned barrier indicates ineffectiveness or non-existence of relevant regulatory bodies, regulations hindering the implementation of innovative technologies and solutions, non-working implementation of these, and inadequate legislations to promote innovative technologies. The latter mentioned issues complicates the implementation of technologies suitable for SC undertakings and can hinder or stop related investments (Painuly, 2001), (Elzinga, 2013), (Brown and Zhou, 2012), (Luthra et al., 2014).

- Existence of updated regulation and rules for new technologies

Legislation of European member states are not always suitable for recent technologies´ implementation. Thus, their application can result as difficult, especially from a legislative point of view (e.g. use of wind turbines in urban areas due to noise problems) (Hansen, 2011). The latter mentioned unfavourable regulations for new technologies can hinder or even stop investments in SC activities (Painuly, 2001), (Luthra et al., 2014).

- Procedures for authorization of technologies

The term above indicates complicated and long lasting procedures needed for the authorization of technologies implementation. The existence of numerous authorities involved in licensing procedures, along with problematic procedures and time consuming permissions for implementation and development of projects activities delay or stop the projects´ execution (Pîrlogea, 2011). Within the analysed SC projects, the before indicated barrier concerns mainly RES technologies like PV (EC, 2015B).

Legislative factors (Cross-sectorial and internal coherence)

- Existence of data security and privacy

The incremented utilization of ICT to manage and collect consumer data provides opportunities concerning the optimization of assembling information, but entails new risks related to illegal appropriation and inappropriate use of data. Therefore, an agreed framework and regulations for information ownership are necessary. The latter mentioned regulations can also provide barriers for data uptake, if the gathered information are sensible to security and privacy issues (e.g. monitoring the behaviour of persons) (Elzinga, 2013), (Brown and Zhou, 2012), (Yerby et al., 2013).

- Tax pressure

The percentage of taxes a corporation or individual has to release when carrying out SC activities is crucial for incentivising the latter mentioned undertakings. High tax pressures can hinder notably or even stop projects related to the treated activities - especially in terms of investments (IEA, 2010), (IEA, 2007), (Puri et al., 2014).

- Transparency of taxation system

The given term, refers to the perceived quality of intentionally shared information provided by the legislator regarding the percentage of taxes a corporation or individual has to pay when carrying out SC activities (Schnackenberg, 2014). Non-transparent taxation systems lead to uncertainty, which in turn can hinder or even stop investments into SC undertakings (Young, 2015), (Vianello, 2013).

- Availability or lack of subsidies

The present term above indicates the possibility to access financial support in relation to the execution of SC activities (Myers and Kent, 2001). There are many forms of subsidies: tax breaks, interest free loans, cash grants etc. (Dictionary, 2015). If such aids are not given, barriers for the investment and implementation of SC activities could be present (Kaminker and Stewart, 2012), (IEA, 2010), (IEA, 2007).

- Existence of regulatory incentives for implementation of SC projects

Financial incentives like tax exemption, feed-in-tariffs, credit facilities and third party financing mechanisms, which support the implementation of innovative technologies, can be considered as measures increasing investments in SC activities (Painuly, 2001), (Piscitello and Bogach, 1998). Delayed or poor incentives regarding undertakings for SC projects, make the latter mentioned application less lucrative (IEA, 2010), (Lee, 2010).

- Tariffs regulations

Taxes imposed regarding imported services and goods can be harmful for the treated kind of projects, if these refer to commodities related to SC activities (INVESTOPEDIA, 2015). The latter mentioned issue can represent a serious barrier to SC undertakings, because of non-effected investments (IEA, 2010), (Kaminker and Stewart, 2012), (IEA, 2007).

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Technical factors

- Existence of affordable and mature technologies suitable for local conditions

The existence of technologies, which are economically affordable, sufficiently developed to guarantee a relatively smooth operability and are useful for present local conditions (e.g. availability of enough wind to activate properly wind power stations) is crucial for the successful implementation of SC projects (IEA, 2010), (Lee, 2010), (Gann, 2012). If the latter mentioned characteristics for technical application are not given, an interruption or even a stop of the treated type of undertakings can appear.

- Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions

The term above, indicates experience related to technologies utilized within SC projects (PV, solar thermal systems - STS, DHS - district heating systems etc.), respective methods for designing as well as implementation of these. An inadequacy of expertise concerning the latter mentioned technologies may lead to delays, unsuccessful installation and problems in correct functioning (Pîrlogea, 2011), (Elzinga, 2013), (Lee, 2010). Moreover, the here described lack of experience can lead also to a shortfall of experts needed for the executions of SC projects (EC, 2015B).

- Existence of training material

Smart city activities imply a permanent technology transfer process, which continuously demands trained personnel. That applies especially to managers, operators responsible for operation and deployment of smart technologies, as well as data managers, decision support workers and analysts (Mosannenzadeh and Vettorato, 2014), (Luthra et al., 2014). The adoption of innovative technologies may be cancelled or delayed due to a lack of needed knowledge and technical skills (Painuly, 2001).

- Monitoring

One of the key elements for a successful technologies implementation in a number of SC projects is the accurate following of energy consumption/production (e.g. during a day or longer periods: for example in summer and/or winter). Constant keeping track and evaluation of the energy use/generation given by smart technologies is of fundamental importance for the treated type of projects. A lack of monitoring activities, related tools (e.g. TRNSYS) and appropriate strategies concerning machineries and systems performance evaluation may lead to an incomplete implementation of project activities (Moss, 2006), (Levermore, 2000), (EC, 2012B).

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Economic factors

- Adverse selection

Adverse selection refers to a market in which producer of energy efficient equipment are more informed concerning the performance and characteristics of furniture than the buyers. The information present to the two latter mentioned parties is asymmetric. Since the described situation is highly common in existing markets, inefficient results are the rule rather than exception (Sanstad and Howarth, 1994), (Greenwald, 1979), (Thollander et al., 2010).

- Principal-agent relationship

The above indicated term refers to an inadequacy of trust between two parties with different interests. For example, investors who are not as well informed regarding the specific criteria of EE investments, will request short payback rates on such purchase, because of their distrust into the executive's ability to transmit such investments. This, in turn leads to neglect cost effective energy efficient purchase (DeCanio, 1993), (Jaffe and Stavins, 1994), (Thollander et al., 2010).

- Split incentives

The above indicated term, refers to the unfortunately common situation in which the potential investor do not correspond to the party paying the bills for energy consumption. In this case, the information concerning available cost effective, energy efficient measures of the potential adopter may not be enough. Acceptance is going to occur solely if the investor can get back the invested amount of money from those, who profit from energy savings (Jaffe and Stavins, 1994). This case relates also to a number of landlord-tenant relationships (Hirst and Braun, 1990), (Thollander et al., 2010).

Financial factors

- Hidden costs

High costs can arise for a number of usual SC project activities (e.g. contracts writing, data seeking, holding meetings etc.). If the latter mentioned costs appear to be higher than the profit derived from implementation, a barrier to possible investments is given. Hence, project activities are not cost effective anymore when such costs appear. Hidden costs can account for three to eight percent of the entire investment in the case of huge energy-intensive firms. Moreover, within non energy-intensive companies of smaller size, such costs are even higher (Hein and Blok, 1995), (Thollander et al., 2010), (Sorrell et al., 2004).

- Accessibility to capital

Inadequate financial support and insufficient funding for research, development and demonstration (RD&D) is a common barrier for a number of SC projects. The difficulty in obtaining funds especially delays the implementation of project activities (Schleich, 2011). Energy efficient technologies are most times more expensive than alternative ones (Almeida, 1998). Obtaining further capital to invest in energy efficient technologies could be problematic as well. Limited access to capital could also arise due to money lending restrictions (Hirst and Braun, 1990).

- Risk and uncertainty

Uncertainty concerning savings in costs operating can arise even if there is knowledge of capital cost for investments. Thus, the investment itself poses a certain risk (Hirst and Braun, 1990). Risk and uncertainty depends also on general future economic conditions and prospective energy prices as well as on energy availability (Stern and Aronson, 1984). Uncertainty regarding energy prices represents a barrier to investment for both, producer and buyer of energy efficient systems (Thollander et al., 2010).

- Up-front costs

Up-front costs are those expenses that incur at the beginning of new projects. These costs discourage investors if too high and therefore, can prolong the periods of fund rising (Dowson et al., 2012), (Pelenur et al., 2012), (IEA, 2010). This can delay or cancel the implementation of project activities.

- Costs of material, construction, and installation

Energy efficient technologies, RE and new technologies are characterized by relatively high investment costs for design, material, installation, and construction. Hence, individuals with low incomes and corporations with a limited availability to capital are not able to invest in such technologies. For example, partners of a SC project decide to implement less energy efficient technologies, because the price of more efficient ones (characterized by higher energy savings in time) is not affordable by them (Pîrlogea, 2011), (Painuly, 2001), (Luthra et al., 2014).

- Economic crisis

Since 2009, the EU is affected by an economic crisis. The economy is experiencing a downturn caused by a financial crisis. The GDP (Gross domestic product) is decreasing, liquidity is drying up and the unemployment rate is growing and growing (WebFinance Inc., 2013), (Global Finance, 2013), (ECB, 2012), (EUROSTAT, 2013), (EC, 2009), (EC, 2013B). According to numerous declarations of interviewees, the latter mentioned consequences of the economic crisis delay activities of SC projects.

- Existence of financial schemes

The above indicated term refers to financial methods used to support economically the undertakings of SC projects. Insufficient financial support and funding for carrying out projects are a frequent barrier for the analysed activities typology (Schleich, 2011), (Pîrlogea, 2011). Huge problems in obtaining funding are reported. The latter described barrier can lead to delays or even to a stop of project activities (EC, 2015B).

- Combining of different financial schemes

The combination of different financial schemes relates to the accumulation of financial methods utilized to assist economically the activities related to SC projects. Concerning the before named combination, especially the aggregation of different schemes on different levels is mentioned: EU, national, regional, provincial etc. (Deacon et al., 2012), (IEA, 2007), (IEA, 2010). The lack of such combination possibilities leads to less support for the treated type of projects.

- Stability of costs during project life cycle

Stability of costs is one output of economic stability (IMF, 2015). In a number of projects, increasing the costs of material and construction during project life cycle (mainly due to inflation) creates cost overruns, meaning that the real costs of implementation are higher than the planed costs (Kaming et al, 1997). This creates financial shortage for projects and can hinder or cancel project activities. Moreover, instability of costs creates uncertainty, which in turn decreases interest in investment and therefore delays project implementation (Pettinger, 2014).

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- Payback time

Payback time refers to the financial risk connected to recover the costs of investment. If the latter mentioned risk is characterized by uncertainty and long time periods (e.g.: for the application of smart technologies or construction/energy sanitation activities), investments in SC application can be inhibited or stopped (Sorrell et al., 2000), (Pîrlogea, 2011), (Luthra et al., 2014).

Operational factors

- Existence of tried and tested solutions and proven on the ground examples

The term above relates to the presence of already used and proved solutions, which are tested by examples yet. In the case of SC projects, the latter described concept refers especially to previously applied technical solutions and application of smart technologies. The shortage of already tried and tested solutions and proven on the ground examples for SC projects in Europe, can represent a barrier for the analysed type of undertakings (Mosaic, 2009), (Elzinga, 2013), (Lee, 2010).

- Complexity of applying solutions with regard to local conditions

Local conditions are crucial for the applicability of solutions related to SC projects. The latter mentioned local conditions refer to specific characteristics in a large range of fields: technical, economical, legislative etc. (IEA, 2010), (Kaminker and Stewart, 2012), (Brown and Zhou, 2012). For example, the local climate conditions can be characterized by such a cloudy weather that the application of PV is not feasible, due to being considerably reduced in its productivity (Severnwye energy agency, 2015).

- Interoperability between systems

Interoperability means the ability of a system to work with or use the parts of another system (Merriam-Webster, 2015). In the case of smart technologies implementation, such as smart grids, a coordination of energy supply and demand is very important. Due to lacking interoperability, the operation can encounter malfunction (Rumph et al., 2013), (Brenna et al., 2012).

- Supporting hard infrastructure

Smart and sustainable hard urban infrastructure plays a prominent role in addressing EU energy targets (Riedy, 2009). A lack of supporting infrastructure, for example while operating building refurbishment, creates stress and annoyance for inhabitants, because refurbishment undertakings are carried out while people are living in the building (EC, 2015B), (Vianello, 2013).

- Well-defined or documented in detail processes

The term above relates to in depth carried out plans. If in the planning phase, the implementation process is not stated clearly or the organization of different steps is not well established, the projects implementation may delay and/or encounter difficulties (Thollander et al., 2010), (Vianello, 2013), (EC, 2015B).

- Existence of performance indicators for technologies implementation

Performance indicators provide a benchmark for measurements of projects implementation (Chan and Chan, 2004). A lack of clear operation and maintenance requirements may lead to a low-quality implementation of SC projects (Kuroda et al., 2012), (Eagan and Joeres, 1997).

Behavioural factors

- Form of information:

Not always information receive as much attention as needed, because people are most times selective about assimilating information rather than seeking it actively. Research underlines specific characteristics on how information is assimilated. People are more likely to remember information if it is peculiar and presented in personalized and vivid manner (Stern and Aronson, 1984), (Palm, 2009), (Palm, 2010).

- Credibility and trust

Credibility and trust with regard to information provider can inhibit its adoption. Stakeholders of SC projects are not always able to acquire accurate information. Usually, they rely on the most credible information source. Thus, the effective dissemination of information depends on the trustworthy of the enunciator (Ramirez, 2005), (Stern and Aronson, 1984), (Thollander et al., 2010).

- Values related to energy efficiency, which may inhibit measures from being undertaken

Values related to EE, which may inhibit measures from being undertaken cover a lack of motivation in participation due to various reasons - e.g.: lack of importance, high costs etc. A lack of values related to smart and sustainable energy may inhibit measures from being undertaken. Values are those assumptions, which shape the basis for ethical action. This barrier may relate to consumer in terms of sustainable behaviour or may relate to investors in terms of investing in sustainable technologies (Aronson and O'Leary, 1983), (Thollander et al., 2010), (IEA, 2007).

- Inertia

Inertia primarily refers to the difficulty in change of behaviour and includes a lack of interest in exchanging a technology into another. In this regard, also the resistance towards new habits has to be nominated. Inertia concerns organizations and individuals, which are dominated by established routines and find it difficult to change their behaviour. Thus, inertia can lead to delays or misuse of projects and their implementation (Stern and Aronson, 1984), (Thollander et al., 2010), (Sorrell et al., 2000).

- Bounded rationality:

Bounded rationality indicates particularly in decision making of individuals. The rationality of persons is constricted to the information level they possess, their limited amount of time and cognitive limitations of their minds. Bounded rationality can lead to unsustainable choices of individuals, such as not applying energy efficient measures (Schiliró, 2012), (Stern and Aronson, 1984), (Thollander et al., 2010).

- Public acceptance of technologies

Public acceptance of technologies refer to the existence of social acceptance for new projects and respective technological application. The latter mentioned acceptance is divided into three different aspects of consents: by the public, key stakeholders, and policy makers (Wüstenhagen et al., 2007). The acceptance by the community determines the application of smart products through a communication process between consumer and their environment (Pîrlogea, 2011). If there is a lack of consumer´ acceptance regarding the above named technologies, an interruption or stop of project implementation can occur (Painuly, 2001).

The three following categories are added by interviewees during the information uptake carried out through the questionnaire mentioned in 2.1.3 CATEGORIES OF BARRIERS AND DRIVERS & THEIR EFFECTIVENESS. These categories are lead back to the last query of the mentioned survey: “Further categories that are relevant to you but have not been mentioned in this questionnaire”:

- Environmental issues

The above named term indicates a higher public acceptance of SC projects if the latter mentioned undertakings handle environmental related issues such as CO2 emission reduction, climate change issues, air pollution concerns etc. A number of interviewees declared that a lack of such topics diminishes the public acceptance of related projects.

- Requirements from the EC concerning reporting and accounting

This category refers to requirements given by the EC concerning reporting and accountancy on SC projects. A number of interviews stated that the latter mentioned requests from side of the EC are in specific cases excessively strict and can be very time consuming.

- Multiple ownership of realities leads to difficulties in implementation of interventions

In this case, the complex ownership structure of realities is mentioned. A fragmented ownership of target properties for SC projects (multifamily houses - MFH, high-rise building entailing offices etc.) can limit the implementation of project interventions (e.g. insulation). Interviewees referred to a number of cases, in which the majority of flat owners had to agree with the projects intervention to make it happen.

2.2.3 EFFECTIVENESS OF BARRIERS AND DRIVERS CATEGORIES

Going ahead, the latter described categories are weighted by experts concerning their perceived effectiveness on SC projects. Next Table 7 visualizes the results of the aforementioned marking process and shows the outcome of the respective IQR calculations:

TABLE 7 - EFFECTIVENESS OF BARRIERS AND DRIVERS CATEGORIES

POLICY CATEGORIES	EFFECTIVENESS	INTERQUARTILE RANGE
National roadmaps, strategies, and policies for energy goals	2.67	2.25
Political commitment over the long term	3.10	3.50

ADMINISTRATIVE CATEGORIES	EFFECTIVENESS	INTERQUARTILE RANGE
Cooperation and trust between different stakeholders	2.90	2.00
Communication between project participants and the public to increase awareness	3.07	3.75
Existence of multi-actor/multi-sectorial planning tools	1.57	2.25
Share of valuable data between different departments	2.27	3.75
Existence of public-private engagement models	1.80	3.00
Existence of financing models suitable for the innovation to address stakeholder involvement	1.27	2.00
Public procurement	2.30	1.75
Coordination of a large number of tenants	1.30	2.25

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Marketing application for awareness and involvement	2.50	3.00
Set up of institutions to support the projects	0.67	1.25
Obligations given to project participants	0.53	0.75
Public participation	2.07	2.25

LEGISLATIVE CATEGORIES (IMPLEMENTATION AND ENFORCEMENT)	EFFECTIVENESS	INTERQUARTILE RANGE
Transparency of legislation	2.13	4.00
Consistency of implementation and interpretation of law	1.20	1.25
Existence of regulatory stability	1.37	1.50
Development procedures that may inhibit or trigger implementation of smart city projects	1.60	3.00
Local budgetary legislations	1.13	1.25
Existence of knowledge about future litigations	1.07	2.00
Effectiveness of regulations for implementation of technologies and solutions	1.10	1.25
Existence of updated regulation and rules for new technologies	1.13	2.00
Procedures for authorization of technologies	1.93	3.25

LEGISLATIVE CATEGORIES (CROSS-SECTORIAL AND INTERNAL COHERENCE)	EFFECTIVENESS	INTERQUARTILE RANGE
Existence of data security and privacy	1.10	2.00
Tax pressure	0.73	1.00
Transparency of taxation system	0.83	1.00
Availability or lack of subsidies	1.83	3.00
Existence of regulatory incentives for implementation of SC projects	0.90	1.25
Tariffs regulations	0.93	1.00

TECHNICAL CATEGORIES	EFFECTIVENESS	INTERQUARTILE RANGE
Existence of affordable and mature technologies suitable for local conditions	2.00	3.00
Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions	3.07	2.00
Existence of training material	1.63	1.50
Monitoring	1.59	2.00

ECONOMIC CATEGORIES	EFFECTIVENESS	INTERQUARTILE RANGE
Adverse selection	1.57	2.00
Principal-agent relationship	0.70	1.00
Split incentives	0.80	1.00

FINANCIAL CATEGORIES	EFFECTIVENESS	INTERQUARTILE RANGE
Hidden costs	0.80	1.00
Accessibility to capital	0.83	1.00
Risk and uncertainty	1.07	1.00
Up-front costs	1.03	1.25
Costs of material, construction, and installation	2.37	3.00
Economic crisis	2.40	4.00
Existence of financial schemes	2.80	3.00
Combining of different financial schemes	0.30	1.00
Stability of costs during project life cycle	0.93	1.00
Payback time	0.97	1.00

OPERATIONAL CATEGORIES	EFFECTIVENESS	INTERQUARTILE RANGE
Existence of tried and tested solutions and proven on the ground examples	2.03	2.25
Complexity of applying solutions with regard to local conditions	1.13	1.25
Interoperability between systems	1.37	2.00
Supporting hard infrastructure	1.70	3.25
Well-defined or documented in detail processes	1.93	3.00
Existence of performance indicators for technologies implementation	1.13	2.00

BEHAVIORAL CATEGORIES	EFFECTIVENESS	INTERQUARTILE RANGE
Form of information	1.67	1.00
Credibility and trust	1.77	2.00
Values related to energy efficiency, which may inhibit measures from being undertaken	0.67	1.00
Inertia	2.03	2.25

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Bounded rationality	2.03	3.00
Public acceptance of technologies	1.77	2.00

ADDITIONAL CATEGORIES	EFFECTIVENESS	INTERQUARTILE RANGE
Environmental issues	4.33	1.00
Requirements from the European Commission concerning reporting and accounting	4.00	2.00
Complex ownership structure of realities	4.00	2.00

Like visible in Table 7, the three highest effectiveness values are given by following categories:

a.) Complex ownership structure of realities

b.) Requirements from the European Commission concerning reporting and accounting

c.) Political commitment over the long term

With regard to the category complex ownership structure, it has to be added that a consistent part of analysed SC projects (approximately 40%) are characterized by retrofitting activities of building.

Regarding the aforementioned category requirements from the EC concerning reporting and accounting is has to be pointed out that almost 20% of the interviewed SC experts named the present issue.

Finally, the political commitment over the long term is indicated by a relevant amount of interviewees (around 15%) as well as SC descriptions found in open access sources (almost 25%) as one of the most crucial factors. On the other hand, a constant and supporting commitment from political side to projects is of extraordinary importance, interviewees added (again almost 25%).

Next, the three lowest effectiveness values are given by following categories:

a.) Obligations given to project participants

b.) Values related to energy efficiency, which may inhibit measures from being undertaken

c.) Principal-agent relationship:

Regarding the category obligations given to project participants a number of interviewees (about 50%) argued, that even if applied, these come out to be not effective at all.

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Concerning values related to EE, which may inhibit measures from being undertaken, the majority of interviewees declared that according to their experience, these kind of values play just a little role. Main reason for that are the type of people involved in SC projects, who are often not volunteers, but selected according to most suitable possibilities to carry out a SC project (e.g. inhabitants of social housing are selected, in order to avoid resistance to retrofitting activities of the dwellings they are living in).

Concluding, also the category principal-agent relationship, is marked by a relatively low effectiveness. As a number of interviewees stated (almost 50%), the indicated relationship is given anyway for the majority of cases and as being common practice it is not that much relevant.

In addition, following two charts (Figure 16 and 17) visualize the most numerous categories (grouped in macro categories) within the collected list of barriers and drivers (macro categories with a resulting percentage of less than 5% are neglected):

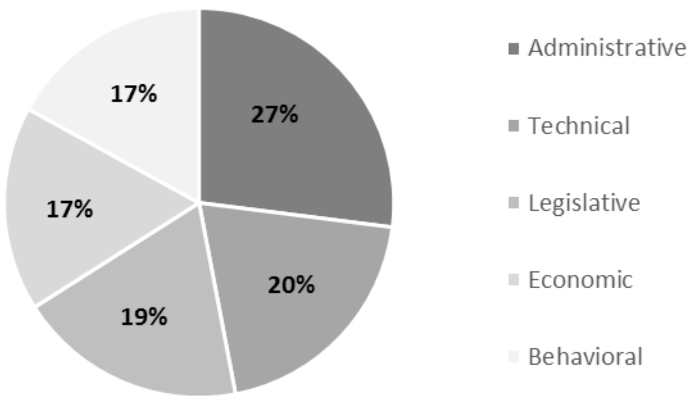

FIGURE 16 - MOST NUMEROUS MACRO CATEGORIES OF BARRIERS

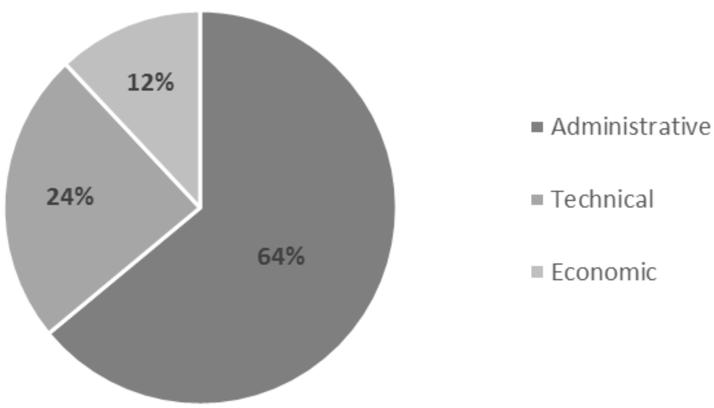

FIGURE 17 - MOST NUMEROUS MACRO CATEGORIES OF DRIVERS

As visible in the two charts above, in both cases the administrative issues result to be the most relevant ones. The same applies to the technical barriers and drivers positioned at second place. The macro category related to legislative contents comes out to be the third most relevant concerning barriers, while it is negligible for drivers. In both cases, the economic section is to find in the lower half of the respective rankings. Finally, the behavioural issues are located in the last position regarding barriers and result to be irrelevant for drivers.

As already mentioned above, a consistency analysis is implemented as well, which determines how much the experts agreed on the effectiveness of the different categories. The IQR of the weights´ distribution has been chosen to quantify the agreement level among the interviewees. As visible above in Table 7 no interquartile range per category exceeds a value of four, which is rather low. Thus, a certain consistency of the experts´ weights is assumed.

The categories marked by the highest IQR numbers are in order:

a.) Economic crisis (IQR: 4.00)
b.) Transparency of legislation (IQR: 4.00)
c.) Share of valuable data between different departments and existence of multi-actor/multi-sectorial planning tools (IQR: both 3.75)

Regarding point a.) it has to be stressed that interviewees from different EU member states (and from various project application sites) provided diverging estimations concerning this category, because the economic crisis affected/affects certain countries more than others. Experts from the northern and middle part of Europe weighted this category with less negative values than interviewees from Southern Europe. In five cases even an evaluation of zero (no influence) has been given. The same applies to issue b.), with the difference that in this case, not only zero values are present (eight times), but three experts declared a positive value too. Concerning the items given within point c.) it is clear that the share of data and application of multi-actor/multi-sectorial tools varies from project to project.

The lowest IQR values is given regarding the category obligations given to project participants (IQR: 0.75) and further 13 issues present in Table 7 above (IQR: both 1.00). Concerning these obligations as well as the other latter mentioned items, the experts strongly agree.

2.2.4 FINAL SWOT MATRIX

As a last step, the final SWOT matrix of the present analysis is provided. The categories indicated in the different sections of the matrix (SWOTs) are characterized by the attributes “cause and effect”. The latter mentioned attributes are specified in brackets after their respective categories. Furthermore, the impact values of the various categories are positioned on their right side. These numbers are summed up under each of the four present sections, representing the total impact value of the present SWOTs. The barriers (weaknesses and threats) are labelled by a minus (“-“) sign, while drivers are marked with a plus (“+”). The categories per section are listed in order of impact magnitude, beginning with the highest value. Due to the impossibility to visualize the described matrix at once, section after section are shown singularly. See Table 8:

TABLE 8 - SMART CITIES BASELINE SWOT MATRIX

STRENGTHS	IMPACTS
Public participation (cause: active involvement of project participants and the population - effect: smooth proceedings of the project activities)	+82.80
Marketing application for awareness and involvement (cause: marketing application for awareness and involvement of the project - effect: smooth process of the planned activities)	+40.00
Cooperation and trust between different stakeholders (cause: well cooperation between project participants - effect: smoothly running project activities)	+34.80
Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions (cause: availability of expertise, awareness, and methods for designing and implementing projects - Effect: smooth project activities)	+27.63
Communication between project participants and the public to increase awareness (cause: energy advice campaigns - effect: smooth project execution)	+22.80
Coordination of a large number of tenants (cause: a project partner takes care of the coordination for a large amount of tenants - effect: smoothly execution of the project)	+22.50
Existence of public-private engagement models (cause: involvement of the public the project - effect: no aversion by the population)	+22.50
Share of valuable data between different departments and partners (cause: consultation activities help to overcome project problems not solvable internally - effect: less problems concerning project proceedings)	+24.27
Existence of financial schemes (cause: presence of financial schemes and tools - effect: easier project procedures)	+13.04
Existence of training material (cause: training activities for project participants - effect: support for the project implementation)	+6.52
Credibility and trust (cause: credible information sources utilized for communications - effect: transmitted information are trustful for tenants)	+6.00

Interoperability between systems (cause: interoperability between systems - effect: successful demand side management)	+6.00
Monitoring (cause: application of monitoring tools to take trace of energy consumption - effect: precise description of the project results)	+4.77
Form of information (cause: notable communications for tenants - effect: transmitted information are well assimilated)	+3.00
Combining of different financial schemes (cause: combination of different financial schemes - effect: higher finance availability for the project)	+3.00
Existence of performance indicators for technologies implementation (cause: monitoring the work progress - effect: support in achieving the project goals)	+2.26
Well-defined or documented in detail processes (cause: following a bottom-up approach when carrying out the project analysis - effect: discovery of findings characterized by fundamental importance)	+1.93
SUM	**+323.82**

WEAKNESSES	IMPACTS
Communication between project participants and the public to increase awareness (cause: insufficient communication about the project - effect: interruption or stop concerning proper participation of utilizers)	-58.33
Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions (cause: lack of experience - effect: lack of experts)	-55.26
Cooperation and trust between different stakeholders (cause: lack of cooperation between project participants - effect: interruption or stop of project activities)	-55.10
Inertia (cause: Inertia - effect: delays or misuse of technologies)	-40.60
Well-defined or documented in detail processes (cause: improper planning of the project - effect: delays or project fail)	-7.72
Public participation (cause: uninteresting project aims - effect: reluctance in participation)	-1.80
Existence of performance indicators for technologies implementation (cause: lack of operation and maintenance requirements - effect: low performance of project implementation)	-1.13
SUM	**-219.94**

OPPORTUNITIES	IMPACTS
Existence of affordable and mature technologies suitable for local conditions (cause: existence of mature and locally tested technologies - effect: facilitation of project activities)	+54.00
Environmental issues (cause: treatment of environmental related issues - effect: higher public acceptance of the project)	+51.96
Political commitment over the long term (cause: political commitment to the project - effect: smoother process of the project)	+34.10
National roadmaps, strategies, and policies for energy goals (cause: presence of national roadmaps for energy goals - effect: framework conditions of the project are easier to define)	+22.50

Availability or lack of subsidies (cause: existence of subsidies related to project aims - effect: support in achieving the project aims)	+21.96
Existence of updated regulation and rules for new technologies (cause: updated regulation for new technologies - effect: smoother implementation of technologies)	+6.00
Existence of regulatory stability (cause: regulatory stability - effect: smooth execution of the project)	+4.11
Effectiveness of regulations for implementation of technologies and solutions (cause: problems in interpretation of law - effect: delays of the project implementation)	+3.75
Local budgetary legislations (cause: local budgetary legislations - effect: finance for the interventions)	+3.75
Set up of institutions to support the projects (cause: establishment of an institution, which supports the project activities - effect: stronger support for project activities)	+2.68
Accessibility to capital (cause: profitability of inhabitants - effect: higher acceptance of the project)	+1.66
Obligations given to project participants (cause: obligations given to project participants - effect: support to run smoothly the project activities)	+1.06
SUM	**+207.53**

THREATS	**IMPACTS**
Availability or lack of subsidies (cause: lack of supporting legislations for the project goals - effect: difficulties in reaching the planned aims)	-58.56
Requirements from the European Commission concerning reporting and accounting (cause: excessive requirements by the EC in terms of reporting and accountancy - effect: high time consumption)	-48.00
Complex ownership structure of realities (cause: multiple ownership of realities - effect: difficulties in implementation of interventions)	-44.00
Supporting hard infrastructure (cause: occupants living in the dwelling during refurbishment - effect: activities lead to stressed and annoyed inhabitants)	-42.50
Public procurement (cause: public procurements - effect: interruption or stop of project implementation)	-41.40
Economic crisis (cause: economic crisis - effect: delay of project activities)	-40.80
Political commitment over long term (cause: changes in political leadership - effect: decrease or elimination of political support to the project)	-40.30
Transparency of legislation (cause: non-transparent legislation - effect: delays concerning project activities)	-39.27
Procedures for authorization of technologies (cause: complicated and time consuming procedures for authorization - effect: delays in project activities)	-38.60
Costs of material, construction, and installation (cause: high costs of material, construction, and installation - effect: reduction of investments and participation in the project)	-34.95
Existence of affordable and mature technologies suitable for local conditions (cause: unavailability of mature technologies - Effect: interruption or stop in reaching project goals)	-14.00
Existence of regulatory incentives for implementation of SC projects(cause: no incentives for the application of RES - effect: aversion to the implementation of RES)	-9.00

Accessibility to capital (cause: insufficient financial support - effect: interruption or stop of project activities)	-8.30
Bounded rationality (cause: bounded rationality - effect: unsustainable choices of utilizers)	-8.12
Public acceptance of technologies (cause: lack of acceptance for new technologies - effect: interruption or stop of project implementation)	-5.31
Complexity of applying solutions with regard to local conditions (cause: complexity of applying technologies in local conditions - effect: problem and delay in construction/implementation)	-4.52
Consistency of implementation and interpretation of law (cause: problems in interpretation of law - effect: delays of the project implementation)	-3.06
Existence of tried and tested solutions and proven on the ground examples (cause: bad odours caused by technologies implementation - effect: aversion to the project)	-2.03
Development procedures that may inhibit or trigger implementation of SC projects (cause: local regulations - effect: impossibility to carry out energy sanitations of historical building)	-1.47
Existence of financing models suitable for the innovation to address stakeholders (cause: lack of appropriate business models - effect: delays in project implementation)	-1.27
Existence of data security and privacy (cause: data security and privacy issues - effect: interruption or stop of data uptake)	-1.10
Risk and uncertainty (cause: improper project proceedings - effect: pressures for tenants)	-1.07
Payback time (cause: uncertainty - effect: low interest for investment in the project)	-0.97
SUM	**-488.60**

Like visible in the given SWOT matrix, the threats part is characterized by the highest amount of categories as well as the highest impacts´ sum: almost -500. The strengths follow with around half of the categories and a total impact value of around +300. On third place concerning impact magnitude, the weaknesses are allocated with an amount of about -200. In terms of impact value, the last position is occupied by opportunities, characterized by approximately the same number of impacts´ total (around +200), but less categories than the before mentioned SWOT section.

The counter position of the present internal parts of the SWOT matrix (strengths and weaknesses), results in a positive number of approximately +100. The strengths´ impact exceeds the respective value of weaknesses for a third. While the situation changes completely for the external sections (opportunities and threats). In this case, a clear superiority of the negative values emerges (almost -300). The impacts´ total of the threats comes out to be twice as high as the respective value for opportunities.

From the resulting numbers of the internal and external part of the SWOT matrix, an overall outcome is obtained, which consist in a negative value of approximately -200. The latter mentioned overall outcome indicates a certain difficulty in carrying out SC projects in Europe until nowadays.

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The latter mentioned result arises primarily due to the aforementioned negative outcome for the external part of the present SWOT matrix. The internal issues of the analysed SC projects appear to facilitate the execution of the treated projects so far. In contrast, the external matter of the investigated SC undertakings result in hindering the past implementation of SC projects.

As shown in the SWOT matrix above, the most relevant categories in terms of impact are:

a.) Public participation

Cause: active involvement of project participants and the population - effect: smooth proceedings of the project activities

b.) Availability or lack of subsidies

Cause: lack of supporting legislations for the project goals - effect: difficulties in reaching the planned aims

c.) Communication between project participants and the public to increase awareness

Cause: insufficient communication about the project - effect: interruption or stop concerning proper participation of utilizers

A high number of appearances within the respective barriers and drivers' list characterizes all three mentioned categories with an emergence rate related to the analysed projects of around 50 (a. and b.) and 30% (c.) respectively.

On the other hand, the less relevant categories in terms of impact are:

a.) Payback time

Cause: uncertainty - effect: low interest for investment in the project

b.) Obligations given to project participants

Cause: obligations given to project participants - effect: support to run smoothly the project activities

c.) Risk and uncertainty

Cause: improper project proceedings - effect: pressures for tenants

The later mentioned categories appear just one or two times in the respective barriers and drivers collections.

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However, a close look to the described SWOT matrix shows that the negative, overall outcome emerges especially due to the 10 first categories within the threats section. These are marked by an impact value ranging from more than -30 to almost -60. No other section entails a so high number of categories characterized by such negative impact numbers.

Moreover, not all selected categories of barriers and drivers, present in Table 6 (CATEGORIES AND MACRO CATEGORIES USED TO GROUP BARRIERS & DRIVERS OF SC PROJECTS) are given in Table 8 (SMART CITIES BASELINE SWOT MATRIX), as not appearing within the around one hundred SC projects analysed.

Following Table 9 indicates all not utilized categories within the SWOT matrix (respective macro categories are indicated as well):

TABLE 9 - BARRIERS AND DRIVERS CATEGORIES NOT UTILIZED IN THE SWOT MATRIX

LEGISLATIVE CATEGORIES (IMPLEMENTATION AND ENFORCEMENT)
Existence of knowledge about future litigations

LEGISLATIVE CATEGORIES (CROSS-SECTORIAL AND INTERNAL COHERENCE)
Tax pressure
Transparency of taxation system
Tariffs regulations

ECONOMIC CATEGORIES
Adverse selection
Principal-agent relationship
Split incentives

FINANCIAL CATEGORIES
Hidden costs
Risk and uncertainty
Stability of costs during project life cycle

BEHAVIORAL CATEGORIES
Values related to energy efficiency, which may inhibit measures from being undertaken

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Interviewees declared that the above indicated categories in Table 9 related to legislative (cross-sectorial and internal coherence) and financial issues are irrelevant for the execution of SC projects, as tax related matters are not crucial (reason not given) for R&D projects and financial issues are usually secured by funding provided by the public sector. Furthermore, interviewees stated to have never perceived the above indicated behavioural category in Table 9 as barrier or driver for SC projects. Moreover, the economic issues are anyway usually present and as such not pertinent for the projects´ execution, interviewees declared. Finally, with regard to the category existence of knowledge about future legislations, respondents underlined the commonly given uncertainty concerning future occurrences, which as such is not crucial for the implementation of SC undertakings. No indications regarding the latter mentioned categories are provided by experts, neither open sources refer to them.

In contrast to the last indicated issues, there are also categories within the SWOT matrix, which appear twice - once in the barriers sections (weaknesses and threats) and once in the drivers parts (strengths and opportunities). The latter indicated categories are:

- Public participation
  Barrier - cause: uninteresting project aims - effect: reluctance in participation
  Driver - cause: active involvement of project participants and the population - effect: smooth proceedings of the project activities

- Cooperation and trust between different stakeholders
  Barrier - cause: lack of cooperation between project participants - effect: interruption or stop of project activities
  Driver - cause: well cooperation between project participants - effect: smoothly running project activities

- Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions
  Barrier - cause: lack of experience - effect: lack of experts
  Driver - cause: availability of expertise, awareness, and methods for designing and implementing projects - effect: smooth project activities

- Communication between project participants and the public to increase awareness
  Barrier - cause: insufficient communication about the project - effect: interruption or stop concerning proper participation of utilizers
  Driver - cause: energy advice campaigns - effect: smooth project execution

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- Existence of performance indicators for technologies implementation

  Barrier - cause: lack of operation and maintenance requirements - effect: low performance of project implementation

  Driver - cause: monitoring the work progress - effect: support in achieving the project goals

- Well-defined or documented in detail processes

  Barrier - cause: improper planning of the project - effect: delays or project fail

  Driver - cause: following a bottom-up approach when carrying out the project analysis - effect: discovery of findings characterized by fundamental importance

- Existence of affordable and mature technologies suitable for local conditions

  Barrier - cause: unavailability of mature technologies - effect: interruption or stop in reaching project goals

  Driver - cause: existence of mature and locally tested technologies - effect: facilitation of project activities

- Political commitment over long term

  Barrier - cause: changes in political leadership - effect: decrease or elimination of political support to the project

  Driver - cause: political commitment to the project - effect: smoother process of the project

- Availability or lack of subsidies

  Barrier - cause: lack of supporting legislations for the project goals - effect: difficulties in reaching the planned aims

  Driver - cause: existence of subsidies and incentives related to project aims - effect: support in achieving the project aims

- Accessibility to capital

  Barrier- cause: insufficient financial support - effect: interruption or stop of project activities

  Driver - cause: profitability of inhabitants - effect: higher acceptance of the project

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2.2.5 HOW TO USE DRIVERS TO OVERCOME BARRIERS

In a last step, due to connecting categories between strengths and threats as well as opportunities and weaknesses sections, following advice can be provided on how to utilize drivers to overcome barriers present in the SWOT matrix. Furthermore, the latter mentioned process has been accomplished also by connecting positive and negative factors of the internal and external part of the given SWOT matrix (strengths and weaknesses - opportunities and threats). Finally, advice are provided by trying to answer following questions: which opportunities can enforce the strengths and how to minimize weaknesses to avoid threats? The following text section report the most relevant connections mentioned above, not repeating similar concepts.

a.) Connections between strengths and threats

Strength: public participation
(cause: active involvement of project participants and the population - effect: smooth proceedings of the project activities)
Threat: complex ownership structure of realities
(cause: multiple ownership of realities - effect: difficulties in implementation of interventions)

Multiple ownership of realities create difficulties in the implementation of interventions. Owners of different realities play a key role in the implementation of projects, as a number of SC undertakings aim to accomplish refurbish activities of building. Active involvement of key actors and project participants could increase the owners’ responsibility, acceptance and interest in the implementation of the project. This in turn, would result in less difficulty in terms of ownership variety due to a smoother cooperation.

Strength: public participation
(cause: active involvement of project participants and the population - effect: smooth proceedings of the project activities)
Threat: existence of affordable and mature technologies suitable for local conditions
(cause: unavailability of mature technologies - effect: interruption or stop in reaching project goals)

Unavailability of mature technologies, which are suitable for local conditions result in an interruption or cancellation of project activities. Active involvement of projects´ key actors, including universities and R&D institutes, from the beginning of the project, could help to improve technologies regarding project objectives and local conditions.

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Strength: public participation

(cause: active involvement of project participants and the population - effect: smooth proceedings of the project activities)

Threat: bounded rationality

(cause: bounded rationality - effect: unsustainable choices of utilizers)

Bounded rationality could be diminished by active involvement of project participant and the population from the beginning of the project, because the involvement may increase their information and awareness on the benefits and costs of different decisions (e.g. on technologies utilization). This would decrease limitations on rationality and result in more sustainable choices.

Strength: public participation

(cause: active involvement of project participants and the population - effect: smooth proceedings of the project activities)

Threat: public acceptance of technologies

(cause: lack of acceptance for new technologies - effect: interruption or stop of project implementation)

A lack of acceptance regarding new technologies has different reasons. One cause is a lack of information (or wrong information) on costs and benefits of a new technology. This threat could be diminished by active involvement of project participants and key actors as well as the population. First, because the latter mentioned involvement could increase their knowledge on costs and benefits of the new technologies and therefore reduce wrong perceptions of these. In addition, active involvement of key actors may result in more balanced decisions and activities that address the benefits of all key actors. This would increase the interest and acceptance of the key players in implementing the project and therefore result in a smoother process of project activities.

Strength: public participation

(cause: active involvement of project participants and the population - effect: smooth proceedings of the project activities)

Threat: development procedures that may inhibit or trigger implementation of SC projects

(cause: local regulations - effect: impossibility to carry out energy sanitations of historical building)

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Local regulations can result in difficulties to carry out project activities such as energy sanitation of historical building. This threat could be diminished by active involvement of different key players (including urban authorities and urban planning regulators) from the beginning of the project. The involvement of urban authorities from the beginning of the project may increase the information on local regulations and therefore result in designing project activities in agreement with these regulations. On the other hand, involvement of urban regulators and legislators could result in some revisions of local regulations. Therefore, the implementation of SC interventions would be facilitated.

Strength: marketing application for awareness and involvement
(cause: marketing application for awareness and involvement of the project - effect: smooth process of the planned activities)
Threat: political commitment over long term
(cause: changes in political leadership - effect: decrease or elimination of political support to the project)

Changes in political leadership result in inconsistent or elimination of political support to the project. This has a huge impact on implementation of projects and result in consistent delays or even cancelation of project activities. Political commitment could be ensured partially by marketing application for awareness and involvement of the project, because marketing increases social and political interest in a project and therefore changes in support will be less probable.

Strength: marketing application for awareness and involvement
(cause: marketing application for awareness and involvement of the project - effect: smooth process of the planned activities)
Threat: public acceptance of technologies
(cause: lack of acceptance for new technologies - effect: interruption or stop of project implementation)

A lack of acceptance for new technologies, which results in interruption or cancelation of project implementation can be diminished through marketing application for awareness and involvement of the project. Marketing may create more interest between the whole population and therefore, could result in a higher acceptance of the project by the population. This in turn would lead to a smoother implementation of the project.

Strength: cooperation and trust between different stakeholders

(cause: well cooperation between project participants - effect: smoothly running project activities)

Threat: public procurement

(cause: public procurements - effect: interruption or stop of project implementation)

Public procurement can result in interruption or cancelation of project activities due to complicated procedures. This threat could be compensated by a well cooperation between public and private participants of the project. A well cooperation would help to make complicated procedures work faster and smoother.

Strength: cooperation and trust between different stakeholders

(cause: well cooperation between project participants - effect: smoothly running project activities)

Threat: procedures for authorization of technologies

(cause: complicated and time consuming procedures for authorization - effect: delays in project activities)

A high number of authorities involved in giving permission for project activities as well as complicated and time consuming procedures for acquiring permission lead to significant delays in project implementation. This threat could be compensated by a well cooperation between different authorities. The latter mentioned cooperation would help to make complicated procedures work faster and smoother.

Strength: cooperation and trust between different stakeholders

(cause: well cooperation between project participants - effect: smoothly running project activities)

Threat: existence of data security and privacy

(cause: data security and privacy issues - effect: interruption or stop of data uptake)

Smart city projects deal with big data gathering and data management. Thus, data security and privacy issues are very important for SC projects and a lack of well-defined standards and regulations of data privacy may result in interruption or cancellation of the data uptake. One solution to overcome this threat could be a well cooperation between project participants in terms of sharing data and information. On the other hand, cooperation may result in more trust and therefore, increase the feeling of security for data sharing. This would result in a smoother flow of data inside the project and easier implementation of the project.

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Strength: existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions
(cause: availability of expertise, awareness, and methods for designing and implementing projects - effect: smooth project activities)
Threat: complexity of applying solutions with regard to local conditions
(cause: complexity of applying technologies in local conditions - effect: problems and delay in construction/implementation)

Although different projects may apply similar SC solutions, each project is implemented in different cities with different contexts. However, this issue could be addressed by the availability of expertise, awareness, and methods for designing and implementing projects. Experts may analyse different legal, social, economic, and environmental (both natural and built) conditions of the project site and design the project activities with respect to local conditions. This would help to smooth the implementation of the projects, because the application of technologies is localized and appropriate for specific situations of the project.

Strength: communication between project participants and the public to increase awareness
(cause: energy advice campaigns - effect: smooth project execution)
Threat: bounded rationality
(cause: bounded rationality - effect: unsustainable choices of utilizers)

Bounded rationality could be diminished by energy advice campaigns, which increase the information and awareness of the population on the benefits and costs of different decisions, technologies, and behaviour. This would decrease limitations on rationality and result in more sustainable choices.

Strength: communication between project participants and the public to increase awareness
(cause: energy advice campaigns - effect: smooth project execution)
Threat: public acceptance of technologies
(cause: lack of acceptance for new technologies - effect: interruption or stop of project implementation)

A lack of acceptance of new technologies, which creates significant interruptions in implementation of projects, can have different reasons. This barrier may rely to a lack of information or wrong information on costs and benefits of a new technology. Another possible reason can be a lack of knowledge on how to apply new technologies, which creates inconvenience and therefore a lack of interest in their application. However, this threat could be diminished by energy advice campaigns, because these increase the population knowledge on costs and benefits of new technologies. Therefore, energy advice campaigns reduce wrong perceptions of the latter mentioned costs and so increase acceptance. Moreover, these campaigns would provide direct aid on how to apply new technologies.

Strength: share of valuable data between different departments and partners
(cause: consultation activities help to overcome project problems not solvable internally - effect: less problems concerning project proceedings)
Threat: availability or lack of subsidies
(cause: lack of supporting legislations for the project goals - effect: difficulties in reaching the planned aims)

A lack of supporting legislations for achieving project objectives may hinder the implementation of project activities. This threat relates mainly to local legislations in which the project is implemented. The given threat could be partially addressed by consultation activities. Consultants might provide project leaders with knowledge on how to exploit these legislations, which help to smoothen project activities and avoid those legislations, which hinder achieving project goals.

Strength: share of valuable data between different departments and partners
(cause: consultation activities help to overcome project problems not solvable internally - effect: less problems concerning project proceedings)
Threat: transparency of legislation
(cause: non-transparent legislation - effect: delays concerning project activities)

Non-transparent legislation lead to unclear investment situation as well as unclear implementation of legislation for project activities. This can delay the project´s implementation due to ambiguous investment and legal situations. In this regard, consultation activities could be very helpful to increase clarity of investment and legal situations in order to avoid misunderstandings and further legal problems during the execution of the project.

Strength: existence of financial schemes
(cause: presence of financial schemes and tools - effect: easier project procedures)
Threat: economic crisis
(cause: economic crisis - effect: delay of project activities)

Economic crisis has different negative impacts on project activities. One of these is the possibility in financing the projects. In this regard, the presence and application of financial schemes and tools would help to alleviate financial crisis problems.

Strength: existence of financial schemes
(cause: presence of financial schemes and tools - effect: easier project procedures)
Threat: cost of material, construction, and installation
(cause: high cost of material, construction, and installation - effect: reduction of investments and participation in the project)

High costs of material, construction, and installation of SC projects discourage investment and therefore hinders projects implementation. This threat could be alleviated by the application of financial schemes and tools in advance, in order to consider high costs and manage them to avoid problems during the implementation of the projects.

Strength: existence of financial schemes
(cause: presence of financial schemes and tools - effect: easier project procedures)
Threats: existence of financing models suitable for the innovation to address stakeholders
(cause: lack of appropriate business models - effect: delays in project implementation)

A lack of appropriate business models, which are suitable for the innovation and involvement of different stakeholders leads to an inappropriate or insufficient investment from both, public and private sectors and therefore may delay project implementation. This problem could be solved by applying existing financial schemes and tools in order to create new business models for innovative SC projects.

b.) Connections between opportunities and weaknesses

Opportunity: existence of affordable and mature technologies suitable for local conditions
(cause: existence of mature and locally tested technologies - effect: facilitation of project activities)
Weakness: existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions
(cause: lack of experience - effect: lack of experts)

Due to the novelty of many SC solutions, there is a lack of knowledge on how to implement these projects. This leads to unpredicted problems and therefore delays during the project implementation. However, this weakness could be alleviated by existing technologies, which are suitable for local conditions. The application of already tested technologies could reduce unpredictable problems during project implementation.

Opportunity: environmental issues
(cause: treatment of environmental related issues - effect: higher public acceptance of the project)
Weakness: public participation
(cause: uninteresting project aims - effect: reluctance in participation)

If the projects´ aim are not interesting, the participation in these decreases. This hinders or even cancels project implementation. One solution to address this problem could be the treatment of environmental related issues inside the project. Experience has showed that the treatment of environmental related issues increases the interest of investors and results in a better acceptance and a higher level of participation of the population (EC, 2015B).

Opportunity: availability or lack of subsidies
(cause: existence of subsidies and incentives related to project aims - effect: support in achieving the project aims)
Weakness: inertia
(cause: inertia - effect: delays or misuse of technologies)

Inertia refers to the application of new or different technologies by the population. In fact, this weakness hinders achieving project aims. However, this barrier could be diminished by providing suitable subsidies for the support of SC activities (e.g. implementation of innovative technological application). Subsidies would act as motivators for people to change their behaviour in order to gain financial benefits. For example, subsidies, which are in favour of RE technologies could encourage investors to invest in projects with RES application.

c.) Connections between strengths and weaknesses

Strength: existence of performance indicators for technologies implementation

(cause: monitoring the work progress, Effect: support in achieving the project goals)

Weakness: existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions

(cause: lack of experience - effect: lack of experts)

A lack of experience in SC projects and new technologies leading to a lack of experts concerning related issues, can result in difficulties for the implementation of the analysed projects. To overcome this problem, it could be possible to apply monitoring methods in order to take trace of the work progress. Monitoring the work progress could inhibit mistakes, which may occur due to a lack of experience and experts.

Strength: communication between project participants and the public to increase awareness

(cause: energy advice campaigns - effect: smooth project execution)

Weakness: inertia

(cause: inertia - effect: delays or misuse of technologies)

Difficulties in change of behaviour concerning the application of new technologies hinders the achievement of project aims. However, this weakness could be diminished by the application of energy advice campaigns. Energy advice campaigns might lead to an easier change of behaviour at users, providing them with advice on how to smooth their transition towards more energy efficient habits.

d.) Connections between opportunities and threats

Opportunity: availability or lack of subsidies

(cause: existence of subsidies and incentives related to project aims - effect: support in achieving the project aims)

Threat: cost of material, construction, and installation

(cause: high cost of material, construction, and installation - effect: reduction of investments and participation in the project)

High costs of material, construction, and installation of SC projects discourage investment and therefore hinder projects´ implementation. This threat could be alleviated by providing suitable subsidies for the support of SC activities (e.g. implementation of innovative technology application).

Subsidies, which are in favour of RE technologies could decrease the investment costs and encourage investors to spend in projects with RES application.

Opportunity: environmental issues
(cause: treatment of environmental related issues - effect: higher public acceptance of the project)
Threat: public acceptance of technologies
(cause: lack of acceptance for new technologies - effect: interruption or stop of project implementation)

A lack of acceptance concerning new technologies creates significant interruptions regarding the implementation of projects. However, the treatment of environmental issues could alleviate this threat. Experience has showen that the treatment of environmental related issues increases the interest of investors and results in a better acceptance of SC projects, as well as a higher level of participation of the population (EC, 2015B).

e.) Connections between opportunities and strengths

Opportunity: existence of affordable and mature technologies suitable for local conditions
(cause: existence of mature and locally tested technologies - effect: facilitation of project activities)
Strength: existence of training material
(cause: training activities for project participants - effect: support for the project implementation)

Training activities for project participants provide expertise in application of new technologies for SC projects. A proper exploitation of mature technologies for local conditions could be trained at project participants. Trained experts could apply already tested technologies properly to retrieve optimal results from them. This would facilitate and increase the quality of project implementation.

Opportunities: political commitment over the long term
(cause: political commitment to the project - effect: smoother process of the project)
Strength: marketing application for awareness and involvement
(cause: marketing application for awareness and involvement of the project - effect: smooth process of the planned activities)

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Marketing application for awareness and involvement of the projects increases social and political interest in the analysed undertakings. Therefore, marketing could enhance the political support during the life cycle of the project. Political commitment during the long term results in a smoother implementation of the projects.

f.) Connections between weaknesses and threats

Weakness: existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions
(cause: lack of experience - effect: lack of experts)
Threat: requirements from the European Commission concerning reporting and accounting
(cause: excessive requirements by the EC in terms of reporting and accountancy - effect: high time consumption)

Excessive requirements by the EC in terms of reporting and accountancy result in a high time and energy consumption and may delay project activities. If the project staff, responsible for reporting and accountancy, is not experienced concerning the latter mentioned issue, this threat may create even more difficulties for the project implementation. Thus, it could be important to employ skilled staff for EC reporting and accountancy requirements to avoid the latter mentioned threat.

As visible, from the indications provided above, the most utilized driver comes out to be public participation.

3. SINFONIA SWOT ANALYSIS

In order to elaborate the concept proof and revision of the baseline with regard to the SINFONIA project, a SWOT analysis is carried out, which focuses on the present project itself. The second of the two aforementioned studies is the present SINFONIA SWOT, which can be considered as an ex-ante assessment of the project, in the early stage of its course. Such an assessment can help the consortium (mainly the WP leaders) to develop a successful implementation strategy, taking into account the most relevant factors highlighted in previous similar experiences (already past or still ongoing SC projects) and the local situation of the pilot cities BZ and IBK.

In this case, the SWOTs are defined by following rules:

- Positive aspects:

- Strengths are elements of the project itself, which provide a positive input to the question: “How is SINFONIA designed to be successful?
- Opportunities are elements outside the project, which provide a positive answer to the question: “Could the given issue help SINFONIA to reach its targets?

- Negative aspects:

- Weaknesses are elements of the project itself, which provide an answer to the question: “What limits will SINFONIA probably encounter do to its design?
- Threats are elements outside the project, which provide a positive input to the question: “Could the present issue reduce the chance of SINFONIA to reach its targets?”

The given analysis is supported by a detailed review of following documents, carried out by WP leaders and municipal experts:

- Description of work (DoW) of the SINFONIA project
- Background analysis concerning the state of the art (local energy master plans) of the pilot cities:

- Sustainable energy action plan (SEAP) for the pilot city of BZ (Vaccaro et al., 2014)
- Energy development plan for the pilot city of IBK (STADT INNSBRUCK, 2011)

First, the applied methodology to generate the SINFONIA SWOT is provided (3.1 SINFONIA SWOT METHODOLOGY). Then, the results of the latter mentioned investigation follow straight within the subchapter 3.2 (SINFONIA SWOT RESULTS).

3.1 SINFONIA SWOT METHODOLOGY

In the present subchapter, the explanation concerning how the above mentioned SINFONIA SWOT is created, follows in various parts. The first section explains by what method the most similar projects to SINFONIA are selected (3.1.1). Then, it is exposed by which means the DoW of SINFONIA is analysed and linked to the most relevant SWOTs (3.1.2). Finally, it is described through what the local energy master plans of the two pilot cities BZ and IBK are investigated in order to enrich the given SWOT analysis of the SINFONIA project itself (3.1.3).

3.1.1 SINFONIA´S MOST SIMILAR SMART CITY PROJECTS

In order to learn from already completed and ongoing SC projects in terms of SWOTs, it makes sense to identify the most similar undertakings to the SINFONIA project, as it is likely to happen that the barriers and drivers faced within these undertakings occur in the SINFONIA project as well due to given similarities between them (e.g. same type of technologies applied).

As a starting point for the latter mentioned aim, the SC projects list described in subchapters 2.1.1, SMART CITY PROJECTS AND THEIR LOCATIONS, and the homonymous RESULTS part 2.2.1 is utilized. Next, all above indicated projects are analysed by taking into consideration a certain amount of criteria: twelve macro criteria (scales etc.) and respective criteria (e.g. district scale: 0 to 5,000 inhabitants etc.). Figure 18 visualizes the subdivision into macro criteria and respective criteria:

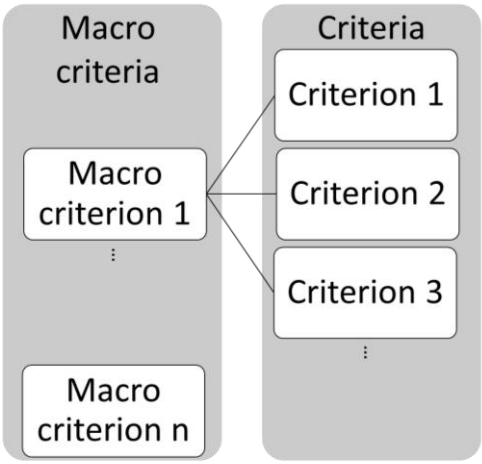

FIGURE 18 - SCHEME OF MACRO CRITERIA AND CRITERIA USED FOR THE SMART CITY PROJECTS ANALYSIS (EC, 2014D), (ENCYCLOPEDIA BRITANNICA, 2014), (JOHNSTON, 2008)

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The latter mentioned macro criteria are derived from previous indicated results in chapter 1, DEFINITION OF SMART CITY, concerning how to analyse SC projects, while the respective criteria are subdivisions of these, organized according to indications gathered from scientific literature sources.

As already mentioned before, not all collected SC projects are derived from open access fonts, but also due to information provided by project partners of the present WP. These SC undertakings are analysed by a questionnaire send to project partners, entailing the above indicated criteria.

A guide to answer the posed questions supports the data uptake from project partners. The questionnaire and corresponding guide are attached in the chapter QUESTIONNAIRE AND GLOSSARY 7.2, QUESTIONNAIRE FOR PROJECT PARTNERS, and 7.3 (GLOSSARY FOR SMART CITIES). While the fulfilled questionnaire are not enclosed for privacy issues.

The above mentioned guide, GLOSSARY FOR SMART CITIES, entails the definition of the most important terms used in the respective questionnaire, which are of fundamental importance when speaking about SC projects.

Next, the two before described data collections shown in Figure 9 and 18 (SCHEME OF THE PROJECTS LIST WITH RESPECTIVE CITIES/LOCATIONS, and SCHEME OF MACRO CRITERIA AND CRITERIA USED FOR THE SMART CITY PROJECTS ANALYSIS) are brought together to form a matrix. Within the latter mentioned matrix, the y-axis consists of the collected SC projects with respective cities/locations, while the x-axis is formed by the macro criteria and criteria utilized to analyse SC undertakings. The sense of such a matrix composition lies in the possibility to check, which criteria apply to each project, marking correspondences project-by-project and city-by-city. The latter mentioned coherence are marked by an “X”. Figure 19 shows the concept of the above described matrix:

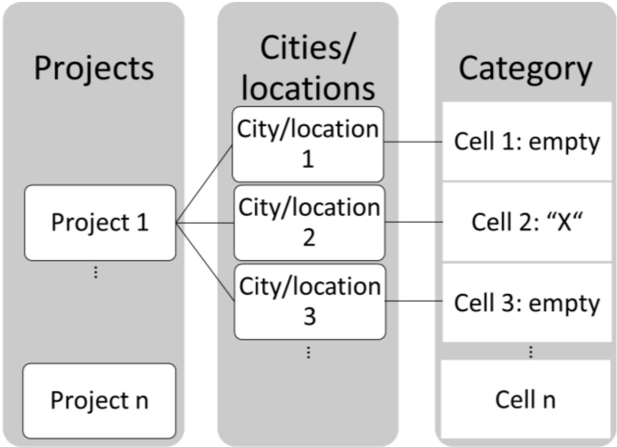

FIGURE 19 - SCHEME OF THE MACRO CRITERIA AND CRITERIA MATRIX USED FOR THE SMART CITY PROJECTS ANALYSIS (EC, 2014A), (EC, 2014C), (AMSTERDAM SMART CITY, 2015), (EC, 2015B), (EC, 2014D), (ENCYCLOPEDIA BRITANNICA, 2014), (JOHNSTON, 2008)

Carrying out the above described analysis it is possible to identify similarities between the various collected SC projects and the SINFONIA project itself. In order to extrapolate the most similar projects to SINFONIA, a formula is utilized, which compares all cities/locations of the projects with the pilot cities of SINFONIA: BZ and IBK. If a correspondence of two "X" is registered within the two compared cities/locations, the applied formula comes up with a value of "1" and if the latter mentioned correspondence is not given, a value of "0" appears. It has to be stressed that slash signs ("/") have been positioned in originally empty cells at the cities of the SINFONIA project, to avoid that two empty cells can result into a value of "1" as well. Hence, disparities are not counted.

As the criteria of BZ and IBK are not identical, the latter mentioned comparison procedures are carried out separately. First, each city of the collected SC projects is compared to IBK and afterwards the same procedure is applied to BZ. The two latter mentioned comparison proceedings result in two different databases: one for BZ and another for IBK.

The amount of criteria per macro criteria statistically normalizes the resulting values of "1", so that every out coming "1" value per macro criteria counts the same. For example, a cell correspondence between two cities within the macro criteria "Scales", which is characterized by six criteria, results into a value of 0.17 (= 1/6).

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Proceeding with the evaluation, each result database (BZ and IBK separately) is summed up per line. Then, the average of sums per line is calculated to normalize each project´s outcome regarding its number of cities/locations. Hence, it is not possible that projects with a higher number of cities/locations automatically result to be more similar to SINFONIA. Finally, the out coming averages per cities/locations and comparison with BZ and IBK are summed up. The latter mentioned results per project are then subtracted from the respective outcome of the SINFONIA project itself. Thus, the lower the resulting difference per SC project is, the higher is its similarity to SINFONIA. By doing so, a ranking of the most similar SC projects to SINFONIA is created. Figure 20 visualizes the here described evaluation proceeding on an example:

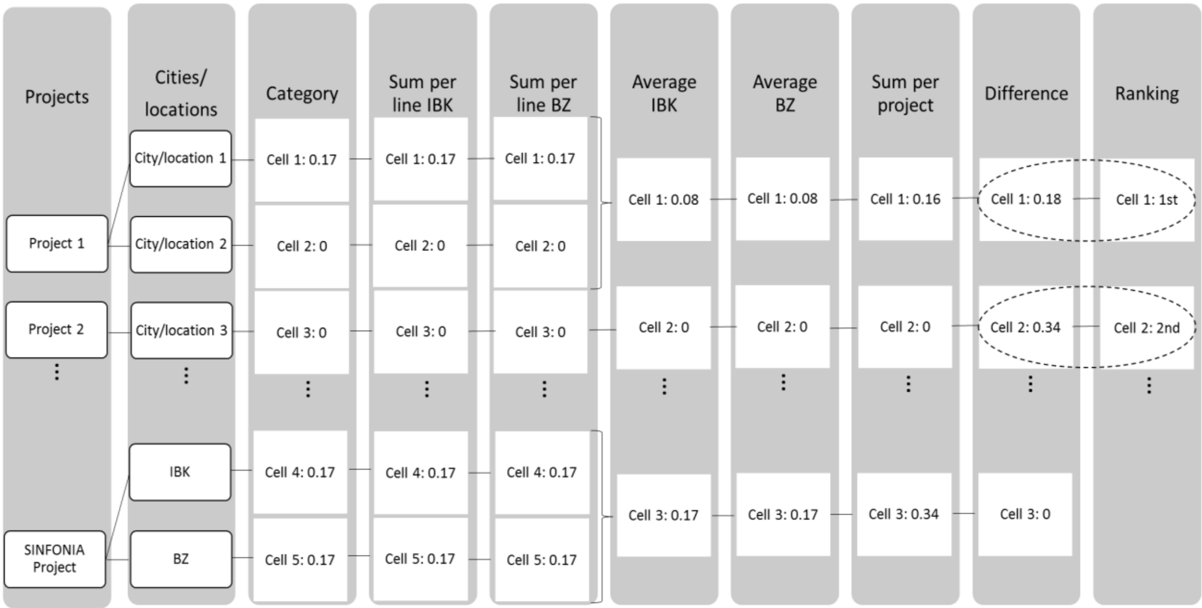

FIGURE 20 - SCHEME FOR THE CALCULATION OF THE MOST SIMILAR PROJECTS TO SINFONIA

As visible in Figure 20, Project 1 would come out to be more similar to SINFONIA as resulting in a lower difference (0.18) than Project 2 (0.34). Both latter indicated outcomes are marked with dashed lines.

3.1.2 SINFONIA PROJECT – DESCRIPTION OF WORK – ANALYSIS

The DoW is a document, which contains the details of the SINFONIA project implementation with regard to the WPs, deliverables, milestones, resources, and costs of the beneficiaries as well as a detailed narrative description of the tasks to be completed. This document consists of two parts:

- Part A of ANNEX I

  This section contains the project summary, the list of participants and the budget breakdown as well as the work plan, which provide details on the implementation of the project.

- Part B of ANNEX I

  This segment is based on information of the project proposal (Part B). However, during the negotiation stage, several sections of the original proposal are updated. Moreover, the consortium shortened and elaborated specific parts of the proposal. Part B of ANNEX I is the narrative part of its respective ANNEX section.

The DoW reports the list of participants, which established the project consortium with respective nationality indications. See Table 10:

TABLE 10 - LIST OF PROJECT PARTNERS OF THE SINFONIA PROJECT (EC, 2014E)

PARTICIPANT NR.	PARTICIPANT´S ORGANISATION NAME	COUNTRY
1 (Coordinator)	(SP) Sveriges Tekniska Forskningsinstitut	SE
2	(MAGIBK) Stadtmagistrat Innsbruck	AT
3	(IKB - incl. USI, ATB-Becker, e3 consult) Innsbrucker Kommunalbetriebe AG	AT
4	(NHT) Neue Heimat Tirol Gemeinnützige WohnungsGmbH	AT
5	(UIBK - incl.alpS) University of Innsbruck	AT
6	(SAT) Tiroler Zukunftsstiftung - Standortagentur Tirol	AT
7	(BOZ) City of Bolzano	IT
8	(EURAC) European Academy Bolzano	IT
9	(IPES) Istituto per l'Edilizia Sociale della Provincia Autonoma di Bolzano	IT
10	(SEL) SEL SPA	IT
11	(CASACLIMA) AGENZIA PER L'ENERGIA ALTO ADIGE	IT
12	(BORAS - incl. Borås Energi och miljö & AB Bostäder) Borås Stad	SE
13	(LARO) City of LaRochelle	FR
14	(CEMS) Corporation municipal of companies from Sevilla	ES
15	(PAFOS) Pafos City	CY
16	(G!E - incl. ATLANTIS, Heidenreich Consulting) Greenovate! Europe	BE
17	(ZAB) Zabala Consulting	ES
18	(TEC) Technofi	FR
19	(CNEES) Centre National d'Expertise sur l'Enveloppe et la Structure	FR
20	(PHI) Passive House Institute	DE
21	(ROSE) Rosenheim City	DE

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22	(ALF) Alfa Laval	SE
23	(LIE) Liebherr Hausgeräte GmbH	AT
24	(TIG - incl. TIWAG-Tiroler Wasserkraft AG) TIGAS - Erdgas Tirol GmbH	AT
25	(IIG) Innsbrucker Immobilien Gesellschaft	AT

The SINFONIA project is structured in 10 WPs, starting from the management (WP1) and ending with the dissemination of the project (WP10).

The WP7 and 8 can be considered as the core of the project, dealing with the on-site implementation in the two pilot cities (WP7: Innsbruck - implementation & realisation and WP 8: Bolzano – implementation and realization).

The implementation phase of SINFONIA addresses the following three aspects through the integration of a portfolio concerning innovative technologies:

- Refurbishing two city districts: the proposed measures involve innovative technical, economic and financial solutions, which significantly increase overall EE of envisaged eco-building. The measures are chosen based on a sound assessment of the social, economic and environmental performances of the different technology options. The detailed metering/monitoring programme will last for one full year, but will be extended in view of continuous monitoring with guarantees of performance. The monitoring programme will include behavioural aspects.

- Implementing innovative solutions for the medium and low voltage electricity distribution grid, to improve the integration of a large share of power generated from RES (biomass, hydro and PV installations). Electricity storage devices and strategies to better match the supply with the demand, as well as ancillary services for the grid stability will be implemented. Technological and economic assessment concerning the integration of electric vehicle into the local grid, with intelligent charging/discharging systems and assessment of the best balance of stationary versus mobile storage is foreseen.

- Implementing innovative solutions for district heating and/or cooling systems (DH/C) energy supply, allowing the improvement of the overall efficiency of the system (heat generation, distribution and final use). District heating and/or cooling systems are based primarily on recovering waste heat and adapting the temperature levels of the networks to the application. Links with industrial activities will be addressed, implementing the use of heat or cold storage devices or systems (EC, 2014E).

Table 11 below summarizes the main key figures and technology components in both project sites:

TABLE 11 - MAIN KEY FIGURES AND TECHNOLOGY COMPONENTS IN BOTH PROJECT SITES OF SINFONIA (EC, 2014E)

AREA OF INNOVATION	TECHNOLOGY COMPONENTS	
	BOLZANO	INNSBRUCK
	*Building from 50-70's* 451 dwellings, retrofitting floor area: 36233 [m^2] Before: 150 [kWh/m^2a] After: 35 [kWh/m^2a] Savings: 84%; 19,8 [GWh/a]; 10500 tons of CO_2eq/a. Multifunctional façades; solar PV panels (2754.9 [m^2] / 250,4 [kW]); solar thermal collectors (1039.5 [m^2] / 454.8 kW)	*Building from 50s-80s,* 548 dwellings, retrofitting floor area: 66486 [m^2] Before: 240 [kWh/m^2a] After: 20 [kWh/m^2a] Savings: 80%; 5.6 [GWh/a] Thermal insulation; PV panels (5000 [kWp]); Low temperature and high temperature DHC network from RES[1]; innovative and efficient HVAC systems. Account of user behaviour.
	Distributed energy control system, real time monitoring and forecasting of energy demand at any time. Electric vehicle and electric-bike recharge stations; smart public lighting; smart meters; smart sensors; software system; test of hydrogen fuelled buses[2].	Load management by smart load control: smart refrigerators (in households and warehouses) and smart hot water boilers in households, load management for distributed heat pumps. Electric mobility, battery storages for PV systems in households, smart plugs, smart meters. Increase in local electricity production by RES: +30% Reduction in fossil fuels -30%
	<u>Smart renewable DH grid:</u> CHP Waste Incinerator[3]; Optimization system for DHC (loads and peaks forecasts, peaks reduction); Meteorological station for local climate forecasts. Energy control system. Installed capacity 30 [MW_{th}] / 11.5 [MW_{el}]; DHC network extension: 15.5 [km] Hybrid CHP backup system for the DH grid (CH_4+H_2) absorption chiller (efficiency: 0.68) Installed and connected to the DHC net.	Power House - Smart energy system, <u>low temperature DH</u> 15 [GWh/a] (max. 10 [MW_{th}] by utilization of drainage water from the Brenner Base Tunnel; Network extension: 2.5 [km] <u>High temperature DH</u> 43 [GWh/a] from RES[4] 10 [MW] heat storage for increasing utilization ration of RES in high temperature DH. High temperature DH network extension: 12 [km].

[1] Biomass, biogas, utilization of water from the Brenner Base Tunnel (Low temperature DH), solar thermal collectors, waste heat from industry, heat recovery from waste water, heat pump cascades, etc.
[2] In the framework of the EU-project CHIC
[3] Considering 18% of biomass content
[4] Biomass, biogas, solar thermal collectors, heat pumps, heat recovery waste water, industrial waste heat

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Like visible in Table 11 above, for both cities the key figures of the SINFONIA project are given in terms of energy and CO2 savings. Next Table 12 shows details of the latter mentioned issue:

TABLE 12 - DETAILS CONCERNING THE MAIN KEY FIGURES IN BOTH PROJECT SITES OF SINFONIA (EC, 2014E)

	Energy saving after 5 years [GWh]	CO2 saving after 5 years [tons]	Energy saving per year [GWh]	CO2 saving per year [tons]	Energy savings (%)	Share of RES (%)
Bolzano						
Building retrofit, Gross (36233 [m^2])	99	52900	19.8	10580	37%	27%
Innsbruck						
Building retrofit, Gross (66486 [m^2])	179	96100	35.8	19220	63%	25%

The latter described Part B of the DoW document is analysed. The content of each WP (from WP2 to 10), is placed in a singular excel sheet, subdividing each task in a single row (around 50 tasks). Work package one was discarded by the evaluation, because it relates solely to management aspects. While the content and titles of the WPs and related tasks are allocated on another sheet.

Next, a matrix is formed to investigate the above indicated tasks. Within this matrix, the y-axis consists of the tasks, while the x-axis is formed by the SWOTs, key elements and main activities performed. The key elements and main activities performed refer to following questions:

- "Which are the key elements involved?"

- Building
- DH/C
- Electricity
- People

- and "Which are the main activities performed?"

- Modelling/development
- Implementation/realization
- Monitoring/data collection
- Assessment (appraisal/evaluation)

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In some tasks all before mentioned key elements are given. Therefore an additional fifth key element is added, which is named "holistic".

Then, the specific task activities and contents are examined in detail in order to assign them to the categories already mentioned and explained in subchapter 2.2.2 (BARRIERS AND DRIVERS OF SMART CITY PROJECTS & THEIR CATEGORIES). After, the obtained categories are allocated within the four different sections of the SWOT matrix following the rules already mentioned in 3.1 (SINFONIA SWOT METHODOLOGY). Furthermore, in this case, if a category is positive or negative is derived from the average calculation of the weightings given by experts per category already mentioned in 2.2.3 (EFFECTIVNESS OF BARRIERS AND DRIVERS CATEGORIES). The latter mentioned experts are these project participants, which worked or are still involved in the projects, resulting to be the most similar to SINFONIA itself. As already mentioned before, the possible value range goes from -5 (negative → barrier: weaknesses and threats) to +5 (positive → drivers: strengths and opportunities). If the average calculated per category results to be positive, a driver is given, while a negative value indicates a barrier. Once again, the IQR calculation is implemented as well, which determines how much the experts agreed on the importance of the categories.

Each category is marked by a reference number (ranging from 1,1 to 10,3) and placed in the SWOT cells, indicating a correspondence with a certain category between a task and one of the four SWOTs section. See Figure 21:

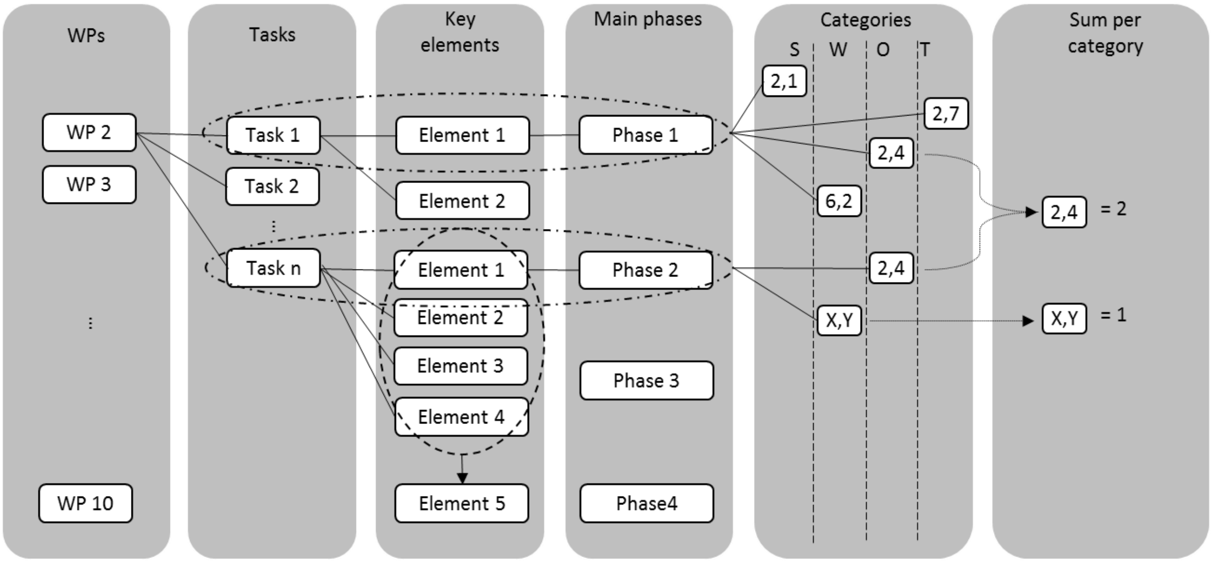

FIGURE 21 - SCHEME OF THE SINFONIA MATRIX FOR SWOTS, KEY ELEMENTS, AND MAIN ACTIVITIES

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Next, the obtained database is submitted to WP leaders, in order to check if the categories has been allocated in a correct way and to confirm, add or delete the inserted key elements and main activities.

3.1.3 LOCAL ENERGY MASTER PLANS ANALYSIS

This section provides information on how the local energy master plans of the pilot cities BZ and IBK are analysed. First, the respective indication concerning BZ are provided, followed by these of IBK:

a.) SEAP of Bolzano (Piano d'Azione per l'Energia Sostenibile di Bolzano)

The SEAP is the formal output of a voluntary agreement between the local authority (in this case the Municipality of Bolzano) and the EC known as the "Covenant of Mayors", with the aim of reducing local CO2 emissions by at least 20% by 2020. This movement was launched in 2008 after the release of the EU climate and energy package. The Covenant of Mayors´ aims to involve local authorities for the achievement of the EU 20-20-20 targets.

The treated movement comprises two main sections. The first focuses on analysing and the second on planning. The analysis concerns the definition of the baseline emissions inventory (BEI) in terms of local energy consumption and CO2 emissions. The baseline year should be 1990, but another year can be chosen according to the availability of information. The planning phase concerns the definition of specific actions in different sectors (e.g. building, lighting, and transportation of the public and private sectors) in order to achieve the reduction targets. For each action there is a data sheet giving the name of the action, a short description, indicators, CO2 emissions savings, responsible person, and estimated costs.

The city of BZ, which has a population of almost 106000 inhabitants, is located in the northern part of Italy (on the border to Austria) and is the capital city of the Autonomous Province of South Tyrol. Since 2005, the city of BZ is tackling the transition from a traditional fossil fuel-based, to a smart efficient and renewable sources-based energy system. The city of BZ is supported by a strong national and local (especially provincial) framework with a clear business plan and roadmaps (South Tyrol Energy Strategy to 2050) stating clear targets in terms of both, CO2 emission reduction and share of efficiency and renewable sources with regard to the local energy system. The local government and the community are active involved in sustainable development projects (ranging from a local to EU scale) since several years and the Autonomous Province promotes itself as a "KlimaLand" (climate land).

Since 2007, the city of BZ has scheduled the development of its own energy action plan and joined the SEAP procedure in 2010. This SEAP is connected to the mobility and master plans of BZ. The SEAP was formally adopted by a municipal council decision on the 10th of June 2014, sets the BEI at the year 2010, and contains 28 different actions for achieving the set CO2 reduction target (-23,83%). Respective actions has to be accomplished in the timeframe of 2014 to 2020. See Table 13:

TABLE 13 - SUSTAINABLE ENERGY ACTION PLAN OF BOLZANO: MAIN KEY FIGURES

SUSTAINABLE ENERGY ACTION PLAN OF BOLZANO		
ANALYSIS	**TARGETS**	**RESULTS**
CO2 emission in 2010 (BEI)		520.715 ton
	CO2 emission reduction expected	-124.093 ton
	CO2 annual emission target in 2020	396.622 ton

The above indicated 28 actions of the BZ SEAP address the following different sectors:

- E (Edilizia e lavori pubblici) Building and public works
- M (Mobilità) Mobility
- R (Energie rinnovabili) RES
- I (Informazione e formazione) Information and awareness
- A (Monitoraggio e reporting) Monitoring and reporting

The whole list of the 28 actions is given by following parts:

- E1 Implementation of provincial resolutions - modification of building regulations
- E2 Construction of a new district heating network
- E3.a Energy assessment of municipal building
- E3.b Refurbishment programme of the municipal building
- E3.c Refurbishment of the municipal building
- E4 Energy assessment and mapping of private building
- M1 Completion of the network of cycle paths and enhancement of cycling in the city
- M2 New urban public transportation system
- M3 Refinement and implementation of the parking plan
- M4 Promoting the use of bicycles and electric vehicles
- M5 City logistic - distribution of goods in city centre

- M6 Coordinated mobility management with meteorological service
- M7 Refurbishment of public lighting and traffic lights
- M8 Car sharing
- R1.a Installation of roof mounted PV and ST panels
- R1.b Intervention programme for roof mounted PV and ST panels
- R1.c Installation of roof mounted PV and ST panels on municipal building
- R2 Exploitation of geothermal resources
- R3 Exploitation of hydroelectric resources
- I1 Supporting energy saving initiatives and the use of local products
- I2 Information campaign and awareness on CO2 emissions issues
- I3 Calculation of individual CO2 emissions
- I4 Environmental sustainability and green public procurement (GPP) within the municipality
- I5 Involvement and awareness of the municipality staff and workers
- I6 Renewable energy park at the “Firmian” landfill
- A1 Monitoring
- A2 Data collection
- A3 Connection between the building activity reduction index and CO2 emissions (Vaccaro et al., 2014)

b.) Energy development plan of IBK (Innsbrucker Energieentwicklungsplan)

The Energy development plan of IBK consist of a detailed status quo analysis concerning the energy consumption of the latter mentioned city (Phase 1). Concrete goals and scenarios are carried out concerning energy use and CO2 emissions of IBK. The latter mentioned goals provide a roadmap, which IBK follows as a model. Phase 2 focuses on funding-strategies, awareness creation and high visibility projects (alpS, 2015).

The so-called “Exemplary scenario” of the Energy development plan of IBK was defined as the target to follow by the municipality decision taken on the 17th of August 2011. Following Table 14 specifies the before indicated Exemplary scenario and the other scenarios of the Energy development plan of IBK.

TABLE 14 - ENERGY DEVELOPMENT PLAN OF INNSBRUCK: MAIN KEY FIGURES

ENERGY DEVELOPMENT PLAN OF INNSBRUCK		
ANALYSIS	TARGETS	RESULTS
CO_2 emission in 2009		405.485 ton
	CO_2 emission reduction expected at the “Minimal Scenario”	-124.093 ton
	CO_2 emission expected at the “Business As Usual (BAU) Scenario” in 2025	530.191,5 ton
	CO_2 emission expected at the “Minimal Scenario” in 2025	392.580 ton
	CO_2 emission expected at the “Exemplary Scenario” in 2025	225.283 ton
	CO_2 emission expected at the “Autarky Scenario” in 2025	15.634 ton

The treated plan foresees several actions, which address following different sectors:

- W (Wohnbau) Residential building
- NW (Nicht-Wohnbau) Non-residential building (others)
- Ö (Öffentliche Gebäude) Public building (without residential building)

The whole list of action is given by these items:

- W1 Modification of the urban plan
- W2 Modification of building regulations
- W3 Building refurbishment
- W4 Construction of new DH networks
- W5 Compulsory connection to DH network
- W6 Use of industrial waste heat
- W7 Contracting for privates and constructors
- W8 Offer of energy monitoring systems
- W9 "All from one source" building refurbishment
- W10 Subsidies
- W11 Independent expert advice
- W12 Information campaign and awareness creation
- NW1 Modification of the urban plan
- NW2 Modification of building regulations
- NW3 Commercial law

- NW4 Construction of new local or district heating networks
- NW5 Compulsory connection to DH network
- NW6 Use of waste heat
- NW7 Contracting for companies
- NW8 Building refurbishment
- NW9 Use of ST energy in commercial building
- NW10 Use of PV energy
- NW11 Smart grids
- NW12 Energy monitoring
- NW13 Energy efficiency in industrial processes
- NW14 Information and advice to the companies
- NW15 Training, education, and continuing education for owners
- NW16 Territorial marketing based on energy
- NW17 Biogas and energy from waste
- NW18 Cooling in new and refurbished building
- NW19 Industrial energy plans
- NW20 Replacement of existing industrial thermal plans
- Ö1 Energy monitoring
- Ö2 Public procurements
- Ö3 Historical listed building refurbishment
- Ö4 Lighthouse projects
- Ö5 Use of local or district heating networks
- Ö6 Use of ST and PV energy
- Ö7 Plant and saving contracting
- Ö8 Public lighting
- Ö9 Smart grids
- Ö10 Green IT
- Ö11 Awareness creation
- Ö12 Energy assessment of public building
- Ö13 Legislative framework for a comprehensive refurbishment
- Ö14 Pioneering role of municipal building (STADT INNSBRUCK, 2011).

First, a deep investigation of both documents is conducted, referred to the general content, as well to analytic data, targets and planned actions.

Second, in collaboration with municipal experts, shared activities between the SINFONIA project and each master plan are highlighted and short motivations are provided in order to define which activities are:

- foreseen or considered within SINFONIA (directly referable to elements of the project)
- potentially additional to SINFONIA (can be related to elements of the project)
- not foreseen or considered within SINFONIA (not directly referable to any element of the project)

Third, activities identified as overlapping or potentially additional are linked with specific tasks of SINFONIA, while not foreseen activates are discarded. This preparatory assessment is submitted to municipal experts in order to receive a comprehensive review of the coherence founded between the DoW tasks and master plans activities. Hence, within the matrix shown in formal Figure 21 (SCHEME OF THE SINFONIA MATRIX FOR SWOTS, KEY ELEMENTS AND MAIN ACTIVITIES), new items within the x-axis are added. See Figure 22:

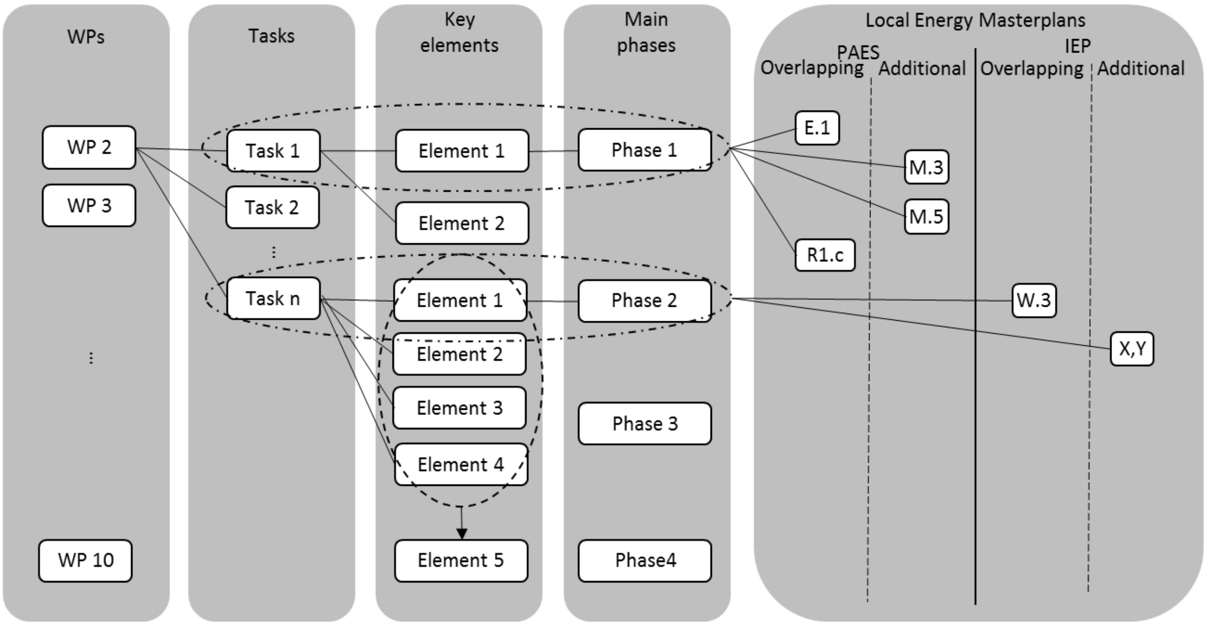

FIGURE 22 - SCHEME OF THE COMPLETE SINFONIA MATRIX

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3.2 SINFONIA SWOT RESULTS

Within the present subchapter, the results regarding the above described SINFONIA SWOT methodology are given in different parts. First, the outcome of the investigation regarding the most similar projects to SINFONIA and the categories classification of barrier and drivers into the four SWOTs areas is exposed (3.2.1). Next, the results concerning the SWOT analysis of the SINFONIA DoW are shown (3.2.2). After, the SINFONIA project activities overlapping the local energy master plans are visualized and commented (3.2.3). Finally, recommendations are provided on how to utilize drivers to overcome barriers present in the final SWOT matrix (3.2.4). The latter mentioned subchapter entails also indications by what method certain drivers could be utilized to enforce other positive elements of the respective SWOT matrix. Moreover, it is explained by which means minimizing specific barriers it is possible to avoid other negatives of the same SWOT matrix.

3.2.1 SINFONIA`S MOST SIMILAR SMART CITY PROJECTS

First, the selected macro criteria and criteria utilized to identify the most similar projects to SINFONIA are exposed. The macro criteria are given in the blue filled lines, in front of every table section, while within the macro criteria “Technologies” bold terms (e.g. Energy transmission and distribution) indicate specific areas of technologies. See Table 15:

TABLE 15 - MACRO CRITERIA AND CRITERIA UTILIZED TO IDENTIFY THE MOST SIMILAR PROJECTS TO SINFONIA (EC, 2014F), (ENCYCLOPEDIA BRITANNICA, 2014), (JOHNSTON, 2008), (GANN, 2012)

SCALES
District scale (0 to 5,000 inhabitants)
Town scale (5,000 to 50,000 inhabitants)
Small city scale (50,000 to 250,000 inhabitants), Metropolis
Medium city scale (250,000 to 500,000 inhabitants)
Large city scale (500,000 to 1,000,000 inhabitants)
Very large city scale (>1,000,000 inhabitants)

GOALS
Energy efficiency
Renewable energy use
Offsetting emissions
Energy use reduction

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SECTORS
Building and districts
Mobility and transportation
Energy networks and infrastructure

STAKEHOLDERS
Mayor/politician
City administration
Utilities, energy service companies, networks operators
Real estate developer
Developers, architects, planners, engineers
Housing/construction companies
Renewable energy industry
Component manufacturers
ICT companies
Financial institutions
R&D institutes and universities
Innovation/technology consultants
Energy consultants
Transportation consultants
End-users

SPATIAL SCALE
Building
Neighbourhood and district

INVOLVEMENT LEVEL
Very small involvement scale (0 to 5,000 inhabitants)
Small involvement scale (5,000 to 50,000 inhabitants)
Medium involvement scale (50,000 to 100,000 inhabitants)
Large involvement scale (>100,000 inhabitants)

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DURATION
Short-term (1-2 years)
Medium-term (3-7 years)
Long-term (>8 years)

SIZE OF THE AREA CONCERNING THE PROJECT APPLICATION
Very small area scale (0 to 100 [ha])
Small area scale (100 to 1,000 [ha])
Medium area scale (1,000 to 5,000 [ha])
Large area scale (5,000 to 30,000 [ha])
Very large area scale (30,000 to 100,000 [ha])

TOTAL BUDGET
Very small total budget (0 to 10 [Mil.€])
Small total budget (10 to 20 [Mil.€])
Medium total budget (20 to 30 [Mil.€])
High total budget (30 to 40 [Mil.€])
Very high total budget (40 to 50 [Mil.€])

TECHNOLOGIES
Energy transmission and distribution:
District heating pipe -Transmission
District heating pipe -Distribution
Energy storage:
Batteries
Electric vehicles to grid (V2G) technology
Solar thermal (ST) electrical steam
Flywheels
Embedded storage
Pumping power station
Insulation
Thermal Storage (buffer Vessels)

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Energy production:
District heating (DH)
District cooling (DC)
District heating and cooling (DHC)
Thermal cooling
Passive cooling
Photovoltaics (PV)
Hydro energy
Combined heat and power (CHP)
Energy from waste (CHP)
Gas fired CHP - Engine
Biomass boiler
Biomass CHP
Electric immersion heater
Solar thermal
Geothermal energy
Wind energy
Organic rankine cycle
Heat pumps
Waste water heat pump
Industrial waste heat
Central heating, ventilation, and air-conditioning (HVAC) systems
Energy monitoring and control:
Distributed intelligence
Enhanced remote control
Active Network Monitoring
Dynamic Asset Rating
Outage Management/supply restoration
Preventive maintenance/asset monitoring
Low voltage network monitoring and control
Voltage and volt-ampere-reactive optimisation (VVO)

Enhanced monitoring & control schemes
Enhanced automatic voltage control
Data collectors/concentrators
Aggregators
Demand Side management
Fibre
Asymmetric digital subscriber line (ADSL)
Power line communication (PLC)
Wireless fidelity (WiFi)
Wireless Mesh
General packet radio service (GPRS)/Global system for mobile communications (GSM)
Mobile application
Data platforms
Living labs
Worldwide interoperability for microwave access (WiMax)
Smart commodities:
Electric vehicles
Smart meters
Smart asset management
Smart domestic appliances
Remote smart controls
Home energy monitoring packages
Energy efficient fans
Energy efficient pumps
Energy efficient lights
Geographic information system (GIS)
Modelling tools

Once again the reader is remembered that the most relevant terms indicated in Table 15 above are explained in detail within the chapter QUESTIONNAIRE AND GLOSSARY, subchapter 7.3 (GLOSSARY FOR SMART CITIES).

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The resulting 10 most similar projects to SINFONIA comes out to be in ranking: four CONCERTO initiative undertakings, five projects of the Smart cities and communities initiative and one ASC activity.

Following Table 16 visualizes the results of the calculation described in 3.1.1, SINFONIA´S MOST SIMILAR SMART CITY PROJECTS, and shows the 10 most similar projects to SINFONIA:

TABLE 16 - RANKING OF THE TEN MOST SIMILAR PROJECT TO SINFONIA

RANKING	PROJECT NAME	FUNDING CALL OR INITIATIVE
1st	CITY-ZEN	FP7
2nd	CHANGE BY USE IN AMSTERDAM	ASC
3rd	POLYCITY	CONCERTO
4th	SOLUTION	CONCERTO
5th	STEP UP (ENERGY PLANNING FOR CITIES)	FP7
6th	INSMART	FP7
7th	ENERGY IN MINDS!	CONCERTO
8th	ACT2	CONCERTO
9th	CELSIUS	FP7
10th	EU-GUGLE	FP7

For further calculation, these 10 given most similar projects to SINFONIA (and related experts) are utilized.

The latter mentioned CONCERTO initiative projects show correspondences to SINFONIA especially regarding the three macro criteria: total budget, size of the area concerning the intervention, and involvement level. In contrast, the main similarities to the Smart cities and communities initiative and ASC undertaking are registered concerning the utilized technologies. The macro category "Stakeholders" comes out to be very similar for all latter mentioned SC projects. City administration, utilities, energy service companies, networks operators, R&D institutes and universities, and end-users result to be present in practically all latter mentioned undertakings.

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3.2.2 SINFONIA PROJECT – DESCRIPTION OF WORK – ANALYSIS

As already mentioned in the subchapter 3.1.2, SINFONIA PROJECT - DESCRIPTION OF WORK - ANALSYIS, a specific step is applied for the allocation of categories within the different sections of the SWOT matrix. If a category is positive or negative is derived from the average calculation of the weighting given by experts already mentioned in 2.2.3, EFFECTIVNESS OF BARRIERS AND DRIVERS CATEGORIES, with the difference that in this case only the marks given by the experts of the 10 most similar projects to SINFONIA are considered. Following Table 17 shows the results of the latter mentioned calculation with respective IQR per category:

TABLE 17 - CLASSIFICATION OF SWOTS BASED ON THE EXPERTS JUDGEMENTS INVOLVED IN THE TEN MOST SIMILAR PROJECTS TO SINFONIA

POLICY CATEGORIES	Average of the most similar projects to SINFONIA	Positive or negative category	SWOT internal or external category	Strengths (S), Weaknesses (W), Opportunities (O) or Threats (T)
National roadmaps, strategies, and policies for energy goals	+1.80	Positive	External	O
Political commitment over the long term	+3.11	Positive	External	O

ADMINISTRATIVE CATEGORIES	Average of the most similar projects to SINFONIA	Positive or negative category	SWOT internal or external category	Strengths (S), Weaknesses (W), Opportunities (O) or Threats (T)
Cooperation and trust between different stakeholders	+2.50	Positive	Internal	S
Communication between project participants and the public to increase awareness	+4.00	Positive	Internal	S
Existence of multi-actor/multi-sectorial planning tools	+0.90	Positive	Internal	S
Share of valuable data between different departments	+2.33	Positive	External	O
Existence of public-private engagement models	+1.40	Positive	Internal	S
Existence of financing models suitable for the innovation to address stakeholder involvement	+1.40	Positive	External	O
Public procurement	-0.67	Negative	External	T
Coordination of a large number of tenants	+0.80	Positive	Internal	S

Marketing application for awareness and involvement	+2.60	Positive	Internal	S
Set up of institutions to support the projects	+0.50	Positive	External	O
Obligations given to project participants	-0.75	Negative	External	T
Public participation	+2.50	Positive	Internal	S

LEGISLATIVE CATEGORIES (IMPLEMENTATION AND ENFORCEMENT)	Average of the most similar projects to SINFONIA	Positive or negative category	SWOT internal or external category	Strengths (S), Weaknesses (W), Opportunities (O) or Threats (T)
Transparency of legislation	-1.11	Negative	External	T
Consistency of implementation and interpretation of law	+0.60	Positive	External	O
Existence of regulatory stability	+0.80	Positive	External	O
Development procedures that may inhibit or trigger implementation of smart city projects	-1.70	Negative	External	T
Local budgetary legislations	-0.30	Negative	External	T
Existence of knowledge about future litigations	-0.40	Negative	External	T
Effectiveness of regulations for implementation of technologies and solutions	+0.90	Positive	External	O
Existence of updated regulation and rules for new technologies	+0.20	Positive	External	O
Procedures for authorization of technologies	-0.80	Negative	External	T

LEGISLATIVE CATEGORIES (CROSS-SECTORIAL AND INTERNAL COHERENCE)	Average of the most similar projects to SINFONIA	Positive or negative category	SWOT internal or external category	Strengths (S), Weaknesses (W), Opportunities (O) or Threats (T)
Existence of data security and privacy	-0.20	Negative	External	T
Tax pressure	-0.10	Negative	External	T
Transparency of taxation system	+0.10	Positive	External	O
Availability or lack of subsidies	+2.40	Positive	External	O
Existence of regulatory incentives for implementation of smart city projects	-0.60	Negative	External	T
Tariffs regulations	+0.60	Positive	External	O

TECHNICAL CATEGORIES	Average of the most similar projects to SINFONIA	Positive or negative category	SWOT internal or external category	Strengths (S), Weaknesses (W), Opportunities (O) or Threats (T)
Existence of affordable and mature technologies suitable for local conditions	+2.50	Positive	External	O
Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions	+2.80	Positive	Internal	S
Existence of training material	+1.20	Positive	Internal	S
Monitoring	+2.00	Positive	Internal	S

ECONOMIC CATEGORIES	Average of the most similar projects to SINFONIA	Positive or negative category	SWOT internal or external category	Strengths (S), Weaknesses (W), Opportunities (O) or Threats (T)
Adverse selection	+0.50	Positive	External	O
Principal-agent relationship	-0.40	Negative	Internal	W
Split incentives	-0.30	Negative	External	T

FINANCIAL CATEGORIES	Average of the most similar projects to SINFONIA	Positive or negative category	SWOT internal or external category	Strengths (S), Weaknesses (W), Opportunities (O) or Threats (T)
Hidden costs	-0.40	Negative	External	T
Accessibility to capital	-0.30	Negative	External	T
Risk and uncertainty	-0.60	Negative	External	T
Up-front costs	-0.70	Negative	External	T
Costs of material, construction, and installation	-1.60	Negative	External	T
Economic crisis	-3.20	Negative	External	T
Existence of financial schemes	+0.10	Positive	Internal	S
Combining of different financial schemes	+0.10	Positive	Internal	S
Stability of costs during project life cycle	+0.80	Positive	External	O

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Payback time	-0.70	Negative	External	T

OPERATIONAL CATEGORIES	Average of the most similar projects to SINFONIA	Positive or negative category	SWOT internal or external category	Strengths (S), Weaknesses (W), Opportunities (O) or Threats (T)
Existence of tried and tested solutions and proven on the ground examples	+1.90	Positive	External	O
Complexity of applying solutions with regard to local conditions	-0.10	Negative	External	T
Interoperability between systems	+1.10	Positive	Internal	S
Supporting hard infrastructure	-1.00	Negative	External	T
Well-defined or documented in detail processes	-1.30	Negative	Internal	W
Existence of performance indicators for technologies implementation	+1.60	Positive	Internal	S

BEHAVIORAL CATEGORIES	Average of the most similar projects to SINFONIA	Positive or negative category	SWOT internal or external category	Strengths (S), Weaknesses (W), Opportunities (O) or Threats (T)
Form of information	+1.80	Positive	Internal	S
Credibility and trust	+1.90	Positive	Internal	S
Values related to energy efficiency, which may inhibit measures from being undertaken	-0.10	Negative	Internal	W
Inertia	-2.10	Negative	Internal	W
Bounded rationality	+0.50	Positive	External	T
Public acceptance of technologies	+1.00	Positive	External	O

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ADDITIONAL CATEGORIES	Average of the most similar projects to SINFONIA	Positive or negative category	SWOT internal or external category	Strengths (S), Weaknesses (W), Opportunities (O) or Threats (T)
Environmental issues	+4.00	Positive	External	O
Requirements from the European Commission concerning reporting and accounting	+4.00	Negative	External	T
Complex ownership structure of realities	+4.00	Negative	External	T

Like visible in Table 17 above, around one third (36%) of the considered categories are negatively marked. Surprisingly, there are item characterized by a positive connotation (e.g. existence of regulatory incentives for implementation of smart city projects), which are negatively signed. A possible reason for the latter mentioned example, is that a good portion (40%) of the analysed 10 most similar projects to SINFONIA are CONCERTO projects. In fact, the CONCERTO initiative started already in 2005, when incentives for implementation of smart city projects were not as high as in following years. In contrast, a number of categories, characterized by a negative association (e.g. bounded rationality) result to have a positive sign. In these case, a number of interviewees declared that they were aware of the problem and could prevent or solve it properly. Hence, no negative influence was given and moreover through overcoming these barrier a positive effect has been registered by experts.

As already mentioned before, again a consistency analysis is implemented, which determines how much the experts agreed on the effectiveness of the different categories. Once more, the IQR of the weights´ distribution has been used to quantify the agreement level among the experts. As visible above in Table 17 no interquartile range per category exceeds a value of four, which is rather low. Thus, a certain consistency of the experts´ weights is again assumed.

The categories marked by the highest IQR numbers are in order:

a.) Political commitment over the long term (IQR: 4.00)

b.) Communication between project participants and the public to increase awareness (IQR: 4.00)

c.) Share of valuable data between different departments and existence of multi-actor/multi-sectorial planning tools (IQR: both 4.00)

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Concerning point a.) it has to be stressed that the political commitment´s importance can vary significantly from project to project. The same applies to issue b.) and c.). All three latter mentioned categories are characterized by a high IQR also within the analysis exposed in previous subchapter 2.2.3 (EFFECTIVENESS OF BARRIERS AND DRIVERS CATEGORIES).

The lowest IQR values is given regarding the category combining of different financial schemes (IQR: both 0.00), values related to energy efficiency, which may inhibit measures from being undertaken (IQR: both 0.25) and set up of institutions to support the projects (IQR: both 0.50). Again, for in all these cases also in previous subchapter 2.2.3 a rather low IQR is present.

Furthermore, following Table 18 visualizes the number of SWOTs present in the different macro categories:

TABLE 18 - SUMMARY OF SWOTS GIVEN BY THE EXPERTS OF THE TEN MOST SIMILAR PROJECT TO SINFONIA

MACRO CATEGORIES	S	W	O	T
Policy	0	0	2	0
Administrative	7	0	3	2
Legislative (Implementation and enforcement)	0	0	4	5
Legislative (Cross-sectorial and internal coherence)	0	0	3	3
Technical	3	0	1	0
Economic	0	1	1	1
Financial	2	0	1	7
Operational	2	1	1	2
Behavioural	2	2	1	1
Additional	0	0	1	2
TOTAL	**16**	**4**	**18**	**23**

The results of the DoW analysis are presented as improved after the corrections made by the WP leaders and municipality experts.

During the WP leaders and experts’ review of the SINFONIA SWOT described in the following section of the present subchapter, these were invited to reconsider the proposed classification of the SWOTs categories. Therefore, a fine-tuning of the SWOTs classification mentioned above is carried out.

A first relevant outcome is the general agreement expressed by the WP leaders on the attribution. Only a dozen is reclassified to other SWOTs categories. The changes made, often relay on discordant judgments about the perception of the category as potentially positive or negative. In contrast, in a minor number of cases the changes made refer to a disagreement among WP leaders on the attribution to the internal or external part of the SWOT matrix.

The latter described result mirrors the range of precise knowledge given by experts concerning local or specific conditions, based on experiences gained on previous project and activities.

In every macro category, at least one category has been reclassified, except in the financial categories (numbers 7,X). The main discordance appears within the legislative categories (numbers 4,X), dealing with cross-sectorial and internal coherence. This variety of judgements can be explained with the variability of the legislative framework and its perception in the different contexts. Issues related to costs, funding, and related risk and uncertainty seems to be recurring across different experiences.

Details concerning the above indicated reclassifications are provided in following Table 19:

TABLE 19 - RECLASSIFICATION OF SWOTS GIVEN BY THE WORK PACKAGE LEADERS AND MUNICIPAL EXPERTS OF SINFONIA

ID	CATEGORY	Original classification	Additional classification(s)	Discordant judgment: positive - negative	Discordant judgment: internal - external
2,7	Public procurement	T	O	*	
2,8	Coordination of a large number of tenants	S	W, T	*	*
2,11	Obligations given to project participants	T	O	*	
3,5	Local budgetary legislations	T	S	*	*
4,1	Existence of data security and privacy	T	O	*	
4,5	Existence of regulatory incentives for implementation of smart city projects	T	O	*	
4,6	Tariffs regulations	O	T	*	
5,2	Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions	S	O		*
6,2	Principal-agent relationship	W	T		*
8,3	Interoperability between systems	S	O		*
8,5	Well-defined or documented in detail processes	W	O, S	*	*

9,4	Inertia	W	T		*
9,6	Public acceptance of technologies	O	T	*	

Within the whole list, the only category never mentioned is 3,4 (development procedures that may inhibit or trigger implementation of SC projects), which refers to urban development plans (including respective procedures and regulations), which can hinder or even stop the implementation of SC project interventions.

A last not mentioned factor is 3,5 (Local budgetary legislations). In this case, the category is missing as originally defined (as a threat), but is solely present once as a strength.

Finally, following Table 20 visualizes the number of SWOTs present in the different macro categories after the latter described review:

TABLE 20 - FINAL CLASSIFICATION OF SWOTS GIVEN AFTER THE WORK PACKAGE LEADERS AND MUNICIPAL EXPERTS REVIEW

MACRO CATEGORIES	S	W	O	T
Policy	0	0	2	0
Administrative	7	1	5	3
Legislative (Implementation and enforcement)	1	0	4	5
Legislative (Cross-sectorial and internal coherence)	0	0	5	4
Technical	3	0	2	0
Economic	0	1	1	2
Financial	0	1	1	2
Operational	3	1	3	2
Behavioural	2	2	1	3
Additional	0	0	1	2
TOTAL	**18**	**5**	**25**	**28**

The obtained SWOT, based on the DoW, shows different results for a number of cases, which are derived by the various points of view of WP leaders and municipality experts. However, it is possible to consider a general perspective, taking into account the absolute recurrence of SWOTs within all tasks.

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In this case, as well as in the "key elements" analysis, almost 20 categories equal or exceed the 20% of appearance (that means 10 appearances within 51 tasks). Moreover, there are also cases in which the categories result in an appearance of nearly 30%.

In the following section a description of the results is given, looking at the presence (or shortcoming) of categories within the different tasks.

Going through the categories list, it is visible that all present policy categories (National roadmaps, strategies, and policies for energy goals and political commitment over the long term) are both recognised as opportunities. These result to be just slightly relevant, as their appearance is given in solely 16% of the tasks.

Following percentages in the next coming paragraphs indicate the presence of different categories with all 51 tasks.

Only a few administrative categories show a relevant recurrence within the SWOT analysis. Concerning one of the two most present administrative categories, a discordance is expressed. The appearance of public procurement in the project implementation is addressed as an opportunity by IBK and perceived as a threat by BZ representatives. A different opinion is also given by WP leaders on the category coordination of a large number of tenants, which is rarely named as strength (2%), but mainly as a threat (12%) or weakness (2%). On the contrary, there is no doubt about public participation (20%) and the share of valuable data between different departments and partners (25%), as being univocally identified like strengths within the SINFONIA project.

Legislative factors dealing with implementation and enforcement recur occasionally, except the predominance of the category existence of updated regulation and rules for new technologies (20%), perceived as an opportunity for the project. The item, development procedures that may inhibit or trigger implementation of SC projects, is never mentioned. Cross-sectorial and internal coherence categories, are indicated to be external issues (opportunities or threats) are just slightly considered. The main recurrence affects availability or lack of subsidies, which is mentioned to be an opportunity for the development of the project (22%).

Besides the legislative, also the technical categories appear only occasionally. Also, the issues existence of training material and existence of expertise, awareness and methods for designing and implementation of new technologies and solutions are characterized by a moderate presence level (both 14%).

Among the economic factors, adverse selection is only mentioned twice (4%). More importance is given to negative factors like a lack of trust between two parties with different interests (principal-gent relationship - 6%) and the so-called split incentives (10%).

The macro category dealing with financial issues shows a quite homogeneous distribution and high item´ presence across the different WPs. Categories like costs of materials, construction, and installation (31%), payback time (29%), and risk and uncertainty (29%) seem to be the most recurrent sources of threats that the SINFONIA project is going to tackle. This situation can be partially balanced by the presence of different categories like existence of financial schemes (27%) and combining of different financial schemes (31%).

The operational sector shows a high heterogeneity among categories. The most relevant category present in the latter mentioned section is complexity of applying solutions with regard to local conditions (20% - threat).

The cutting edge approach of the SINFONIA project is revealed by the lack of categories like tried and tested solution and proven on the ground examples (6%) and the presence of complexity of applying solutions with regard to the local conditions (20%).

The last area covered by the SWOT analysis deals with the behavioural aspects. Again, the heterogeneity of categories highlights the complexity of the given macro category. Moreover, the recurrence of certain categories comes up with a notable relevance. Two of them appear to be particularly important as weaknesses of the project: values related to EE, which may inhibit measures from being undertaken (20%) and the inertia (22%). In contrast, the public acceptance of the technology (25%) can play a positive role, as an opportunity for the SINFONIA project.

Among the additional categories, collected during the survey performed for the development of the so-called SMART CITIES BASELINE SWOT, only environmental issues (20%) appears relatively often. Other categories of the given macro area are practically never mentioned.

Looking at the appearance of the different categories within the four SWOT areas it is possible to highlight the following considerations.

From the whole project perspective:

- The most relevant strengths are:

- 7,8 Combining of different financial schemes
- 7,7 Existence of financial schemes
- 2,12 Public participation

- The most relevant weaknesses are:

- 9,4 Inertia
- 9,3 Values related to EE, which may inhibit measures from being undertaken

- the most relevant opportunities are:

- 9,6 Public acceptance of technologies
- 2,4 Share of valuable data between different departments and partners
- 4,4 Availability or lack of subsidies
- 7,9 Stability of costs during project life cycle
- 3,8 Existence of updated regulation and rules for new technologies
- 10,1 Environmental issues

- and the most relevant threats are:

- 7,5 Costs of material, construction, and installation
- 7,10 Payback time
- 7,3 Risk and uncertainty
- 7,1 Hidden costs
- 7,2 Accessibility to capital
- 7,4 Up-front costs
- 7,6 Economic crisis
- 8,2 Complexity of applying solutions with regard to local conditions

Looking only at the so-called "holistic tasks", which involve all four key elements of the project (building, DH/C network, electricity grid, and people) it is possible to identify the following categories:

- the most relevant strengths are:

- 2,12 Public participation

- 5,3 Existence of training materials
- 2,2 Communication between project participants and the public to increase awareness
- 2,1 Cooperation and trust between different stakeholders
- 9,2 Credibility and trust
- 9,1 Form of information

- the most relevant weaknesses are:

- 9,4 Inertia
- 9,3 Values related to energy efficiency, which may inhibit measures from being undertaken

- the most relevant opportunities are:

- 9,6 Public acceptance of technologies
- 2,4 Share of valuable data between different departments and partners
- 4,4 Availability or lack of subsidies
- 3,8 Existence of updated regulation and rules for new technologies
- 1,2 Political commitment over the long term
- 1,1 National roadmaps, strategies, and policies for energy goals
- 4,5 Existence of regulatory incentives for implementation of smart city projects

- and the most relevant threat is:

- 9,5 Bounded rationality

Looking at the singular key elements of the SINFONIA project it is possible to find similarities among the different technology areas (building, DH/C network, and electricity grid), while the section people seems to be often interested by other categories (these are not rarely the same, which appear in the "holistic tasks"):

- the most relevant strengths are:

- 7,7 Existence of financial schemes
- 7,8 Combining of different financial schemes (also shared with people)

- 2,12 Public participation (this is obviously the most relevant for people)

- the most relevant weaknesses are:

- 9,4 Inertia (also shared with people)
- 9,3 Values related to energy efficiency, which may inhibit measures from being undertaken (also shared with people)

- the most relevant opportunities are:

- 4,4 Availability or lack of subsidies
- 2,4 Share of valuable data between different departments and partners
- 9,6 Public acceptance of technologies
- 7,9 Stability of costs during project life cycle
- 1,2 Political commitment over the long term
- 4,3 Transparency of taxation system (this is not relevant for people)
- 4,6 Tariffs regulations (this is not relevant for people)
- 10,1 Environmental issues

- the most relevant threats are:

- 7,5 Costs of material, construction, and installation
- 7,10 Payback time
- 7,3 Risk and uncertainty
- 7,1 Hidden costs
- 7,2 Accessibility to capital
- 7,4 Up-front costs
- 7,6 Economic crisis
- 4,2 Tax pressure (this is not relevant for people)
- 4,5 Existence of regulatory incentives for implementation of SC projects (is not relevant for people)

Particular categories with high relevance in the section people, but sometimes slightly considered in the other three technology areas (building, DH/C, and electricity) are:

- within strengths:

- 7,8 Combining of different financial schemes
- 2,12 Public participation
- 2,2 Communication between project participants and the public to increase awareness
- 9,2 Credibility and trust
- 2,1 Cooperation and trust between different stakeholders
- 2,9 Marketing application for awareness and involvement

• within weaknesses (the same as in the three technology areas):

- 9,4 Inertia
- 9,3 Values related to energy efficiency, which may inhibit measures from being undertaken

• within opportunities:

- 2,4 Share of valuable data between different departments and partners
- 9,6 Public acceptance of technologies
- 1,2 Political commitment over the long term
- 1,1 National roadmaps, strategies, and policies for energy goals
- 3,8 Existence of updated regulation and rules for new technologies
- 4,5 Existence of regulatory incentives for implementation of smart city projects

• within threats:

- 9,5 Bounded rationality
- 7,3 Risk and uncertainty
- 3,1 Transparency of legislation

The categorization of information extracted from the DoW and the connection with the categories is the result of a careful interpretation of the DoW´s content, on the basis of a semantics and pragmatics analysis. Nevertheless, the latter mentioned proceeding remains subjective. Therefore, the review of WP leaders and local experts is needed, in order to find a common agreement or highlight different perceptions.

Following Table 21 summarize the relevance (in terms of appearance) of the single categories, according to the four SWOT areas. Categories underlined are introduced by WP leaders and experts.

TABLE 21 - RELEVANCE OF SWOT CATEGORIES WITHIN THE SINFONIA PROJECT EX-ANTE ASSESSMENT

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RELEVANCE	
Very high (= or > to 30%)	***
High (= or > to 20% and <30%)	**
Moderate (> to 0% and <20%)	*
Not mentioned	-

STRENGTHS											
			MAIN PHASES					KEY ACTIVITIES			
ID	CATEGORY	ABSOLUTE	MODELLING/ DEVELOPMENT	IMPLEMENTATION /REALIZATION	MONITORING/ DATA COLLECTION	ASSESSMENT (APPRAISAL/ EVALUATION)	HOLISTIC TASKS	BUILDING	DH/C NETWORK	ELECTRICITY GRID	PEOPLE
2,1	Cooperation and trust between different stakeholders	*	*	*	*	*	***	*	*	*	**
2,2	Communication between project participants and the public to increase awareness	*	*	*	*	*	***	*	*	*	**
2,3	Existence of multi-actor/multi-sectorial planning tools	*	**	-	-	*	*	*	*	*	*
2,5	Existence of public-private engagement models	*	*	-	-	*	*	*	*	*	*
2,8	Coordination of a large number of tenants	*	-	-	*	*	-	*	*	*	-
2,9	Marketing application for awareness and involvement	*	-	***	***	*	*	*	*	*	**
2,12	Public participation	**	***	*	*	*	***	**	**	**	***
3,5	Local budgetary legislations	*	-	*	-	-	-	*	-	-	-
5,2	Existence of expertise, awareness, and	*	**	***	**	*	-	*	*	*	*

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	methods for designing and implementation of new technologies and solutions										
5,3	Existence of training material	*	**	-	*	*	***	*	*	*	*
5,4	Application and/or development of monitoring tools strategies	*	*	*	**	*	*	*	*	*	*
7,7	Existence of financial schemes	**	*	***	**	***	-	***	***	***	*
7,8	Combining of different financial schemes	***	*	***	***	***	-	***	**	**	**
8,3	Interoperability between systems	*	-	***	**	*	-	*	*	*	*
8,5	Well-defined or documented in detail processes	*	-	-	-	*	-	*	-	-	-
8,6	Existence of performance indicators for technologies implementation	*	*	***	**	*	-	*	*	*	*
9,1	Form of information	*	*	*	*	*	**	*	*	*	*
9,2	Credibility and trust	*	*	-	-	*	**	*	*	*	**

WEAKNESSES											
			MAIN PHASES					KEY ACTIVITIES			
ID	CATEGORY	ABSOLUTE	MODELLING/ DEVELOPMENT	IMPLEMENTATION /REALIZATION	MONITORING/ DATA COLLECTION	ASSESSMENT (APPRAISAL/ EVALUATION)	HOLISTIC TASKS	BUILDING	MODELLING/ DEVELOPMENT	IMPLEMENTATION /REALIZATION	MONITORING/ DATA COLLECTION
2,8	Coordination of a large number of tenants	*	-	*	-	-	-	*	-	-	-
6,2	Principal-agent relationship	*	-	**	**	*	-	*	*	-	*
8,5	Well-defined or documented in detail processes	*	*	-	-	*	*	*	*	*	*
9,3	Values related to energy efficiency, which may inhibit	**	**	*	*	*	***	*	*	*	***

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	measures from being undertaken										
9,4	Inertia	**	**	*	**	*	***	**	*	*	***

OPPORTUNITIES											
			MAIN PHASES					KEY ACTIVITIES			
ID	CATEGORY	ABSOLUTE	MODELLING/DEVELOPMENT	IMPLEMENTATION/ REALIZATION	MONITORING/ DATA COLLECTION	ASSESSMENT (APPRAISAL/ EVALUATION)	HOLISTIC TASKS	BUILDING	MODELLING/ DEVELOPMENT	IMPLEMENTATION/ REALIZATION	MONITORING/ DATA COLLECTION
1,1	National roadmaps, strategies and policies for energy goals	*	***	-	*	*	***	*	*	*	***
1,2	Political commitment over the long term	*	***	-	-	*	***	**	**	**	**
2,4	Share of valuable data between different departments and partners	**	***	*	**	***	***	**	**	**	***
2,6	Existence of financing models suitable for the innovation to address stakeholder involvement	*	-	*	*	*	*	*	*	*	*
2,7	Public procurement	*	-	***	**	*	-	*	*	*	*
2,10	Set up of institutions to support the projects	*	*	***	**	*	*	*	*	*	*
2,11	Obligations given to project participants	*	-	*	-	-	-	*	-	-	-
3,2	Consistency of implementation and interpretation of law	*	-	***	**	*	-	*	*	*	*
3,3	Existence of regulatory stability	*	-	***	**	*	-	*	*	*	*
3,7	Effectiveness of regulations for	*	-	***	**	*	-	*	*	*	*

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	implementation of technologies and solutions										
3,8	Existence of updated regulation and rules for new technologies	**	***	***	**	**	**	*	**	**	**
4,1	Existence of data security and privacy	*	-	*	**	*	-	*	-	-	*
4,3	Transparency of taxation system	*	*	-	-	**	-	**	**	**	-
4,4	Availability or lack of subsidies	**	***	-	-	**	**	**	**	**	*
4,5	Existence of regulatory incentives for implementation of smart city projects	*	*	***	**	*	**	*	*	*	**
4,6	Tariffs regulations	*	*	-	-	**	-	**	**	**	-
5,1	Existence of affordable and mature technologies suitable for local conditions	*	*	-	*	*	-	*	*	*	-
5,2	Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions	*	-	*	*	*	-	*	-	-	*
6,1	Adverse selection	*	-	-	-	*	*	*	*	*	*
7,9	Stability of costs during project life cycle	**	*	***	**	**	-	**	**	**	*
8,1	Existence of tried and tested solutions and proven on the ground examples	*	-	**	*	*	-	*	*	*	*
8,3	Interoperability between systems	*	-	**	**	*	-	*	*	*	*
8,5	Well-defined or documented in detail processes	*	-	**	*	*	-	*	*	*	*
9,6	Public acceptance of technologies	**	**	*	**	**	***	**	**	**	***
10,1	Environmental issues	**	*	**	**	**	*	*	**	**	*

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COLLABORATIVE PROJECT; GRANT AGREEMENT NO 609019

WORK PACKAGE: 2
VERSION: FINAL VERSION
DATE: 30/05/2015

THREATHS											
			MAIN PHASES					KEY ACTIVITIES			
ID	CATEGORY	ABSOLUTE	MODELLING/ DEVELOPMENT	IMPLEMENTATION/ REALIZATION	MONITORING/ DATA COLLECTION	ASSESSMENT (APPRAISAL/ EVALUATION)	HOLISTIC TASKS	BUILDING	MODELLING/ DEVELOPMENT	IMPLEMENTATION/ REALIZATION	MONITORING/DATA COLLECTION
2,7	Public procurement	*	-	***	**	*	-	*	*	*	*
2,8	Coordination of a large number of tenants	*	*	***	**	*	-	*	-	-	*
2,11	Obligations given to project participants	*	-	*	*	*	*	*	*	*	*
3,1	Transparency of legislation	*	*	***	**	*	*	*	*	*	**
3,4	Development procedures that may inhibit or trigger implementation of smart city projects	-	-	-	-	-	-	-	-	-	-
3,5	Local budgetary legislations	-	-	-	-	-	-	-	-	-	-
3,6	Existence of knowledge about future litigations	*	-	***	**	*	-	*	*	*	*
3,9	Procedures for authorization of technologies	*	*	***	**	*	-	*	*	*	*
4,1	Existence of data security and privacy	*	*	*	***	*	-	*	*	*	-
4,2	Tax pressure	*	*	-	-	**	-	**	**	**	-
4,5	Existence of regulatory incentives for implementation of smart city projects	*	*	-	-	**	-	**	**	**	-
4,6	Tariffs regulations	*	-	-	*	-	-	-	-	*	*
6,2	Principal-agent relationship	*	-	-	*	-	-	-	*	-	-
6,3	Split incentives	*	*	-	*	*	*	*	*	*	*

7,1	Hidden costs	**	*	***	**	***	-	**	**	**	*
7,2	Accessibility to capital	**	*	***	**	**	-	**	**	**	*
7,3	Risk and uncertainty	**	*	***	***	***	-	**	**	**	**
7,4	Up-front costs	**	*	***	**	**	-	**	**	**	*
7,5	Costs of material, construction, and installation	***	*	***	***	***	-	***	**	**	*
7,6	Economic crisis	**	*	***	**	**	-	**	**	**	*
7,10	Payback time	**	*	***	***	***	-	**	**	**	*
8,2	Complexity of applying solutions with regard to local conditions	**	-	***	***	*	-	*	*	*	*
8,4	Supporting hard infrastructure	*	-	**	**	*	-	*	*	*	*
9,4	Inertia	*	-	**	*	*	-	*	-	*	*
9,5	Bounded rationality	*	**	**	**	*	**	*	*	*	**
9,6	Public acceptance of technologies	*	-	*	-	*	-	*	*	*	-
10,2	Requirements from the European Commission concerning reporting and accounting	-	-	-	-	-	-	-	-	-	-
10,3	Complex ownership structure of realities	*	-	*	*	-	-	*	-	-	-

3.2.3 LOCAL ENERGY MASTER PLANS ANALYSIS

The results of the local energy master plans analysis are presented as improved after the municipal experts´ review. The priorities for the realization drawn in the master plans for the two pilot cities were reviewed through meetings with municipalities' representatives of BZ and IBK.

The two energy master plans, are characterized by the presence of recurrent elements: a baseline inventory (on energy and CO2 emissions), one or more scenarios, and a list of actions across different sectors.

In both cases:

- the baseline inventory should provide a reliable quantification of the site conditions and main key figures relevant for project implementation in the fields of energy production and consumption
- the defined targets provide reliable quantifications (because technically supported and politically committed) of the cities' ambitions to the next future and therefore a relevant framework for project goals achievements

The final results of the review are reported in following tables 22 and 23, for BZ and IBK respectively:

TABLE 22 - SINFONIA PROJECT ACTIVITIES OVERLAPPING THE SUSTAINABLE ENERGY ACTION PLAN OF BOLZANO (VACCARO ET AL., 2014)

			Overlapping			Motivation (shared with local municipal experts)
			Foreseen or considered within SINFONIA	Potentially additional to SINFONIA	Non foreseen or considered within SINFONIA	
Figures	BEI	Baseline emission inventory (2010)	*			This inventory provides a reliable quantification of the site conditions and main key figures relevant for the project implementation
Figures	TAR	CO_2 reduction target (2020)	*			This target provides reliable quantification of the city ambitions and key figures relevant for project goals. Formally adopted with the municipal council decision taken on the 10th of June 2014
Actions	E1	Implementation of provincial resolutions – modification of building regulations	*			This action is directly referable to some elements of the project (building)
Actions	E2	Construction of a new DH network		*		Within the project the construction of a brand new DH network is not foreseen, however an enhancement of the existing energy production plant and managing system, in order to transform the existing network in a smarter one is planned.

	E3.a	Energy assessment of municipal building	*			This action is directly referable to elements of the project (building)
	E3.b	Refurbishment programme of the municipal building	*			This action is directly referable to elements of the project (building)
	E3.c	Refurbishment of the municipal building	*			This action is directly referable to elements of the project (building)
	E4	Energy assessment and mapping of private building			*	Private building are not involved in the project
	M1	Completion of the network of cycle paths and enhancement of cycling in the city			*	Cycle paths are not elements of the project
	M2	New urban public transportation system			*	Public transportation is not an element of the project
	M3	Refinement and implementation of the parking plan			*	Parking facilities are not an element of the project
	M4	Promoting the use of bicycles and electric vehicles		*		This action can be connected with the creation of smart points along cycle paths and recharging stations for bikes
	M5	City logistic - distribution of goods in city centre		*		This action is referred to the city centre, however it could be extended in future to other districts, like Talvera, San Quirino, and Gries
	M6	Coordinated mobility management with meteorological service		*		This action can be connected with the creation of smart points
	M7	Refurbishment of public lighting and traffic lights		*		This action can be connected with the creation of the smart points along cycle paths
	M8	Car sharing			*	Car sharing is not an element of the project
	R1.a	Installation on building´ roof of PV and solar thermal panels	*			This action is directly referable to elements of the project (building)
	R1.b	Intervention programme for the installation on the roofs of municipal building of PV and solar thermal panels	*			This action is directly referable to elements of the project (building)
	R1.c	Installation on the roofs of municipal building of PV and solar thermal panels	*			This action is directly referable to elements of the project (building)
	R2	Exploitation of geothermal resource			*	This action is currently under review by the municipality and the development is not foreseen in the short term

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	R3	Exploitation of hydroelectric resource			*	This action is currently under review by the municipality and the development is not foreseen in the short term
	I1	Supporting energy saving initiatives and use of local products			*	This action is mainly referred to the purchase of services or consumption goods and not directly referable to any element of the project
	I2	Information campaign and awareness on CO2 emission issues	*			This action is directly referable to elements of the project (stakeholders)
	I3	Calculation of individual CO2 emissions			*	This action is not directly referable to any element of the project
	I4	Environmental sustainability and GPP within the municipality			*	At this stage, the GPP mechanism was not implemented in the public procurements referable to project activities (building refurbishment design)
	I5	Involvement and awareness of the municipality staff and workers	*			This action is directly referable to some elements of the project (stakeholders)
	I6	Renewable energy park at the Firmian landfill			*	This action is not directly referable to any element of the project
	A1	Monitoring	*			This action is directly referable to activities of the project (monitoring)
	A2	Data collection	*			This action is directly referable to activities of the project (data collection)
	A3	Connection concerning CO2 emission			*	This action is not directly referable to any element of the project
	Key					
	E	Edilizia e lavori pubblici = Building and public works				
	M	Mobilità = Mobility				
	R	Energie rinnovabili = RES				
	I	Informazione e formazione = Information and awareness				
	A	Monitoraggio e reporting = Monitoring and reporting				

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TABLE 23 - SINFONIA PROJECT ACTIVITIES OVERLAPPING THE ENERGY DEVELOPMENT PLAN OF INNSBRUCK (STADT INNSBRUCK, 2011)

			Overlapping			
			Foreseen or considered within SINFONIA	Potentially additional to SINFONIA	Non foreseen or considered within SINFONIA	Motivation (shared with local municipal experts)
Figures	JE	Baseline energy demand inventory (2009)	*			This inventory provides quantification of the site conditions regarding the energy use (heating and power) in building and the main key figures relevant for the project implementation. The generation side was not analysed. The domestic use was investigated in detail. The industrial use needs to be updated.
Figures	BAU	Business as usual scenario (2025)			*	This scenario was not adopted by the municipality
Figures	MIN	Minimal scenario (2025)			*	This scenario was not adopted by the municipality
Figures	VOR	Exemplary scenario (2025)	*			This target provides a reliable quantification of the city ambitions and key figures relevant for project goals. Formally adopted as reference scenario with the municipal decision taken on the 17th of August 2011
Figures	AUT	Autarchy scenario (2025)			*	This scenario was not adopted by the municipality
Actions	W1	Modification of the urban plan	*			This action is currently in progress. A new urban planning concept till 2025 is under development; energy issues will be incorporated within the plan for the first time
Actions	W2	Modification of building regulations			*	This action is not directly referable to any element of the project, because the jurisdiction is under the provincial authority

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	W3	Building refurbishment	*			This action is directly referable to elements of the project (building)
	W4	Construction of new district heating networks	*			This action is directly referable to some elements of the project (DHC network)
	W5	Compulsory connection to DH network			*	This action is currently under review by the municipality and the development is not foreseen in the short term
	W6	Use of industrial waste heat	*			This action is directly referable to some elements of the project (DHC network)
	W7	Contracting for privates and constructors			*	This action is not directly referable to any element of the project
	W8	Offer of energy monitoring systems	*			This action is directly referable to elements of the project (building)
	W9	"All from one source" building refurbishment			*	This action is not directly referable to any element of the project
	W10	Subsidies	*			This action is directly referable to some elements of the project (building). Different subsidies can be combined and project partners are eligible
	W11	Independent expert advice		*		This action can be connected with elements of the project (stakeholders). Independent expert advice given by the municipality is actually compulsory for access to subsidies
	W12	Information campaign and awareness creation	*			This action is directly referable to elements of the project (stakeholders)
	NW1	Modification of the urban plan	*			This action is currently in progress. A new urban planning concept till 2025 is under development; energy issues will be incorporated for the first time
	NW2	Modification of building regulations			*	This action is not directly referable to any element of the project, because

						the jurisdiction is under the provincial authority
	NW3	Commercial law			*	This action is not directly referable to any element of the project. Moreover the jurisdiction is under the national authority
	NW4	Construction of new local or DH networks	*			This action is directly referable to some elements of the project (DHC network)
	NW5	Compulsory connection to DH network			*	This action is currently under review by the municipality and the development is not foreseen in the short term
	NW6	Use of waste heat	*			This action is directly referable to some elements of the project (DHC network). Waste heat from the sewage water system and geothermal waste heat from the Brenner base tunnel is going to be used
	NW7	Contracting for companies			*	This action is not directly referable to any element of the project
	NW8	Building refurbishment	*			This action is directly referable to some elements of the project (building).
	NW9	Use of solar thermal energy in commercial building	*			This action is directly referable to some elements of the project (building).
	NW10	Use of PV energy	*			This action is directly referable to some elements of the project (building).
	NW11	Smart grids	*			This action is directly referable to some elements of the project (electricity supply and distribution grid).
	NW12	Energy monitoring	*			This action is directly referable to some elements of the project (building).
	NW13	Energy efficiency in industrial processes		*		This action is referable to elements of the project (DHC network)
	NW14	Information and advice to the companies			*	This action is not directly referable to any element of the project

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	NW15	Training, education, and continuing education for owners	*			This action is directly referable to elements of the project (stakeholders)
	NW16	Territorial marketing based on energy		*		This action is referable to elements of the project (stakeholders)
	NW17	Biogas and energy from waste	*			This action is directly referable to some elements of the project (DHC network). Waste heat and combined heat and power from biogas is going to be used
	NW18	Cooling in new and refurbished building	*			This action is directly referable to elements of the project (building), in terms of minimum requirement according to the provincial legislation
	NW19	Industrial power plans	*			This action is directly referable to elements of the project (DHC network).
	NW20	Replacement of existing industrial thermal plans			*	This action is not directly referable to any element of the project
	Ö1	Energy monitoring			*	This action is referred to public building (without residential building); therefore not directly referable to any element of the project
	Ö2	Public procurements			*	At this stage, the GPP mechanism was not implemented in the public procurements referable to project activities (building refurbishment design)
	Ö3	Historical listed building refurbishment			*	Historical listed building are not elements of the project
	Ö4	Lighthouse projects development			*	This action is referred to public building (without residential building); therefore not directly referable to any element of the project
	Ö5	Use of local or DH networks			*	This action is not directly referable to any element of the project
	Ö6	Use of solar thermal and PV energy	*			This action is directly referable to elements of the project (DHC networks and electricity)

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	Ö7	Plant and saving contracting			*	This action is not directly referable to any element of the project
	Ö8	Public street lighting			*	Public street lighting is not an element of the project
	Ö9	Smart grids	*			This action is directly referable to elements of the project (electricity supply and distribution grid).
	Ö10	Green IT			*	This action is not directly referable to any element of the project
	Ö11	Awareness creation	*			This action is directly referable to some elements of the project (stakeholders)
	Ö12	Energy assessment of public building			*	This action is not directly referable to any element of the project
	Ö13	Legislative framework for a comprehensive refurbishment	*			This action is directly referable to elements of the project (building)
	Ö14	Pioneering role of municipal building			*	This action is referred to public building (without residential building); therefore not directly referable to any element of the project
	Key					
	W	Wohnbau = Residential building				
	NW	Nicht-Wohnbau = Non residential building (others)				
	Ö	Öffentliche Gebaudes = Public building (without residential building)				
	JE	Jähliche Energieverbrauch = Baseline energy demand inventory (2009)				
	BAU	Business as usual scenario = Business as usual scenario (2025)				
	MIN	Minimalszenario = Minimal scenario (2025)				
	VOR	Vorbildszerario = Exemplary scenario (2025)				

The cross analysis of the SINFONIA project and the energy master plans show a relevant overlapping area:

- 60%[1] of the activities concerning the SEAP of BZ are overlapping the SINFONIA project or are potentially additional to it
- 56%[2] of the activities concerning the Energy development plan of IBK are overlapping the SINFONIA project or are potentially additional to it

3.2.4 HOW TO USE DRIVERS TO OVERCOME BARRIERS

The present subchapter follows the proceedings of previous subchapter 2.2.5, HOW TO USE DRIVERS TO OVERCOME BARRIERS, with the difference that in this case the connections between different issues of the SWOTs refer to the present SINFONIA SWOT. Moreover the following categories mentioned are not specified by the attributes "cause and effect" as it is also the case for the SINFONIA SWOT matrix above (Table 21 RELEVANCE OF SWOT CATEGORIES WITHIN THE SINFONIA PROJECT EX-ANTE ASSESSMENT).

a.) Connections between strengths and threats

Strength: existence of financial schemes
Threat: up-front costs

High expenses at the beginning of the project can discourage investors and may raise objection about planned activities. This problem could be prevented by incorporating suitable financial schemes in the financial plan of the project. That would increase the cash flow.

Strength: combining of different financial schemes
Threat: accessibility to capital

Limited access to capital can act as a barrier, because energy efficient technologies are most times more expensive than alternative ones and require high investments. This barrier could be addressed by the combination of different financial schemes on different levels: national, regional, provincial, municipal etc. This would reinforce the self-sustenance capacity of the analysed project.

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[1]The above indicated percentage comes out by dividing the number of overlapping (or potentially additional) activities analysed within the SEAP of BZ and the DoW of SINFONIA by the total amount of activities of the BZ SEAP (18/30 = 60%)

[2]The above indicated percentage comes out by dividing the number of overlapping (or potentially additional) activities analysed within the Energy development plan of IBK and the DoW of SINFONIA by the total amount of activities of the IBK Energy development plan (27/48 = 56%)

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b.) Connections between opportunities and weaknesses

Opportunity: public acceptance of technologies
Weakness: inertia

A lack of interest in understanding new technologies or preconception about their real utility, can negatively affect the expected SC project results. This bias could be solved by reinforcing the social acceptance of technologies through adequate information on them (e.g. organizing respective information evenings). This would increase the awareness of end-users concerning new technologies and so bring the project forward.

c.) Connections between strengths and weaknesses

Strength: public participation
Weakness: values related to energy efficiency, which may inhibit measures from being undertaken

Values such as co-benefits related to EE (e.g. clean air) are not always considered. This can lead to an incomplete assessment, limited only to energy savings and costs reduction and therefore to a lack of motivation concerning the treated SC undertaking. An effective involvement of stakeholders in the investigation and assessment of co-benefits could enlarge their perception on positive aspects related to EE measures.

d.) Connections between opportunities and threats

Opportunity: share of valuable data between different departments and partners
Threat: complexity of applying solutions with regard to local conditions

Local conditions among case studies and pilot sites may considerably diverge in a large range of fields: economical, legislative, environmental, etc. This can lead to a difficult or unfeasible implementation of certain measures. A possible way to prevent this unwanted situation could be to reinforce the exchange of valuable and reliable data among the partners involved in the project. This would lead to an establishment of a common baseline and database, allowing the development of feasible application, tailored on local situations.

e.) Connections between opportunities and strengths

Opportunity: availability or lack of subsidies

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Strength: combining of different financial schemes

Profitability for partners involved in the project can act as a driver, because energy efficient technologies are most times more expensive than alternative ones and require high investments. This opportunity could be stressed by the combination of different financial schemes on different levels: national, regional, provincial, municipal etc. That would reinforce the capacity of self-sustenance of the analysed project.

f.) Connections between weaknesses and threats

Weakness: values related to energy efficiency, which may inhibit measures from being undertaken
Threat: hidden costs

The implementation of innovative measures can lead to unexpected additional expenses, due to their way of management, adverse effects etc. If the uncertainty about possible hidden costs is too high, a barrier to possible investments can be given. Moreover, this barrier could be even worse if reinforced by skeptical considerations about the real economic benefits of EE measures. Thus, it might be important to analyse in detail previous experiences of application concerning the treated measures. That would help to define a comprehensive framework of benefits and costs within a certain time range.

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4. SWOT TOOL

The SWOT approach is a wide used analysis and decision supporting tool, which helps developing sound strategies, projects, action plans or simply evaluating the positives and negatives of the analysis´ object. The SWOT technique can be applied to companies, public administration, projects or even single persons. The purpose of this approach is to identify all possible elements, which can have a positive or negative influence on the object of the analysis.

Smart city projects are complex activities, which entail multiple actions in a various context. A SWOT analysis can therefore be a useful technique to assess the situation of the project and to highlight relevant information. For facilitating the elaboration of such an analysis within the SINFONIA project a specific tool has been created.

The tool allows elaborating a simple 2 X 2 SWOT matrix containing, the list of the SWOTs individuated by the operator and should be followed by further depth analysis as described in the subchapter 4.1.3 (HOW TO USE THE RESULTS OF THE SWOT TOOL). The utilization of the SWOT TOOL is very simple, so that all actors interested in SC projects are able to utilize this application. Given the wide spectrum of users and scale of applicability, some simplifications are necessarily introduced and the tool should therefore be considered as a preliminary analysis technique.

The following section 4.1, SWOOT TOOL METHODOLOGY, describes how the tool is developed, while the section 4.2, SWOT TOOL RESULTS, contains the outcomes concerning the application of this tool for the cases of BZ and IBK within the SINFONIA project.

4.1 SWOT TOOL METHODOLOGY

The present subchapter contains the explanation concerning how the tool is developed. In the first part, the structure of the tool is described (4.1.1). In the second part, the description of how the questions are elaborated is given (4.1.2). Finally, it is explained how to use the results of the SWOT TOOL (4.1.3).

4.1.1 STRUCTURE OF THE SWOT TOOL

The idea behind the tool is to ask a set of questions related to different aspects, which are relevant for a SC project. Then, accordingly to the answers given by the user, this tool returns a 2 X 2 SWOT matrix reporting the related SWOTs.

The software is developed in "Python language" using a so-called "Django framework" to dynamically create the web page (not freely accessible) entailing a questionnaire and to render a final SWOT matrix containing the most important issues (Python Software Foundation, 2015), (Django Software Foundation, 2015).

The main database used to store the questions and answer is "Postgresql" (PostgreSQL Global Development Group, 2015). The database structure entails a table with the main information/topics and another table with the questions and related answer, which are then inserted in the SWOT matrix. The main structure of the Postgresql database is split in four tables. One table with the user profile, one with the topic and one table defines the questions of the questionnaire. This table contains also the origin of the question: if it is internal or external. Furthermore, a fourth table entails the answer concerning the user´ replies (positive, negative or do not know) to the question. This table contains the foreign key to the user profile, the foreign key to the question and a Boolean value (data type with two vales: true and false) to store the answer of the user. Based on the user´s answers the SWOT matrix is then filled. The main structure of the database is reported in Figure 23 (generated by Postgresql):

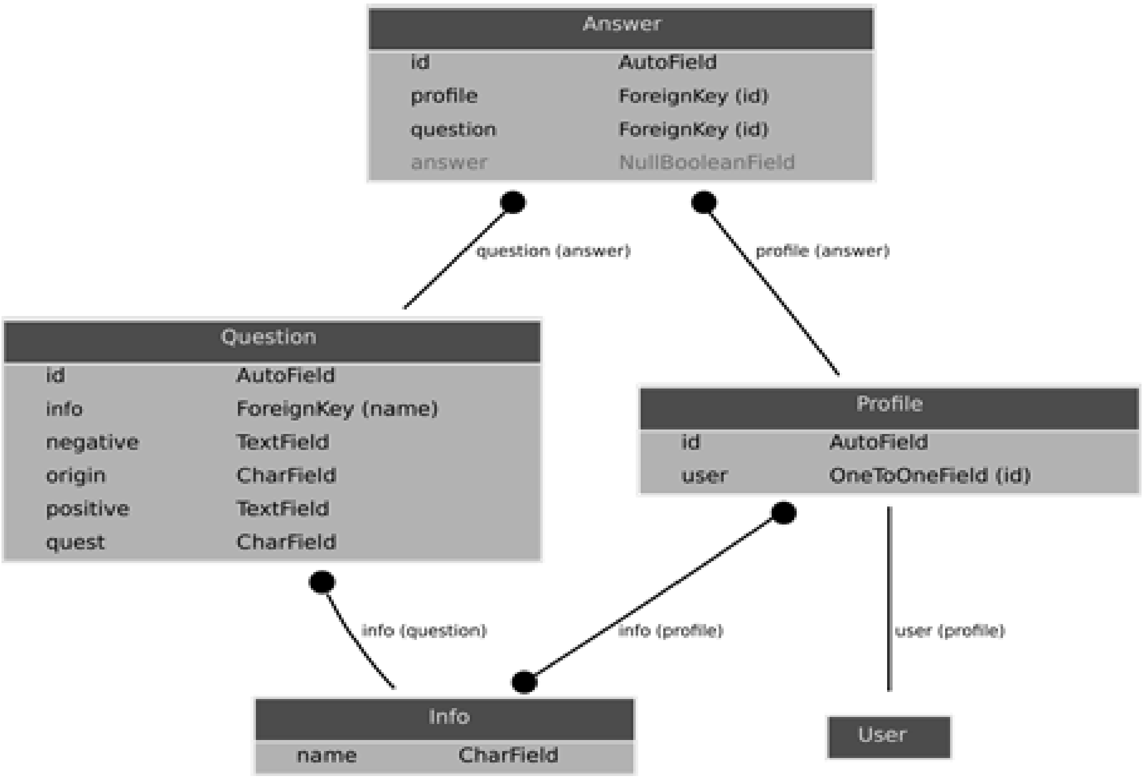

FIGURE 23 - STRUCTURE OF THE SWOT TOOL DATABASE (POSTGRESQL GLOBAL DEVELOPMENT GROUP, 2015)

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The questions can be answered with yes or no (and do not know as a third default option). The answer yes or no determines if the response has to consider a positive aspect (strength or opportunity) or a negative one (weakness or threats). If the SWOT TOOL utilizer indication to a query is “do not know”, the questioned issue does not result within the out coming SWOT matrix. Whether a question is related to an internal category (strength or weakness) or to an external one (opportunity or threats) is defined in advance by the general SWOT analysis rules already exposed in subchapter 2.1.2 (BARRIERS AND DRIVERS OF SMART CITY PROJECTS).

The questions might have sometimes a too broad meaning, covering a wide range of aspects, or the answers yes-no-do not know might not be sufficient to represent the underlying complexity. The alternative would have been to elaborate a tool with hundreds of questions with a level of detail that becomes truly interesting only when an action related to a specific sector is meant to be undertaken.

4.1.2 QUESTIONS OF THE SWOT TOOL

The tool contains about 60 yes-no-do not know questions. These questions derive mainly from the categories elaboration of the analysis conducted within the SINFONIA project on the barriers and drivers existing in SC projects given in subchapter 2.1.2, BARRIERS AND DRIVERS OF SMART CITY PROJECTS, and 2.2.2 (BARRIERS AND DRIVERS OF SMART CITY PROJECTS & THEIR CATEGORIES).

The around 60 categories are reformulated in form of questions and positive and negative answers related to each single question are elaborated. With this set of questions and answers, an software application is created. By answering yes, no or do not know to each question and by considering the initial subdivision in internal and external factors, the application allows elaborating a 2 X 2 SWOT matrix containing the first step of a SWOT analysis with individuation of the SWOTs. Since the questions derives from the 60 categories, which in turn are the synthesis of more than 400 barriers and 300 drivers, the tool represent also an useful checklist of possible barriers and drivers.

The utilizer of the described SWOT tool are invited to select a “no” answer rather than indicating “yes” or “do not know” if the question posed refers to a possible barrier and the respondent is uncertain concerning its answer. By doing so, the list of possible weaknesses and threats results to be more complete.

4.1.3 HOW TO USE THE RESULTS OF THE SWOT TOOL

The SWOT TOOL provides the user with a questionnaire. The answer of the user are used to populate the final SWOT matrix. However, the SWOT tool serves to a number of further purposes:

- It is a checklist, which should allow making developers of SC projects aware of existing problems and difficulties
- It helps setting the focus on some of the aspects which should be addressed in the project elaboration or implementation and that might be omitted
- It allows to elaborate the first steps of a SWOT analysis and therefore could be used as a support for the project management

Concerning the last point, the SWOT table produced by the application becomes a proper investigation when the generated list (subdivided in the four SWOT areas) is used as a support for further in depth analysis.

The idea is to focus the attention on the weakness and threats and make people aware of them so that they can try to address them. The strengths and the opportunities should be enforced and exploited, while the weakness and threats should be minimized.

Once again, rather than simply answering to the following questions:

- how to utilize and take advantage of strengths?
- how to mitigate weaknesses?
- how to take advantage of and benefit from each opportunity?
- how to avoid threats?

the four areas of the SWOT matrix are set against each other and following queries are addressed:

- which opportunities can enforce the strengths or which strengths can be used to exploit the opportunities?
- which opportunities can help minimizing the weakness?
- how to use strengths to minimize threats?
- how to minimize weakness to avoid threats?

Therefore relationships between the latter mentioned factors can be identified and strategies based on them may be elaborated (Mind Tools Ltd., 2015).

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4.2 SWOT TOOL RESULTS

Within the present subchapter, the results regarding the above described SWOT TOOL methodology are given in various sections. Beginning, the outcome of the SWOT TOOL application for BZ and IBK related to the case of the SINFONIA project are reported (4.2.1). Then, recommendations are provided on how to utilize drivers to overcome barriers present in the final SWOT matrices of the two pilot cities (4.2.2). The latter mentioned subchapter entails also indication by what method certain drivers could be utilized to enforce other positive elements of the respective SWOT matrix. Moreover, it is explained by which means minimizing specific barriers it is possible to avoid other negatives of the same SWOT matrix. Finally, a comparison between the final SWOT matrices of IBK and BZ is provided (4.2.3) too.

4.2.1 FINAL SWOT MATRICES FOR INNSBRUCK AND BOLZANO

The final SWOT matrices of the present analysis are provided separately for the case of BZ and IBK concerning the SINFONIA project. The categories indicated in the different sections of the matrix (SWOTs) are again characterized by the attributes “cause and effect”. The latter mentioned attributes are specified in brackets after their respective categories. Due to the impossibility to visualize the described matrix at once, section after section are shown singularly. The following SWOT matrices entail specific requirements (changes of categories positioning within the SWOT matrices, refinements concerning the description of the categories etc.) expressed during the SINFONIA workshop on the 10th of April 2015 in BZ, where the present tool has been applied by the project participants of WP2. The latter mentioned requirements has been positioned within the most suitable categories in the following matrices. Furthermore, the given SWOT matrices entail a grey coloured section after each category, in which it is explained why the different issues are positioned within the different SWOT section. In occasion of the workshop, a demo version of the SWOT TOOL has been used, which addresses the most important categories indicated in Table 6 (CATEGORIES AND MACRO CATEGORIES USED TO GROUP BARRIERS & DRIVERS OF SMART CITY PROJECTS). Following Figure 24 shows the graphical results of the workshop, for the case of IBK, indicating the most frequent macro categories, while Table 24 indicates the findings in detail concerning the latter mentioned pilot city:

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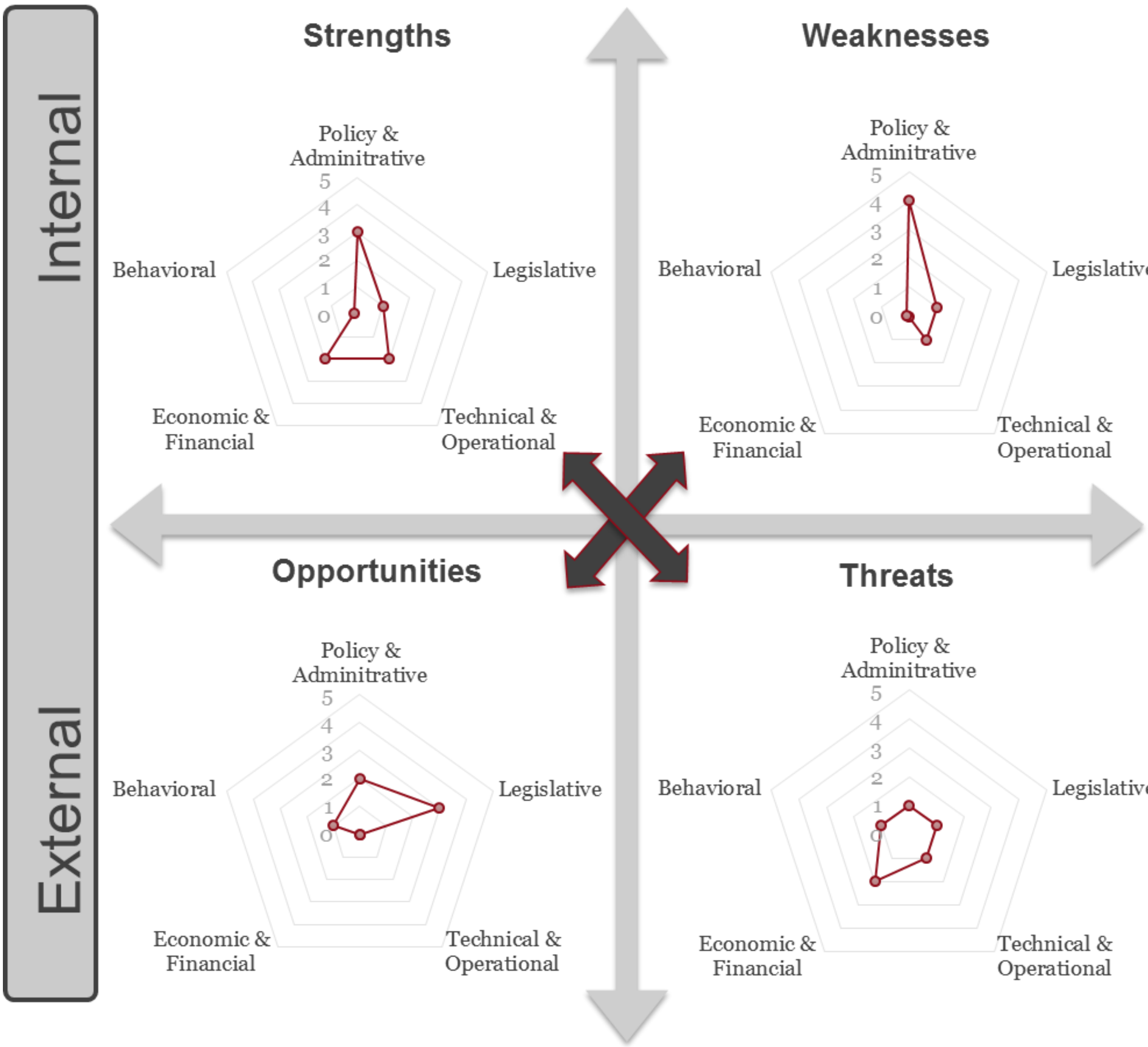

FIGURE 24 - GRAPHICAL RESULTS OF THE WORKSHOP REGARDING INNSBRUCK

As visible in Figure 24 above, concerning the internal section, the majority of factors concern policy and administrative issues. In contrast, concerning the external part, the highest amount of points is given by legislative item.

TABLE 24 - SWOT MATRIX OF THE SWOT TOOL APPLICATION FOR INNSBRUCK

STRENGTHS
Cooperation and trust between different stakeholders (cause: active involvement of stakeholders in the project - effect: implementation of the project is fostered)
The cooperation of different stakeholders in Innsbruck is already present, as a number of Austrian project partners are connected one to each other at company level and are in specific cases partly owned by the same institution: either the City of Innsbruck or the Province of Tyrol. Moreover, various stakeholders involved in SINFONIA already know each other due to past cooperation. Finally, a district meeting between all partners is held every month.
Existence of financial schemes (cause: presence of financial schemes and tools - effect: easier financing procedures for the project)

The SINFONIA project joined different financial methods to be supported economically. In 2010 the city of Innsbruck carried out a study (FIT for SET), financed by the Austrian Climate and Energy Fund, in which a number of measures has been detected to transform Innsbruck into a smart city. These measures has then been integrated within SINFONIA. Furthermore, provincial funding as well as monetary contribution from local companies involved in the project have been provided to execute the analysed project in Innsbruck.
Environmental issues (cause: treatment of environmental issues - effect: higher public acceptance of the project)
There is a long tradition in Innsbruck, as well as in the Province of Tyrol and Austrian regarding environmental issues. Also within SINFONIA a number of environmental topics are addressed (e.g. CO2 emission reduction). A consistent part of the latter mentioned topics are derived from the Energy development plan of Innsbruck (published in 2009).
Existence of regulatory incentives for implementation of smart city projects (cause: profitability of inhabitants - effect: higher acceptance of the project)
There are a number of regulatory incentives, which provide support for the implementation of the SINFONIA project in Innsbruck. These incentives are provided at national level (e.g. Renewable energy act – Ökostromgesetz). One of the most important above mentioned aid are feed-in-tariffs for electricity production through renewable energy sources.
Well-defined or documented in detail processes (cause: clear instruction and duties given to project participants - effect: smooth running of project activities)
At administrative level, clear instruction and duties are provided to project participants. The latter mentioned activity is especially given by district meetings, which are held monthly. During these district meetings the status quo of the project is reported. Furthermore, challenges and problems of the project are exposed and respective solution are tried to be found. Additionally, task forces has been established to deal with specific topics.
Accessibility to capital (cause: proper financial support - effect: smoother implementation of project activities)
There are various financial support, from which the SINFONIA project takes advantage. The latter mentioned aid refer to city level funding, as well as provincial and national level ones. One of the most important backing is given by housing subsidy (Wohnbauförderung), which address retrofitting as well as new construction activities of building if a certain energy efficiency level is met by the energy sanitation.
Existence of expertise, awareness, and methods for designing and implementing of new technologies and solutions (cause: availability of expertise, skills, and methods for designing and implementing projects - effect: smooth project activities)
A number of project partners are highly experienced in the fields they are working in. Concerning the latter mentioned point, especially the University of Innsbruck and the Passive House Institute has to be mentioned. Moreover, well-instructed and long term experienced planners and installers are present.
Requirements from the European Commission concerning reporting and accounting (cause: no unnecessary time is spent for reporting and accountancy given by European Commission requirements - effect: smoother execution of the project)
There are various project partners, which already joined experience in fulfilling requirements of the European Commission for reporting and accounting. Furthermore, unexperienced project collaborators take advantage of support from their experienced colleagues to accomplish the latter mentioned requests.

WEAKNESSES
Communication between project participants and the public to increase awareness (cause: absence of energy advice campaigns - effect: lack of support to the project execution)
No special attention is paid to the communication between project participants and the public to increase awareness concerning the SINFONIA project in Innsbruck. Moreover, there are no energy advice campaigns aiming to reach the latter mentioned goal. The responsible for the implementation of the given smart city

undertaking are aware of the fact that the indicated lack represents a problem and these are already working on an appropriate communication strategy, which includes energy advice campaigns.
Set up of institutions to support the projects (cause: absence of an institution, which supports the project activities - effect: missing help for the project execution)
No new institution has been set up to support the project in Innsbruck. Furthermore, the creation of such a new operative unit is not foreseen. It is believed that further support is not necessary, as the already present project partner are expected to provide the needed assistance. With regard to the latter mentioned aid especially following institutions has to be named: Standortagentur Tirol, Stadtmagistrat Innsbruck and alpS.
Public participation (cause: absence of active involvement of the population - effect: delay or stop of project activities implementation)
While information are provided to the population, there is no active involvement of all inhabitants. Due to the SINFONIA project does not refer to all sector (e.g.: mobility is excluded), the involvement level is not extended to the entire public, but is limited to the fields treated.
Existence of training material (cause: no training activities for project participants - effect: difficulties in the project implementation)
No special attention is given to training activities for project participants. With regard to the indicated issue, solely manuals for users of dwellings undergoing an energy sanitation are foreseen. The latter mentioned manuals aim to instruct the inhabitants regarding a right use of new technologies installed within their dwellings.
Marketing application for awareness and involvement (cause: insufficient communication about the project to the public - effect: proper participation of end-users is hindered or stopped)
Until now, no common marketing strategy concerning the implementation of the SINFONIA project is present. However, the latter mentioned issue has been recognised to be a relevant problem by project responsible of Innsbruck. The Austrian project partners are already working on such a common marketing strategy to overcome the indicated barrier.
Development procedures that may inhibit or trigger implementation of smart city projects (cause: development procedures that may inhibit implementation of smart city projects - effect: delays or hindering of the project realization)
The existing urban plans partially hinder the implementation of the SINFONIA project´s intervention, because of mainly two concepts: the preservation of sites of historic interest (Denkmalschutz) and the townscape protection (Ortsbildschutz). The two latter mentioned item represent a barrier especially in the cases of photovoltaics, solar thermal system and façade installation.

OPPORTUNITIES
Existence of public-private engagement models (cause: presence of ESCOs - effect: facilitation of the activities implementation)
Energy service companies are present in Innsbruck. These enterprises operate successfully in the given locality since years. Furthermore, the latter mentioned type of firms are also part of the SINFONIA project in Austria.
Availability or lack of subsidies (cause: existence of subsidies related to project aims - effect: easier achieving of the project goals)
There are a number of possibility to access financial support concerning the implementation of SINFONIA activities in Innsbruck. Among these, following two opportunities has to be mentioned. First, the Tyrolean housing subsidies (Tiroler Wohnbauförderung) and second the Kommunalkredit Public Consulting. The Tyrolean housing subsidies consist in monetary aid, which are given if certain energy efficiency level of building are reached, while the Kommunalkredit Public Consulting provides financial support for environmental friendly interventions - as for companies as well as single person.
Political commitment over the long term (cause: political commitment to the project - effect: smoother process)
Political support for the SINFONIA project is given, as a constant effort is present since a number of years to transform Innsbruck into a smart city. Hence the SINFONIA project joins the input of various projects,

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which are already completed, like the Energy development plan of Innsbruck and the FIT for SET undertaking. With regard to the political commitment of the present smart city activity, especially the Stadtmagistrat Innsbruck, the Province of Tyrol and the Standortagentur Tirol has to be named.
Complex ownership structure of realities (cause: absence of variation in ownership of building - effect: implementation of activities related to retrofitting are not stopped)
In the case of the SINFONIA implementation within Innsbruck, problems concerning a complex ownership structure of realities are not given. Reason for that is the selection of building, which undergo an energy sanitation, belonging solely to one owner: either to the real estate company of Innsbruck (Immobiliengesellschaft der Stadt Innsbruck) or to another housing company called Neue Heimat Tirol.
Development procedures that may inhibit or trigger implementation of smart city projects (cause: considering land use constraints - effect: sound planning of project activities)
As during the proposal face of the given smart city project, land use constraints has been considered, the latter mentioned issue does not represent a threat for the successful implementation of the analysed undertaking.
Public acceptance of technologies (cause: absence of fears for safety related to technology implementation - effect: higher acceptance of the project)
No fear regarding the technologies application has been perceived from side of the end-users in Innsbruck. Due to the latter mentioned perceived data, a higher acceptance of the project implementation is expected.

THREATS
Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions (cause: a lack of awareness from side of users concerning application of technologies - effect: inappropriate utilization of technologies)
The tenants of the building, undergoing an energy efficiency sanitation within the city of Innsbruck, do not have the knowledge of how to use properly the new technologies installed within their homes. The latter mentioned problem refers especially to the heating, ventilation and air-conditioning system with heat recovery.
Stability of costs during project life cycle (cause: low energy prices - effect: disinterest towards projects aiming at reducing energy consumption and demotivation of users to switch towards more energy efficient technologies)
As in Innsbruck low energy prices are present, a certain demotivation of end-users is given to decrease the energy consumption in building addressed by the SINFONIA project, because tenants are not facing relevant costs´ reduction by energy saving undertaking.
Public acceptance of technologies (cause: lack of acceptance of new technologies - effect: project implementation is hindered or stopped)
A lack of acceptance from side of tenants concerning new technologies, installed in dwellings undergoing an energy sanitation, is present. The latter mentioned barrier is given especially regarding the heating, ventilation and air-conditioning installation of the residential building, which lead to a reduction of the flats´ living space. Moreover, a number of dwellings addressed by the present smart city project in Innsbruck are occupied by elderly person, which are characterized by a particular aversion to new technologies.
Costs of material, construction, and installation (cause: high costs of material, construction, and installation - effect: reduction of investments and participation in the project)
A number of costs related to material, construction and installation foreseen in the SINFONIA project result to be very high. Among these, especially the monitoring has to be named. The costs for the latter mentioned activity reach a value of 50000€ per building. With regard to this activity in particular the cabling is very expensive.
Share of valuable data between different departments and partners (cause: data security and privacy issues - effect: data collection is hindered or stopped)

Due to the given national legislation, data security and privacy issues result to be a problem for the data gathering needed to accomplish the aims of the SINFONIA project. One of the most relevant barriers, is represented by the possibility to retrieve energy consumption information of building only in assembled form, given by a raster of 100 X 100 meters. Hence, the energy use data are not ascribable to specific infrastructure.
Effectiveness of regulations for implementation of technologies and solutions (cause: lack of supporting legislation for the project goals - effect: difficulties in reaching the planned aims)
Certain legislation represent a barrier to reach the energy goals set within the present smart city project in Innsbruck. One of the most problematic laws is given by the Electricity industry and organization act (Elektrizitätswirtschafts-und-organisationsgesetz), which can obstacle the application of photovoltaics on building.

As visible in Table 24 above, in this case the number of categories present in the positive (strengths) part of the internal section slightly exceeds the issues within the negative part (weaknesses), with eight and six issues respectively. In contrast, concerning the external part, an equalization is given with six items present for both opportunities and threats.

Following Figure 25 shows the graphical results of the workshop, for the case of BZ, indicating the most frequent macro categories, while Table 25 indicates the findings in detail concerning the latter mentioned pilot city:

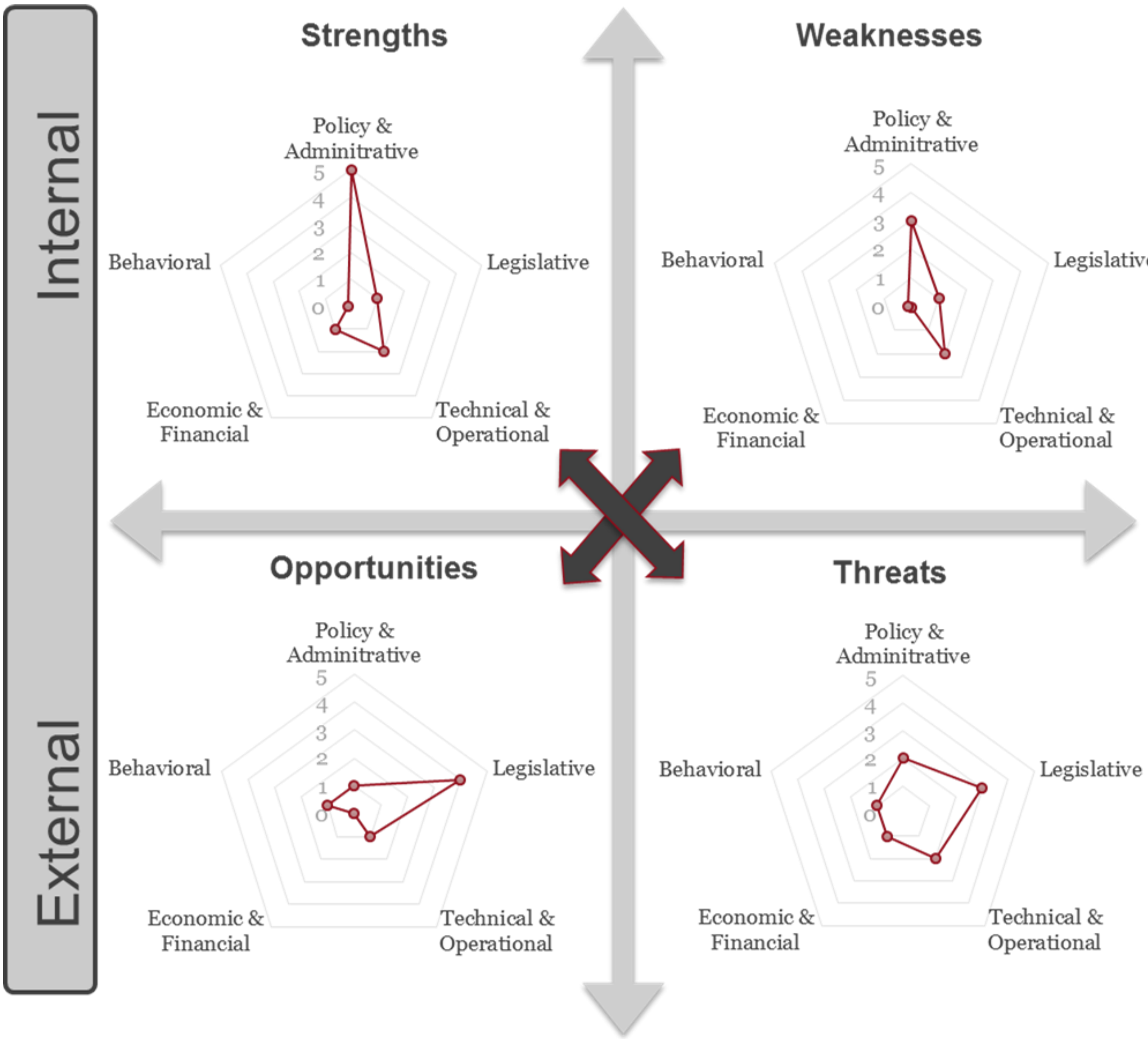

FIGURE 25 - GRAPHICAL RESULTS OF THE WORKSHOP REGARDING BOLZANO

As visible in Figure 25 above, concerning the internal section, again the majority of factors concern policy and administrative issues. In contrast, once more concerning the external part, the highest amount of points is given by legislative item.

TABLE 25 - SWOT MATRIX OF THE SWOT TOOL APPLICATION FOR BOLZANO

STRENGTHS
Cooperation and trust between different stakeholders (cause: active involvement of stakeholders in the project - effect: implementation of the project is fostered)
In Bolzano the cooperation between key stakeholders for the transformation of the city in a smart city is already present. This is demonstrated by a number of shared projects promoted by the three components scientific, academic and industry at local and European level, as well as by the presence of already established stakeholders working groups. This experience led the partners of Bolzano to work smoothly from the proposal elaboration phase. A district meeting between all partners is conducted monthly.
Communication between project participants and the public to increase awareness (cause: energy advice campaigns - effect: smoother project execution)
There is a common understanding among district partners for the promotion of a common strategy for the public communication of the SINFONIA results. The local communication working group was set up with the aim of promoting public awareness related to the smart city transformation of Bolzano. The parallel activity of estimating the co-benefits and co-opportunities, generated by SINFONIA in Bolzano feeds the contents of this communication campaign.
Existence of financial schemes (cause: presence of financial schemes and tools - effect: easier financing procedures for the project)
There is a number of financial method used to financially support the SINFONIA implementation activities. In addition to the European Union funding to carry out research and development projects, financial support from side of the Autonomous Province of South Tyrol is provided.
Environmental issues (cause: treatment of environmental issues - effect: higher public acceptance of the project)
The sensibility of local stakeholders on environmental issues is very strong since many years. This is due to the fact that historically the interactions between the environment preservation was of mutual benefit for the society development. This is demonstrated by a number of facts - one of them is that the municipality of Bolzano in 2005 promoted an energy plan for the city, which contributed to the creation of the baseline for the SINFONIA activities implementation.
Existence of regulatory incentives for implementation of smart city projects (cause: profitability of inhabitants - effect: higher acceptance of the project)
Various financial incentives exist, which support the SINFONIA undertaking in Bolzano. Those are given especially at local (provincial level). Among the most important incentives provided by the Autonomous Province of South Tyrol, there is the "bonus energia" (energy bonus), which includes the possibility of 20% volume increase of dwellings in case these undergo an energy refurbishment, reaching defined energy efficiency levels.
Existence of training material (cause: training activities for project participants - effect: better project implementation)
Several specialized training are performed in Bolzano for planners as well as tenants of the dwellings, which are retrofitted within the SINFONIA project. Main target of this activity is to prepare planners for the implementation of innovative technologies and to instruct tenants regarding an appropriate use of new technologies.
Marketing application for awareness and involvement (cause: proper communication about the project to the public - effect: enforced participation of end-users)
Since the beginning of SINFONIA, special attention has been given to a proper communication of the project to the public. Already in an early stage of the project, several press communication has been carried out by all partners of Bolzano together. The latter mentioned communication found a consistent resonance within television, radio and newspaper reports.
Existence of expertise, awareness, and methods for designing and implementing of new technologies and solutions

(cause: availability of expertise, skills, and methods for designing and implementing projects - effect: smooth and high-quality project execution)
There is a previous experience among partners of Bolzano in designing and implementation of research and development projects. The latter mentioned indication refers especially to CasaClima, the European Academy Bolzano and the Techno Innovation South Tyrol. The careful selection process of designers ensures the appropriate level of expertise for the interventions that are planned.
Requirements from the European Commission concerning reporting and accounting (cause: no unnecessary time is spent for reporting and accountancy given by European Commission requirements - effect: smoother execution of the project)
Most of the project partners in Bolzano have experience in fulfilling requirements of the European Commission for reporting and accounting. Less experienced partners receive coaching in this regard from the district leader.

WEAKNESSES
Set up of institutions to support the projects (cause: absence of an institution, which supports the project activities - effect: missing help for the project execution)
There are no new institution set up to support SINFONIA in Bolzano, as previous structures already exist. Furthermore, the creation of such an operative unit is not foreseen. It is believed that further support is not necessary, as the already present project partner are expected to provide the needed assistance.
Public participation (cause: absence of active involvement of the population - effect: delay or stop in implementation of the project activities)
Due to the fact that the SINFONIA project interventions are focusing on three different sectors (buildings, smart grid and district heating), the involvement level is not extended to the general public, but is largely confined to the active participation of the main actors of the indicated sectors.
Well-defined or documented in detail processes (cause: not clear instruction and duties given to project participants - effect: activities are hindered)
A rather general description of the instruction and duties of project participants in Bolzano led to the fact that there was a delay in several actions of the project as the improvement of the project from a management point of view was needed. However, concerning the latter mentioned issue a number of improvements has been performed.
Existence of expertise, awareness, and methods for designing and implementing of new technologies and solutions (cause: changes of expert human resources - effect: delay in implementation of the project activities)
Since the beginning of the SINFONIA project, there has been a rotation of human resources within the project. This issue was faced especially due to normal occurrence (e.g. maternity leave) and already led to delays in the project execution.
Development procedures that may inhibit or trigger implementation of smart city projects (cause: development procedures that may inhibit implementation of smart city projects - effect: delay or difficulty implementation of the project activities)
The existing urban plans of Bolzano hinder the implementation of smart city project intervention, because these do not foresee the possibility to increase the volume of building through insulation activities, if the respective saturation level is already reached. Closely related to that is the fact that the distance between building cannot be diminished by energy efficiency intervention. However, a variation of the local urban plan has already been approved by the provincial government in order to use the energy bonus explained above at the buildings selected for sanitation within the SINFONIA project. Respective detailed plans are under elaboration.
Public procurement (cause: no particular attention paid to public procurements - effect: delay or stop of the project implementation)
Due to the complexity of the national legislation, a number of problems arise when applying public procurement. Bureaucracy and laws characterized by long procedures and complicated processes lead to

a high time consumption and moreover, objection can be filed concerning winner declaration of tenders, which in turn may lead to long lasting court trails.

OPPORTUNITIES
Availability or lack of subsidies (cause: existence of subsidies related to project aims - effect: easier achieving of the project goals)
Retrofitting activities of Bolzano can be supported by several financial solutions. These subsidies are given especially at national and provincial level. Among those, one of the most relevant national subsidies is given by a 65% tax detraction of investment cost regarding energy sanitation of building, which can be written off tax expenditures within a time period of 10 years. Another important financial support is provided by the Autonomous Province of South Tyrol in form of loans given for activities concerning energy refurbishment of buildings.
Development procedures that may inhibit or trigger implementation of smart city projects (cause: existence of relevant energy requirements - effect: enforcement of project activities)
There are several national and provincial legislative energy requirements that impact directly activities of SINFONIA in Bolzano. Among these, one of the most important prerequisite concerns the CasaClima B certification (< 50 [kWh/m^{2}a] for heating demand) regarding new constructed and refurbished building.
Political commitment over the long term (cause: political commitment to the project - effect: smoother process of project implementation)
Political support for the SINFONIA project is provided as the Autonomous Province of South Tyrol is continuously pushing through legislation in the direction of transforming Bolzano into a smart city. Among others, one of the most significant related laws is the provincial Law 9/2010, which foresees contribution for interventions aiming to reduce energy consumption. Furthermore, energy efficiency and C02 reduction are part of the Bolzano municipality´s strategy.
Existence of affordable and mature technologies suitable for local conditions (cause: availability of mature technologies - effect: aims of the project are reached)
Due to the existence of a waste incinerator, a heat source for the district heating system is already present. Furthermore, a part of the district heating transmission network is already given. Also concerning the application of solar panels (solar thermal and photovoltaics), a suitable solar irradiation is present in a number of location within Bolzano.
Complex ownership structure of realities (cause: absence of variation in ownership of building - effect: smoother procedures for implementation of activities related to retrofitting)
In the case of the SINFONIA implementation within Bolzano, problems concerning a complex ownership structure of realities are not given. Reason for that is the selection of building, which undergo an energy sanitation, belonging solely to one institution: either to the Institute for Social Housing of the Autonomous Province of Bolzano (Istituto per l'Edilizia Sociale della Provincia Autonoma di Bolzano) or to the Municipality of Bolzano.
Development procedures that may inhibit or trigger implementation of smart city projects (cause: considering land use constraints - effect: sound planning of project activities)
The Municipality of Bolzano pays attention to the diverse land use constraints since decades. The various land use constraints are entailed within the urban plans, which are periodically updated. Furthermore, the Municipality of Bolzano pays special care on the so-called RIE (riduzione impatto edilizio - reduction of the construction impact) index, which guaranties the creation of green areas within urban space in the same size these get lost due to construction activities.
Public acceptance of technologies (cause: absence of fears for safety related to technology implementation - effect: higher acceptance of the project)
No fear concerning the technologies application has been perceived from side of the end-users. Therefore, a higher acceptance of the project implementation is expected.

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THREATS
Inertia (cause: resistance towards behaviour changes related to energy consumption - effect: delays or hindering of project implementation)
The tenants of the building, which were selected for the retrofitting measures in SINFONIA, are social housing building that are inhabited to a larger extent by elderly population, which shows higher resistance towards changing behaviour in energy consumption. The latter mentioned issue has been already recognised as a barrier by the responsible of the SINFONIA project in Bolzano and various solution possibilities are under discussion.
Existence of public-private engagement models (cause: absence of ESCOs - effect: drawback of the activities implementation)
Energy service companies, as a very innovative concept, are still in a development phase related to the city of Bolzano. These need still time to establish themselves within the local economy. Main reason for that is missing financial aid to operate on the market in a competitive way.
Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions (cause: a lack of awareness from side of users concerning application of technologies - effect: inappropriate utilization of technologies)
The tenants of the retrofitted buildings, within the city of Bolzano, have largely low level of awareness on proper use of the new technologies installed in their homes. This issue has already been detected by building owners in Bolzano and a number of possible solution are taken into consideration.
Effectiveness of regulations for implementation of technologies and solutions (cause: lack of effective legislation for supporting the project goals - effect: difficulties in reaching the planned aims)
The national legislation is characterized by complexity and non-transparency, in particular, there are ineffectiveness and partially non-existence of relevant regulatory bodies, regulations hindering the implementation of innovative technologies and solutions, non-working implementation of these, and inadequate legislations to promote innovative technologies.
Procedures for authorization of technologies (cause: complicated and time consuming procedures for authorization - effect: delays of project activities)
The national legislation implies a high level of bureaucracy. Therefore, procedures for the authorization of technological application and solution for SINFONIA activities in Bolzano result to be rather complicated and time consuming.
Costs of material, construction, and installation (cause: high costs of material, construction, and installation - effect: reduction of investments and participation in the project)
Considering the price divergence of material, construction, and installation between different European Union member countries, the European Commission contribution to carry out the SINFONIA activities in Bolzano, result to be relatively low.
Share of valuable data between different departments and partners (cause: data security and privacy issues - effect: data collection is hindered or stopped)
The national law on data security and privacy issues leads to delays concerning the data gathering necessary to fulfil the goals set within the SINFONIA project. This has already been recognised to be a serious barrier and several potential solutions are being sought. Major difficulties has been faced until now trying to overcome the indicated problem.
Complexity of applying solutions with regard to local conditions (cause: considering all unfavourable local topographic conditions - effect: proper planning and implementation of project activities)
Neither during the project proposal phase, nor while the building selection, unfavourable local topographic conditions within Bolzano have been considered. Consequently the problem arose that not all selected building are allocated in a suitable position for the application of all chosen technologies. For example, a number of building resulted to be not irradiated properly for the application of photovoltaics and solar thermal systems.
Transparency of legislation

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(cause: non-transparent legislation - effect: delays of project activities)
The perceived quality of intentionally shared information from side of the national legislator is relatively low. Uncertainty and therefore time delays in running project activities of SINFONIA within Bolzano are the consequence.

As it was already the case in previous Table 24, also here the number of categories present in the positive side (strengths) of the internal section exceeds the respective negative part (weaknesses), with nine and six issues respectively. The same applies to the external part of this SWOT matrix, characterized by with seven and nine items given for opportunities and threats respectively.

4.2.2 HOW TO USE DRIVERS TO OVERCOME BARRIERS

The given subchapter follows the proceedings of the two homonymous subchapters 2.2.5 and 3.2.4 (HOW TO USE DRIVERS TO OVERCOME BARRIERS). Within the present case, the connections between different items of the SWOTs refer to the given matrices for IBK and BZ provided by the application of the SWOT TOOL on the SINFONIA project.

First the SWOT matrix concerning the pilot city of IBK is taken to a closer look (Table - 24 SWOT MATRIX OF THE SWOT TOOL APPLICATION FOR INNSBRUCK):

a.) Connections between strengths and threats

Strength: existence of regulatory incentives for implementation of smart city projects
(cause: profitability of inhabitants - effect: higher acceptance of the project)
Threat: stability of costs during project life cycle
(cause: low energy prices - effect: disinterest towards projects aiming at reducing energy consumption and demotivation of users to switch towards more energy efficient technologies)

Low energy prices can act as a barrier to reduce energy utilization, because the consumer are not affected by great expenses if a high level of energy use is given. Moreover, the latter mentioned cause may lead also to energy users in not being interested to switch towards more energy efficient technologies. This problem could be solved by allowing users to profit from energy savings. This would increase the acceptance of the project by users and help to reach the project aims in terms of energy utilization reduction.

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Strength: environmental issues
(cause: treatment of environmental issues - effect: higher public acceptance of the project)
Threat: public acceptance of technologies
(cause: lack of acceptance of new technologies - effect: project implementation is hindered or stopped)

Public acceptance of unconventional technologies can hinder or even stop the successful implementation of the SINFONIA project. This barrier could be addressed by the treatment of environmental issues, because the latter mentioned topic might increase the public acceptance of the project activities.

Strength: cooperation and trust between different stakeholders
(cause: active involvement of stakeholders in the project - effect: implementation of the project is fostered)
Threat: share of valuable data between different departments and partners
(cause: data security and privacy issues - effect: data collection is hindered or stopped)

Data security and privacy issues to accomplish the needed investigations can hinder or even stop the foreseen data collection. As already mentioned before, one of the most crucial problems related to data security and privacy issues refer to the question of the information property. This problem could be addressed by cooperation between different stakeholders, in form of contracts, which enable the utilization of valuable data, while this data do not change property.

b.) Connections between opportunities and weaknesses

Opportunity: public acceptance of technologies
(cause: absence of fears for safety related to technology implementation - effect: higher acceptance of the project)
Weakness: public participation
(cause: absence of active involvement of the population - effect: delay or stop of project activities implementation)

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If there is no active involvement of the population within the treated project, delays or failure of this SC undertaking can be the consequence. However, the absence of fears for safety concerning technology implementation could help to overcome the latter mentioned problem. In fact, if fears connected to safety issues of technologies are not given, the acceptance in the project might not decrease.

c.) Connections between strengths and weaknesses

Strength: existence of regulatory incentives for implementation of smart city projects
(cause: profitability of inhabitants - effect: higher acceptance of the project)
Weakness: public participation
(cause: absence of active involvement of the population - effect: delay or stop of project activities implementation)

Active involvement of the population can be of fundamental importance for the smooth proceeding of the SINFONIA project. If the latter mentioned process is not given, the project execution could be delayed or stopped. This problem could be faced by taking advantage of a possible profitability for the population (e.g. due to incentives). Hence, inhabitants might be motivated to participate on the project activities. This would lead to a higher acceptance of the undertaking from side of the population and so bring forward the project´s implementation.

Strength: well-defined or documented in detail processes
(cause: clear instruction and duties given to project participants - effect: smooth running of project activities)
Weakness: communication between project participants and the public to increase awareness
(cause: no energy advice campaigns - effect: lack of support to the project execution)

The absence of energy advice campaigns can lead to a missing project support. However, clear instruction and duties given to project participants could alleviate/overcome this problem, as also the latter mentioned instructions might rise the population’s awareness concerning SINFONIA´s activities.

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Strength: cooperation and trust between different stakeholders

(cause: active involvement of stakeholders in the project - effect: implementation of the project is fostered)

Weakness: marketing application for awareness and involvement

(cause: insufficient communication about the project to the public - effect: proper participation of end-users is hindered or stopped)

Communication about the SINFONIA project (by radio, television, newspapers etc.) to the public can be highly important. If the latter mentioned issue is not given, a proper participation of end-users may be hindered or even stopped. This barrier could be addressed by the cooperation between different stakeholders (e.g. project participants). If for example, the representatives of a pilot city created certain marketing communications (e.g. a video) and the other pilot location different kinds of publicity releases (e.g. a flyer), the latter mentioned marketing deliveries might be exchanged, adopted and provided for the inhabitants of both localities. That would increase the marketing effect and so smoothen the implementation of the treated project.

d.) Connections between opportunities and threats

Opportunity: availability or lack of subsidies

(cause: existence of subsidies related to project aims - effect: easier achieving of the project goals)

Threat: public acceptance of technologies

(cause: lack of acceptance of new technologies - effect: project implementation is hindered or stopped)

A lack of acceptance regarding new technologies, utilized within the present SC project, can hinder or even stop the analysed undertaking. However, end-users might be motivated to use unconventional technologies due to the existence of related subsidies.

e.) Connections between opportunities and strengths

Opportunity: availability or lack of subsidies

(cause: existence of subsidies related to project aims - effect: easier achieving of the project goals)

Strength: accessibility to capital

(cause: proper financial support - effect: smoother implementation of project activities)

Proper financial support can be a crucial element for the feasibility of the analysed project. The latter mentioned disposability of monetary possibilities could be enforced by the existence of subsidies related to the project aims. The before indicated element can be accumulated to the already provided funding for the undertaking´s execution.

Opportunity: political commitment over the long term
(cause: political commitment to the project - effect: smoother process)
Strength: environmental issues
(cause: treatment of environmental issues - effect: higher public acceptance of the project)

The treatment of environmental issues can be very important for the successful implementation of the treated project. In fact, environment related topics may lead to a higher acceptance of this SC undertaking by the population. This driver could be even more fortified through political commitment regarding the latter mentioned topic.

f.) Connections between weaknesses and threats

Weakness: communication between project participants and the public to increase awareness
(cause: energy advice campaigns - effect: smooth project execution)
Threat: existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions
(cause: a lack of awareness from side of users concerning application of technologies - effect: inappropriate utilization of technologies)

A lack of awareness given by utilizers regarding technologies applied within the SINFONIA project, can lead to a relevant problem as an improper use of machineries and systems could be the consequence. The latter mentioned barrier might be even worse, if energy advice campaigns for users are missing. Thus, taking advantage of the before named campaigns would lead to avoid an incorrect utilization of technologies.

Next, the resulting SWOT matrix for the case of BZ is considered (Table 25 - SWOT MATRIX OF THE SWOT TOOL APPLICATION FOR BOLZANO):

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a.) Connections between strengths and threats

Strength: existence of regulatory incentives for implementation of smart city projects
(cause: profitability of inhabitants - effect: higher acceptance of the project)
Threat: inertia
(cause: resistance towards behaviour changes related to energy consumption - effect: delays or hindering of project implementation)

Inertia or resistance towards behaviour changes related to energy consumption may act as a barrier for proper application of new technologies by end-users. In fact, this barrier can hinder the achievement of project aims. However, this barrier could be diminished by allowing users to profit from energy savings. This would increase the acceptance of the project by energy users and help to reach the project aims in terms of reducing energy consumption.

b.) Connections between opportunities and weaknesses

Opportunity: political commitment over the long term
(cause: political commitment to the project - effect: smoother process of project implementation)
Weakness: set up of institutions to support the projects
(cause: absence of an institution, which supports the project activities - effect: missing help for the project execution)

A Lack of an institution, which supports the analysed project activities, may result in a shortage of help for the project execution. This problem could be solved by existing political commitment, which enforces and supports project objectives. In fact, political support might cover some functions of the lacking institution.

c.) Connections between strengths and weaknesses

Strength: cooperation and trust between different stakeholders
(cause: active involvement of stakeholders in the project - effect: implementation of the project is fostered)
Weakness: existence of expertise, awareness, and methods for designing and implementing of new technologies and solutions
(cause: changes of expert human resources - effect: project implementation is delayed)

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If expert human resources are missing or changed during the life cycle of the project, there may be some difficulties and delays for finding new experts. This problem could be solved through active involvement and cooperation of project participants in order to cover the latter mentioned gap.

Strength: existence of expertise, awareness, and methods for designing and implementing of new technologies and solutions
(cause: availability of expertise, skills, and methods for designing and implementing projects - effect: smooth and high-quality project execution)
Weakness: well-defined or documented in detail processes
(cause: not clear instruction and duties given to project participants - effect: activities are hindered)

A lack of clear instructions and duties for the SINFONIA project participants can cause confusion concerning the participant tasks. This may delay the implementation of project activities. That problem could be alleviated if project participants exploit their own expertise, awareness, and existing methods for designing and implementing projects to handle and improvise unclear instructions. Thus, a higher quality of the project execution would be given.

Strength: cooperation and trust between different stakeholders
(cause: active involvement of stakeholders in the project - effect: implementation of the project is fostered)
Weakness: public procurement
(cause: no particular attention paid to public procurements - effect: delay or stop of the project implementation)

Public procurement may result in an interruption or cancelation of SINFONIA project activities, due to complicated procedures. To avoid this problem, it could be possible to take advantage of the existing cooperation between public and private project participants. This cooperation would help to make complicated procedures work faster and smoother.

d.) Connections between opportunities and threats

Opportunity: political commitment over the long term
(cause: political commitment to the project - effect: smoother process of project implementation)
Threat: inertia
(cause: resistance towards behaviour changes related to energy consumption - effect: delays or hindering of project implementation)

Inertia or resistance towards behaviour changes related to energy consumption may act as a barrier for a proper application of new technologies by end-users. This barrier can hinder the achievement of the SINFONIA project aims. However, this problem could be alleviated through existing political support for the analysed project. Political support creates a secure environment, which can motivate energy users and increase the acceptance of the project. This could help to reach the project aims in terms of reducing energy consumption.

Opportunity: availability or lack of subsidies
(cause: existence of subsidies related to project aims - effect: easier achieving of the project goals)
Threat: costs of material, construction, and installation
(cause: high costs of material, construction, and installation - effect: reduction of investments and participation in the project)

High costs of material, construction, and installation may demotivate investors and end-users to participate in the treated project. However, existing subsidies could reduce the investment costs and therefore support and encourage investment and participation in the project.

e.) Connections between opportunities and strengths

Opportunity: availability or lack of subsidies
(cause: existence of subsidies related to project aims - effect: easier achieving of the project goals)
Strength: existence of regulatory incentives for implementation of smart city projects
(cause: profitability of inhabitants - effect: higher acceptance of the project)

Profitability for inhabitants can increase the acceptance of the SINFONIA project. To maintain and increase this profitability, it could be possible to exploit existing subsidies, which enforce more profit for investors and users. This would lead to a higher acceptance of the project, which facilitates the achievement of the project goals.

f.) Connections between weaknesses and threats

Weakness: well-defined or documented in detail processes
(cause: not clear instruction and duties given to project participants - effect: activities are hindered)
Threat: share of valuable data between different departments and partners
(cause: data security and privacy issues - effect: data collection is hindered or stopped)

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Data security and privacy can create difficulties in gathering required data for the execution of the the analyzed project. A lack of clear instruction on how to collect data could exacerbate this problem. Thus, it might be important to provide clear instructions on how to collect and use data in order to avoid privacy and security problems.

4.2.3 COMPARISON OF THE MATRICES FOR INNSBRUCK AND BOLZANO

Within a last step of the interpretation concerning the given SWOT matrices, a comparison between these is provided. Core aim of this exercise is to identify possible synergies between the two pilot cities of the SINFONIA project.

First, the above shown figures 24 and 25 (GRAPHICAL RESULTS OF THE WORKSHOP REGARDING INNSBRUCK and BOLZANO) are set against each other. Within both latter mentioned figures, concerning the internal section, the majority of factors concern policy and administrative issues and concerning the external part, the highest amount of points is given by legislative item.

Following text sections are subdivided in similarities and differences of SWOTs regarding BZ and IBK:

- Strengths

- Similarities

  First, it has to be stated that the majority of issues entailed within the strength section of the two matrices are equal. These item address the active involvement of stakeholders, presence of financial schemes and tools, treatment of environmental issues, profitability of inhabitants, availability of expertise, skills, methods for designing and implementing projects, and no unnecessary time spent for reporting and accountancy given by EC requirements.

- Differences

  The few differences encountered refer to clear instruction and duties given to project participants and proper financial support indicated for IBK, which is missing regarding BZ. Furthermore, within the SWOT matrix of BZ three strengths are mentioned, which are not present for IBK: energy advice campaigns, existence of training material, and proper communication (marketing) about the project.

- Weaknesses

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- Similarities

Once again, the issues indicated within this section of the two matrices correspond for the majority of cases. The equal items concern the absence of an institution, which supports the project activities, absence of active involvement of the population and development procedures that may inhibit implementation of smart city projects.

- Differences

Only within the weaknesses part of IBK are to find the following item: absence of energy advice campaigns, no training activities for project participants, and insufficient (or improper) communication (marketing) about the project. Moreover, not clear instruction and duties given to project participants, change of expert human resources and no particular attention paid to public procurement are indicated solely in the case of BZ.

- Opportunities

- Similarities

Also in this case, the majority of item entailed within the given part of the two matrices are the same. The topics addressed are: existence of subsidies related to project aims, political commitment to the project, absence of variation in ownership of building, considering land use constraints, and absence of fears for safety related to technology implementation.

- Differences

The few differences identified refer first to the presence of ESCOs (energy service companies), present only in the case of IBK. What´s more, within the SWOT matrix of BZ two strengths are mentioned, which are not present for IBK: existence of relevant energy requirements and availability of mature technologies.

- Threats

- Similarities

Solely in this case, the majority of issues diverge. The identified equal topics refer to a lack of awareness from side of users concerning the application of technologies, high costs of material, construction, and installation, data security and privacy issues.

- Differences

  Concluding, these differences are present only in the case of IBK: low energy prices, a lack of acceptance of new technologies, and a lack of supporting legislation for the project goals. In contrast, following threats are given solely for BZ: resistance towards behavior changes related to energy consumption, absence of ESCOs, a lack of effective legislation for supporting the project goals, complicated and time consuming procedures for authorization, not considering all unfavorable local topographic condition, and non-transparent legislation.

Summing up, most barriers and drivers resulting from the application of the SWOT tool emerge to be given in both pilot cities of the SINFONIA project. Hence, there is the possibility to develop synergies as for a common problems solving process as well as for the aim to enforce these factors, which give force to the implementation of the present SC undertaking. Concluding, regarding the differences identified between BZ and IBK, there is the possibility to learn from each other, transforming the negative issues detected into positives ones, following the good practice example of the respective pilot city.

5. DISCUSSION AND CONCLUSIONS

Smart cities are complex systems, which aim to respond to recent urban challenges and benefit from new urban opportunities. It is important to consider that the application of information communication technologies in urban services and infrastructure, integration of different systems in planning and implementation, collaboration of different stakeholders in all the stages of urban development, investment in social capital, and innovation is the smart cities alphabet. However, the performed literature review of the defined concept is subject to controversy. Furthermore, the described concept is characterized by continuous improvements.

So far, the quantitative SMART CITIES BASELINE SWOT analysis shows a certain difficulty in implementing smart city undertakings within Europe. This inconvenience derives especially from issues external to the analysed activities (opportunities and threats). In contrast, the matters internal to the projects dealt with, support the implementation of smart city undertakings. As visible from the conclusive SWOT matrix, the external section shows a negative result, which exceeds the positive outcome of the internal part by almost three times. Hence, the overall result of the SWOT matrix is characterized by a pertinent negative outcome. Anyhow, this result is derived from the perception of experts, who judged the effectiveness of different factors on projects they were/are involved in.

The factors with the highest impact values in total are public participation, availability or lack of subsidies, communication between project participants and the public to increase awareness. Thus, the involvement in the project activities and measures to promote participation appear to be highly relevant.

The analysis of impact numbers regarding internal and external factors affecting the implementation of previous or still ongoing smart city projects shows that the most important strengths are public participation, marketing application for awareness and involvement, and cooperation and trust between different stakeholders. This result highlights the importance of the information exchange when carrying out smart city activities. Next, the main weaknesses or shortcomings of the treated projects turn out to be communication between project participants and the public to increase awareness, existence of expertise, awareness and methods for designing and implementation of new technologies and solutions, and cooperation and trust between different stakeholders. Once more, the exchange of data results to be very important. The main opportunities are given by existence of affordable and mature technologies suitable for local conditions, environmental issues, and political commitment over the long term. Hence, in this case the technical and environmental related items prevail. Finally, the threats characterized by the highest impact values are availability or lack of subsidies, requirements from the European Commission concerning reporting and accounting, and complex ownership structure of realities. These threats are all connected to legislation.

The obtained final SWOT matrix entails barriers and drivers, which have not been mentioned in previous scientific literature sources (e.g. European Commission requirements in terms of reporting and accounting). These barriers highlight the importance of creating an appropriate context for collaboration of stakeholders in all phases of the project (planning, implementation, monitoring etc.).

On the other hand, experts stated that a number of barriers or drivers, which are mentioned in scientific literature sources, are not relevant to the investigated projects. Not always a justification is named for these absences (e.g. in the case of transparency of taxation system). A possible reason for that is the expiring of specific barriers due to recent improvements in European legal and regulatory frameworks.

The most utilized driver to provide advice on how to overcome barriers present in the final SWOT matrix is public participation. As this factor is characterized also by the highest impact number of all elements within the conclusive SWOT matrix, this issue turns out to be the key driver of the entire SMART CITIES BASELINE SWOT analysis.

The SMART CITIES BASELINE SWOT provides an understanding of the general internal and external drivers and barriers of European smart city projects. It is helpful for new smart city undertakings, because it indicates risks and opportunities, which could occur. This SWOT refers also to a number of important considerations for decision makers, useful when initiating and evaluating smart city activities. Moreover, the SMART CITIES BASELINE SWOT is applicable for further analysis of specific projects as it is utilized as a base for the SINFONIA SWOT.

By looking at the quantity of appearance of the different item within the four areas of the qualitative SINFONIA SWOT analysis, we can recognize the most relevant factors of the homonymous project. This inquiry indicates the following three factors to be the most important ones in total: combining of different financial schemes, costs of material, construction, and installation, and payback time. As it is visible, all latter mentioned issues are related to economics.

In this regard, the most important strengths of SINFONIA relate again to the combining of different financial schemes, existence of financial schemes, and public participation. Hence, once more the economic issues prevail. The most relevant weaknesses lie mainly in behavioural item related to mental constraints of individuals: inertia, values related to energy efficiency, which may inhibit measures from being undertaken, and principal agent relationship. The major opportunities are: public acceptance of technologies, share of valuable data between different departments and partners, and availability or lack of subsidies. Thus, the concept of information exchange is again highlighted. Concluding, the major threats are once more primarily related to economic and financial topics like costs of material, construction and installation, payback time, and risk and uncertainty.

A consistent support of the SINFONIA undertaking to execute the expected energy master plan activities is registered. The cross checking of the SINFONIA activities and these of the energy master plans indicate a significant overlapping of about 60% for both cases: Bolzano and Innsbruck. This means that the development of the SINFONIA project can provide a relevant contribution for both pilot cities concerning the implementation of foreseen activities by the execution of their energy plans.

This investigation provides the necessary knowledge about the cities (targets, scenarios etc.) and strategies (e.g. areas of interventions). According to the information collected, a more detailed revision and update of the starting conditions recognized by both energy master plans (baseline energy and emission inventory and implemented actions) is desirable and needed.

The application of the self-developed SWOT TOOL for Bolzano and Innsbruck within the SINFONIA project shows that there is the possibility to evolve synergies for a common problem solving process as well as for the goal to enforce these factors, which strengthen the implementation of the analysed smart city undertaking. Concluding, the two pilot cities of SINFONIA have the chance to learn from each other as in a number of cases weaknesses and threats for one city come out to be strength and opportunities for the other location.

6. REFERENCES

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7. QUESTIONNAIRE AND GLOSSARY

7.1 BARRIERS AND DRIVERS QUESTIONNAIRE

Please evaluate the effectiveness of each factor concerning the implementation of smart city projects by circling the items with a value ranging from -5 to +5 as follows:

- -5 (very effective barrier) to -1 (less effective barrier)
- 0 = neutral
- +5 (very effective driver) to +1 (less effective driver)

TABLE 26 - CATEGORIES AND MACRO CATEGORIES USED TO GROUP BARRIERS & DRIVERS OF SMART CITY PROJECTS AND RESPECTIVE WEIGHTING POSSIBILITIES

POLICY CATEGORIES											
National roadmaps, strategies, and policies for energy goals	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Political commitment over the long term	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5

ADMINISTRATIVE CATEGORIES											
Cooperation and trust between different stakeholders	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Communication between project participants and the public to increase awareness	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Existence of multi-actor/multi-sectorial planning tools	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Share of valuable data between different departments	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Existence of public-private engagement models	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Existence of financing models suitable for the innovation to address stakeholder involvement	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Public procurement	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Coordination of a large number of tenants	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Marketing application for awareness and involvement	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Set up of institutions to support the projects	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Obligations given to project participants	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Public participation	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5

LEGISLATIVE CATEGORIES (IMPLEMENTATION AND ENFORCEMENT)											
Transparency of legislation	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Consistency of implementation and interpretation of law	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Existence of regulatory stability	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Development procedures that may inhibit or trigger implementation of SC projects	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Local budgetary legislations	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Existence of knowledge about future litigations	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Effectiveness of regulations for implementation of technologies and solutions	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Existence of updated regulation and rules for new technologies	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Procedures for authorization of technologies	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5

LEGISLATIVE CATEGORIES (CROSS-SECTORIAL AND INTERNAL COHERENCE)	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Existence of data security and privacy	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Tax pressure	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Transparency of taxation system	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Availability or lack of subsidies	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Existence of regulatory incentives for implementation of SC projects	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Tariffs regulations	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5

TECHNICAL CATEGORIES											
Existence of affordable and mature technologies suitable for local conditions	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Existence of expertise, awareness, and methods for designing and implementation of new technologies and solutions	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Existence of training material	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Monitoring	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5

ECONOMICAL CATEGORIES											
Adverse selection	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Principal-agent relationship	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Split incentives	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5

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FINANCIAL CATEGORIES											
Hidden costs	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Accessibility to capital	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Risk and uncertainty	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Up-front costs	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Costs of material, construction, and installation	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Economic crisis	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Existence of financial schemes	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Combining of different financial schemes	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Stability of costs during project life cycle	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Payback time	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5

OPERATIONAL CATEGORIES											
Existence of tried and tested solutions and proven on the ground examples	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Complexity of applying solutions with regard to local conditions	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Interoperability between systems	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Supporting hard infrastructure	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Well-defined or documented in detail processes	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Existence of performance indicators for technologies implementation	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5

BEHAVIORAL CATEGORIES											
Form of information	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Credibility and trust	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Values related to energy efficiency, which may inhibit measures from being undertaken	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Inertia	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Bounded rationality	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Public acceptance of technologies	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5

FURTHER CATEGORIES THAT ARE RELEVANT TO YOU BUT HAVE NOT MENTIONED IN THIS QUESTIONNAIRE											
	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5

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7.2 QUESTIONNAIRE FOR PROJECT PARTNERS

1.) Have you ever participated at a smart city project? If yes, please indicate the name of the project and city/location.

a.) Yes ☐

b.) No ☐

Name of the project: ___________________________________

Name of the city/location: _______________________________

2.) Which of the following goals were addressed?

a.) Energy efficiency ☐

b.) Renewable energy use ☐

c.) Offsetting emissions ☐

d.) Energy use reduction ☐

3.) Which sectors have been considered?

a.) Building and districts

α.) New building and districts ☐

β.) Existing building and districts ☐

b.) Mobility and transportation

α.) Transportation infrastructure ☐

β.) Vehicles ☐

γ.) Mobility demand management ☐

c.) Energy networks and infrastructure

α.) District heating and cooling (DHC) ☐

β.) Smart electricity network (smart grid) ☐

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γ.) Smart gas network ☐

d.) Others: ____

4.) Which stakeholders have been involved?

a.) Mayor/politician ☐

b.) City administration ☐

c.) Utilities, energy service companies, network operators ☐

d.) Developers, architects, planners, engineers ☐

e.) Construction companies ☐

f.) Industries ☐

g.) Component manufacturers ☐

h.) Renewable energy industry ☐

i.) ICT companies ☐

j.) Financial institutions ☐

k.) R&D institutes and universities ☐

l.) End-users (owners and tenants) ☐

m.) Others:____

5.) Which scale did the project address?

a.) Building ☐

b.) Neighbourhood and district ☐

Furthermore, please indicate the number of inhabitants involved in the project: ______________________

6.) What was the time scale of the project?

a.) Short-term (1-2 years) ☐

b.) Medium-term (3-7 years) ☐

c.) Long-term (>8 years) ☐

7.) Please indicate the total budget of the project in [Mil.€]: ______________________________________

8.) Please indicate which technologies have been applied:

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TABLE 27 - TECHNOLOGIES LIST AND RESPECTIVE MACRO AREAS (IEA, 2014A), (IEA, 2014B), (BOURNE, 1982), (KAUFMANN ET AL., 2004), (RODRIGUE, 2013), (BROADDUS, 2013), (LUND, 2014), (FREEMAN, 2010), (SMART CITIES STAKEHOLDER PLATFORM, 2013), (HOUSTON, 2014), (HOLVECK, 2001), (ANDERSON, 2012), (MELOGRANO AND PEZZUTTO, 2014), (NATIONAL RENEWABLE EMERGY LABORATORY, 2014), (ASHRAE, 2005), (BRELIH, 2005), (ENERGY SAVING PUMPS, 2012), (EC, 2014G)

	TECHNOLOGIES	
Energy transmission and distribution	District heating pipe - transmission	☐
	District heating pipe - distribution	☐
Energy storage	Batteries	☐
	Electric vehicles to grid (V2G) technology	☐
	Solar thermal electrical steam	☐
	Flywheels	☐
	Embedded storage (building level)	☐
	Thermal storage (buffer vessels)	☐
Energy production	District heating (DH)	☐
	District cooling (DC)	☐
	District heating and cooling (DHC)	☐
	Thermal cooling	☐
	Photovoltaics	☐
	Hydro energy	☐
	Combined heat and power (CHP)	☐
	Energy from waste	☐
	Gas fired CHP - engine	☐
	Biomass CHP	☐
	Electric immersion heater	☐
	Solar thermal	☐
	Wind energy	☐
	Organic rankine cycle	☐
	Heat pumps	☐
	Waste water heat pump	☐
	Central heating, ventilation and air-conditioning (HVAC) systems	☐
Energy monitoring and control	Distributed intelligence	☐
	Enhanced remote control	☐
	Active network monitoring	☐
	Dynamic asset rating	☐
	Outage management/supply restoration	☐
	Preventive maintenance/asset monitoring	☐
	Low voltage network monitoring and control	☐
	Voltage and volt-ampere-reactive optimization (VVO)	☐
	Enhanced monitoring and control schemes	☐
	Enhanced automatic voltage control	☐

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	TECHNOLOGIES	
Energy monitoring and control	Data collectors/concentrators	☐
	Aggregators (distributed energy sources)	☐
	Demand side management	☐
	Fibre	☐
	Asymmetric digital subscriber line (ADSL)	☐
	Power line communication (PLC)	☐
	Wireless internet free internet (WiFi)	☐
	Wireless mesh	☐
	General packet radio service (GPRS)/general system for mobile communication (GSM)	☐
	Worldwide interoperability for microwave access (WiMax)	☐
Smart commodities	Electric vehicles	☐
	Smart meters	☐
	Smart asset management	☐
	Smart domestic appliances	☐
	Remote smart controls	☐
	Home energy monitoring packages	☐
	Energy efficient fans	☐
	Energy efficient pumps	☐
	Energy efficient lights	☐
Others		

7.3 GLOSSARY FOR SMART CITIES

1. Scales

The city scales defined on the number of inhabitants given in Table 15, MACRO CRITERIA AND CRITERIA UTILIZED TO IDENTIFY THE MOST SIMILAR PROJECTS TO SINFONIA, are based on following sources: (EC, 2014F), (Encyclopedia Britannica, 2014), and (Johnston, 2008). Furthermore, the EC (2014) and Encyclopaedia Britannica (2014) indicate a city of more than 50,000 inhabitants to be a metropolis.

2. Goals

Smart city goals include:

1- Energy efficiency

Restraining and managing the increase of energy consumption (IEA, 2014A); e.g. usage of highly efficient HVAC systems.

2- Renewable energy use

Energy derived from natural processes (e.g. wind); e.g. bioenergy, hydropower, solar, wind, geothermal, and ocean power (IEA, 2014A).

3- Offsetting Emissions

Reducing GHG emissions (i.e. H2O, CH4, N2O and O3) from urban areas.

4- **Energy use reduction**

Minimizing the energy demand and cutting unnecessary energy consumption; e.g. reduced standby energy consumption.

3. Sectors

There are different smart city planning sectors, which mainly include:

1- Building and district

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A district is a geographic area in the city with relatively consistent character. It includes different elements of urban structure: building, land use, social groups and economic activities (Bourne, 1982). This sector is dividable into two main subsectors:

1-1-New building and districts

1-2-Existing building and districts

2- Mobility and transportation

Transportation is the end-to-end movement of people, goods and information through specific paths of time and space (Kaufmann et al., 2004). Various modes of urban transportation include road, rail and telecommunication, which comprehend different means of transportation: private cars, non-motorized (e.g. walking and cycling), public transportation etc. (Rodrgiue et al., 2013). The mobility and transportation sector is divided into three main subsectors:

2-1- Transportation infrastructure

The fixed installations, which allow a vehicle to operate. These consists of the street layout, stations and facilities for parking and maintenance.

2-2- Vehicles

Machineries used to carry people or goods from one place to another; e.g. electrically driven vehicles.

2-3- Mobility demand management

Managing the mobility demand to make use of transportation resources (including road space, clean air, fuel, and parking facilities) more efficient; e.g. mobile application (i.e. GPS), multi-modal and shared transportation, public transit improvements, rideshare programs, telework, walking and cycling improvements (Menon, 2013).

3- Energy networks and infrastructure

Those infrastructures, which concern energy production, transmission, distribution, and storage. Smart energy networks are divided in three main subcategories (Lund, 2014):

3-1- District heating and cooling

A network that includes distributed heating and/or cooling production units and centralized plants, which serve and connect the building inside the neighbourhood or city. This network includes individual contributions from the connected building.

3-2- Smart electricity network (smart grid)

An integrated electricity infrastructure, which combines the actions of all users connected to it, in order to deliver an efficient, sustainable, economic, and secure electricity supply.

3-3- Smart gas network

An integrated gas infrastructure that combines the actions of all users connected to it, in order to deliver efficient, sustainable, economic and secure gas supplies, and storage.

4. Stakeholders

Stakeholders are any group or individual, who can affect or are affected by the achievement of the project objectives (Freeman, 2010). The main stakeholders involved in smart city projects are as follows:

1. Mayor/politician
2. City administration
3. Utilities, energy service companies, network operators (electric, thermal, sewage etc.)
4. Real estate developers
5. Developers, architects, planners, engineers
6. Housing/construction companies
7. Renewable energy industry (PV, ST, heat pumps etc.)
8. Component manufacturers (windows, facades, HVAC components etc.)
9. ICT companies
10. Financial institutions
11. R&D institutes and universities
12. Innovation/technology consultants
13. Energy consultants
14. Transportation consultants
15. End-users (or users: owners, tenants etc.) (Smart Cities Stakeholder Platform, 2013)

5. Spatial scale

A hierarchical distribution of area in the city based on size as well as socio-economic cohesion is called spatial scale. Smart city projects can be applied in two main spatial scales, which are described below:

1- **Building scale**

This scale concerns smaller developments, including individual dwellings, apartment blocks or commercial building, which provide opportunities for integrating smart city solutions into or around building.

2- Neighbourhood scale

This scale involves the development of distinct groups of dwellings, including a mix of uses and varies in size from an individual block to a large estate with regard to the cities' characteristics. A block is a unit of land or attached lot/parcel bounded by a roadway or other barriers (Holveck, 2001).

6. Involvement level

The involvement level is defined on the number of inhabitants given in Table 15, MACRO CRITERIA AND CRITERIA UTILIZED TO IDENTIFY THE MOST SIMILAR PROJECTS TO SINFONIA, which is based on indications provided by CONCERTO activities (EC, 2012B).

7. Duration

This point refers to the period of time (length) in which the implementation of the project will take place. It can be divided in (Houston, 2014):

1- Short-term plans

These projects last for about one to two years.

2- **Medium-term plans**

In this case the period of time is significantly longer as the before named indication: three to seven years.

3- **Long-term plans**

These projects last for more than eight years.

8. Size of the area concerning the intervention

The size of the area concerning smart city project application is measured in [ha]. The respective subdivision given in Table 15, MACRO CRITERIA AND CRITERIA UTILIZED TO IDENTIFY THE MOST SIMILAR PROJECTS TO SINFONIA, bases on indications provided by CONCERTO activities (EC, 2012B).

9. Total budget

The total budget of the projects indicates not only the European Commission contribution to carry out the mentioned projects (50% or 75%), but includes also funding to reach 100% of the monetary needs.

10. Technologies applied

TABLE 28 - TECHNOLOGIES LIST AND RESPECTIVE DECRIPTION (IEA, 2014A), (IEA, 2014B), (BOURNE, 1982), (KAUFMANN ET AL., 2004), (RODRIGUE, 2013), (BROADDUS, 2013), (LUND, 2014), (FREEMAN, 2010), (SMART CITIES STAKEHOLDER PLATFORM, 2013), (HOUSTON, 2014), (HOLVECK, 2001), (ANDERSON, 2012), (MELOGRANO AND PEZZUTTO, 2014), (NATIONAL RENEWABLE EMERGY LABORATORY, 2014), (ASHRAE, 2005), (BRELIH, 2005), (ENERGY SAVING PUMPS, 2012), (EC, 2014G)

	TECHNOLOGIES	TECHNOLOGIES DESCRIPTION
Energy transmission and distribution	District heating pipe - transmission	Bulk pipes carrying hot water from the power station to the city heating grid with a heat capacity starting from 25 [MW] up to a potential of 10 [GW]. The maximum reasonable distance for transmission pipes is estimated at around 150 [km].
	District heating pipe - distribution	Distribution pipes for carrying hot water (or steam) to the end-user with flow temperatures up to 120°C. Steel pipes can be used for higher and plastic pipes for lower temperature requirements.

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	TECHNOLOGIES	TECHNOLOGIES DESCRIPTION
Energy storage	Batteries	Technologies currently available are lead-acid and hybrid lead-acid, lithium-ion, sodium - sulphur, nickel-metal-hydride, and flow cells. These can be used for load balancing and reinforcing the network to better cope with intermittent sources. Electrical energy storage technologies are expandable and can release energy over various time frames.
	Electric vehicle to grid (V2G) technology	A technology system, where electric vehicles provide energy storage or distributed generation. This system can be used as an additional demand-side management possibility.
	Solar thermal electrical steam	A technology for storing heat prior to converting it to electricity. The process is made more efficient by using concentrated solar power, which allows higher heat temperatures. Thermal storage is achieved by using pressurized steam, phase change materials and molten salts.
	Flywheels	A type of kinetic energy storage in rotors loaded with magnets. It is used for voltage regulation and stabilization in order to reduce transmission costs over long distances, such as from wind parks or solar farms. The technology has a fast power response and short discharge times, which allows to be used for power quality application, but limits its use in large-scale application.
	Embedded storage	Used to optimize network utilization and the power profile of a building. Reduces the need for peak load reinforcement and improves system losses. This technology is still being trailed at various scales.
	Pumped-storage power station	A system for energy storage and generation, which operates by moving water from a lower to a higher reservoir, when the demand for electricity is low. In this way, it is used for load balancing by releasing the stored water at the time of high electricity demand.
	Insulation	Thermal insulation in building is used to reduce heating and cooling costs by providing resistance to heat transfer. Therefore, it is possible to increase energy efficiency/reduce the energy use.
	Thermal storage (buffer vessels)	Thermal storage usually refers to hot water storage in combined heat and power systems. Other solutions to be considered in homes are diurnal and seasonal thermal storage. These include the use of underground labyrinths, phase change materials and thermal mass.

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	TECHNOLOGIES	TECHNOLOGIES DESCRIPTION
Energy production	District heating (DH)	A DH system distributes hot water or steam generated in a centralized place for residential and commercial heating requirements, such as space heating and domestic hot water (DHW) preparation.
	District cooling (DC)	A DC system distributes chilled water generated in a centralized place for residential and commercial cooling requirements.
	District heating and cooling (DHC)	A DHC system combines the two technologies mentioned above in order to provide energy consumer to economically sound, environmentally optimal and efficient sources of heating and cooling through a piping network.
	Thermal cooling	Space cooling provided by using a thermally driven heat pump.
	Passive cooling	Cooling systems based on the interaction between the building and its surrounding environment. Main passive strategies include natural ventilation, evaporative cooling, high thermal mass, radiative cooling, and earth coupling.
	Photovoltaics (PV)	Solar photovoltaic panels, which convert sunlight and daylight (indirect sunlight) into electricity.
	Hydro energy	The generation of electrical energy by using the renewable energy contained in falling or flowing water. The three main methods for generation are storage, pumped storage, and run-of-river.
	Combined heat and power (CHP)	Combined heat and power technologies convert different types of fuels to heat and power. Fuel is fired in a boiler to produce steam for use in a rankin cycle.
	Energy from waste	This technology uses waste as a basic fuel in the combined heat and power process. It is suitable for producing low-carbon heat at low costs, typically generating around five units of heat for one of power. This ratio can however be varied during the steam cycle.
	Gas fired CHP - engine	The gas fired combined heat and power engine converts gas to heat and power - it can use an engine or a turbine. Engines are of smaller capacity, ranging from to 50 to 2500 [kW], while turbines can be medium to large, ranging from 5 to 600 [MW].
	Biomass boiler	Biomass (e.g. pellets) driven boilers for space heating and domestic hot water (DHW) preparation.
	Biomass CHP	This technology uses wood as a fuel to generate heat and power. The power/heat ratio can be varied according to meet different requirements, while wood can also be gasified and then burned directly in gas engines.

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	TECHNOLOGIES	TECHNOLOGIES DESCRIPTION
Energy production	Electric immersion heater	The electric immersion heater converts electricity to hot water. It is scalable and can be used as a power sink when the grid or distribution network is overloaded.
	Solar thermal (ST)	Solar panels that convert direct sunlight into thermal energy, which is used to heat water and can then be used for space heating or domestic use.
	Geothermal energy	This technology is a clean and renewable source of heat produced and stored within the Earth, used in various application worldwide.
	Wind energy	Wind energy is extracted from wind through wind turbines for the purpose of generating electricity.
	Organic rankine cycle	The organic rankine cycle uses an organic mass fluid instead of water as in the conventional rankine cycle. It has application in waste heat recovery as well as biomass, geothermal, and solar thermal power generation.
	Heat pumps	A heat pump allows to transfer heat from one fluid at a lower temperature to another at a higher temperature, where the fluid takes a liquid a gaseous state in response to temperature and pressure conditions.
	Waste water heat pump	This technology extracts heat from wastewater through the use of a heat pump.
	Industrial waste heat	Industrial waste heat is heat created as a by-product of industrial processes. Common sources of waste heat are combustion gases discharged to the atmosphere, heated products exiting industrial processes and heat transfer from hot equipment surfaces. The waste heat can be collected and reused for heating or for the generation of mechanical or electrical energy.
	Heating, ventilation, and air-conditioning (HVAC) systems	The HVAC are various systems and technologies used to provide acceptable indoor air quality and thermal comfort.
Energy monitoring and control	Distributed intelligence	Distributed intelligence is a system for real-time decision-making, based on inputs from a network of processing sensors. It allows real-time monitoring of power flows in the network.
	Enhanced remote control	The enhanced remote control expands the existing supervisory control and data acquisition facilities (SCADA) into the network, resulting in improved response times, reduction in network downtime and improved restoration times for the customer.
	Active network monitoring	This technology monitors power flows at selected substations, giving an insight into real-time power flows and quality and voltage regulation. It has important implications for distributed generation and demand-side management.
	Dynamic asset ratings	These technology uses weather sensors (wind speed, solar radiation etc.) to provide system operators with real-time data.

	TECHNOLOGIES	TECHNOLOGIES DESCRITPTION
Energy monitoring and control	Outage management/supply restoration	Technologies used to minimize the impact of network breakdowns. The goal is to restore the supply to as many customers as possible in the shortest time possible. Outage management can range from simple changes in the business processes to the complex use of different tools.
	Preventive maintenance/asset monitoring	Data provided by various sensors can be used to early detection of potential failure. In that way, these reduce costs and safety risks. Examples include pressure alarms, winding temperature and dissolved gas analysis.
	Low voltage network monitoring and control	Data for low-voltage grids is practically non-existent at the moment. Improvements in monitoring and metering could lead to a better understanding of network load profiles and a better use of assets, with fewer disruptions to the customer.
	Voltage and volt-ampere-reactive optimization (VVO)	Active voltage control is used to prevent issues with the sudden rise of voltage coming to the substations. This improves responsiveness required for load balancing and enables better connections of intermittent renewables to the grid.
	Enhanced monitoring and control schemes	This technology refers to the monitoring of voltage and reactive power in order to improve network stability and reduce losses through the use of solid state devices. That allows dynamic adjustments of network characteristics.
	Enhanced automatic voltage control	The given technology is a system of devices, which can help to keep grid voltages within limits in order to respond to challenges like the increased distributed generation. Examples include taking additional voltage sensing input from points on the network and in-line voltage regulators.
	Data collectors/concentrators	Data collectors/concentrators are used for providing an interface between individual meters and the data warehouse, using various communication technologies.
	Aggregators	Aggregation is the process of organizing distributed energy sources into larger units, which strengthens their bargaining power and participation in electricity trading. It already plays a role in demand response, with the key issue to bring the aggregators to the distribution level, where a significant load balancing could be achieved.

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	TECHNOLOGIES	TECHNOLOGIES DESCRIPTION
Energy monitoring and control	Demand side management	Technologies used to match customer demand with the economic availability of generation. Various application exist, for example through remote control of appliances and heating, security monitoring, lighting control etc.
	Fibre	Fibre optical cables are installed in the ground. The cables are rugged, do not corrode and are immune to electromagnetic and radio frequency interference, while having high capacity and reliability.
	Asymmetric digital subscriber line (ADSL)	This technology is a broadband communications technology used for accessing the internet. It has a good coverage and is reliable, with capacity being a potential issue.
	Power line communication (PLC)	A system for carrying data on a power line conductor for wireless area network application. Low-voltage and medium-voltage PLCs can be used on existing distribution grids.
	Wireless internet free internet	This technology allows for a wireless exchange of data over a computer network. It has a high user base, it is comparatively cheap and easy to install. Common issues are coverage and channel interference.
	Wireless mesh	The wireless mesh is a network made up of radio nodes, where nearby devices can communicate between each other to create smart data routing – finding the most efficient path and changing it when a node stops working. It can be set-up quickly. Various technologies and protocols exist, which connect different devices.
	General packet radio service (GPRS)/ Global system for mobile communication (GSM)	This technology is a mobile data service standard for wireless communications, which runs at the maximum speed of 114 kilobits per second. The global system for mobile is a standard for the second generation of mobile networks, which runs at 9.6 kilobits per second.
	Mobile application	Mobile application are computer software, which run on mobile devices - usually smartphones and tablets. Mobile application have potential in energy monitoring and management, enabling users to reduce energy use and costs.
	Data platforms	These platforms are centralized computing systems used for collecting and managing large data sets from different sources in a consistent manner.
	Living labs	Living labs are research concepts, which consists of a user-centred, real-life experimentation environment in a territorial or regional context. It often includes citizen-public-private partnerships, where users are not only subjects, but producers of innovation. Common research methods include action research, crowd sourcing and participatory design.
	Worldwide interoperability for microwave access (WiMax)	This technology is a broadband communications standard used to for connectivity over large geographic areas, as an alternative to cable. Signal quality can be an issue in densely built areas.

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	TECHNOLOGIES	TECHNOLOGIES DESCRIPTION
Smart commodities	Electric vehicles	Electric vehicles can be pure-electric, parallel- and series-hybrids. They are imagined as alternatives to standard vehicles with a high carbon footprint and have also a storage potential. Electric vehicles have impacts on loads, voltage levels and power quality.
Smart commodities	Smart meters	Smart meters are utility meters for electricity, natural gas or water, which make use of a two-way communications technology. They allow for greater control and automation of energy consumption and as such provide benefits for use in smart grids.
Smart commodities	Smart asset management	Smart asset management uses data from the network to improve asset management capabilities and performance, as well as to develop new processes and principles.
Smart commodities	Smart domestic appliances	Appliances with a capability to respond to signals from smart meters. Examples of uses of smart appliances include refrigeration, home computing products and consumer electronics.
Smart commodities	Remote smart controls	The current generation of remote smart controls allow for the control of appliances in homes when occupiers are out. These smart buttons can be connected to smart plugs, which can monitor energy consumption of an individual appliance.
Smart commodities	Home energy monitoring packages	These packages consist of a range of technologies – usually an in-home display, an online interface and a meter in addition to communication technology and domestic appliance controls.
Smart commodities	Energy efficient fans	Energy efficient ventilators: energy consumption is low for the intended task.
Smart commodities	Energy efficient pumps	Energy efficient pumps are characterized by a low energy consumption.
Smart commodities	Energy efficient lights	Energy efficient lights (energy saving lamps): energy consumption is low for the intended task.
Smart commodities	Geographic information system (GIS)	Geographic information system are a computerized data management tool, which can be used to store, manage and visualize all types of spatial or geographical data. Two types of data are raster data (satellite imagery) and vectors.
Smart commodities	Modelling tools	These tools are used to identify relationships between data objects in complex systems, explaining how these elements interact with each other. Usually these models are represented graphically through diagrams and flow charts.

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Abbreviations and synonyms

Abbreviations

ADSL	Asymmetric digital subscriber line
ASC	Amsterdam Smart City
BZ	Bolzano
BEI	Baseline emissions inventory
CHP	Combined heat and power
DH	District heating
DHC	District heating and cooling
DH/C	District heating and/or cooling system
DoW	Description of work
EC	European Commission
EE	Energy efficiency
Eeb	Energy-efficient building
EU	European Union
FP6	Sixth Framework Programme
FP7	Seventh Framework Programme
GIS	Geographic information system
GDP	Gross domestic product
GPP	Green public procurement
GPRS	General packet radio service
GSM	Global system for mobile communication
ha	Hectare
H&C	Heating and cooling
HVAC	Heating, ventilation, and air-conditioning
IEA	International Energy Agency
IBK	Innsbruck
IT	Information technology
ICT	Information communication technology
IQR	Interquartile range
kWh	Kilo Watt hour
kWp	Kilo Watt peak
MWel	Mega Watt (electric)

MWth	Mega Watt (thermal)
Mil.	Million
MCDA	Multiple-criteria decision analysis
MFA	Multifamily house
Mtoe	Million tonnes oil equivalent
NGO	Non-governmental organisation
OECD	Organization of Economic Co-operation and Development
nZEB	Nearly zero energy building
PLC	Power line communication
PV	Photovoltaics
RE	Renewable energy
RES	Renewable energy sources
R&D	Research and development
ROI	Return on investment
SC	Smart city
SEAP	Sustainable energy action plan
SEC	Smart energy city
SET	Strategic Energy Technology
SCSP	Smart City Stakeholder Platform
ST	Solar thermal
SWOTs	Strengths, weaknesses, opportunities and threats
V2G	Electric vehicle to grid
VVO	Voltage and volt -ampere-reactive optimization
Wimax	Worldwide interoperability for microwave access
WP	Work package

Synonyms

Factors	Issues, item, points, categories
Group	Assembly
SC project	SC undertaking, SC activity
Cities/locations	Places, localities, locations

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APPENDIX: DOCUMENT INFORMATION

SINFONIA DELIVERABLE FACT SHEET	
PROJECT START DATE	1 June 2014
PROJECT DURATION	60 months
PROJECT WEBSITE	http://www.sinfonia-smartcities.eu
DOCUMENT	
DELIVERABLE NUMBER:	2.1
DELIVERABLE TITLE:	SWOT analysis report of the refined concept/baseline
DUE DATE OF DELIVERABLE:	31 May 2015
ACTUAL SUBMISSION DATE:	31 May 2015
AUTHORS:	Simon Pezzutto, Roberto Vaccaro, Pietro Zambelli, Farnaz Mosannenzadeh, Adriano Bisello, Daniele Vettorato (EURAC research)
REVIEWERS:	Alyona Zubaryeva (EURAC research)
WORK PACKAGE NO.:	2
WORK PACKAGE TITLE:	Design & specifications of scalable/ replicable refurbished district templates
WORK PACKAGE LEADER:	EURAC research
WORK PACKAGE PARTICIPANTS:	SP, magibk, Innsbrucker Kommunal, NHT, UIBK, TZS, Comune di Bolzano, EURAC, IPES, SEL SPA, CASA CLIMA, Borås Stad, COMMUNE DE LA ROCHEL, CEMS, MUNICIPALITY OF PAFO, Greenovate! Europe, PASSIVE HOUSE INSTITUTE, ROSE, ALFA LAVAL CORPORATE, Liebherr-Hausgeräte
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DRAFT/FINAL:	Final
NO OF PAGES (INCLUDING COVER):	200
KEYWORDS:	Smart energy districts, smart city, smart cities baseline SWOT, SWOT tool