Green Thoughts, Green Futures

PLANNING FOR ENERGY EFFICIENT CITIES

Katariina Kiviluoto, Annika Kunnasvirta,
Timo Mieskonen, Lotta Ek, Julia Haselberger,
Mikael Kullman & Evert Meijers (eds.)


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PLEEC

Planning for an Energy Smart City

More than 50% of all people globally are living in cities today. Enhancing the sustainability and efficiency of urban energy systems is thus of high priority for global sustainable development. A transition towards Energy Smart Cities calls for technological, innovative, behavioural and structural capacities – in other words a holistic approach to city planning.

For this reason, the PLEEC project – **"Planning for Energy Efficient Cities"** – funded by the EU Seventh Framework Programme has applied an integrative approach to achieve sustainable, energy-efficient, smart cities. By coordinating strategies and combining best practices, PLEEC has developed a general model for energy efficiency and sustainable city planning. By connecting scientific excellence and innovative enterprises in the energy sector with ambitious and well-organized cities, the project aimed to reduce energy use in Europe in the near future and will therefore be an important tool contributing to the EU's 20-20-20 targets.

The main project outcomes were individual Energy Efficiency Action Plans for the six “PLEEC cities” on how to improve their energy efficiency in a strategic and holistic way. In order to make this knowledge available to further European cities the project developed a general model on energy efficiency and sustainable urban planning – accessible through an online model website.

The PLEEC consortium consisted of 18 partners from 13 different European countries representing **six medium-sized cities** (Eskilstuna/Sweden, Tartu/Estonia, Turku/Finland, Jyväskylä/Finland, Santiago de Compostela/Spain and Stoke-on-Trent/UK), **nine universities** (Mälardalen University, Turku University of Applied Sciences, Hamburg University of Applied Sciences, Vienna University of Technology, University of Copenhagen, Delft University of Technology, University of Rousse, Santiago de Compostela University and University of Ljubljana) and **three industry partners** (LMS Imagine-Siemens, Smart Technologies Association SMARTTA, Eskilstuna Strängnäs Energy & Environment).

For more information on PLEEC, see
www.pleecproject.eu

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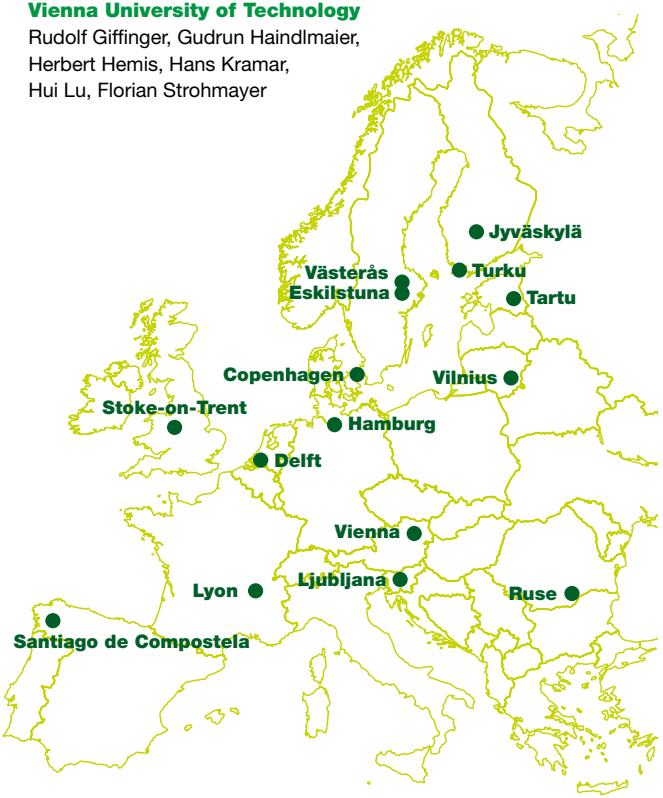


Table of contents

Connecting the dots

Tackling the 20-20-20 targets with a holistic approach

Urban areas account for two-thirds of global energy requirements and are expected to house three quarters of the world's population by 2050. Energy is an intrinsic determinant of all urban settlements. It interconnects the built environment with socioeconomic activities, transport, industry and the individual citizens in their everyday lives. Unabated though it may seem, energy reductions are in dire need as cities tackle to reduce global greenhouse gas emissions.

Fortunately, energy efficiency is high on the European agenda. In December 2015, the COP21 agreement was reached in Paris whereby 160 parties representing 187 countries committed to reduce greenhouse gas emissions and keep global warming well below 2°C. Each party defined its emissions reduction plan. The European Union pledged to reduce its emissions by 40% by 2030, thereby going well beyond the goals of the European Union's 20-20-20 plan to reduce emissions and improve energy efficiency by 20% by 2020. Cities and communities have a crucial role to play in reaching these ambitious objectives.

In the face of an ever-growing energy demand but finite resources, efficiency is imperative. Technological solutions abound and some cities excel in energy efficient spatial planning. Great efforts are still needed, however, to get all the citizens, officials and private companies on board to better capture the vast potential for energy savings in each and every community, industry, workplace or household. Nonetheless, holistic knowledge about the energy efficiency potential in cities is far from complete. Currently, a variety of individual strategies and approaches by different stakeholders tackling separate key aspects hinders strategic energy efficiency planning. Nevertheless, energy use can be reduced in Europe in the near future, if we connect scientific excellence and innovative enterprises in the energy sector with ambitious and well-organized cities.

We are facing the biggest challenge ever, which will affect not only mankind, but all life on earth. Climate change is not something which will happen someday in the future. It is already here. But so are the solutions. Let us prepare for a greener future.

Eric Lecomte
Policy Officer, DG for Energy, European Commission

Think green.
Think efficiency.
Think smart.
Think the future.

The way we plan and build our cities is influencing the present and future demand for energy. The PLEEC project set out to make European cities more energy smart. This booklet, **"Green Thoughts, Green Futures"**, presents the main findings of the project in a popularized, easy-to-approach manner. The title of the booklet falls down to the very basics of energy efficiency: making rational, well-informed and holistic choices in city planning to promote energy efficiency is simply the way of the future. Decisions can be made to install new technical appliances to boost energy saving. Actions can be introduced to encourage people to make correct decisions to use less energy in their daily life. Plans and policies may be devised to promote energy efficient city planning.

However, all these efforts are futile without a holistic view and clear targets – based on an involvement of all stakeholders to reach a shared view and agreement how each specific city can thrive sustainably in the 21st century, amidst a rapidly growing population, scarce resources and other sustainability challenges.

Within the PLEEC framework, five key fields of urban development have been identified: Green Buildings and Land-use, Mobility and Transport, Technical Infrastructure, Production and Consumption and Energy Supply. Green Thoughts, Green Futures explores the most relevant aspects of energy efficiency in these key urban fields from a city perspective: the technologies, thoughts, processes and innovations that are already underway yet in need of more work. Improving the efficiency of how we produce and consume energy is simply the most sensible thing to do about our common future. The time for energy efficiency in cities is now. Momentum is growing. All one needs to do is hop along.

"City governments should create a body dedicated exclusively to energy issues. A body invariant before government changes, able to tackle all energy issues in the city as well as to transmit all these commitments and solution to the population."

– *Esteban Vieites, Researcher, University of Santiago de Compostela, Spain*

"An energy smart city is characterized by clear political commitment regarding the improvement of energy efficiency; a comprehensive strategy with short/medium/long termed goals of energy efficient urban development and strong governance efforts supporting urban innovations which meet economic, technical and social challenges."

– *Rudolf Giffinger, Professor in Regional Science, Vienna University of Technology, Austria*

"The biggest challenge for reaching energy efficiency targets is the lack of binding legislation. It is clear that voluntary measures are not sufficient – we wouldn't pay taxes on a voluntary basis either. Climate change and resource scarcity are slowly advancing processes which don't create the sense of urgency that is needed for action."

– *Sirpa Pietikäinen, Member of the European Parliament, Finland*

"A smart city is characterized by a (very) low energy consumption per capita and a very low carbon footprint, while still increasing the citizens' quality of life."

– *Thomas Madreiter, Planning director, City of Vienna, Austria*

"A smart city is a dense city, which is highly energy and resource efficient, based on resilient resource systems, powered by renewable energy sources and well-functioning public transportation."

– *Pernilla Lindström, Comprehensive planner/ Spatial planner, Eskilstuna, Sweden*

"An energy smart city would be a city that is low in energy consumption, while providing a good livability for its citizens. It is not only a city where energy consumption is low, but also an efficient city. This could be that it provides good housing that is energy efficient or it uses smart ways of producing necessary energy (if possible in renewable forms), or it provides effective public transport (or bicycle and pedestrian infrastructure) to make these transport modes easy, fast, safe, and at a low price, or it is organised land-use-wisely in a way that it is easy to use the public or soft-mode transportation."

– *Gertrud Jørgensen, Professor in Urban Planning, University of Copenhagen, Denmark*

"An energy smart city is one that is aware of its energy use and in all decisions tries to minimize its energy use, both in practical everyday life and in major decisions with great impact on the city's future structure."

– *Olov Åslund, Project coordinator, Eskilstuna City, Sweden*

"A smart city is a city with a good coordination between different parts of the energy field. Heating, electricity and transports – it all fits together. Often the spatial planning could be the same if you want to improve either of them. Densifying is often the answer to make them sustainable and financially smart. One important note is that you have to relate to the city's history and use it to build a new energy smart city."

– *Mats Hällnäs, Head of Eskilstuna Planning Department, Sweden*

"An energy smart city means a city where energy is produced sustainably (and locally, if possibly) and energy consumption in the whole city, including e.g. households, industry and traffic, is as low as possible."

– *Kati Kankainen, Coordinator, Association for sustainable development in Jyväskylä, Finland*


Internet-of-things
Green roofs
Energy renovations
Super-blocks
Vertical gardens
Energy performance certificates
Passive houses
Retrofitting
Land-use
PV-panels
Hands-on guidance
Nearly zero energy houses
Passive cooling
Thermal insulation
Glazing
Energy labels
Optimized solar access
Smart solutions
Dense urban form

Building energy-smart cities

Solving the energy puzzle

Green buildings and land-use

Buildings currently generate 36% of the CO_2 emissions in Europe and energy use in buildings accounts for the largest share of energy consumption in the EU. Since the need to address growing CO_2 emissions and increasing energy consumption in buildings is pressing, the EU has set definite targets and strategies to deal with the challenge. Additionally, EU member states have national plans focusing on the ways to reduce emissions and to decrease energy consumption in buildings. Many European cities and regions have also created their own energy efficiency strategies encompassing buildings and land use issues.

However, increasing the overall energy efficiency of buildings is no simple matter. A holistic view covering new technological solutions, energy smart city planning and people's behaviour should be adopted. No long-lasting results can be achieved without combining these aspects into a functioning whole: **energy smart buildings require energy smart people and an urban form equipped to support new technological innovations.** Without this integrated approach, cities might end up having state-of-the-art, yet ill-advisedly positioned buildings occupied by residents with incomplete understanding of the finer features of their apartments. To avoid this kind of a worst-case scenario, all parts of the energy puzzle should be taken seriously. However, it should be noted that if all existing buildings were renovated to the standard for new low energy buildings the EU would reduce the heat demand by maybe 60–70% until 2050.

"Cities should focus on energy efficient buildings, both for heat and cooling to reach their energy efficiency goals. This is where the largest potentials are and where the city itself has a lot of leverage."

– *Max Gruenig, Senior Fellow, Coordinator EU Research, Ecologic Institute*

Curbing the CO_2 emissions brick by brick

Making resource and energy efficient buildings

Energy consumption of buildings can be divided into **residential** (75%) and tertiary or **non-residential** energy consumption (25%). Residential energy use is simply the consumption of energy at home, i.e. the energy used for heating and cooling of the residential space, heating of water used at home, and the energy used for lighting and various electronical appliances. Non-residential energy consumption whereas stands for the consumption of energy at offices, the health sector, schools, hotels and restaurants, wholesale and retail trade and other types of buildings and is very much related to ventilation and heat recovery of these buildings. Following a steep increase in energy consumption in the EU, energy consumption levels have begun to stabilize and even gradually decrease.

An integrated approach combining technology, city planning and people's behaviour is vital if cities want to see an even steeper decrease in energy consumption. New technological solutions are known to be a key driver in decreasing energy consumption in buildings. However, spatial developments such as the increase in house volumes can unfortunately offset the gains derived from installing new technologies. In addition, people might find themselves in lock-in situations (e.g. turning an old house into an energy smart house is very expensive), which hinder the adoption of new ideas and technologies. In order for these lock-ins to be solved, cities should pay special attention to overcoming the barriers that prevent people from implementing energy efficiency measures in their houses or apartments. Some of these barriers might be difficult to unravel, but sometimes simple measures such as organizing low-threshold energy guidance to house owners might do the trick. However, it is crucial for cities to **identify critical barriers** and focus their efforts on solving them. Without properly addressing these barriers, energy efficiency related efforts might only have short-term effects and the results may remain modest.

"Energy efficiency in the field of housing, industry and public services is most important in my opinion. Here I have to stress that energy efficiency should not be the one and only aim. Good balance with quality of life is absolutely inevitable. For example minimizing the consumption of energy might lead to poor indoor climate. This kind of approach should be avoided."

– *Raimond Tamm, Energy expert, Tartu Science Park, Estonia*

"Communication should be carried out by utilizing building associations and face-to-face communication. Small support instruments could be generated to encourage smart investments. Cities can promote energy and resource wisdom by easing the license process regarding for example solar panels or heat pump installations. Support instruments should be promoted more, and the knowledge and awareness of both residents and property managers should be increased."

– *Raimo Peltovuori, Resident and chairman of a housing company, Jyväskylä, Finland*

Building technologies have a lot to offer in terms of making buildings more energy efficient. Passive houses and near zero energy houses are nowadays more common when building new houses or apartments. Stricter building regulations make them viable alternatives for prospective house builders. However, technologies suitable for new buildings are often not as applicable for the older building stock. This is problematic as one of the key challenges in the EU is to find ways to tackle energy efficiency of older houses and buildings. This is no small matter as approximately 35% of the EU's existing building stock is over 50 years old and most of the buildings are in need of an energy retrofit. Energy renovations are, at their worst, time-consuming, costly and unattractive. Yet there is a pressing urgency to get them done if cities are to meet the emission targets. One way to **make energy renovations into a more tempting alternative** is to use a combination of incentives, encouraging examples and hands-on guidance.

PLEEC CITIES

Tartu (Estonia)

Energy saving made into a competition

We have a winner!

Many Estonians live in energy inefficient, poorly-constructed Soviet era apartment buildings. As a consequence, the average annual heating energy used in the buildings is higher than in other industrial nations with a similar climate. With rising energy costs, household energy consumption is no small matter in a nation where heating is required for a major part of the year. However, there is reluctance to invest in the energy efficiency of older inefficient buildings, and practical information regarding both the risks and benefits is sorely needed to convince owners to take measures.

Tartu City Government decided to address the issue by organizing a competition which searched for realizable and innovative energy efficient building solutions. The competition was targeted to both citizens and companies, but it proved out to be easier to attract companies to take part in it. The contest is nowadays organized annually and many practical energy efficient solutions have been brought into the limelight this way. However, cities contemplating on organizing similar events should remember that a clear promotional strategy is needed to attract participants and to get enough media attention.

Boosting energy efficiency

New technological solutions for buildings

Heating and cooling are the most energy intensive sectors of a building's energy use. As a consequence, the choice of heating system can significantly affect the amount of energy used in a building and thus determine the emissions generated by a building to a great degree. The energy efficiency of a heating system can be considerably increased if for example new renewable energy based heating systems, different kinds of heat pumps, or district heating and cooling systems are adopted. In addition, investing in new insulation, glazing and ventilation technologies will keep the generated heat or cool air inside the house and decrease the amount of excess energy needed for these processes. Glazing can even be used as a way to generate energy (e.g. transparent PV panels), and green roofs and walls can be utilized to absorb excess heat and water. Moreover, microgeneration of electricity with PV panels or small scale wind turbines are also viable options and offer a way for neighbours and neighbourhoods to generate and even sell electricity as a collective effort. All in all, the steep upfront costs of energy renovations can make them somewhat unattractive, but **underlining the benefits of energy renovations in the long run** as well as offering even a small incentive to alleviate the costs can act as an encouragement. Additionally, inspiring true stories, playful neighbourhood competitions and support from city officials may create a communal undertone, which might work wonders and serve as a positive driver for the implementation of energy renovations.

The choice of heating system or adding extra insulation is not the only way technology can be used to lower the energy consumption of buildings. The energy performance of newer buildings is already measured with energy performance certificates and electrical appliances include clear energy labels to guide consumers. In addition, there are almost endless possibilities to utilize **ICT, Big Data and the Internet of Things** to increase the energy smartness of buildings. Energy efficiency can be enhanced with ICT-based solutions (such as smart meters, smart plugs, smart applications and different kinds of sensors), which are getting more and more common in buildings. However, cities face a risk of not having enough energy smart citizens capable of understanding the finer details of new smart technologies. This is why **accessible guidance and education** is needed alongside ICT and new innovations.

"Cities should focus on reducing the energy demand for heating and cooling in our building stock. This will not only create a lot of local jobs, but it will also reduce the energy bills of (vulnerable) people and hence ensure high-quality, affordable housing."

– *Thomas Madreiter, Planning director, Vienna, Austria*

PLEEC CITIES

Santiago de Compostela (Spain)

Teaching an old city new tricks

The challenges of energy efficiency in a historic city

The historic, UNESCO designated city of Santiago de Compostela has several urban and climatic features that can be considered positive for energy efficiency. However, the topic has not been a high priority issue for neither the society nor the municipal authorities, and thus local urban plans do not recognize the matter explicitly. In addition, due to some characteristics such as a mild climate, extensive green areas and a compact urban area, the citizens of Santiago de Compostela generally have poor awareness of energy efficiency and climate change issues. Likewise, the relationship between energy efficiency and the conservation of local heritage is challenging, and all actions targeted towards the historical centre are strictly controlled by different regulations, including a special plan. Creating a link between heritage conservation and energy efficiency is therefore instrumental in gaining momentum for energy efficiency efforts in the city.

The city is currently advocating energy efficiency mainly by setting an example in city owned buildings and by gradually making sustainable adaptations to public services, such as public lightning and waste collection. All in all, the municipal actions for energy efficiency have mainly targeted the decrease of CO_2 emissions through traffic plans, the improvement of energy efficiency of municipal buildings and the management of municipal energy and water services with sustainable ends. Like so many other historical cities, Santiago de Compostela needs to finely balance between history, urban form and future requirements. However, the prospects of becoming an energy efficient city is within reach now that initial steps have already been taken.

Urban planning makes a difference

Land-use and planning as a tool

Urban form has a great impact on the energy consumption of cities. The types of houses we build, their size, their orientation and the configuration of houses together in blocks, the street layout and the presence of open spaces as well as their vegetation all affect the potential energy consumption of the built environment. In European cities, the potential effect planning and urban form have on the energy consumption of the built environment is far from being fully utilized. Even if the interaction between planning, behaviour and technology blurs any estimation of the single impact of one of these activities, we can safely assume that the potential savings of urban planning on a city level are at least **10–15 percent out of the total building energy use, simply by optimizing their urban form.**

Energy efficient cities are **dense and compact.** Compact cities have more tightly spaced urban form and residential buildings, offices and commercial areas are located closer to one another within the city boundaries. Also the type and size of residential buildings located in a city greatly affect the energy use of buildings. For example, detached single-family houses may consume more energy than average multi-family dwellings. This may partly be a result of generally **larger house volumes** and greater amounts of exposed surface area.

In addition to location and type of buildings in a city, compactness also determines building height, street width and the distance between buildings. Unfortunately, in certain climates and at certain latitudes, cities can be too compact and dense. This might, for instance, limit the amount of direct sunlight entering through windows, which may in turn offset the positive impacts of otherwise dense urban form. This is why a **balance between compactness** and for example the basic human need for **green, open space** should not be forgotten. Fortunately, relaxing green areas can be brought into cities in new ways by adding roof gardens, vertical gardens and other green surfaces among inorganic and alienating structures. The greening of surfaces will not only increase the overall **well-being of citizens,** but also helps to solve some of the problems related to, for example, the heat island effect or excess stormwaters.

Cities can influence the energy efficiency related issues also by **considering their layout.** Street and building orientation can substantially lower energy consumption, but local climate and other local needs should dictate the type of solutions a city takes. It is evident that approaches used in a southern European setting may not be directly transferable in the north, but cities can still learn from each other in many ways. For example, **optimizing solar access** with carefully planned building and street layout has positive impacts on the overall energy efficiency of cities. Additionally enhancing passive cooling with the help of for example deciduous trees or the choice of building colour and type of surface materials will decrease the need for energy intensive cooling systems during the warmer months.

littleny / Shutterstock.com

"City planning has advantages: it has the potential to make better cities, to lower energy consumption or to make a green lifestyle the easiest choice."

– *Gertrud Jørgensen, Professor in Urban Planning, University of Copenhagen, Denmark*

EUROPEAN CITY SUCCESS STORIES

Bologna (Italy)

Identifying buildings in need

Master of energy efficient city planning

Bologna woke up to the climate change and ever-growing CO_2 emissions in mid-2000. To tackle this detrimental development, the city of Bologna started developing the new City Energy Programme in 2007. The existing energy-inefficient building mass was identified as one of the biggest source of the emissions and chosen as the focal point of the programme.

The main idea of the programme was the integration of energy efficiency interventions and analysis of energy issues with the city planning process. The collected Energy Atlas helps with the identification of urban areas with the highest energy intensity. It can also help to identify specific buildings needing energy efficiency improvements. When planning new developments, energy issues can now be integrated more effectively.

The structural plan of Bologna utilizes the results of the Programme. Eleven city districts with highest priorities in increasing energy efficiency form areas called Urban Energy Basins. In these Basins, the city applies specific energy policies and the predicted saving for improvements is calculated. The energy standards are calculated to result in a 20% reduction of CO_2 emissions in the housing sector (both new and refurbished buildings) in 15 years.

Bologna is a good example of an integrated approach in city planning that makes plans and their actions more rational and long-lasting.

EUROPEAN CITY SUCCESS STORIES

Münster (Germany)

Enabling the transformation

The municipality as an effective market driver

In 1997, the City of Münster embarked upon a market transformation by mandating low-energy building standards in sales contracts of city-owned land. The effect of the action was huge. Until 2010, 80% of all new buildings constructed followed the city's energy efficiency requirements which are significantly stricter than existing German federal building regulations. What is even more impressive is that this number includes also new buildings on non-city owned land.

The conditions in Münster supported the success of the scheme. The municipality owns about half of undeveloped land and city residents were receptive to the change. Also, the financial situation of the homeowners was suitable for investments. The scheme was cheap for the municipality as the cost of the whole scheme was only about half a million euros, which is low in comparison to the achieved savings.

The results are impressive. The implementation of this market driver resulted in energy savings of 13 million kWh per year in the city. The programme shows that when city officials dare to think innovatively and out of the box, without fearing failure, the achieved results can also be more significant and longer lasting.

The way forward

Make it visible – Use city owned buildings as examples and make their energy use public.

Make use of available space – Use the cityscape and open surfaces innovatively with for example green roofs, solar panels, vertical gardens and innovative glazing.

Optimize urban form – Urban form can support energy efficiency. However, remember the balance between compactness and the need for open space and green areas.

Make it fun – Create a positive undertone and make your efforts fun and creative.

Make it worthwhile – Underline the benefits of energy efficiency in the long run and remember that even a small incentive can act as an encouragement.

Use stick and carrot – A carefully balanced combination of both stick and carrot is needed to engage and encourage people.

Make it simple – Do not forget the end-user when you design energy smart solutions for your city.

Make it into a brand – Branding the energy smartness of your city can help to boost the economy.

For more information

- PLEEC report Energy Efficiency Indicators
- PLEEC report 3.1. Technical state-of-the-art innovative solutions
- PLEEC report 4.3. Thematic report on urban energy planning: Buildings, industry, transport and energy generation
- PLEEC report 5.1. Case study reports on energy efficiency and behaviour
- PLEEC report 5.5. Planning behaviour-driven energy efficiency interventions in a city context

The PLEEC documents are available at: www.pleecproject.eu

Smart mobility planning

Cycling

Car free zones

Low carbon

BEVs

Sharing economy

Electric bike

Charging stations

Public transport

Cargo bike

Walking

Reduced parking

Electric scooter

Electric vehicles

Co-ownership

Renewable fuels

Connectivity

Solar powered charging lanes

Collective transport

Moving the masses – urban transport in transition

Changing the way we move

Mobility and transport

The EU has set ambitious targets to reduce overall CO_2 emissions by 2050. Transport emissions should be cut by at least 60% by 2050 in relation to the 1990 levels. Reduction potential is recognized especially in urban areas where mixed strategies supporting both smart solutions and sustainable modes of transport (such as walking, cycling, collective and public transport) should be emphasized. Efforts should especially focus on optimizing transport infrastructure and the urban form to support the transition towards sustainable mobility.

Many things can be achieved by technological and structural changes and by changing the way urban areas are planned. However, to achieve lasting results **cities also need to find ways to encourage people to change their emission intensive travelling habits.** This is no easy task, but one essentially achievable through coordinated efforts, urban planning, government support and by creating a positive momentum for change. This change might simply start by reclaiming city streets and treating them as collective arenas supporting multiple uses and not only as gateways or as potential parking spaces for private cars.

"Smart cities have smart urban planning in their core. In a smart, urban environment public transportation, services, green areas and pedestrian ways form a network that enable fluid movement of people and increase the welfare of citizens."

– Sirpa Pietikäinen, Member of the European Parliament, Finland

"It's important to both increase the modal share of cycling, walking and public transport and to increase the amount of "green cars" – for example cars using biogas or electric cars."

– *Kati Kankainen, Coordinator, Association for sustainable development in Jyväskylä, Finland*

"Transport could be a tough challenge, but actually we know how we should build a transport effective city. If we stick to that, transport shouldn't be a problem."

– *Mats Hällnäs, head of Eskilstuna Planning Department, Sweden*

New technical solutions for travel

A city without oil

Technology has a lot to offer in lowering the emissions generated by motorized transport. Various alternative renewable fuels (biofuels, CNG, LNG), multiple fuel sources (hybrids, flexible fuels) and electric vehicles are already becoming popular and more available among early adopters and progressive cities. However, an even wider level of deployment and new approaches are needed if cities are to transform their motorized transport systems into ones that are **less energy intensive and eventually carbon neutral.** Battery electric vehicles (BEVs), in particular, will require **new infrastructure investments** as an extensive network of charging stations is required for the recharging of these vehicles. In addition, **economic incentives** decreasing the higher than average investment costs will send a positive signal to those contemplating on whether or not to buy an alternative fuel powered car. More often than not, people simply lack the financial resources to invest into new technologies and go for an older model, even if they would prefer not to.

Fortunately, sustainable transport does not need to be based only on a high percentage of relatively expensive low emission private vehicles. Cities can achieve an energy efficient transport system through **optimized urban form** and **enhanced public transport.** Therefore, cities striving to become energy smart should develop their existing public transport systems by carefully examining **new technological solutions** already available (such as renewable fuels, hybrid systems and electric motors) and choosing the ones which best serve local needs. This will transform public transport into a system which is not only sustainable and energy efficient but also optimized to meet local requirements. In order to succeed in this, cities need to adopt an **integrated approach** combining low emission technologies, careful urban planning and a great deal of sensitivity to the different aspects influencing people's travel behaviour. After all, buses, trams or local trains are energy efficient, sustainable and cost-effective only to the degree they are in active use and utilized for daily travels.

Cities should also serve the growing number of those people who prefer to **walk or cycle** in the city. Electric bikes, cargo bikes, electric scooters and other small scale vehicles are already common sights in the urban landscape. Although increasing the uptake of these types of vehicles is more a question of urban planning and behaviour, there are also technological aspects to be considered with respect to the phenomenon. Among other things, charging stations (e.g. solar powered charging lanes), smart solutions for bicycle sheltering and new technical infrastructure for bicycle lanes are needed to support and encourage people to hop on the saddle.

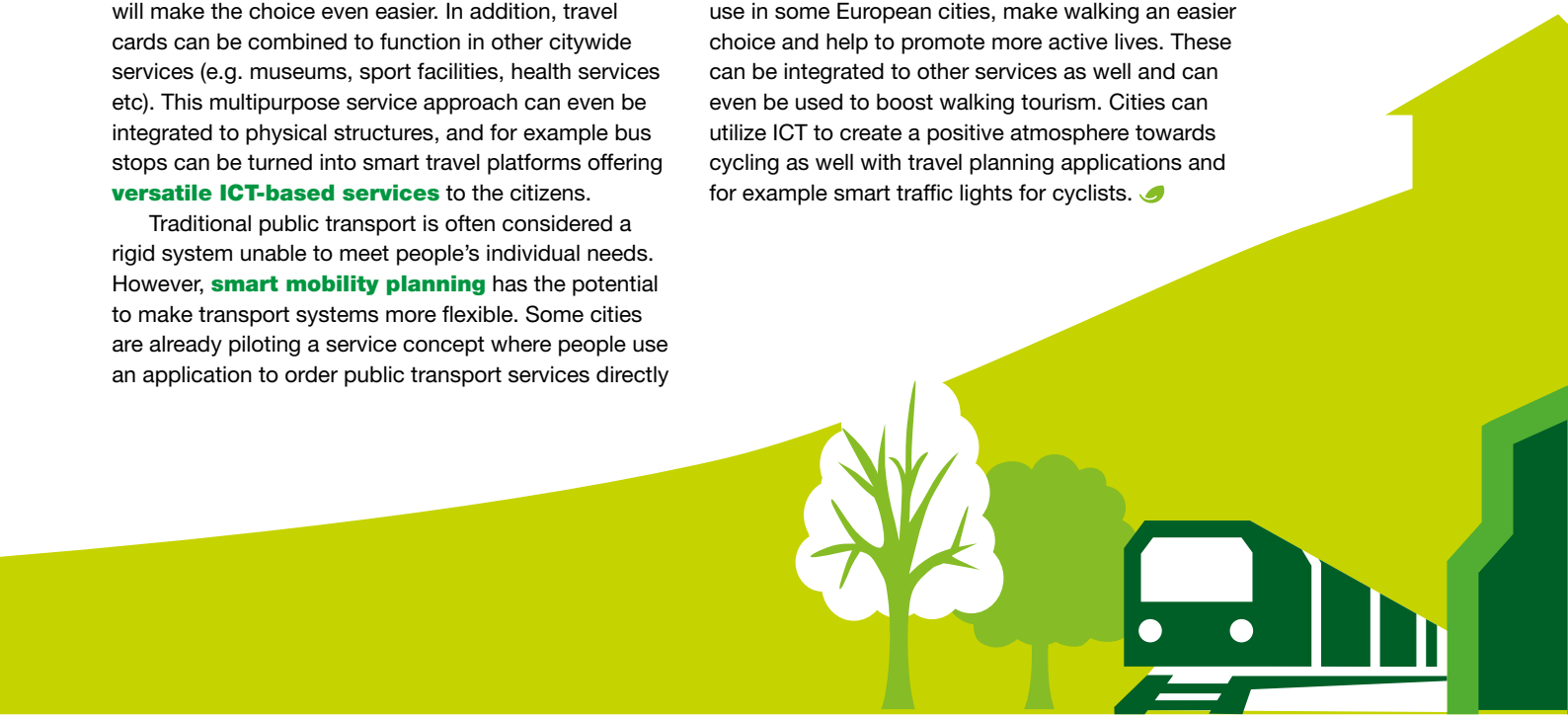
Making use of smart solutions

Smart mobility planning

ICT offers almost endless possibilities to cities looking for ways to make their transport systems better meet the needs of their citizens. Cities can encourage a sharing economy by creating online platforms for car and bicycle sharing. In addition, providing people with support and real time travel information with various travel planning applications will most likely lower the threshold to change one's travel habits. Making sustainable modes of transport more accessible to as many as possible is essential. Integrated applications with both travel planning options and mobile ticketing systems will make the choice even easier. In addition, travel cards can be combined to function in other citywide services (e.g. museums, sport facilities, health services etc). This multipurpose service approach can even be integrated to physical structures, and for example bus stops can be turned into smart travel platforms offering **versatile ICT-based services** to the citizens.

Traditional public transport is often considered a rigid system unable to meet people's individual needs. However, **smart mobility planning** has the potential to make transport systems more flexible. Some cities are already piloting a service concept where people use an application to order public transport services directly to their doorstep. This type of activity might seem a rather expensive investment for cities, but can in fact save money indirectly by supporting the independent and active lives of the elderly or other target groups. As European citizens are inevitably aging fast, these types of services targeting the elderly can considerably increase the overall quality of life of the citizens, at the same time saving money in the long run by keeping the elderly active as they age.

ICT solutions can also be used as a way to encourage walking and cycling. Pedestrian wayfinding systems and mobile walking applications, already in use in some European cities, make walking an easier choice and help to promote more active lives. These can be integrated to other services as well and can even be used to boost walking tourism. Cities can utilize ICT to create a positive atmosphere towards cycling as well with travel planning applications and for example smart traffic lights for cyclists.



PLEEC CITIES

Stoke-on-Trent (the UK)

Transforming a city with a cycling strategy

Giving cycling a go

In the 1990s, the cycling levels in Stoke-on-Trent were similar to the national average with cycling accounting for less than 2% of all trips. However, public interest and the fact that more cycles than cars were sold each year showed that there was undoubtedly enormous potential to increase the number of trips made by bicycle across the city. The Stoke-on-Trent city government decided to seize this opportunity and began a long-term strategy work in 1996. The aim was to promote cycling together with a wide range of interested organizations, groups and individuals. The strategy was targeted at all citizens of the city and consisted of various measures including promotional work, infrastructure improvements and the development of the close to non-existent cycling network of the city.

Turning a low-cycling city area into one that supports cycling takes a lot of time and effort. After more than a decade of hard work, Stoke-on-Trent is finally on its way to transforming from a no-cycling city into a pro-cycling city. Any city pondering on whether or not to carry out this kind of strategy work should be prepared for a long-term commitment, as the transformation does not happen overnight. In addition, it is vital to make sure all levels of the city organization support the undertaking. Moreover, determination, strong funding expertise and cross-sectional co-operation are instrumental to keep the work on the right track.

Incentives supporting sustainable transport

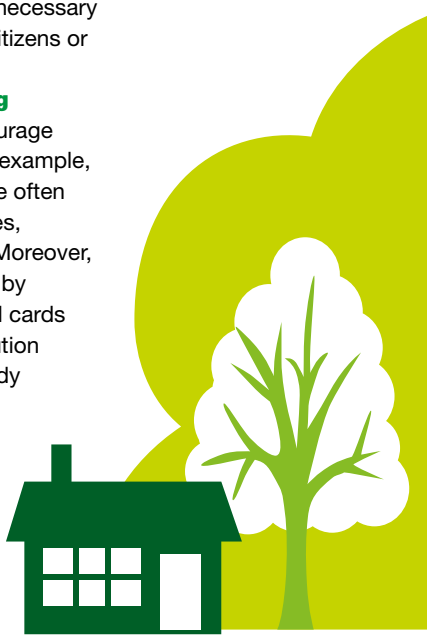
Making smart moves more attractive

> "Investing in bike paths may be seen as a luxury that a city cannot afford, while a new motorway makes terribly good sense to everybody, although the price is very much higher."
>
> *– Gertrud Jørgensen, Professor in Urban Planning, University of Copenhagen*

Turning a traditional transport system into a smart and sustainable one does not happen without support. In addition to having the will to change, **cities need a clear strategy which drives the transport systems towards transformation.** Citywide transport strategies should be based on an integrated approach which takes into consideration the best available technological solutions supporting local transport needs, urban form encouraging sustainable transport and the behavioural aspects affecting people's transport choices. The progression towards a sustainable, smart transport system is easier to achieve, **if the enormity of the challenge is scaled down with successive steps and in accordance with local needs.**

However, cities need more than just a strategy to achieve their goals. **A fair combination of carrot and stick** will give leverage to the cities and turn strategies into concrete actions. These tools can take the form of different kinds of financial incentives such as tax reliefs for renewable fuels, low carbon vehicle investments, public transport or car-sharing. On the other hand increased taxation for fossil-based fuels, high emission private vehicles or other big polluters will encourage the shift towards low or zero emission transport. In addition, it is increasingly common that older trucks and diesel cars are not allowed to enter dense urban areas such as city centres. Nevertheless, all **fiscal incentives need to be finely balanced** and contemplated in order not to invoke unnecessary **rebound effects** or rejection among the citizens or companies.

Additionally, different kinds of **financing instruments** can be implemented to encourage the shift towards sustainable transport. For example, inexpensive loans may be used to curtail the often steep purchase prices of low carbon vehicles, co-owned cars or cargo bikes, if available. Moreover, the use of public transport may be boosted by offering city employees or workplaces travel cards at lower cost. Cities can also follow the solution some European forerunner cities have already taken of lowering public transport fares or, even more radically, by making public transport fare-free.



EUROPEAN CITY SUCCESS STORIES

Burgos (Spain)

Going bio

The use of biofuels in public transport

Burgos sits logistically in a favourable position between Spain, France and Portugal, making it a perfect place for industrial development. Transport and mobility have also been in the centre of the city's actions to be more sustainable. These actions have made it the forerunner in Spain in terms of sustainable mobility and transport.

The city has implemented a brave and awarded strategy to make public transportation more sustainable by using only 100% biofuels in buses and emergency vehicles. Information campaigns were organized to encourage citizens to recycle used oil and to promote public transport for different user groups. As a result, now almost all the city buses are using biodiesel and the use of public transport has risen.

One part of the strategy was also the development of the city centre to become car-free and the development of a free bicycle loan system. 75% of the streets in the historical city centre have been converted to pedestrian traffic only and heavy traffic has been eliminated. The bike loan system has also been a great success: cycling has increased significantly and Burgos has now one of the largest networks of bicycle lanes in Spain.

Matyas Rehak / Shutterstock.com

Reducing the need to travel

The importance of urban planning for sustainable transport

Urban form and transport energy consumption are inseparably linked. Cities can encourage **compact development** which reduces travel distances and the need for travel especially by motorized vehicles. Shorter travel distances can make walking and cycling more attractive alternatives to cars and help cities decrease transport energy consumption. Higher densities also help to increase the viability of public transport. In addition, cities can enhance the impacts of compact development by mixing land uses to bring housing closer to jobs and services. Local services, housing and work opportunities can encourage a more locally-based and active lifestyle where bicycles, walking and other non-motorized travel choices are used more often and the energy needed for transport is considerably decreased.

Urban planning and land-use development are connected to sustainable transport also through streets. Cities can increase the energy efficiency of transport by **designing street networks that provide good connectivity** between destinations. In addition, energy consumption may be decreased by **street design and layout,** and by providing extensive **bicycle lane networks** and wide enough pavements. Furthermore, safe and attractive cycling and walking routes can help cut down journey distances, promote healthy lifestyles and reduce the demand for private vehicles.

Cities can also affect travelling modes by **demand management measures,** such as reducing the supply and increasing the cost of parking. For example, giving priority to bicycle parking spaces and ensuring the sufficiency of safe bicycle parking infrastructure in close proximity to residential areas and other key locations (e.g. transit hubs, city centres, workplaces) may increase the appeal of cycling and other lighter travel modes. On the other hand, creating multipurpose parking spaces with electric charging opportunities and parking spaces for bicycles, cargo bikes and other lighter travel modes is also a good option. Cities can even deny access to cars by creating car free super-blocks or carbon neutral city centres.

EUROPEAN CITY SUCCESS STORIES

Freiburg (Germany)

Involvement creates movement

City of green transport

"My vision of an energy smart city would include large city centres without car traffic. In this city, one would be able to walk and bike wherever one wants. And for those people preferring public transport, it would be largely available for all transportation needs."

– *Sirpa Pietikäinen, Member of the European Parliament*

Freiburg has branded itself the Green City. The city has focused on sustainable development for decades and one of the key measures in the greening process is its transport policy. Freiburg promotes especially environmentally-friendly ways of traveling in the city area like walking, cycling and public transport.

The main idea of Freiburg's transport policy is to form a compact city where people can travel effortlessly and quickly between different city districts. The city's transport system plans support strong district centres, new developments along the main transport routes and prioritizing inner-city development over suburban sprawl. New development areas where the innovative transport policy is visible are for example the Vauban and Riesefeld districts. Both have good public transport connections and streets with limited car use and low speed limits and, most importantly, a community that supports these environmentally-friendly ways of travelling. Involving people and taking social aspects into account in planning city transport have been the key to success in Freiburg.

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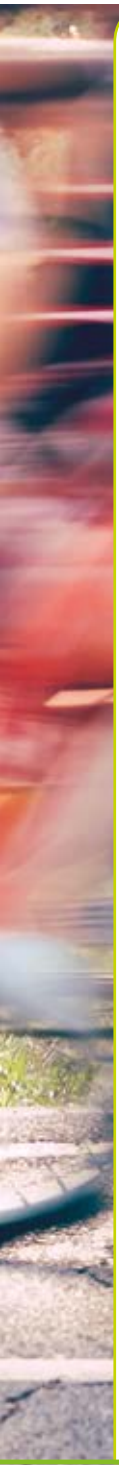

The way forward

Make it normal – Show example and invest in sustainable transport modes throughout your city activities and functions.

Make it smooth – Ensure good connectivity both locally and regionally.

Make it worthwhile – Encourage sustainable modes of transport with incentives and smart solutions.

Optimize urban form – Strive for an urban form which supports sustainable transport and reduces the need for travel.

Use a stepwise approach – Make the transformation of your traffic system more manageable by breaking it into smaller steps.

Make it positive – Use encouraging examples and collective efforts.

For more information:

- PLEEC report Energy Efficiency Indicators
- PLEEC report 3.1. Technical state-of-the-art innovative solutions
- PLEEC report 4.3. Thematic report on urban energy planning: Buildings, industry, transport and energy generation
- PLEEC report 5.1. Case study reports on Energy efficiency and behaviour
- PLEEC report 5.5. Planning behaviour-driven energy efficiency interventions in a city context

The PLEEC documents are available at: www.pleecproject.eu

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Technological innovations
Sewage and water distribution networks
Smart grids
Digital revolution
Big Data
Waste
Heating and cooling grids
Public lighting
Internet-of-Things (IoT)
Smart meters
Living laboratories
Information and communications technologies (ICT)

Technical infrastructure of tomorrow

Getting smart

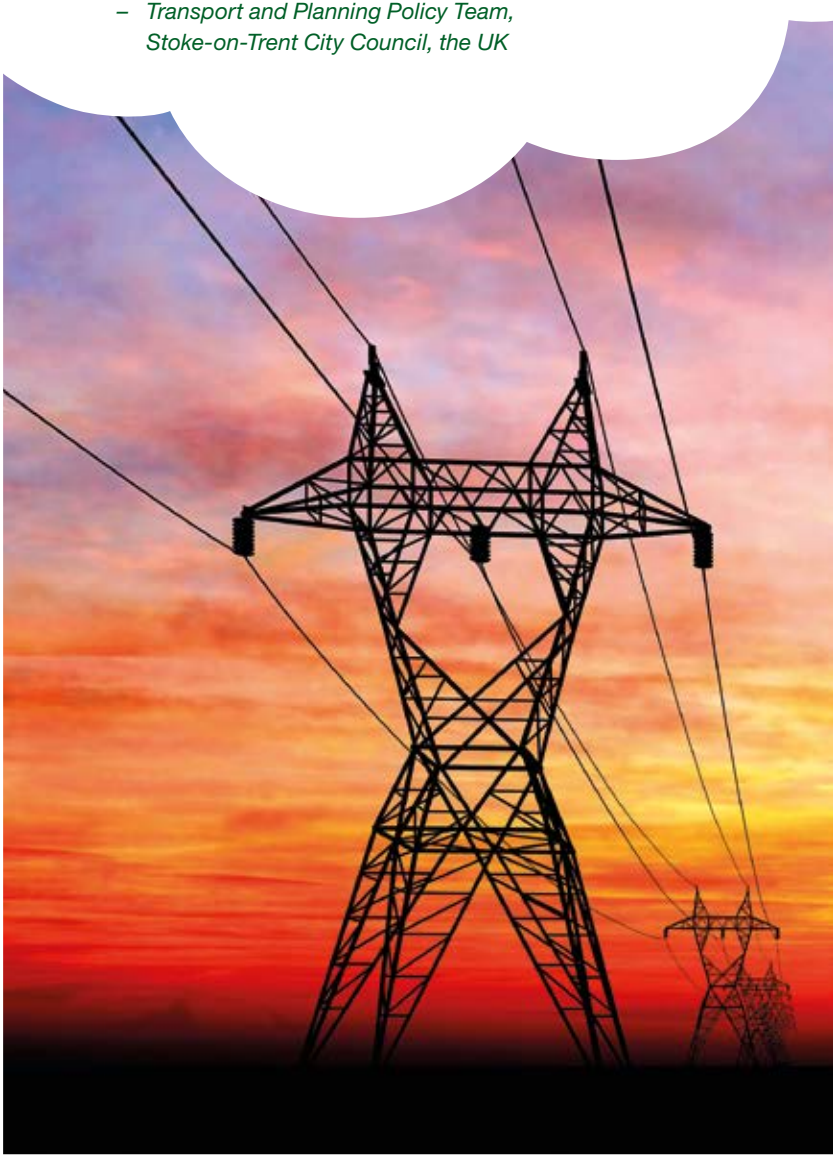
Technical infrastructure

The world is becoming more and more technologically advanced. The digital revolution of the last decade has resulted in the fact that soon one might not find structures or applications without computer and information technology. When we are speaking of technology in the context of energy efficiency, the term **"smart"** comes up frequently. A smart city can be defined in numerous ways, but it is universally agreed that it is strongly linked to technical infrastructure and innovations, in particular information and communications technologies (ICT). Choosing the suitable technological developments for a city are important regarding both the short-term energy performance as well as the long-term sustainability of the city.

Cities are living laboratories for energy efficiency technologies as they are in constant change and new innovations can be implemented to the existing infrastructure via city planning processes. The technical infrastructure of a city consists of electric power grids, heating and cooling grids, waste, sewage and water distribution networks and public lighting. Technological innovations that reduce energy demand or help to change consumer behaviour can be implemented upon the city's technical infrastructure. Both technical and technological interventions play an important role in making energy saving measures possible.

"An energy smart city would be a city able to produce or obtain all its energy requirements (heat, power, transport) locally by means of decentralized energy and energy recovery systems, from low carbon sources as much as feasible, and managing and controlling the distribution and use of such energy using a smart grid to ensure the highest energy efficiency, smooth demand over time, and lower energy losses."

– *Transport and Planning Policy Team, Stoke-on-Trent City Council, the UK*



"Nowadays many things, like the quality of air as well as the volume of traffic and consumption of energy, are already being monitored and measured. By using that information we are able to make cities more effective."

– *Meri Lumela, II Vice Chair of the City Board, Jyväskylä, Finland*

ICT and Smart grids

Energy efficiency from information

The modern technical infrastructure makes energy transfer and the use of natural resources more efficient. The energy transfer infrastructure is becoming more dynamic with **smart grids,** energy networks that automatically monitor energy flows and adjust to changes in the energy supply and demand both on macro and micro level. Smart grids will have a significant role in integrating renewable energy to the energy supply network. Especially in weather-dependent wind and solar energy production grid operators will benefit from smart grids and the better possibilities to plan ahead and combine weather information with energy demand. Smart grids also give the consumers who produce their own energy a chance to respond to prices and sell the excess to the grid. This is both a chance and a challenge for city officials: **how to make sure that city development plans support smart grids and decentralized energy production?**

Technical advances like smart grids and smart meters help make energy saving easy for consumers as they can provide real-time, automatic information on energy consumption. Smart meters allow consumers to adapt their energy usage to different energy prices throughout the day, saving money on their energy costs by consuming more energy during lower price periods. The EU has goals to replace 80% of electricity meters with smart meters by 2020. The transition to smart metering and smart grids alone can reduce annual household energy consumption in the range of 10%.

Technological interventions alone have rather low impact without any accompanying plan to promote behavioural change. It is good to remember that **the success of the introduction of new technologies largely depends on the acceptance and perceptions of the people using them.**

Interconnected networks of technical infrastructure

Different public and privately owned physical spaces in cities are getting more connected by wireless and mobile networks. Buildings, for instance, are becoming huge computers full of appliances that monitor, model and manage the energy flows like heating, cooling and electricity. Pavements and streets can be installed with sensors that react to changes in temperature and activate the heating. Public lighting can be optimized by the time of day. Monitoring is getting easy from anywhere you are via personal computers or smart devices. These networks are part of the so-called **Internet-of-Things (IoT),** a network of interlinked physical objects, sensors and applications. It enables applications to connect with each other and exchange data.

Sensor networks in cities gather enormous quantities of information **(so-called Big Data)** from interconnected smart objects and grids. Real-time analysis and response to this information and modelling of behaviour patterns become possible with high capacity processing and computing power. The possibilities to use this information in promoting resource efficiency (for instance in decreasing water consumption, enhancing industrial processes or reducing waste) are endless. Connected energy efficiency technologies do not only affect the consumption of energy resources but also increase **resource efficiency** in general.

"Rules and regulations of industrial production and products may be one of the most effective ways of ensuring technical changes: building standards, standards for car emissions, street lights etc."

– *Gertrud Jørgensen, Professor in Urban Planning, University of Copenhagen, Denmark*

"It is difficult to predict the advances in technology destined to reach the energy efficiency goals, but I consider that the increment of renewable energy should play a relevant role. Besides, some initiatives carried out with children nowadays aim to educate them in these issues in order to reach new generations more committed to energy efficiency."

– *Esteban Vieites, Researcher, University of Santiago de Compostela, Spain*

EUROPEAN CITY SUCCESS STORIES

Zwolle and Breda (Netherlands)

Smart grids
Smarter people

Two Dutch cities, Zwolle and Breda, have been in the cutting edge of smart grid development. About 300 households in the Zwolle district Muziekwijk and the Breda districts Meulenspie and Easystreet have been equipped with smart grid equipment and solar panels to produce their own energy. Smart meters, energy computers, smart washing machines and dryers use Internet-of-Things (IoT) to communicate with each other.

These smart appliances are directed at the home-owners. They help homeowners to make calculated decisions on how to adjust their energy consumption with real use and also with the renewable energy supply. These pilot districts give valuable information about the sustainable energy systems and how to design, maintain and manage smart grids in a consumer-friendly manner.


REMOTE HOME CONTROL
ONLINE HOME AUTOMATION
CLIMATE
LIGHTING
SECURITY
ENTERTAINMENT
22°C
ECO MODE
NORMAL

New business opportunities from energy efficiency technology

Energy efficiency is becoming a big business for the ICT industry. We live in an increasingly digital world where products and services are more and more online. **Web-based products** have user-friendly interfaces, which are based on complex systems of networks and technical infrastructure and give the customer more freedom to control his or her own behaviour and consumption. Enterprises can gain huge savings by using these services and their use can also boost greener corporate images.

There are still many obstacles preventing renewable technical infrastructure becoming more mainstream in the built city environment. Market and social barriers, lack of interest in energy issues as well as regulatory barriers like restrictive procurement rules still prevent larger-scale business opportunities coming true in many places. Lack of information and competences about technical renewable energy infrastructure among city officials and citizens can sometimes be seen as inadequate city support.

The initial investments as well the risks on returns are still high. When aspiring towards the ultimate goal of becoming a sustainable, energy smart city, every city should acknowledge these barriers and try to overcome them with the energy efficiency industry and citizens. Cities and municipalities are themselves significant customers to the ICT and energy industry. They can act as positive market drivers and excellent examples to the citizens and enterprises.

"I think that technological solutions go hand-in-hand with people's behaviour. We have wonderful technologies available on the market, but the efficient usage of those technologies depends a lot on people's behaviour."

– *Raimond Tamm, Energy expert, Tartu Science Park, Estonia*

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PLEEC CITIES

Eskilstuna (Sweden)

Colour-coded waste bags storm the city

Optical sorting of household waste

Cities can make use of existing infrastructure to boost their energy efficiency. As a result of careful planning, the Swedish city of Eskilstuna became the first city to colour sort six different fractions of household waste in 2010. Optical sorting was seen as a cheap and flexible system and existing garbage trucks could be used to collect the waste from households. The overall goal was to increase the efficiency of sorting and to better utilize waste also in the waste processing unit.

How does it work then? It is pretty simple, really. Food, packaging and newspapers are sorted from other waste and placed in coloured plastic bags, which are then thrown into regular trash. The waste is collected by Eskilstuna Energy and Environment and optically sorted by a machine at the local recycling centre. Food waste is turned into biogas, packaging becomes new packaging and the remaining fragments are incinerated for energy. Households get new waste bags simply by informing the postman.

The ratio between burnable waste and food waste has clearly become better after the colour-coding started, which makes this an encouraging example to other cities looking for new ways to cope with waste management issues.

The way forward

Involve people. Work together towards a common goal with a group that shares your interests (communities, NGOs, neighbourhoods and workplaces).

Be smart. The municipality can set a positive example and act as a market driver by investing on transition to smart technical infrastructure.

Visualise the energy. Collect and visualize energy data for everyone to see and to learn about city's and their own energy use.

Be brave but consistent. Dont't be afraid of taking bold steps in introducing new technical innovations but plan them carefully.

For more information

- PLEEC report 3.1. Technical state-of-the-art innovative solutions
- PLEEC report 3.2. Improving Energy Efficiency Through Technology – Case Studies
- PLEEC report 4.3. Thematic report on urban energy planning: Buildings, industry, transport and energy generation
- PLEEC report 5.1. Case study reports on Energy efficiency and behaviour
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Resource efficiency

Circular economy

Services

Goods

Industries

Behaviour

Long-term gains

Energy saving

Feedback

Context

Motivation

Awareness

Rebound effect

Governance

Target groups

Costs and benefits

Wise choices

Values

Using less, producing more efficiently

Stop, in the name of energy!

Production and consumption

A major part of energy in industrial societies is consumed by residential and commercial buildings, industry and transportation. The production and consumption of goods and services encompass a vast part of all activities in any given society – and therefore also release a large share of global carbon dioxide emissions.

The way cities source, process and use resources has a huge impact their economic development and the quality of life of citizens. Cities are thereby faced with the dilemma of how to make infrastructural choices and adopt technologies that will help them promote **energy saving behaviours of citizens.** And vice versa – cities need to adopt such governance models that will lead to wise choices in infrastructure planning and technological procurements on the city level. The choices made today have far reaching implications on the level of energy efficiency that can be achieved in each city in the future.

Industrial energy efficiency policies serve both environmental and economic objectives – reducing greenhouse gas emissions, improving energy security and lowering the costs of industrial production. A diversity of planning and policy measures can be adopted on national, regional or urban levels to promote a **Circular Economy** – a system of production and consumption that creates as little economic and natural material loss as possible. In a circular economy, the majority of the products and the resources used in production processes are reused or recycled. Cities drive economic growth, and in order to make this growth sustainable, economic, administrative and fiscal instruments to promote circular economy need to be applied.

"Cities can have a significant impact on people's energy efficiency behaviour and consumption habits. When it comes to choices in what we eat, cities can exert their influence too. Agriculture with its heavy methane emissions is one of the major contributors to global warming. Cities need to promote awareness and raise critical discussion on food choices and choose to focus on serving more environmentally friendly food at city workplaces. Cities should also support innovations to promote the substitution of meat-based products. When the masses start changing their habits, industries will follow suit."

– *Juha Kääriä, Head of Education and Research, Turku University of Applied Sciences, Finland*

"It is important to not only focus on the cars, buildings and energy use. We also need to focus on people's lifestyle and behaviour. What people eat, how they travel, what they buy and how they live their lives. This is not the easiest part for a city, but still, it is essential to reach the goals."

– *Erica Eneqvist, Project Manager, Technical Research Institute of Sweden, Sweden*

Oh, behave!

Promoting the behavioural change of consumers

The behaviour of individual citizens plays a huge role in promoting energy efficient practices on a city level. For the most part, energy use is invisible to the everyman and rarely consciously contemplated. While energy efficiency is considered a logical approach by professionals working within the field of energy consumption, **the benefits of energy efficiency may be obscure and difficult to grasp from the perspective of the end user.** As consumers, citizens have the possibility – and responsibility – to cut back on emissions via the consumption choices they make.

It has been acknowledged that technical improvements carried out in isolation tend to have a lower impact on saving energy as do ones combined with measures intended to encourage behaviour change. **Changing consumer behaviour in the context of energy efficiency is a complex equation of many different things** – first and foremost the knowledge, awareness, norms, values and motivation of the target group. The consumer, naturally, is not a homogenous subject but encompasses all city dwellers of different cultural backgrounds and socio-economic levels. When planning city policies that target the energy efficiency behaviour of consumers, the measures should therefore always be carefully chosen in order to address the specific characteristics of the targeted consumer group.

In the face of ever-tightening budgetary restrictions, the potential **economic benefits of behavioural change** should not be overlooked either. In most cities, energy efficiency programmes with a strong behavioural aspect have most likely been implemented. It has been found, however, that within these projects, efforts and programmes there is a serious lack of assessment tools and genuine understanding of intervention effectiveness in terms of costs and benefits. Thereby the success of these interventions varies greatly. In order to gain the biggest possible benefits also in relation to funds and resources invested, **cost-benefit relations should always be included in planning the measures.**

"I think the main challenge we face is to be able to change the behaviour of citizens to be more responsible in energy consumption. This applies to virtually all areas: lighting, waste management, transportation, heating, etc. All this bearing in mind that new generations will surely be much more educated and socially aware of the challenges of sustainability."

– *Fernando Suárez, Chief of Innovation, Santiago de Compostela Town Hall, Spain*

"A combination of all three aspects – people's behaviour, technological solutions and city planning – are important in achieving an energy smart city. Although the technological solutions are important, at the end it is the people who handle the systems or devices, so when benchmarking with these three possibilities the people's behaviour bears major weight."

– *Esteban Vieites, Researcher, University of Santiago de Compostela, Spain*

Many political, economic and informational instruments may be applied with the aim of obtaining the desired behavioural changes. **Economic measures,** such as taxes, fees and subsidies as well as legal regulations are commonly used and often effective methods to induce these required behaviour changes. For many reasons, however, such structural measures are met by public or political resistance, which may severely hamper the implementation of these measures.

The use of **soft measures,** such as information provision and organization of choice settings, so-called nudges, is thereby common amongst the heavier and often politically more challenging regulations.

Human behaviour tends to conform to distinct patterns and is guided by general principles. However, unfortunately, when it comes to human behaviour, there are no one-size-fits-all, infallible solutions for solving these issues. Behaviour is complex in any case, and especially in relation to energy efficiency, where so many different actors and interests abound. An energy smart city needs to take certain things into account when trying to influence the citizens' energy use habits:

- People tend to **discount future energy savings and instead focus on short term gains.** Combined with the aversion to engage in seemingly arduous installing of energy efficiency measures, people's willingness to take action may be hindered. The appeal of longer term improvements to properties can be increased by including an upfront incentive as part of the installation of the energy efficiency measure.
- **Feedback** is an integral element of effective learning, raising energy awareness and changing consumer's attitudes to energy consumption. With no appropriate frame of reference, the consumer has no means of determining whether their use of energy is excessive or not. In order to make a conscious effort to reduce one's energy consumption, the energy end user needs to receive timely and accurate information on how much energy is consumed by different functions.
- **The rebound effect** is one of the main risks when initiating/realizing energy efficiency investments. Sometimes money saved in one energy efficiency measure may lead to increased energy use elsewhere. Therefore possible rebound effects should always be carefully considered when planning to implement energy efficiency investments.

"When it comes to energy consumption, smart cities facilitate environmentally friendly choices of the citizens for example by tendering energy efficient renovations and solar panel acquisitions for households intending to reduce their energy bill and carbon footprint. In public buildings, the cities should look into installing green roofs and walls to increase the CO_2 absorption from the city air. On a larger scale, greener options should be chosen through using firmer sustainability criteria in public procurement. Smart city of the future is creating plenty of public spaces that increase the sense of community – something that our societies today are very much lacking."

– *Sirpa Pietikäinen, Member of the European Parliament*

Circular economy

The oblivion of "take, make and dispose"

How can cities create prosperity and well-being while still preserving the resources and environment? It is perhaps about time for cities to re-evaluate how they operate in a world of a growing population, amongst the imperative of continuous economic growth. Being able to **restore and regenerate natural capita**l is the key to transitioning to a new economic model and becoming less dependent on cheap materials and energy. As cities stand at the end of an era of cheap materials and energy, using less is no longer enough. Cities can achieve a competitive advantage with the wise use of resources.

Sustainable urban development of today cannot be thought of without the concept of circular economy. In the European Union alone, three billion tonnes of waste is thrown away each year, with only a small fraction recycled or reused. In a world of an ever-growing population, resource depletion and climate change, **circular economy** provides the logical solution. In a circular economy, the linear economy evolves into a circular one where instead of producing, using and throwing out the product it is converted into raw materials, which are then used to create a new one. To allow for this process, products should be designed so that the materials used are separable and recyclable.

Circular economy by definition entails a variety of opportunities for profitability. However, development is sometimes hindered by non-financial barriers, such as unintended consequences of regulations or social factors. Waste regulations may hinder reuse of materials, or lack of experience of companies leave opportunities undetected. City policymakers play an important role in facilitating the transition into a circular model by addressing these market and regulatory failures, creating conditions that enable circular economy initiatives to flourish.

Residues as raw material

Industrial symbiosis as a driver of green growth

In order to thrive amidst changing economic models in the face of environmental challenges as well as demand side requirements, companies need to reinvent themselves. Co-operation between companies of various different sectors is essential. **Industrial symbiosis** is one possible approach to adopting circular economy principles and green growth.

Industrial symbioses are industrial ecosystems where one company's residual becomes another's raw material. These symbioses involve interconnections between traditionally separate industries to create mutual benefits in the form of physical exchange of materials, energy water or other by-products. At its best, **real competitive advantage is achieved along with improved environmental and economic performance.** For cities, industrial symbioses can provide a valuable tool for improving their environmental sustainability and managing their energy and waste flows.

"In terms of energy smartness, the energy produced and consumed in the city is produced sustainably, without emissions. The principles of circular economy are used in energy production (for example by making biogas from biowaste) and consumption, and also the traffic is free of emissions."

– *Kati Kankainen, Coordinator, Association for sustainable development in Jyväskylä, Finland*

PLEEC CITIES

Jyväskylä (Finland)

Resource wisdom roadmap 2050

Well-being and resource wisdom

Societies are facing a drastic decline in natural resources, growing population and climate change, which is forcing them towards a wiser use of resources. As a consequence, recycling-based economies, energy efficiency and cooperation between companies to save materials are becoming more common also in European cities. Furthermore, wiser use of natural resources is becoming an increasingly important asset in international competition.

Popova Valeriya / Shutterstock.com

In 2013, Jyväskylä and the Finnish Innovation Fund Sitra decided to tackle this challenge by launching a joint project “Towards Resource Wisdom”. The purpose of this project was to create duplicable models for an ecologically resource-wise lifestyle in urban environments in cooperation with local residents, companies and organisations. In practice, the aim is encourage citizens to adopt an ecologically sustainable lifestyle and enable them to develop resource-wise ways for their everyday lives.

As a part of the project, Jyväskylä has made a resource wisdom road map towards 2050. The bar is set high: transport and energy production will be carbon-neutral by 2050 the latest, no waste will be taken to landfills for disposal and residents adjust their lifestyles to fit the One Planet Living approach. The road map is divided into six paths: energy, transport, future water management scenarios, food production and consumption, waste and materials management, and envisaging resource efficient daily lives in the future. A holistic take on resource wisdom is a good alternative for other European cities as well to boost their economies, cut emissions and to increase the general well-being of their citizens.

EUROPEAN CITY SUCCESS STORIES

Malmö (Sweden)

Making waste redundant

Some seriously smart waste business

In Malmö, waste is not wasted. Even the word waste is almost redundant when reuse of resources is key. Malmö has taken a comprehensive approach to recycling whereby all household waste is collected and 98 percent of the waste is reused or recycled into new materials or energy. From 2014, all Malmö citizens have had the opportunity to recycle their food waste through waste grinders, vacuum systems or paper bags in garbage bins. The city has put effort into facilitating this behavioural trend by constructing weather-proof complexes, ”miljöhus”, which house separate containers clearly labelled, often with visual images, to recycle food waste and other waste fractions. The food waste is collected and produced into biogas to fuel the city’s buses, garbage trucks, taxis and cars. The entire bus fleet actually runs on gaseous energy, and even the residue nutritional substances from the fermentation process are used to replace artificial fertilizers in the fields.

Malmö was indeed the first large city in Sweden to make the political decision that organic waste will be collected by all city households. The goal is part of one of the most ambitious climate targets in the world – for the city administration to become climate neutral by 2020 and to for the city run on renewable energy by 2030. The Malmö case aptly demonstrates how good governance, sound technological choices and emphasis on behaviour change can bring about immense advancements on the road to climate neutrality. While the process is still ongoing, Malmö can readily claim itself one of the most inspirational cases of all-encompassing sustainability efforts in the world.

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The way forward

Plan it holistically – Adopt such governance models that will lead to wise choices in infrastructure planning and technological procurements on city level.

Make it positive – Communicate the benefits of energy efficiency to the citizens regularly and with illustrative examples of money and time saved via wiser energy use habits.

Make it profitable – Highlight the potential economic benefits of behavioural change.

Make it easier to invest – People tend to discount future energy savings and instead focus on short term gains. Apply upfront incentives to increase the appeal of investments.

Provide feedback – The energy end user needs to receive timely and accurate information on how much energy is consumed in daily functions.

Watch out for rebound – Sometimes money saved in one energy efficiency measure may lead to increased energy use elsewhere.

Embrace circular economy – To bring about sustainable economic growth, economic, administrative and fiscal instruments need to be applied to promote the wise use of resources.

Cooperate with the industries – Industrial symbioses can provide a valuable tool for improving cities' environmental sustainability and managing their energy and waste flows.

For more information:

- PLEEC report 4.3. Thematic report on urban energy planning: Buildings, industry, transport and energy generation
- PLEEC report 5.1. Case study reports on Energy efficiency and behaviour
- PLEEC report 5.5. Planning behaviour-driven energy efficiency interventions in a city context
- Ellen MacArthur Foundation: Delivering the Circular Economy. A Toolkit for Policymakers.

The PLEEC documents are available at: www.pleecproject.eu


Solar energy
Geothermal energy
Energy security
Water
New business models
Combined Heat and Power
Energy storage
Wind
Biomass
ESCOs
Renewable energy
Decentralized energy production

Energy supply in turmoil

The time of the dinosaurs is finally ending

Energy supply

The urban world is addicted to energy. Cities consume huge amounts of energy round the clock and as urbanisation increases, so does global energy consumption. Implementing technologies in everything demands more and more from the electricity production chain. Old buildings and out-of-date infrastructure waste energy through leakage. At the same time, climate change and the decreasing supply of fossil fuels challenge decision makers to find new solutions for sustainable energy supply. Representing more than 70% of global energy demand, urban energy policies are essential in achieving global climate goals. The time to be energy smart is definitely now.

The challenges are huge. About 80% of the world's energy use is still based on fossil fuels. **Renewable energy sources** and **decentralized energy production** challenge traditional centralized energy supply networks which have been based on fossil fuels. There is also major energy saving potentials in the total energy chain, which consist of primary energy sources, their conversion to energy and transfer to the consumers. Growing interest in sustainable energy production among households is encouraging, but people desperately need more information on the available options and on how to efficiently utilize their existing energy infrastructures. These challenges are important reasons why city officials, policy makers and NGOs need to act together in keeping the good momentum alive.

"An energy smart city is a city aware of its energy consumption. It has set goals for consumption and is taking actions for reaching the goals."

– *Kaspar Alev, Analyst, Tartu City, Estonia*

"We should proceed towards our goals with courage and determination. Environmental policy and sustainable development should be taken into account in all decision-making. Economic issues and environmentally friendly solutions and alternatives shouldn't be set against each other."

– *Meri Lumela, II Vice Chair of the City Board, Jyväskylä, Finland*

"The main challenge will be to find the right relation between using the energy supplies that have been developed in the city and local solutions. The right relation must support the progress of existing infrastructure as a large number of consumers depend upon it."

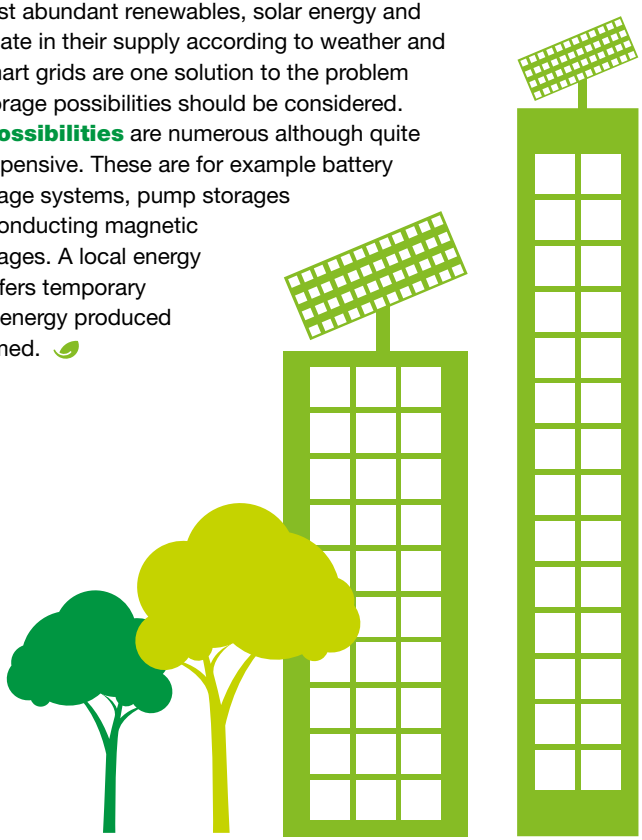
– *Mati Raamat, City Engineer, Tartu, Estonia*

Unlocking renewable energy potentials

We are living exciting times when speaking of transitioning towards renewable energy production. The production of renewables has increased significantly in the European Union during the new millennium. It reached 15% of total energy production in 2013, up from 8.3% in 2004. Germany has been a financial catalyst of renewable energy production in the EU. Its investments have helped to lower prices of renewable energy technologies, particularly photovoltaics. Renewable energy sources are **solar energy (photovoltaics and thermal), water, wind, geothermal energy and biomass.**

Not all energy sources and technologies are suitable for every city. Which renewable energy source is the most favourable for the city and its habitants depends on geography as well as the conditions and availability of primary energy sources. The built environment causes challenges to the sustainable local renewable energy production in the form of shading, air quality, noise, dirt and pollution. Other aspects like acceptance of citizens and policy makers, availability of spaces and suitable infrastructure as well as energy pricing, planning requirements and incentives have an effect on the development of a city's energy supply. By raising the profile of energy issues, better results will be achieved as principles of energy efficiency and clean energy are integrated into decision-making processes and city structures. For cities, focusing on renewable energy is also beneficial for the city brand and marketing.

The most abundant renewables, solar energy and wind, fluctuate in their supply according to weather and season. Smart grids are one solution to the problem but also storage possibilities should be considered. **Storage possibilities** are numerous although quite new and expensive. These are for example battery energy storage systems, pump storages and superconducting magnetic energy storages. A local energy storage buffers temporary changes in energy produced and consumed.



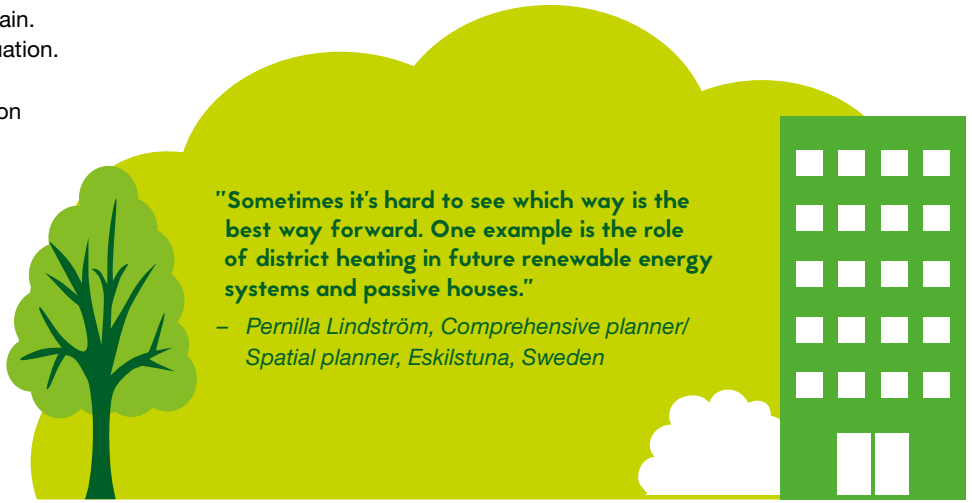
Small is the new big

Decentralized energy supply versus centralized models

How energy should be produced and distributed is under constant scrutiny. Available energy systems can be categorized as centralized or decentralized. The centralized energy production model is a traditional network model of large-scale power plants feeding power grids. The typically fossil-based fuel is transported, often long distances, to the plants, causing huge environmental impacts. Converted energy is then transferred by power grids to end-users far from the production place. In a **decentralized model,** however, the network consists of many small plants close to the end-users. Also the source of primary energy is usually harvested by or near the plant. Many times plants are owned by the end-users.

The centralized energy production model is efficient but it is also inflexible, wastes energy in the transfer and doesn't support local energy production. It is also vulnerable to disturbances in the supply chain. The depletion of fossil fuels isn't helping the situation. In many places, it has also led to environmental degradation. The decentralized energy production model isn't without problems but it utilizes resources more efficiently.

It is, however, important to see that centralized energy production will not become redundant. District heating, especially produced by Combined Heat and Power (CHP) plants, and also district cooling of city areas are the most cost-effective ways to produce and distribute thermal energy. Once power plant technologies develop further, renewable energy production can also become more and more centralized. In other words, decentralization should be seen as one part of the global sustainable energy puzzle. In the future, it is likely that secure, sustainable and economically feasible energy systems will combine the best qualities of centralized and distributed systems, forming a ICT-supported hybrid.



PLEEC CITIES

Turku (Finland)

Preparing for a new future

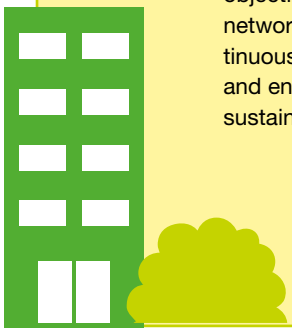
Energy systems in transition

Decentralization of energy supply enables new settlement structures in all kinds of populated areas. For example, different forms of individual heat pumps can be applied in sparsely populated areas, whereas cluster solutions with a decentralized, low-energy heating grid can take advantage of energy efficient housing, and still organize around a bigger entity to ensure energy security in a more urban context.

Skanssi is a new development southeast of the city centre of Turku, Finland, which is to become a sustainable district for approximately 8,000 residents by 2030. The area serves as a pilot project for an integrated energy supply and demand system, and is, by and large, meant to operate self-sufficiently.

The heating system will have its own operating system which allows to lower the temperature in the pipes and use intelligent optimization based on “heat consumption profiles”, geothermal heat utilization, solar power, district cooling, processing of surplus heat, and small CHP plants. In terms of energy, the overall objective is to focus on smart energy and distribution networks, smart grids, local energy production, continuous monitoring and documentation of results, and encouraging and informing the residents about sustainable habits.

While Skanssi serves the purpose of attracting new taxpayers to the already growing municipality, it is also perceived as an avant-garde sustainability project, which can be used to boost the sustainable image of the city. Together with new transport solutions these types of developments can change the spatial conditions for sustainable urban development, especially regarding new developments.



"In year 2030, energy smart means decentralized energy production and local management of the energy transition process at the neighborhood level."

– *Max Gruenig, Senior Fellow, Coordinator EU Research, Ecologic Institute*

The renewed energy industry

New business models challenging old ways

The structure of the energy industry and particularly the electricity production industry is changing. New energy landscapes – like renewables replacing fossil and nuclear fuels with increasingly decentralized energy production – force energy producers to rethink their business models. **The customer-side business model** is emerging alongside traditional energy business models. In a customer-side business model, energy systems are located on the property of the customer. Possible technologies are usually based on renewable energy sources. The customer can then sell the excess energy further to the network. Available technologies are for example photovoltaic, CHP micro power, geothermal heat pumps, and micro-wind turbines.

Possible new business models can be catecorized as:

1. Product-Service-System models
2. Business models based on new revenue models
3. Business models based on new financing schemes

Product-service systems are business models which link together delivery of the energy combined with the energy-related service. **Energy Service Companies (ESCOs)** are one of the most common examples of product-service-system business models for sustainable energy. An example of product-service-system business model is an Energy Supply Contracting (ESC) model, where ESCO supplies useful energy, such as electricity under a long-term contract to a building owner or building user. It is suitable especially for the production of renewable energy.

Business models based on new revenue models are not based on traditional market-based ways of getting revenue. New profits can partly be guaranteed by governmental subsidies or tariffs. Profits can also be gained from the value-rise of the property or the product, like a building, when it gets environmental benefits from renewable energy production for instance through green certification. **New financing schemes,** such as leasing renewable energy equipment can also be feasible options.

The current political environment with regulations and laws has an important role on the success of business models of renewable energy production. Especially business models based on new revenue models or financing schemes are almost wholly supported by incentives launched by the government. Cities can't bury their heads in the sand. With their own regulations, incentives and guidance, the cities can support local businesses and inhabitants in getting on the winning train of sustainable energy business.

EUROPEAN CITY SUCCESS STORIES

Carbon Neutral Municipalities (Finland)

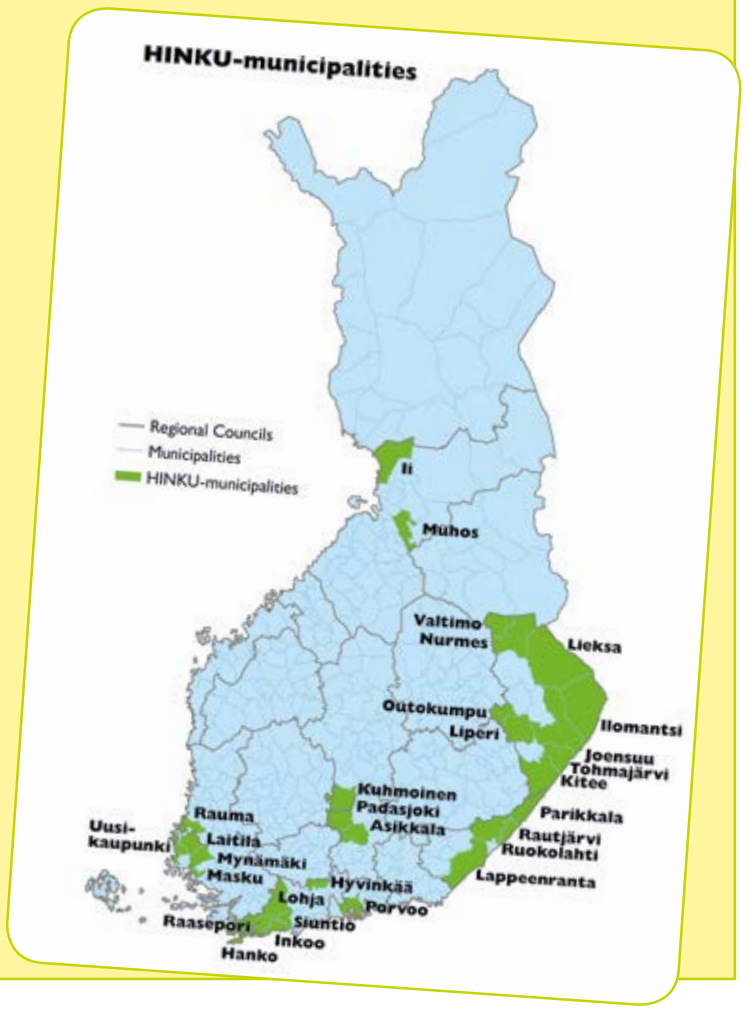
Municipalities acting as laboratories

A joint framework for curbing GHG emissions

In Finland, a joint network of municipalities, businesses and citizens striving for carbon neutrality have established a working model, the HINKU network, to create and carry out solutions to reduce greenhouse gas emissions. The goal is to reach EU emission reduction targets more rapidly and extensively than required by set deadlines, at the same time producing solutions with economic and social benefits.

Joint commitment is key here. What began as pilot of five municipalities now features altogether 29 Finnish municipalities acting as laboratories by working to curb their greenhouse gas emissions ahead of schedule. Improving energy and resource efficiency are essential in HINKU actions. A municipality may both alter its own policies and planning practices and also strive to drive other actors in the area to take action. Between 2007–2013, HINKU municipalities had succeeded in reaching a 21% greenhouse gas emission reduction.

In essence, HINKU municipalities strive towards a green economy. Taking energy and climate issues into consideration is a must for companies these days, and HINKU municipalities have demonstrated some good practices on how eco-efficient solutions can offer business opportunities. The aim is to create domestic markets for climate-friendly technologies as well as to establish a showcase of Finnish technology. At the same time, the local community is strengthened and well-being increased through cost reductions and energy self-sufficiency.



EUROPEAN CITY SUCCESS STORIES

Ljubljana – European Green Capital 2016 (Slovenia)

Paving the future

Boosting energy efficiency in a middle-sized city

Ljubljana in Slovenia was denoted the European Green Capital in 2016 – an achievement well deserved. Ljubljana was awarded for raising environmental awareness amongst its citizens, for its sustainability strategy 'Vision 2025', its implementation of a range of urban green measures over the past decade and its impressive transportation network.

Ljubljana has undergone an impressive transformation in city sustainability in the last 10–15 years. A city previously dominated by car transport and choking traffic jams, Ljubljana can now boast of efficient public transport system and pedestrian and cycling networks. The main traffic artery has undergone a traffic regime modification and the old city centre closed to all motorized traffic. By 2020, the goal is to reach a modal split of one third of walking and cycling, one third of public transport and only one third of personal cars (now two thirds).

Three quarters of the entire territory of Ljubljana are green areas: contiguous aquatic, forest and agricultural areas. Naturally, preserving and protecting the city's green areas as well as the revitalization of brownfield areas have been a significant focus of city policy.

The first European capital to move towards Zero Waste, Ljubljana has placed heavy emphasis on waste prevention and reduction, product reuse and material recycling. Among the finalists for the European Green Capital 2016, Ljubljana was actually the only one that did not have a waste incineration plant. Although this could be seen as a disadvantage, the alternative solution – replacing disposal and energy recovery in the framework of a comprehensive waste management plan and a consequent Zero Waste society – wholly supports a model of circular economy.

Ljubljana aptly demonstrates the importance of constructive dialogue with all concerned when planning for energy efficiency improvements. There was a genuine will to thoroughly understand the citizens' mobility needs, for example. An intensive dialogue with stakeholders and citizens took place in the planning phase in order to achieve a system which was not only sustainable but also one that was based on the citizens' needs.

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EUROPEAN CITY SUCCESS STORIES

Vaxjö (Sweden)

Pioneers of energy transition

The making of fossil free Växjö

In 1996 Vaxjö, a mid-sized city in southern Sweden, set the ambitious goal of becoming fossil fuel free by mid-century. This was a daring, unanimous decision on behalf of the politicians. Together with the local firms, industries and transport companies, they created a policy commitment "Fossil Fuel Free Växjö" to stop using fossil fuels and reduce CO_2 emissions in heating, energy, transport, businesses and homes. Vaxjö decided to take responsibility as a city and to show that even a small city can tackle climate change big time.

The main ingredient in the fossil fuel free recipe is production of heat and power from biomass alongside a massive expansion of district heating. Using biofuels for cars and buses and installation of solar panels in homes, municipal buildings and industry buildings are also strong components in the mix. Vaxjö already derives over 50% of its energy from renewables. The municipality closely monitors CO_2 emissions and energy savings in heating, electricity and transport. It is recognized that in order to achieve a change in people's energy saving habits, Vaxjö has to make it easier to live a life without fossil fuels. For this, cheap and convenient district heating, attractive public transport and good walking and cycling paths work wonders.

The example of Vaxjö demonstrates yet again the importance of a concerted, holistic effort of a city and its partners in cooperation to reach a common goal. Commitment and clear goal-setting together with rigorous planning measures and careful monitoring of CO_2 emissions seem to make for a successful effort.

The way forward

Consider your options. Base your policy actions on local energy potential.

Create networks of target groups. Link people, energy industry and NGOs together for building sustainable energy future.

Support local energy transition. Give guidance and financial support for homeowners and local businesses in transition to the renewable energy production.

For more information:

- PLEEC report 3.1. Technical state-of-the-art innovative solutions
- PLEEC report 3.2. Improving Energy Efficiency Through Technology – Case Studies
- PLEEC report 4.3. Thematic report on urban energy planning: Buildings, industry, transport and energy generation
- PLEEC report 5.5. Planning behaviour-driven energy efficiency interventions in a city context
- Energy Center of Netherlands (ECN): Business models for renewable energy in the built environment

The PLEEC documents are available at: www.pleecproject.eu

Visions for an energy smart city

The urban population in the world now exceeds over 50% and there is no sight of urbanization slowing down. Two thirds of all the energy on the planet is consumed in cities, and cities are also responsible for over 70% of the world's greenhouse gas emissions. Cities face numerous challenges posed by economic and technological changes. The way we plan our urban energy landscapes is therefore essential for cities' competitiveness and sustainable urban development.

The medium-sized cities in Europe naturally face different challenges in comparison to metropolises and they may be less well equipped to deal with them in terms of critical mass, resources and institutional capacities. On the other hand, although lacking in size, medium-sized cities have qualities which set them apart in striving towards urban improvement: better controllability, flexibility and efficiency of strategies and policies. Most cities possess unique characteristics that may open for unimagined potentials if utilized in a holistic manner. In the midst of tightening budgetary restrictions and resource deficits, energy efficiency can offer cities some practical solutions to meet their energy needs without compromising their developmental goals.

The PLEEC project started off with the essential premise of **holistic planning** – the need to achieve ambitious energy saving goals, taking into consideration the three interconnected perspectives of energy efficiency planning – city structure, technological choices and behaviour of citizens. This need for a holistic view is pressing as cities tackle to overcome the legislative requirements set by the EU, as well as the fiscal ones brought on by the ever-growing struggle to thrive amidst the capricious global economy.

Cities have great leverage in shaping urban form, choosing innovative technologies and implementing policies to promote more energy efficient behaviour. The PLEEC project aimed to develop a proven model for concerted, step-by-step efforts to guide medium sized cities towards greater energy efficiency.
The model can be seen as a framework considering individual cities' conditions and opportunities. Its stepwise approach starts from the identification of a smart city profile addressing various stakeholders'

"Energy efficiency requires a strong introduction of new inventions. We also need to be able to predict, for example, what kind of changes are going to take place in business and in industry in the near future and in the long run. On the other hand a huge challenge is to influence and change people's attitudes and their behaviour."

– *Meri Lumela, II Vice Chair of the City Board, Jyväskylä, Finland*

"The most important thing in achieving an energy smart city is the identification of innovation potentials based on local and place dependent conditions as well as reducing/ subsidizing costs of and improving social awareness on energy efficient urban development."

– *Rudolf Giffinger, Professor in Regional Science, Vienna University of Technology, Austria*

views and requirements. This way, the PLEEC model gives guidance towards a long term energy efficiency action plan, helping the planner to cope with the enormity of the task and making the transformation process more manageable.

Past decisions have shaped contemporary cities which may limit the options of today – choices in fuels, technologies, and distribution networks are naturally interdependent and driven by both physical, financial and governance investments. Path dependency not only concerns technological choices but to a large extent also planning policies and practices. Still, there is room for new path creation in each and every city. History binds us, but only to some extent. The choice is ours. We collected opinions and visions for the future from city officials, politicians, MEPs, experts, NGO representatives and ordinary citizens that you have seen everywhere in this booklet and following pages. **They share the same vision: promoting and increasing energy efficiency is vital for our cities now and in the future.**

The aim of this booklet has been to give the reader an overview of one of the most pressing concerns in cities these days – the production and use of energy in a sustainable and efficient manner. In addition to this, tools and ideas for city planners, officials and the like are provided to aid in exploring the issue further – essentially some fuel for envisioning. It is vital to remember that there is no single solution for energy efficiency in cities. However, there are various paths to take on this mission.

The booklet in your hands serves as a starting point to all the possible options towards a sustainable future.

What we do next depends on us.
Are you ready for the change?

The PLEEC Tool

A Guide for Energy Efficiency Planning in Cities

Become energy efficient!

Planning for energy efficiency is not a linear process. The steps are interlinked and dependent of each other. Also, approaching energy efficiency can be done from different perspectives. The PLEEC project is founded on the conviction that a combination of the perspectives technology, structure and behaviour will lead to greater results than if each perspective works on its own.

One of the main objectives of the PLEEC project was to develop a tool for energy efficiency planning in European middle-sized cities. The PLEEC tool has gathered the experiences from all the 18 partners of PLEEC in their efforts to study energy efficiency planning in cities and to develop the energy efficiency action plans (EEAPs) for the 6 partner cities. The PLEEC tool aims to guide other cities through the process of writing their EEAP. On what should we focus? What pitfalls should we avoid? How do we choose actions to reach our goal?

For more information on these issues, please take a look at www.pleecproject.eu

How do we get started?

INITIATING THE PLANNING PROCESS

Get the decision

- Get political support
- Co-operate across departments
- Give strong arguments on why an EEAP is needed
- Find a place for the EEAP

Set up project

- Get inspiration from others
- Get consensus on a general vision
- Build a cross departmental project group
- Choose an experienced coordinator
- Write a project plan
- Consider the city's pre-conditions

Engage stakeholders

- Choose the right stakeholders
- Aim for stakeholder diversity
- Engage the public in different parts of the planning process

External and internal factors which may affect energy efficiency planning in cities

Where are we?

ANALYSIS OF THE CURRENT SITUATION

- Collect data to identify the city's strengths, deficits and opportunities
- Choose appropriate energy efficiency indicators for providing information and establishing and implementing a monitoring system for the EEAPs
- Elaborate the city's Smart City Profile to identify the same types of cities for detecting good practices

Where do we want to go?

SETTING GOALS AND IDENTIFYING SOLUTIONS

- Green Buildings & Land Use
- Mobility & Transport
- Technical Infrastrucure
- Production & Consumption
- Energy Supply

How do we implement?

APPROVAL AND IMPLEMENTATION OF THE PLAN

- Write the plan
- Establish the timeline
- Get approval for the EEAP
- Prepare to implement the plan

Stakeholders

WHY do we need stakeholders and participation in the planning processes?

At different stages of the process the function of stakeholders is different, ranging from the collection of ideas in the beginning until the implementation of the plan and informing the relevant addressed groups at the end of the planning process. Involving stakeholders prevents opposition, creates commitment to the plan and trust – both part of a democratic approach. Furthermore, stakeholders can share resources and possibly funding for piloting or certain actions.

HOW to gather and motivate the necessary stakeholders for energy efficiency planning? How can stakeholders contribute to the successful initiation of energy efficiency actions?

The way how to deal with stakeholders depends on the purpose of the stakeholder involvement: communication ("listen, not talk") vs. dissemination ("inform the citizens"). An important factor for successful stakeholder involvement is to clearly communicate the benefits to the stakeholders to motivate them to participate in the process. Highlighting why and how it pays off for the stakeholder to be involved and take part is essential. However, the various stakeholders have different interests and backgrounds. Therefore target group specific language and settings are needed for each group to address and motivate them properly.

Stakeholder involvement is a long-term, time-consuming process that needs to be done from the early start in the planning process and on a regular, frequent basis. One needs to be aware that stakeholder involvement raises expectations that should be met by the plan in the end.

WHO are the relevant stakeholders?

The identification and selection of the "right" stakeholders needs to be done according to the goals and the perspective and scope of the plan as well as by the level of power of the stakeholders. However, it is often challenging to attain the desired list of stakeholders due to lack of interest or available time by the relevant stakeholders. Also, the fact that different groups of stakeholders have different goals may require altered stakeholders at various stages of the planning process.

How do you envision an energy smart city could look like in the year 2030?

"Decentralized provision of renewable energy produced within the city-region; integrated mobility conditions in city region; better monitoring systems impacting private and public decision making."

– *Rudolf Giffinger, Professor in Regional Science, Vienna University of Technology, Austria*

"An energy smart city in 2030 would be a decentralized one and local management of the energy transition process would take place at the neighborhood level."

– *Max Gruenig, Senior Fellow, Coordinator EU Research, Ecologic Institute*

"In 2030, an energy smart city will have reduced its CO_2 emissions substantially. It will have eliminated any investments in fossil fuel facilities for the last five (to ten) years and most of the building stock will be refurbished and heated with district or waste heat or with renewables. Renewable energy will be on the people's minds, causing them to invest in participatory solar power plants and to avoid using petrol-based cars."

– *Thomas Madreiter, Planning director, Vienna, Austria*

"I think smart cities are the key to sustainability in many ways. We need to invent new environmentally friendly ways of living and working. I think digital technology and new innovations of renewable energy will reduce energy consumption and actually enable a better quality of life for us."

– *Meri Lumela, II Vice Chair of the City Board, Jyväskylä, Finland*

"When trying to achieve an energy smart city, planning and people's behaviour are the aspects to focus on, technology is just a tool."

– *Martin Kikas, Director of Tartu Regional Energy Agency, Bioenergy expert, Tartu, Estonia*

"A dense city which is highly energy and resource efficient, based on resilient resource systems, powered by renewable energy sources and well functioning public transportation."

– *Pernilla Lindström, Comprehensive planner / Spatial planner, Eskilstuna, Sweden*

"I think it is difficult to estimate such long-term, especially from the point of view of technological innovation. But I think many tools will be developed to improve energy efficiency in all areas of municipal management, but mostly, I think that will change radically the perception of the population on the need to be more consistent and responsible care natural resources and the environment."

– *Fernando Suárez, Chief of Innovation, Santiago de Compostela Town Hall, Spain*

"An energy smart city needs brave politicians that hold on to the energy- and climate solutions even when there is a lot of complaints."

– *Mats Hällnäs, head of Eskilstuna Planning Department, Sweden*

"An energy smart city would definitely have a high quality and efficient public transport system, in the form of metro, light rail or other. It would have very good infra-structure for bicycles and pedestrians. It would have high quality urban environments and green open space in relatively dense city structures, and in the less dense suburbs there would be local centres with higher densities. Houses will be renovated to high energy standard. There will be more car-sharing and the cars will be more energy efficient and cleaner."

– *Gertrud Jørgensen, Professor in Urban Planning, University of Copenhagen*

"The main systems (traffic, lighting, buildings) will have an integrated management. Share of renewables is at least 50% of all fuel consumption. Energy losses have been decreased to minimum level."

– *Jaanus Tamm, Project Manager, Tartu city, Estonia*

"What is needed is political courage and the ability to show leadership that will help the city and its inhabitants to move from an industrial city with a major economic challenges to a new type of succesfull, climate smart-industrial city with many small entrepreneurial companies."

– *Olov Åslund, Project coordinator, Eskilstuna kommun, Sweden*

"100% renewable energy. Energy efficient in all sectors. Resources are used as efficiently as possible for energy production (no left-overs wasted). Info-technology is widely exploited in different energy related actions to maximize the outcome. People continuously analyze their behaviour when the con-sumption of energy is considered and are ready to change their behaviour to maximize the outcome."

– *Raimond Tamm, Energy expert, Tartu Science Park, Estonia*

Improving the energy performance of cities – Energy efficiency monitoring and databases as tools for cities

In general, an energy efficiency monitoring system fosters an organizational learning process and promotes sustainable knowledge on the energy efficiency situation in respective cities.
A monitoring system integrated into an Energy Efficiency Action Plan or at least accompanying it will help cities to improve their overall performance on energy efficiency. In addition, it will help to ensure the quality of any measures and strategies targeted towards a more energy efficient future. By using a monitoring system, city representatives can identify recent developments of the energy situation, develop or adapt strategies in time and assess planning targets. Constant monitoring of energy efficiency in a city also supports future decision finding processes and helps to avoid silo decisions by providing a comprehensive overview across trends in various relevant domains.

PLEEC Energy Efficiency Indicators – a 2-level-approach to measure energy efficiency

National Energy Efficiency Action Plans (NEEAPs) set out estimated energy consumption, planned energy efficiency measures and the improvements individual EU countries expect to achieve. Each EU country must draw up these plans every three years, as set by the Energy Efficiency Directive. Within the PLEEC project the six partner cities developed their EEAPs on a municipal level. By taking off from a SMART city profile, where the municipal energy consumption is illustrated, the cities set goals for energy efficiency and actions to reach these goals. However, in order for the cities to measure energy performance, indicators are needed.

The PLEEC project has suggested a set of 50 indicators, which can be used to effectively monitor the energy efficiency of a given city. However, as cities might not be able to measure all these indicators, a dual approach has been proposed. This approach comprises of first-level indicators or the so called core performance indicators, which measure the energy efficiency in general terms. These are strongly suggested to be used in all cities aiming for energy efficiency. The second-level-indicators, or the target based energy efficiency indicators are those considered and elaborated in a monitoring system due to specific problems or according to recent targets the energy efficient urban action plans have lifted up.

Transition towards energy smart cities through strategic eco-innovations

Innovation for energy efficiency should be integrated in city planning as a means to eliminate **carbon emissions** and to achieve **circular economy.** These together should form the core dimension of an energy smart city. In addition, city planning needs to critically reflect on and reorient the concept of growth and embrace other concepts such as green development and growth instead.

Learning from others is crucial, but imitation seldom works. Therefore, it is advisable to innovate systemically from the city's given situation. The aim is to adopt, adapt and integrate carefully chosen best available practices based on the energy system and sustainability transition journey of the city. Additionally, cities should develop a city eco-innovation profile based on local situation, values and visions. Cities might want to choose the core area for frontline eco-innovation, but the main effort is to facilitate embedding external energy solutions in city practices.

City planning needs to mobilize and integrate innovation drivers in different sectors – business, public, civic, academic, natural – in the city, and channel them towards long-term sustainability transition aims. Moreover, it is wise to utilize systems thinking, to map the energy system and look for the intervention points that can create important change in the whole system. The resulting strategic approach should be adopted into planning and coordinated empowerment of all relevant actors in an open innovation process is generally an ideal to be striven for in city planning. The cities should also identify the core challenges in innovation and transition work, and develop measures to deal with them through city planning.

There is no one best way to support urban eco-innovation through city planning. A broad based, interactive, participatory and situational approach is commendable and helps in the process of developing a city specific innovation and technology adoption strategy. This will guide the city through the transition towards an energy smart city.

"Energy efficiency requires a strong introduction of new inventions. We also need to be able to predict, for example, what kind of changes are going to take place in business and in industry in the near future and in the long run. On the other hand a huge challenge is to influence and change people's attitudes and their behaviour."

– *Meri Lumela, II Vice Chair of the City Board, Jyväskylä, Finland*

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The way we plan
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"Green Thoughts, Green Futures" gives the reader
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holistic choices in city planning to promote energy efficiency is
simply the way of the future. The booklet in your hands serves
as a starting point to all the possible options towards
a sustainable future in city planning.

SEVENTH FRAMEWORK PROGRAMME

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