European Smart City Initiative

Assessment of Best Practices to Stimulate Market- / Demand-Pull

C. Mandl
T. Kuttner

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Leiter: DI Michael Paula

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European Smart City Initiative:

Assessment of Best Practices
to Stimulate Market- / Demand-Pull

Prof. Dr. Christoph Mandl
Mag. Theresa Kuttner
Mandl, Lüthi & Partner

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Im Auftrag des Bundesministeriums für Verkehr, Innovation und Technologie

Vorbemerkung

In der Strategie der österreichischen Bundesregierung für Forschung, Technologie und Innovation ist deutlich verankert, dass Forschung und Technologieentwicklung zur Lösung der großen gesellschaftlichen Herausforderungen beizutragen hat, wobei die Energie-, Klima- und Ressourcenfrage explizit genannt wird. In der vom Rat für Forschung und Technologieentwicklung für Österreich entwickelten Energieforschungsstrategie wird der Anspruch an die Forschung durch das Motto „Making the Zero Carbon Society Possible!" auf den Punkt gebracht. Um diesem hohen Anspruch gerecht zu werden sind jedoch erhebliche Anstrengungen erforderlich.

Im Bereich der Energieforschung wurden in den letzten Jahren die Forschungsausgaben deutlich gesteigert und mit Unterstützung von ambitionierten Forschungs- und Entwicklungsprogrammen international beachtete Ergebnisse erzielt. Neben der Finanzierung von innovativen Forschungsprojekten gilt es mit umfassenden Begleitmaßnahmen und geeigneten Rahmenbedingungen eine erfolgreiche Umsetzung der Forschungsergebnisse einzuleiten. Ein wesentlicher Erfolgsfaktor für die Umsetzung ist die weitgehende öffentliche Verfügbarkeit der Resultate. Die große Nachfrage und hohe Verwendungsquoten der zur Verfügung gestellten Ressourcen bestätigen die Sinnhaftigkeit dieser Maßnahme. Gleichzeitig stellen die veröffentlichten Ergebnisse eine gute Basis für weiterführende innovative Forschungsarbeiten dar. In diesem Sinne und entsprechend dem Grundsatz des „Open Access Approach" steht Ihnen der vorliegende Projektbericht zur Verfügung. Weitere Berichte finden Sie unter www.NachhaltigWirtschaften.at.

DI Michael Paula
Abteilung für Energie- und Umwelttechnologien
Bundesministerium für Verkehr, Innovation und Technologie

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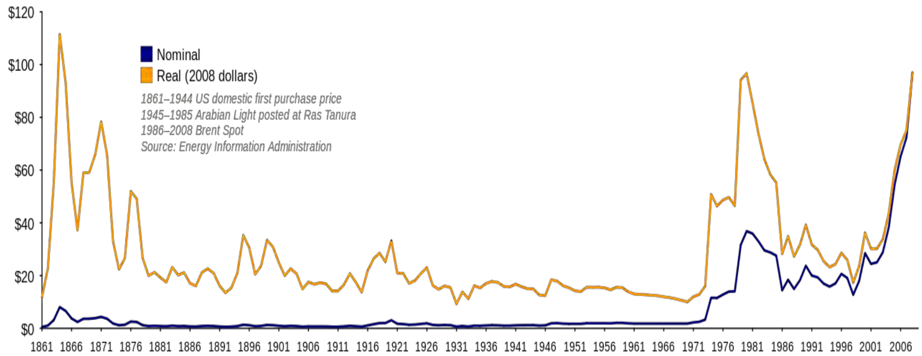
0 INTRODUCTION

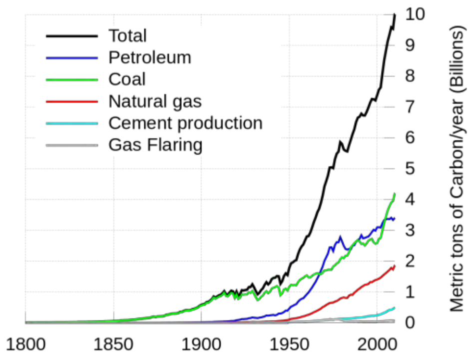
Ever since the 1973 oil crisis when the price of oil had risen from US$3 per barrel in October 1973 to nearly $12 in March 1974,

Figure 1: Oil price development 1861-2008[1]



energy remained high on the political agenda. However, it was not the price of oil but the exponential growth of greenhouse gas emissions

Figure 2: Development of world greenhouse gas emissions[2]



that led to the *Kyoto Protocol* and its signing in 1997. Its approval by the European Community in 2002 triggered a set of communications, decisions, and directives by the European Commission driven by the 2007 "Energy Policy for Europe". *In this Strategic Energy Review the Commission proposes that the European Energy Policy be underpinned by an EU objective in international negotiations of 30% reduction in greenhouse gas emissions by developed countries by 2020 compared to 1990. In addition, 2050 global GHG emissions must be reduced by up to 50% compared to 1990, implying reductions in industrialised countries of 60-80% by 2050.*[3]

In turn, the European Energy Policy gave rise to a number of initiatives, the *European Initiative on Smart Cities* being prominent among them. Its objective is *to reduce by 40% the greenhouse gas (reference year 1990) emissions by 2020, that will demonstrate not only environmental and energy security benefits but also to provide socio-economic advantages in terms of quality of life, local employment and businesses, and citizen empowerment.*[4]

Since 2007, the development and implementation of Smart City technologies advances rapidly, particularly in the northern parts of the EU. In Austria, however, implementation of Smart City technologies remain comparatively slow due to the lack of market-pull / demand-pull. To accelerate Smart City implementation in Austria, existing technology push needs to be accompanied by measures to induce market-pull / demand-pull.

This study describes and analyses best practice Smart City realisations in Europe with special emphasis on market-pull / demand-pull activities. Insights from these analyses result in policy recommendations for strengthening Smart City market-pull / demand-pull.

In doing so, two complementary methods of empirical social research were employed: Comprehensive desk research as well as analysis of documents on the selected ventures and on Smart City initiatives at large, and Dialogue Interviews. The latter were conducted with key persons of the selected Smart City endeavours. The in-depth analyses focussed on the crucial aspects of their realisations: Intended and unintended results, initial reason for undertaking, pushbacks against implementation, important supporters of the undertaking, key success factors, modifications from original concept to final implementation, future development, and lessons learnt.

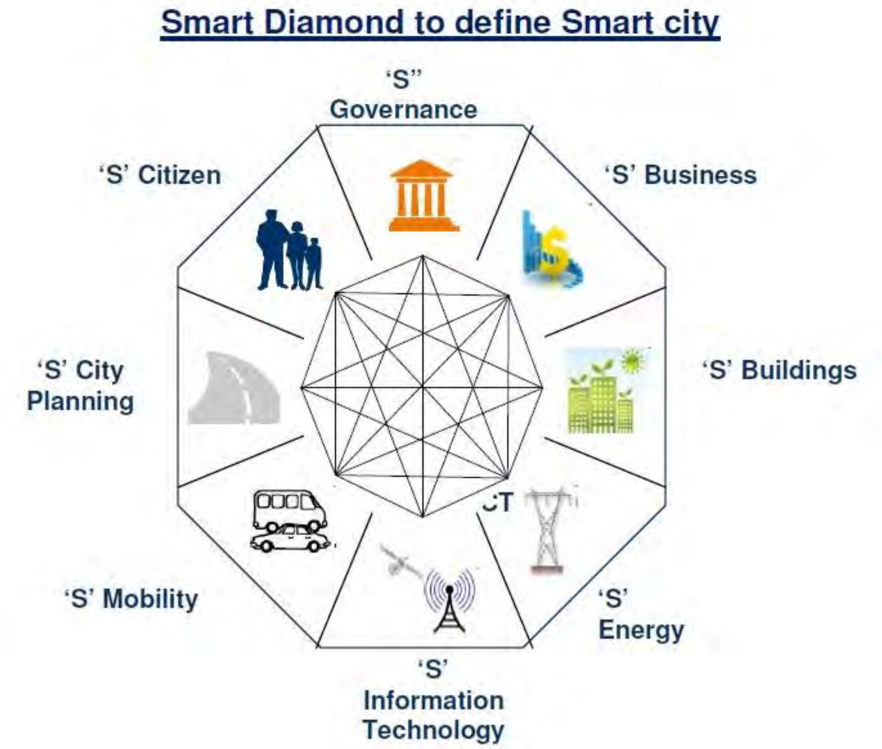
This study reports on the findings and insights obtained through this investigation. Specific information on the research methods utilised is presented in chapter 3.

1 SMART CITY – DEFINITIONS AND CHALLENGES

Definitions for *Smart City* vary greatly. When the term was first coined in the 1990s, emphasis was put on ICT and e-Government services. In recent years, all aspects of energy production, distribution and consumption are also associated with Smart City (including energy efficiency, integration of decentralized energy sources, sustainability etc.). Thus, Smart City is used interchangeably with other terms such as *Eco-City*, *Intelligent City*, *Sustainable City*, etc. An overview of key Smart City definitions can be found in *Mapping Smart Cities in the EU* by the DG internal Policies (2014)[5].

The consultancy agency Frost & Sullivan identified eight axes that characterise a smart city – as shown in figure 3.

Figure 3: Smart City Definition, Frost & Sullivan[6]



The above-pictured axes can also be found in the Smart City concept conceived by the EU. Against the backdrop of climate change, the term has been picked up by the European Commission and is employed in various EU actions and initiatives with the aim to contribute substantially to the achievement of the set climate targets. *Smart City,* for the EU, is thus defined as follows:

> *In Smart Cities, digital technologies translate into better public services for citizens, better use of resources and less impact on the environment. […] A Smart City is a place where the **traditional networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of its inhabitants and businesses.** […] But the Smart City concept goes beyond the use of ICT for better resource use and less emissions. It means smarter urban transport networks, upgraded water supply and waste disposal facilities, and more efficient ways to light and heat buildings. And it also encompasses a more interactive and responsive city administration, safer public spaces and*

meeting the needs of an ageing population. […] With this vision in mind, the European Union is investing in ICT research and innovation and developing policies to improve the quality of life of citizens and ***make cities more sustainable in view of Europe's 20-20-20 targets***.[7]

EU's focus on energy aspects was further stressed in a 2007 communication on achieving the energy efficiency targets through the implementation of a European Strategic Energy Technology Plan (SET-Plan)[8]. The *Smart Cities Initiative* embedded in this SET-Plan and the thereof emerging *European Innovation Partnership on Smart Cities and Communities*[9] emphasise the importance of energy[10] within the smart city concept, and in this context clearly refer to the EU 2020 climate and energy targets[11]:

The SET-Plan has two major timelines:[12]
For 2020, the SET-Plan provides a framework to accelerate the development and deployment of cost-effective low carbon technologies. With such comprehensive strategies, the EU is on track to reach its 20-20-20 goals of a 20% reduction of CO2 emissions, a 20% share of energy from low-carbon energy sources and 20% reduction in the use of primary energy by improving energy efficiency by 2020.
For 2050, the SET-Plan is targeted at limiting climate change to a global temperature rise of no more than 2°C, in particular by matching the vision to reduce EU greenhouse gas emissions by 80-95%. The SET-Plan objective in this regard is to further lower the cost of low-carbon energy and put the EU's energy industry at the forefront of the rapidly growing low-carbon energy technology sector.

The Smart Cities initiative aims to ***improve energy efficiency*** *and to step up the deployment of* ***renewable energy*** *in large cities going even* ***further than the levels foreseen*** *in the EU energy and climate change policy. This initiative will support cities and regions that take pioneering measures to progress towards a radical reduction of greenhouse gas emissions through the sustainable use and production of energy.*[13]

Below, the definitions for *Smart City* by those countries / cities where best practice projects have been selected and further examined in this report are stated – including the prevailing definitions for Smart City in Austria.

Austria (BMVIT):

The Smart City concept aims to take this [the fact that solutions to challenges for cities have to consider the variety and mutual dependence of various factors; authors' remark*] into account by providing an integrated planning and implementation of all pertained aspects (power generation and distribution, built infrastructure, services, mobility, industrial production and trade). Smart Cities are to connect optimized resource efficiency with a high attractiveness for residents and businesses; they contribute to the reduction of the consumption of energy and resources to a sustainable and acceptable level.*[14]

Vienna:

Smart City Wien – the intelligent city, fit for the future – is [..] answer and departure into a new energy, mobility and economic system, which prioritises the achievement of ambitious climate and energy efficiency targets and the safeguard of the high quality of living of its citizens. This however is only achievable when the people can derive a definite benefit from existing and future innovations.[15]

Denmark:

Smart City can be defined as a city, which systematically makes use of ICTs to turn its surplus into resources, promote integrated and multi-functional solutions, and improve its level of mobility and connectedness. It does all this through participatory governance based on collaboration and open source knowledge.[16]

'Smart Cities' use ICT to become more intelligent and efficient in their use of resources, resulting in cost and energy savings, improved service delivery and quality of life, and reduced environmental footprint – all supporting innovation and a low-carbon economy.[17]

Hamburg:

A smart city, i.e. one that is well connected and well designed, improves quality of life through intelligent, innovative infrastructures that help to make mobility more efficient, protect resources, and reduce negative environmental impact. As such, sensor and information technologies will continue to play an ever-greater role in the future.[18]

Helsinki:

For Helsinki, Smart City means more than advanced infrastructure and state-of-the art technological solutions. For Helsinki, Smart City signifies also advancing open engagement of the citizens and the rest of the city community, pioneering in open data and transparency of city governance, as well as promoting agile service development.[19]

Netherlands:

We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.[20]

Amsterdam:

A Smart City is a city where social and technological infrastructures and solutions provide sustainable economic growth. This improves the city's residents' quality of life.[21]

Yet Smart City is not just an interesting invention whose time has come because the necessary technologies are now available, it is also a concept and a vision challenged along five different dimensions. Coping with these challenges will be crucial for Smart City to sustain.

1.1 Problem wickedness dimension

A broadly shared experience seems to be that while societal problems mount up, actions to counter them lack impact. As a result, a culture of blaming "the others" – the politicians, the managers, the scientists, the consumers, the investors, the banks, the media – spreads. "The others" are seen as groups of people who sabotage seemingly well-meant efforts to cope with pressing societal problems, among them are climate change and sustainability. A conspiracy theory of sorts.

The problems that scientists and engineers have usually focused upon are mostly "tame" or "benign" ones. As an example, consider a problem of mathematics, such as solving an equation; or the task of an organic chemist in analysing the structure of some unknown compound; or that of the chess player attempting to accomplish checkmate in five moves. For each the mission is clear. It is clear, in turn, whether or not the problems have been solved. Wicked problems, in contrast, have neither of these clarifying traits; and they in-

clude nearly all public policy issues – whether the question concerns the location of a freeway, the adjustment of a tax rate, the modification of school curricula, or the confrontation of crime.[22]

Already in 1973 the term *wicked problem* was coined describing a class of problems that are difficult or impossible to solve because of incomplete, contradictory, and changing requirements. The term "wicked" is used to denote resistance to resolution. Wicked problems display specific characteristics:

- The problem is not understood until after the formulation of a solution.
- Wicked problems have no stopping rule.
- Solutions to wicked problems are not right or wrong.
- Every wicked problem is essentially novel and unique.
- Every solution to a wicked problem is a 'one shot operation.'
- Wicked problems have no given alternative solutions.

Societal problems are inherently wicked, explaining at least to some extent why these seem to be building up rather than being resolved. As if this was not already bad enough, in 2012 the term *super wicked* was introduced to characterize a new class of global environmental problems:

> *Super wicked problems comprise four key features: time is running out; those who cause the problem also seek to provide a solution; the central authority needed to address them is weak or non-existent; and irrational discounting occurs that pushes responses into the future. Together these features create a tragedy because our governance institutions, and the policies they generate (or fail to generate), largely respond to short-term time horizons even when the catastrophic implications of doing so are far greater than any real or perceived benefits of inaction*.[23]

1.2 Climate change dimension

Not least because of the inability of the world's nations to come up with legally binding climate change mitigation actions, the European Union passed a number of laws, i.e. *on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020*[24] and *on energy efficiency*[25].

In the decision of the European Parliament on the effort to reduce greenhouse gas emissions, it is stated:

> *The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC), which was approved on behalf of the European Community by Council Decision, is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The view of the Community is that in order to meet this objective, the overall global annual mean surface temperature increase should not exceed 2°C above pre-industrial levels, which implies that global greenhouse gas emissions should be reduced to at least 50% below 1990 levels by 2050. The Community's greenhouse gas emissions covered by this Decision should continue to decrease beyond 2020 as part of the Community's efforts to contribute to this global emissions reduction goal. Developed countries, including the EU Member States, should continue to take the lead by committing to collectively reducing their emissions of greenhouse gases in the order of 30 % by 2020 compared to 1990. They should do so also with a*

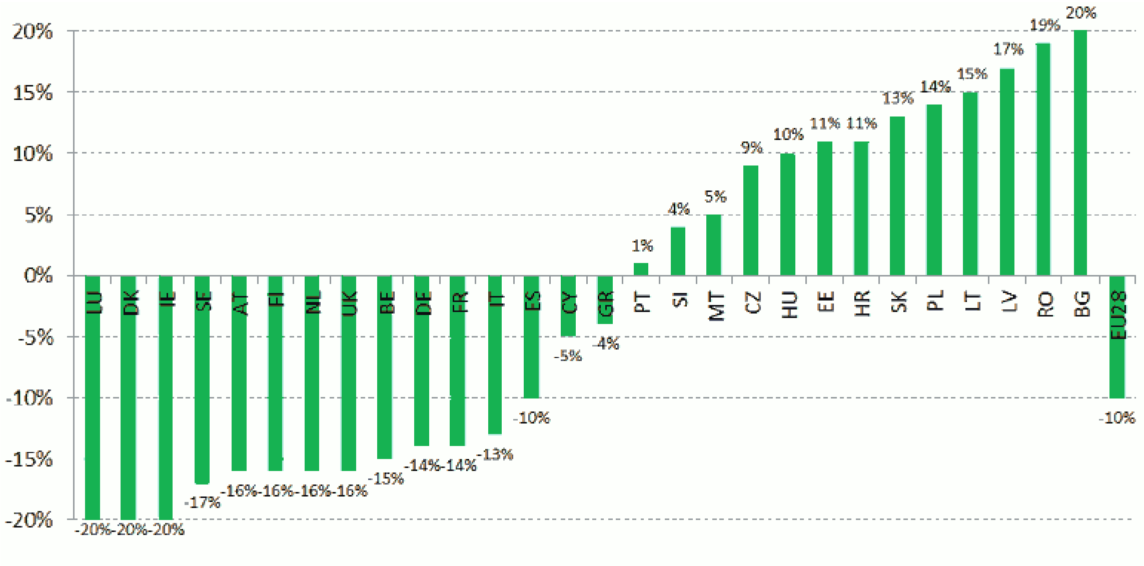
view to collectively reducing their greenhouse gas emissions by 60 to 80 % by 2050 compared to 1990.[26]

Furthermore, in the directive on energy efficiency it is stated:

The rate of building renovation needs to be increased, as the existing building stock represents the single biggest potential sector for energy savings. Moreover, buildings are crucial to achieving the Union objective of reducing greenhouse gas emissions by 80-95 % by 2050 compared to 1990.[27]

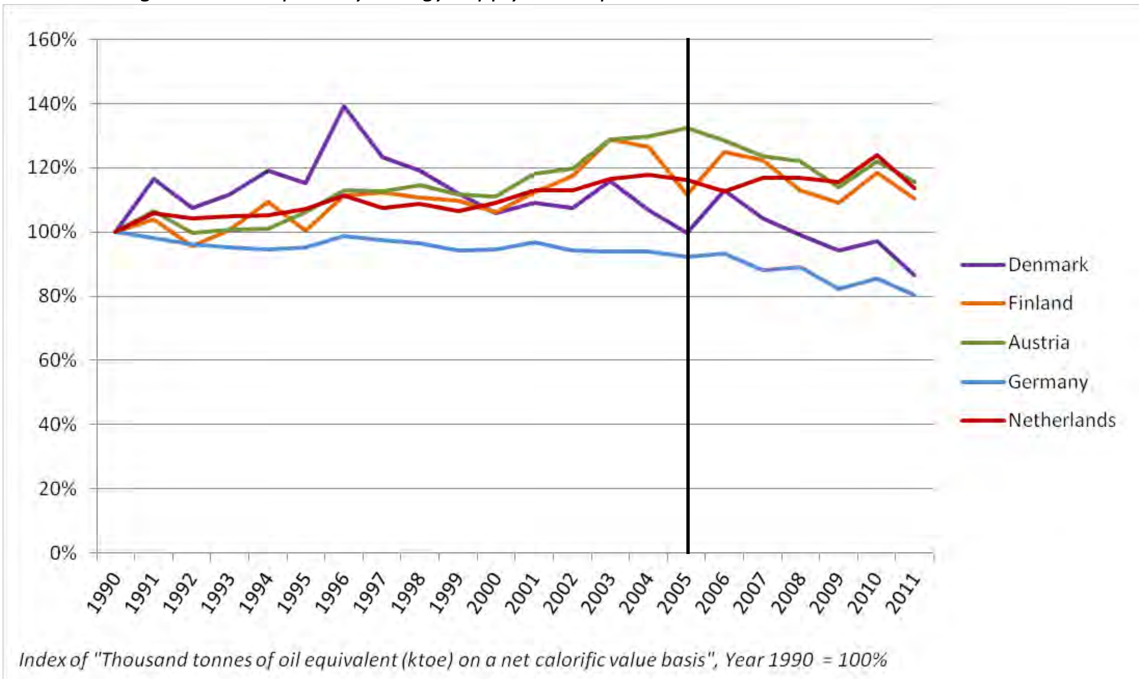
Greenhouse gas emission targets for 2020 have been set based on Member States' relative wealth (measured by Gross Domestic Product per capita). They range from a 20% emissions reduction by 2020 (from 2005 levels) for the richest Member States to a 20% increase for the least wealthy one, Bulgaria.

Figure 4: National emission targets for 2020 (from 2005 levels)[28]



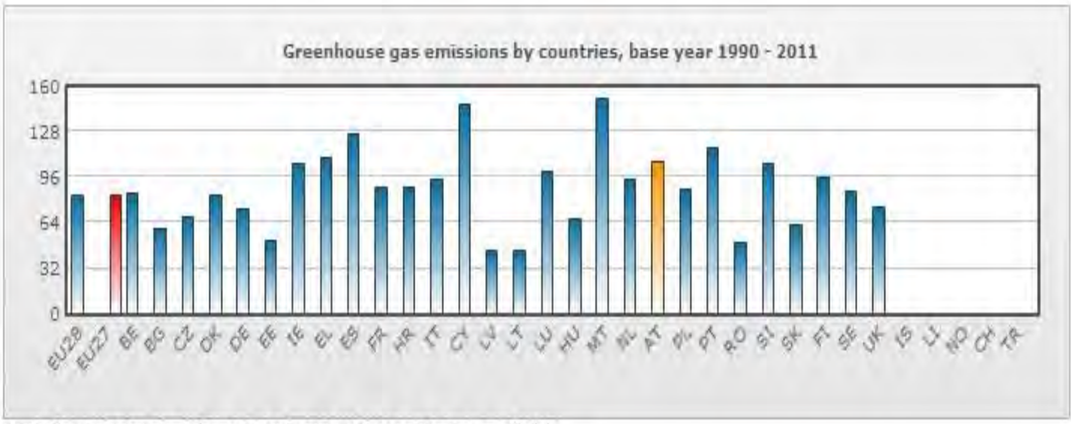
How the countries analysed in this study are progressing can be seen in figure 5,

Figure 5: Total primary energy supply development 1990-2011 – Non-Renewables[29]



and also in figure 6:

Figure 6: Greenhouse Gas Emissions by Countries[30]



Data for 1990-2010 for ME, HR, MK, TR, US, JP not available

Greenhouse gas emissions

Greenhouse gas emissions, base year 1990 (Index 1990 = 100)

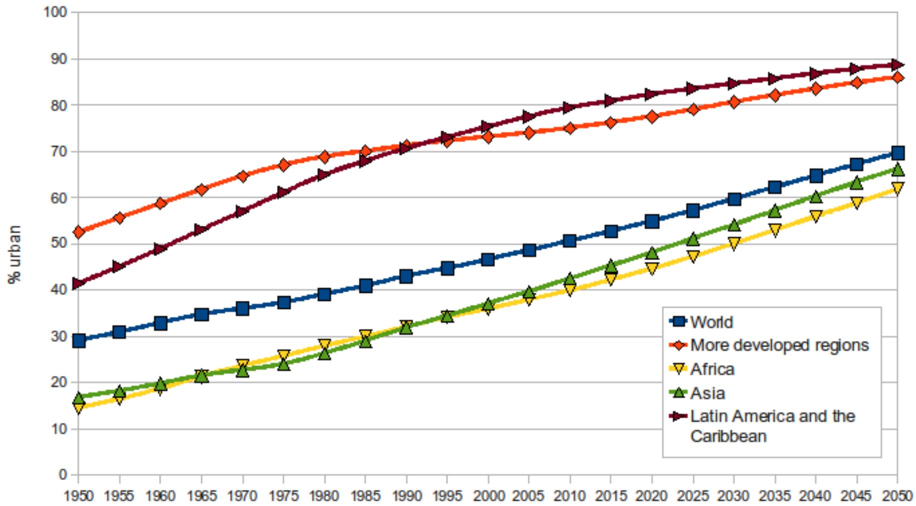
While the national emission targets for 2020 seem easily achievable for most Member States, the target for 2050 is another story altogether:

> *In order to keep climate change below 2°C, the European Council reconfirmed in February 2011 the EU objective of reducing greenhouse gas emissions by 80-95% by 2050 compared to 1990, in the context of necessary reductions according to the Intergovernmental Panel on Climate Change by developed countries as a group. This is in line with the position en-*

dorsed by world leaders in the Copenhagen and the Cancun Agreements. These agreements include the commitment to deliver long-term low carbon development strategies. Some Member States have already made steps in this direction, or are in the process of doing so, including setting emission reduction objectives for 2050.[31]

With the ongoing and projected urbanization – figure 7 – it is obvious that such a target can only

Figure 7: Percentage of Population Living in Urban Areas by Region, 1950-2050[32]



be achieved if, and only if each and every city in Europe reduces its greenhouse gas emissions by 80-95% by 2050 compared to 1990. Such is the rational of the European Initiative on Smart Cities of *The European Strategic Energy Technology Plan*:

> *The European Initiative on Smart Cities aims to demonstrate the feasibility of rapidly progressing towards our energy and climate objectives at a local level while proving to citizens that their quality of life and local economies can be improved through investments in energy efficiency and reduction of carbon emissions. This Initiative will foster the dissemination throughout Europe of the most efficient models and strategies to progress towards a low carbon future.*[33]

1.3 Societal benefit dimension

Smart City as an investment and an endeavour to improve a city's infrastructure, contributes value to society. Unfortunately, such additional benefit is unevenly distributed. Worse, the benefit itself is multidimensional, including increasing air quality and quality of life, reducing primary energy consumption, decreasing energy imports, reducing greenhouse gas emissions, accelerating the spread of innovative technological solutions and improving the competitiveness of industry. Because of this, smart city investments face the two well-known dilemmas described in the following.

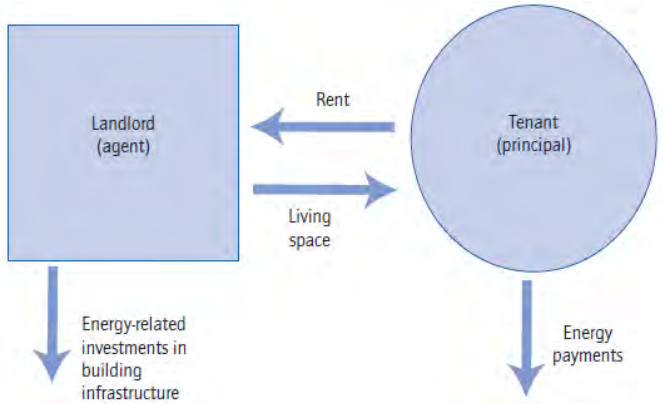
Pareto improvement

Given an initial allocation of goods among a set of individuals, a shift to a different allocation that makes at least one individual better off without worsening any other individual's situation is called a Pareto improvement. An allocation is defined as "Pareto efficient" when no further Pareto improvements can be made. It is important to note, however, that a change from an inefficient allocation to an efficient one is not necessarily a Pareto improvement. Thus ensuring that nobody is disadvantaged by a change may require compensation of one or more parties. For instance, if a smart city investment reduces greenhouse gas emission from thermal power stations, the situation deteriorates sharply in the view of the greenhouse gas emitter. However, the loss to the electric utility will be more than offset by the reduction of external costs. This means the electric utility can be compensated for the loss while still leaving a net gain for others in the economy, a Pareto improvement. In real-world practice, such compensations have unintended consequences. They can lead to incentive distortions over time as agents anticipate such compensations and change their actions accordingly.

Principal-agent problem[34]

The problem arises where two parties have different interests and asymmetric information (the agent having more information) such that the principal cannot directly ensure that the agent is always acting in the principal's best interests particularly when activities that are useful to the principal are costly to the agent. Moral hazard and conflict of interest may arise. Indeed the principal may be sufficiently concerned at the possibility of being exploited by the agent that he chooses not to enter into a transaction at all when that deal would have actually been in both parties' best interests: a suboptimal outcome that lowers welfare overall. The common principal-agent relationship described in energy efficiency studies is the landlord-tenant situation, shown in *figure 8.*

Figure 8: Energy-related transaction between a landlord and a tenant[35]



In this example, the tenant pays rent to the property owner in exchange for use of the building. The tenant pays energy costs that are largely determined by the infrastructure present in the building. The property owner makes (or declines to make) investments in the building to lower its energy consumption. The property owner has no incentive to make efficiency investments because only the tenant benefits from these reduced costs. If energy prices rise, the property owner still lacks any incentive to respond by making additional investments to improve efficiency.

1.4 Technology dimension

Smart City is an innovation because it is a *process, including its outcome, by which new ideas respond to societal or economic needs and demand and generate new products, services or business and organisational models that are successfully introduced into an existing market or that are able to create new markets and that contribute value to society*[36]. However, the Smart City concept is primarily based on existing technologies. The challenge is the seamless integration of these different technologies. Constituting technologies of Smart City are:

- Information and communications technology, e.g. internet of things, big data, collaborative consumption and automatic control
- Low-energy buildings, encompassing high levels of insulation, energy efficient windows, low levels of air infiltration and heat recovery ventilation (to lower heating and cooling energy)
- Smart meter and smart grid
- Solar energy technology, e.g. solar heating, solar cooling, photovoltaics
- Sustainable transport, e.g. migrating transportation from fossil-based energy to other alternatives
- Zero emission electricity production

The basis of the technology dimension in the EU context is the *Strategic Energy Technology Plan* (*SET-Plan)*[37] and the SET-Plan Implementation[38], i.e. the European Initiative on Smart Cities[39]:

> *Local authorities will propose and implement holistic problem-solving approaches, integrating the most appropriate technologies and policy measures. This would involve ambitious and pioneer measures in buildings, energy networks and transport.*
>
> ***Buildings***
>
> *New buildings with net zero energy requirements or net zero carbon emissions when averaged over the year by 2015, thus anticipating the requirements of the recast Directive on the energy performance of buildings (EPBD). This requirement could be anticipated (e.g. 2012) for all new buildings of the local public authority (city).*
> *Refurbish of the existing buildings to bring them to the lowest possible energy consumption levels (e.g. passive house standard or level of efficiency that is justified by age, technology, architectural constrains) maintaining or increase performances and comfort. This would include innovative insulation material (solid insulation, vacuum insulation, vacuum windows, cool roofs, etc.)*
>
> ***Energy networks***
>
> *Heating and Cooling*
> *Innovative and cost effective biomass, solar thermal and geothermal applications*
> *Innovative hybrid heating and cooling systems from biomass, solar thermal, ambient thermal and geothermal with advanced distributed heat storage technologies.*
> *Highly efficient co- or tri-generation and district heating and cooling systems.*
>
> *Electricity*
> *Smart grids, allowing renewable generation, electric vehicles charging, storage, demand response and grid balancing.*

Smart metering and energy management systems.
Smart appliances (ICT, domestic appliances), lighting (in particular solid state lighting for street and indoor), equipment (e.g. motor systems, water systems)
To foster local RES electricity production (especially PV and wind applications).

Transport

Low carbon public transport and individual transport systems, including smart applications for ticketing, intelligent traffic management and congestion avoidance, demand management, travel information and communication, freight distribution, walking and cycling.
Sustainable mobility: advanced smart public transport, intelligent traffic management and congestion avoidance, demand management, information and communication, freight distribution, walking and cycling.

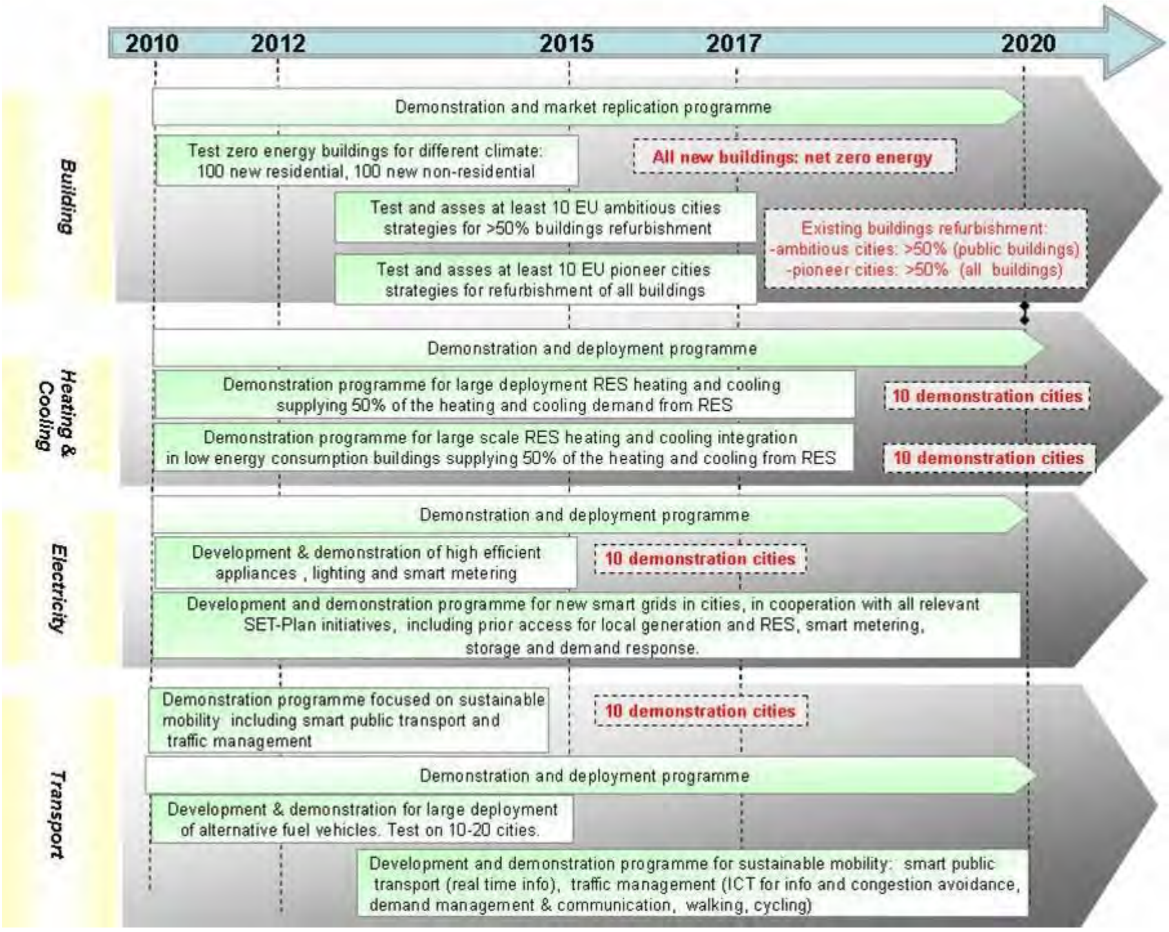
1.5 Public policy dimension

Public policy is the guide to action taken by the administrative executive branches of the state with regard to a class of issues in a manner consistent with law and institutional customs. The European Commission's Smart Cities public policy is stated in the Smart Cities and Communities – European Innovation Partnership[40]:

The SCC (Smart Cities and Communities European Innovation Partnership) is a partnership across the areas of energy, transport and information and communication with the objective to catalyse progress in areas where energy production, distribution and use; mobility and transport; and information and communication technologies are intimately linked and offer new interdisciplinary opportunities to improve services while reducing energy and resource consumption and greenhouse gas and other polluting emissions.

The objectives of the SCC will be by 2020 to demonstrate and scale up at least 20 major innovative solutions that combine energy, transport and ICT technologies and enable pioneering cities to outperform in terms of achieving the EU targets for reducing carbon emissions, use of renewable energy sources, and for increasing energy efficiency.

Figure 9: Indicative Roadmap of the European Initiative on Smart Cities[41]



In line with the Framework Programme for Research and Innovation (2014-2020), the European Union's focus for Smart Cities is on *Innovation Actions*[42]:

> *Any legal entity may participate in a Fast Track to Innovation ("FTI") action. Actions funded under FTI shall be innovation actions. The FTI call shall be open to proposals relating to any technology field under the specific objective "Leadership in enabling and industrial technologies" providing dedicated support for research, development and demonstration and, where appropriate, for standardisation and certification, or to any of the specific objectives under the priority "Societal challenges". The activities shall cover the full cycle from basic research to market, with a new focus on innovation-related activities, such as piloting, demonstration activities, test-beds, support for public procurement, design, end-user driven innovation, social innovation, knowledge transfer and market take-up of innovations and standardisation.*

Thus, for 2014-2020 the European Commission's Smart Cities public policy is focussing less on funding research than on fostering innovation-related activities, such as piloting and demonstration activities, which require development but not necessarily research – the SCC lighthouse projects[43].

Additionally, the European Union's directive on energy efficiency[44] specifies measures that contribute to cities becoming smart(er):

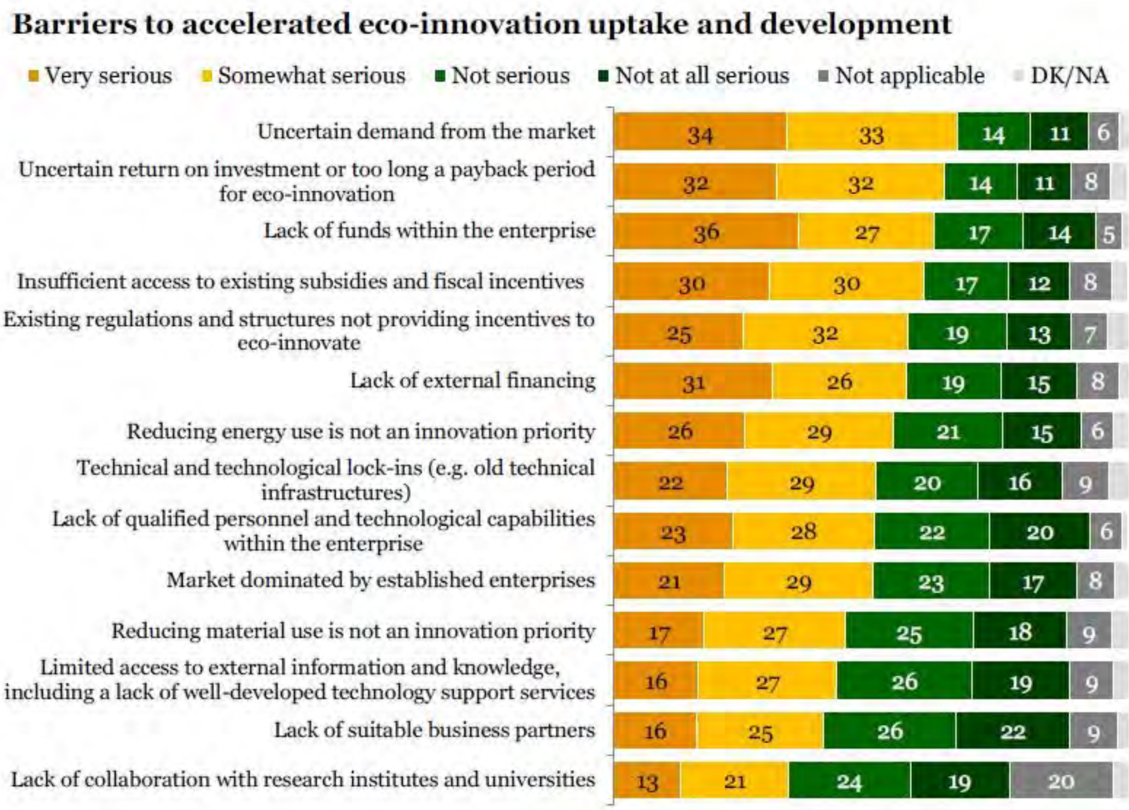
- *Member States shall establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private.*
- *Each Member State shall ensure that, as from 1 January 2014, 3 % of the total floor area of heated and/or cooled buildings owned and occupied by its central government is renovated each year to meet at least the minimum energy performance requirements.*
- *Member States shall ensure that final customers for electricity, natural gas, district heating, district cooling and domestic hot water are provided with competitively priced individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use.*
- *Member States shall adopt policies, which encourage the due taking into account at local, and regional levels of the potential of using efficient heating and cooling systems, in particular those using high-efficiency cogeneration. Account shall be taken of the potential for developing local and regional heat markets.*
- *Member States shall take appropriate measures to remove barriers to energy efficiency as regards the split of incentives between the owner and the tenant of a building or among owners, with a view to ensuring that these parties are not deterred from making efficiency-improving investments by the absence of rules for dividing the costs and benefits between them.*

2 BARRIERS TO SMART CITY MARKET- / DEMAND-PULL

It is generally accepted that rapid dissemination of innovative energy technologies contributes to climate protection and to strengthening of new and innovative business in this domain. Hence, how can the rate of diffusion of new energy technologies and thus of smart city technologies that are already commercially available be increased, when at the same time this rate is influenced by the prevailing general framework and numerous, partly interdependent individual decisions? This question has so far received little attention. The *Good Practice Policy Framework for Energy Technology*[45] constitutes a basis to tackle this issue as well as the article *Marginalization of end-use technologies in energy innovation for climate protection*[46].

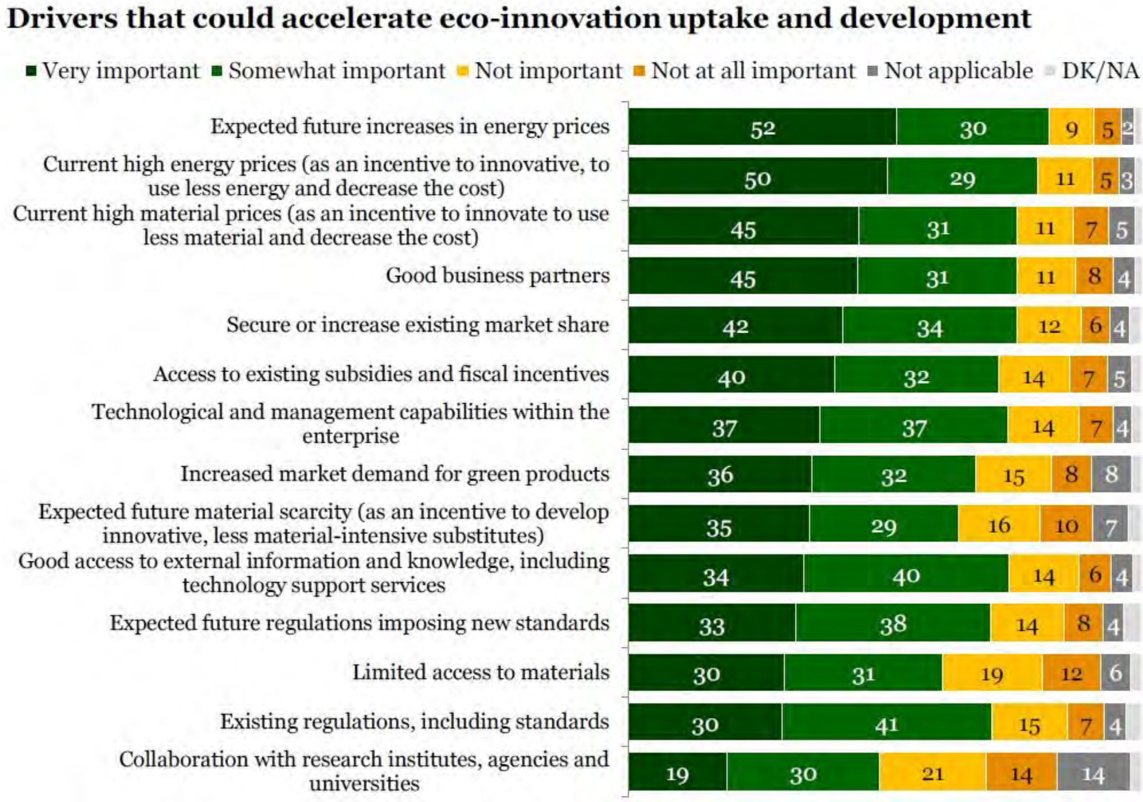
In a study commissioned by the EC Directorate-General Environment, 5.222 managers of SMEs in the 27 EU Member States were interviewed via telephone to *investigate the behaviour, attitudes and expectations of entrepreneurs towards the development and uptake of eco-innovation as a response to rising prices of resources and resource scarcity*[47]. Figure 10 sums up the findings regarding the barriers in the respective companies (the list of barriers was predefined).

Figure 10: Barriers to eco-innovation uptake – Eurobarometer[48]



Besides the barriers, a list of possible drivers of eco-innovation uptake and development was presented to the contacted managers which was to be rated by importance to the respective manager's company.

Figure 11: Drivers of eco-innovation uptake – Eurobarometer[49]



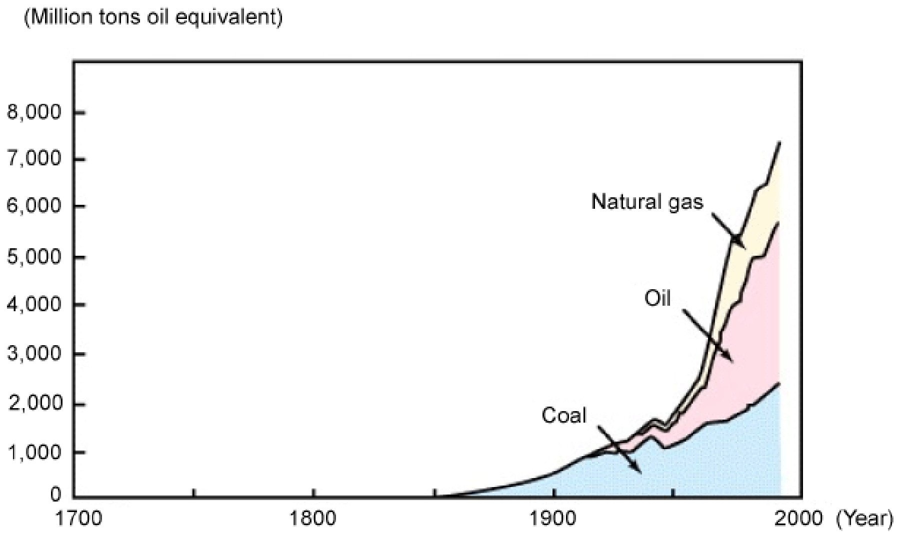
From these barriers, one might conclude that uncertainty about demand from the market and thus uncertainty about return on investment are the greatest barriers while collaboration with research institutions play a minor role. This is well in line with the findings on diffusion of innovations[50] and the lean start-up movement[51]. However, these are not the only issues that might slow down the adoption of smart cities technologies.

2.1 Economies of scale

The simple denotation of *economies of scale* is doing things more efficiently with increasing size or speed of operation. Economies of scale often originate with fixed capital, which is lowered per unit of production as design capacity increases. In wholesale and retail distribution, increasing the speed of operations, such as order fulfilment, lowers the cost of both fixed and working capital. Other common sources of economies of scale are purchasing (bulk buying of materials through long-term contracts), managerial (increasing the specialization of managers), financial (obtaining lower-interest charges when borrowing from banks and having access to a greater range of financial instruments), marketing (spreading the cost of advertising over a greater range of output in media markets), and technological (taking advantage of returns to scale in the production function).

Some of the comparatively new smart city technologies, e.g. solar heating and cooling, RES electricity production, and low carbon public transport and individual transport systems are competing with well-established technologies based on fossil fuel. Given that fossil fuels are in use since the middle of the 19th century, the advantage of fossil fuel based technologies in terms of economies of scale is obvious.

Figure 12: World fossil fuel consumption



Source: Environment Agency's "White Paper on the Environment" (1998)

2.2 Network effect

A network effect is the effect that one user of a good or service has on the value of that product to other people. When network effect is present, the value of a product or service is dependent on the number of others using it. The classic example is the telephone. The more people who own telephones, the more valuable the telephone is to each owner. This creates external benefit because a user may purchase a telephone without intending to create value for other users, but does so in any case. Online social networks work in the same way, with sites like Twitter and Facebook becoming more useful as more users join. Over time, network effects can create a bandwagon effect as the network becomes more valuable and more people join, in a positive feedback loop.

Less known, nevertheless still existing is network effect in district heating and cooling systems. The more people are using district heating and cooling, the more cost-efficient the district heating and cooling system is for each user. This creates external benefit because a user may use a district heating and cooling system without intending to create value for other users, but does so in any case.

Network effect also occurs with filling stations and, especially, charging stations. In case private investors (rather than public investors) build such infrastructure, a chicken-and-egg situation ensues. As long as no charging stations exist, users will be reluctant to buy an electric car. Vice versa, as long as no one drives an electric car, private investors will be disinclined to build charging stations.

2.3 Sunk cost fallacy

A sunk cost is a past cost that has already been incurred and cannot be recovered. The sunk cost is distinct from economic loss. An example of sunk costs may be investment into a power station that now has a lower value or no value whatsoever. For example, the amount of € 20 million has been spent on building a new power station; the value at present is zero because it cannot be operated without losses due to high prices of fossil fuel and low prices of electricity. The plant could be completed for an additional € 10 million and be operated with an annual loss of € 1 million, or abandoned and a different but profitable plant built for € 15 million. It should be obvious that abandonment and construction of the alternative power station is the more rational decision, even though it represents a total loss of the original expenditure – the original sum invested is a sunk cost. If decision-makers have the wrong incentives, the completion of the plant may be chosen. For example, politicians or managers may have more incentive to avoid the appearance of a total loss.

Many people have strong misgivings about "wasting" resources (loss aversion). In case of a non-refundable ticket, many people, for example, would feel obliged to go to the performance despite not really wanting to anymore, because doing otherwise would be wasting the ticket price; they feel they've passed the point of no return. This is sometimes referred to as the sunk cost fallacy. This behaviour is inefficient because it misallocates resources by depending on information that is irrelevant to the decision being made. Colloquially, this is known as "throwing good money after bad".

The sunk cost fallacy is also known as the "Concorde Fallacy", referring to the fact that the British and French governments continued to fund the joint development of Concorde even after it became apparent that there was no longer an economic case for the aircraft. The project was regarded as a "commercial disaster" but political and legal issues had ultimately made it impossible for either government to pull out.

Recently, a couple of fossil fuel based power stations were built and completed in Europe but never went operational due to very low electricity prices. The completion of those fossil fuel based power stations may be considered as the result of sunk cost fallacy resulting in higher stranded assets than might have been unavoidable.

> *Over the last 18 months, an increasing number of major EU utilities have decided to mothball or prematurely close recently built, high-efficiency combined-cycle gas turbine (CCGT) power plants, motivated by the combined effects of decreased electricity demand, changing fuel prices and depressed carbon prices. As write-downs on gas generation assets have been reported across the continent, EU energy markets have seen high-performing CCGT plants rendered stranded assets, while coal generation has gained market share. These stranded assets have affected company balance sheets and disincentivised capacity investment. Beyond financial impacts on firms and investors, decisions to mothball CCGTs have led to increasing carbon emissions in some countries and compromised system security in others*.[52]

Table 1: EU utility impairments during 2013 – thermal and gas assets (in million EUR) [53]

Utility	Date	Total Impairment	Thermal impairment	Gas-power impairment	Assets noted
Statkraft	14-Feb-13	375.95	274.12	274.12	German gas-power assets
GDF Suez	28-Feb-13	2,000.00	2,000.00	2,000.00	EU gas-power assets
SSE	22-May-13	692.87	362.00	> 327.80	UK CCGTs, coal assets
Verbund	12-Jun-13	1,130.00	1,030.00	659.00	Austrian and French CCGTs
Vattenfall	23-Jul-13	3,462.18	2,168.20	> 1,690.00	Dutch gas-power and coal assets
GDF Suez	31-Jul-13	200.00	200.00	200.00	Dutch, French and German CCGTs
RWE	14-Aug-13	800.00	800.00	> 800.00	Dutch thermal generation assets
Total		8,661.00	6,834.32	> 5,950.92	

As a side effect, the money required to complete these plants is not available for smart city technologies, i.e. smart grids and local RES electricity production.

2.4 External costs

External costs are the costs that affect a party who did not choose to incur that cost. For example, activities that cause air pollution impose health and clean-up costs for the whole society. If external costs exist, such as pollution, the producer/user may choose to produce/use more of the product than would be produced/used if the producer/user were required to pay all associated external costs. Overall cost to society is defined as the sum of the imputed monetary value of costs to all parties involved. Thus, unregulated markets in goods or services with significant external costs generate prices that do not reflect the full social cost of their transactions; such markets are therefore inefficient.

In the context of production and use of buildings, energy networks and transport external costs are:

- Air pollution from burning fossil fuels,
- Anthropogenic climate change from burning oil, gas, and coal.

Because of such external costs, market prices of fossil fuels are lower than they should be; giving fossil fuels a competitive advantage over other sources of energy.

2.5 Lock-in

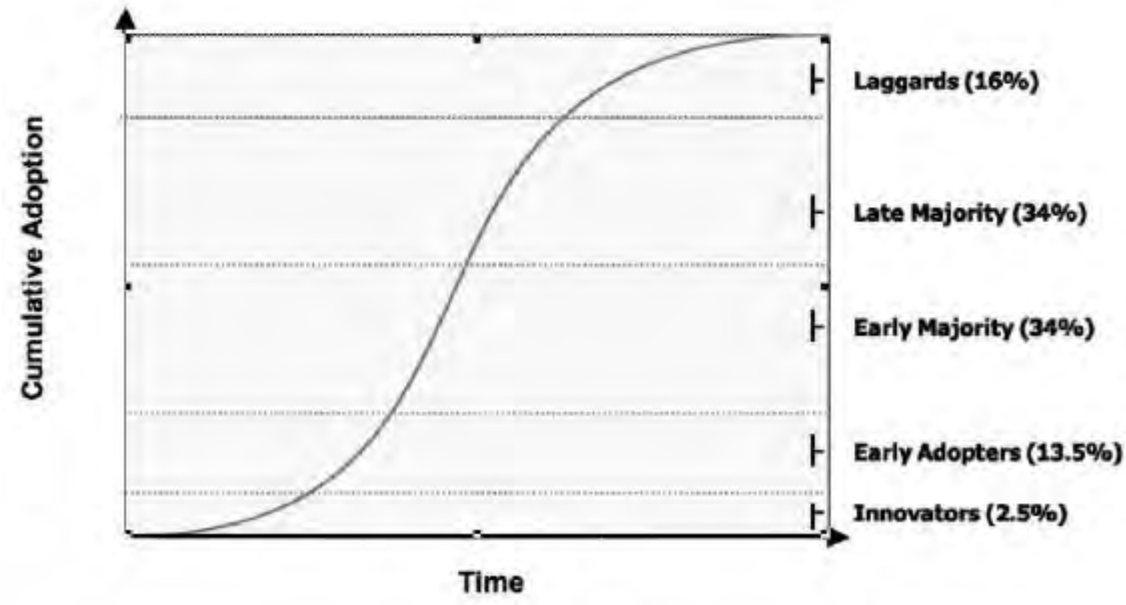
Lock-in means that a particular technology is dominant, not because its inherent costs are low or performance is good, but because it enjoys the benefits of increasing returns to scale. As a result, decision makers are greatly influenced by the dominance of a technology rather than by their preferences for its inherent properties. The wider system can therefore not easily escape the dominant technology. Increasing returns to scale can be due to a range of demand- and supply-side factors, including economies of scale in production, learning effects and infrastructure availability. The result of lock-in is that decision-makers feel forced to choose the dominant technology, even if their intrinsic preference for it might be low.

Understanding of how markets operate is based upon the assumption of diminishing returns: products that get ahead in a market eventually run into limitations, so that a predictable equilibrium of market shares is reached. But economies have undergone a transformation from bulk-material manufacturing to design and use of technology. As this shift has taken place, the underlying mechanisms that determine economic behaviour have shifted from ones of diminishing to ones of increasing returns. Increasing returns are the tendency for that which is ahead to get farther ahead, for that which loses advantage to lose further advantage. They are mechanisms of positive feedback that operate within markets to reinforce that which gains success or aggravate that which suffers loss. Increasing returns generate not equilibrium but instability: If a technology gets ahead, increasing returns can magnify this advantage, and the technology can go on to lock in the market.[54]

2.6 Rate of adoption

Any new technology follows the same diffusion pattern when becoming available.

Figure 13: Rate of Adoption Curve[55]



At the beginning, growth is exponential. Thus depending on the annual growth/adoption rate time until the early majority adopts a new technology may vary between a couple of months to even centuries. Two and a half centuries passed from the first demonstration that citrus fruits prevent scurvy until citrus use was mandated in the British merchant marine, despite the importance of the problem and unambiguous evidence supplied by controlled experiments.[56] It took from 1964 when Leonard Kleinrock published his PhD Thesis on Communication Nets until late 1994 when the Internet started to become a market success.

Compared to innovations in the ICT sector the adoption rate of new technologies in buildings, energy networks and transport is low:

Cities across Europe are already planning and acting for a more sustainable future characterised by investments in innovative, integrated technologies and services such as buildings, *heating/cooling, mobility, lighting, broadband communications and other utilities. Several European cities have established programmes integrating the energy, transport and ICT sectors in order to deliver more efficient services for their inhabitants. However, these developments will not take place over night. For instance, in Europe new buildings represent only about 1% of the housing stock annually and less than 10% of road vehicle stock is newly registered each year, which means that introducing new technologies in existing cities will take time*.[57]

2.7 Business model

Today, new technologies alone are rarely successful on the market. Thus, any new technology has to be accompanied by an appropriate business model to foster adoption and increase adoption rate.

A business model describes the rationale of how an organization creates, delivers, and captures value, in economic, social, cultural or other contexts. The process of business model construction is part of the business strategy. The term business model is used for a broad range of informal and formal descriptions to represent core aspects of a business, including purpose, business process, target customers, offerings, strategies, infrastructure, organizational structures, trading practices, and operational processes and policies.

Technology based companies, intrigued by their own invention, often overlook the importance of a valid business model for the market success of a new technology:

> *By late 1999, major Google investors had started to get antsy. Google had about 50 employees at the time and was starting to catch on with Internet users, but it was bleeding cash. That's when Page and Brin started to take a closer look at GoTo.com, a rival search engine that was beginning to reap huge revenues with a novel advertising model. Like the way companies bought ads in the Yellow Pages, websites could pay for top placement on the GoTo.com results page for a given keyword. Search ads would be far more cost-efficient than other types of online ads, because advertisers would be paying to reach only those people who were already searching for their products. Instead of paying for page-views – an old-media model that had come to dominate the Web – advertisers would pay only when people actually clicked on their ads. And their placement on the GoTo.com results page would be determined through an auction, so that more desirable keywords would command higher prices, while less common keywords could be had for as little as a penny per click. As a search engine, GoTo.com had nothing on Google. But as a way of making money on searches, it was ingenious. In 2002 Google launched its own pay-per-click, auction-based search-advertising product, called AdWords Select. It was instant gold, and Google soon dropped the original AdWords altogether. As revenues rocketed, the company turned its first annual profit that year.*[58]

3 STUDY DESIGN AND METHODOLOGY

To analyse best implementation practices regarding Smart City technologies we made use of the case study approach.

> *Case studies are analyses of persons, events, decisions, periods, projects, policies, institutions, or other systems that are studied holistically by one or more methods. The case that is the subject of the inquiry will be an instance of a class of phenomena that provides an analytical frame – an object – within which the study is conducted and which the case illuminates and explicates*.[59]

Because Smart City is a relevant answer to a super wicked problem – "time is running out" – this study focusses on successful measures and actions that stimulate the market and create demand or market pull. What can one learn from such measures and actions with high leverage for accelerating demand or market pull and thus adoption rate in Denmark, Finland, Germany and The Netherlands for other countries especially for Austria?

3.1 Document analysis

For all case studies an extensive search for and, consequently, analysis of all available documents in English and German was undertaken. This included documents describing the contextual, regulative, legal and historical framework on a national level to better understand reasons why projects were done one way in one country and another way in another country. The list of all these documents can be found in *Annex IV – Knowledge Base* and, in addition in *Annex V – Notes*.

3.2 Dialogue interviews

A dialogue interview is an in-depth interview using the concept of dialogue[60] conceived by David Bohm[61]. Bohm Dialogue is a free-flowing conversation in which participants attempt to reach a common understanding, experiencing everyone's point of view fully and nonjudgmentally. This can lead to new and deeper understanding. It utilizes a theoretical understanding of the way thoughts relate to reality. This method is particularly appropriate to bring the experiences of the interviewee to the surface. To gain insights into what worked and why, as well as what did not work and why not is at the core of this type of interview. For the interviewees such conversations are also an opportunity to reflect upon their own experiences in ways they usually do not do themselves or with their project team. As such, dialogue interviews have the potential to lead to new insights for both, interviewee and interviewer that they did not have prior to the dialogue interview.

Principles of dialogue interview are:[62]

- Create transparency and trust about the purpose and the process of the interview; establish a personal connection.
- Suspend your voice of judgment to see the situation through the eyes of your interviewee.
- Do not be afraid to ask simple questions or questions you think may reveal a lack of some basic knowledge.

- Thoroughly appreciate and enjoy the story that you hear unfolding.
- Try to focus on the best future possibility for your interviewee and the situation at hand.
- Feel free to deviate from your questionnaire if important questions occur to you.
- Do not interrupt a brief moment of silence. Moments of silence can serve as important trigger points for deepening the reflective level of a conversation.
- Capture observations and insights in your journal; after the interview, record your thoughts and impressions.

Guiding questions in the dialogue interviews were:

- What were intended and what were unintended results of the undertaking?
- What was the initial reason for the undertaking?
- What were the greatest pushbacks against the implementation of smart cities technologies?
- Who were the most important supporters?
- What made the undertaking a success?
- What are the expectations and intentions for future development?
- What would you do differently if you were to undertake the project again?

The methodological rational for addressing a small number of people through dialogue interviews rather than addressing many people via a survey is to gain deeper insights from few rather than superficial answers from many. To inquire more deeply into given answers is easily done within the framework of dialogue interview and near to impossible in a survey.

3.3 Selection of interviewees

The selection of the interviewees followed the selection of the case studies of best practice projects described in *chapter 4 – Best practices of smart cities in Europe*. For each selected case study, we identified key members of the implementation team that were part of the team from the beginning until the finalization of the undertaking as well as representatives from the funding agency/institution if appropriate. We also conducted an interview with a representative from European Energy Regulators. The intention was to grasp the experiences and insights of stakeholders along the value chain of each case study: Innovators, early adopters, energy regulators, local governments, infrastructure owners, real estate owners and end users. All interviewees are listed in *Annex III – Interviewees*.

4 BEST PRACTICE SMART CITY REALISATIONS – INTERVIEW RESULTS

This chapter presents the results of the interviews for each best practice smart city realisation. Additionally, the assertions from the interviewees are backed up as much as possible by documents to validate these statements. Thus, all the citations from documents are rooted in assertions from interviewees that were investigated in detail after the interview to substantiate the content.

Based on information received through dialogue interviews with key stakeholders of the projects (see list of interviewees in Annex III) and substantiated through documentary research (see Annex IV – Knowledge Base and Annex V – Notes) the findings for each case study are structured in the following way:

Fact-Box and overview of the project

a) Intended and unintended results
b) Initial reason for undertaking
c) Pushbacks against implementation
d) Important supporters of the undertaking
e) Key success factors
f) Modifications from original concept to final implementation
g) Future development
h) Lessons learnt

Because some of the Smart City undertakings were still in progress not all aspects a)-h) could be investigated for each best practice smart city realisation. In view of that, seven Smart City smart city realisations instead of the three originally planned were investigated.

4.1 Best practice selection criteria

A considerable amount of time and effort was put into the selection of suitable smart city projects presented in this study. A number of smart and eco-city projects were considered and were assessed based on the following criteria:

- The project or initiative should be conducted in a European country.
- Transferability of the underlying concepts to the (climatic) conditions in Austria should be possible. Projects in Southern Europe were not short-listed on grounds of different climatic conditions.
- Projects and involved cities should be comparable with Austrian cities (e.g. in relation to the size or number of inhabitants).
- Priority was given to Smart City projects which are already completed or which are at an advanced state of implementation in order to gain the most evidence-based insights.
- Projects should range in category from ***"New Development"*** and ***"Retrofit"*** to ***“Brownfield Development / Urban Transformation”*** – which are presently very popular in Nordic cities (e.g. Helsinki Jätkäsaari / Kalasatama; Stockholm Royal Seaport; Copenhagen Nordhavn) – as they all reveal different aspects and challenges in the implementation.

- Initiatives should feature the integration and interconnection of various smart city concepts: distributed electricity generation, energy-efficient buildings, Smart Grids, etc.

- In addition, the aim was to identify and further examine projects, which were financed from non-public and non-EU funds, as this can offer insights into unprecedented business models and company-visions.

Based on these criteria, the following countries were selected:
- Denmark [Copenhagen; ECO-City]
- Finland [Eco-Viikki; SGEM/Smart Grids and Energy Markets]
- Germany [Hamburg]
- The Netherlands [ASC / Amsterdam Smart City; PowerMatching City]

Each case study is preceded by a short description of the status of Smart City initiatives in the respective country as well as national climate targets (where information in English was available).

Before going into detail, the countries where the selected projects and initiatives take place are compared by their respective development of total primary energy supply (TPES) in the following figures. Even though all countries in focus are situated within Europe / the EU, and should thus have their energy strategies aligned towards one common EU climate and energy target, the charts show significant differences. The chapters 4.2-4.5 aim to uncover some of the aspects that potentially led to the different developments.

Figure 14: Development of Total Primary Energy Supply 1990-2011[63]

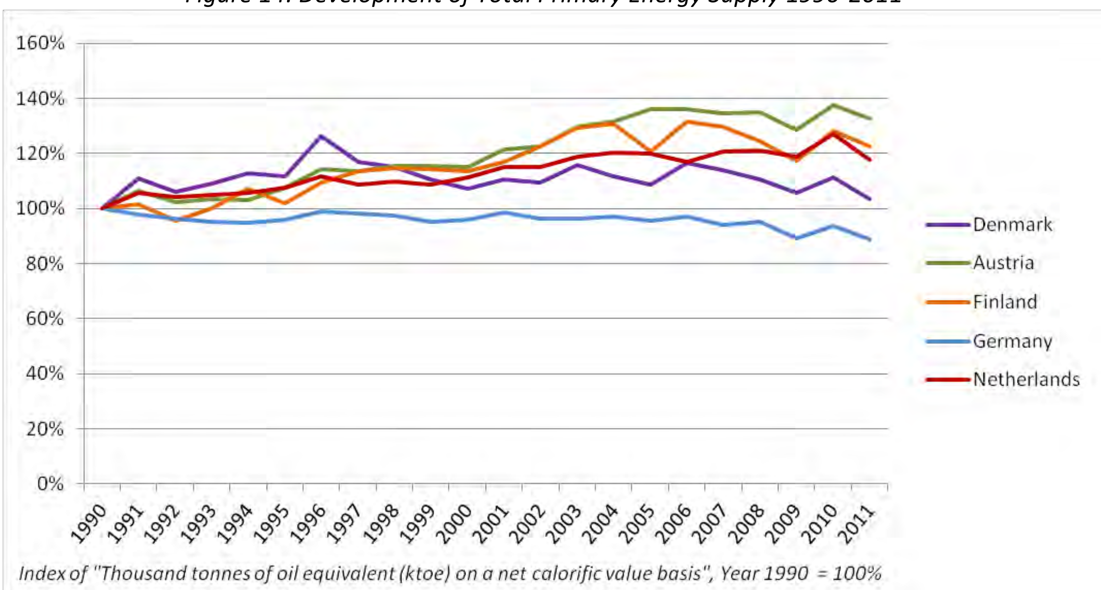


Figure 15: TPES development 1990-2011 – Renewables[64]

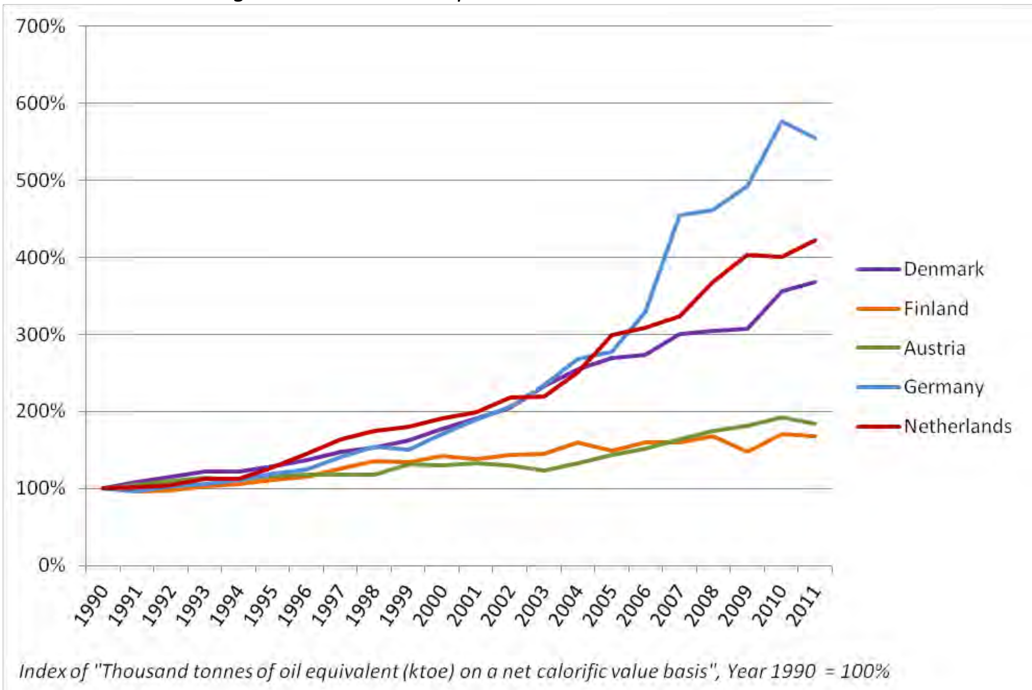
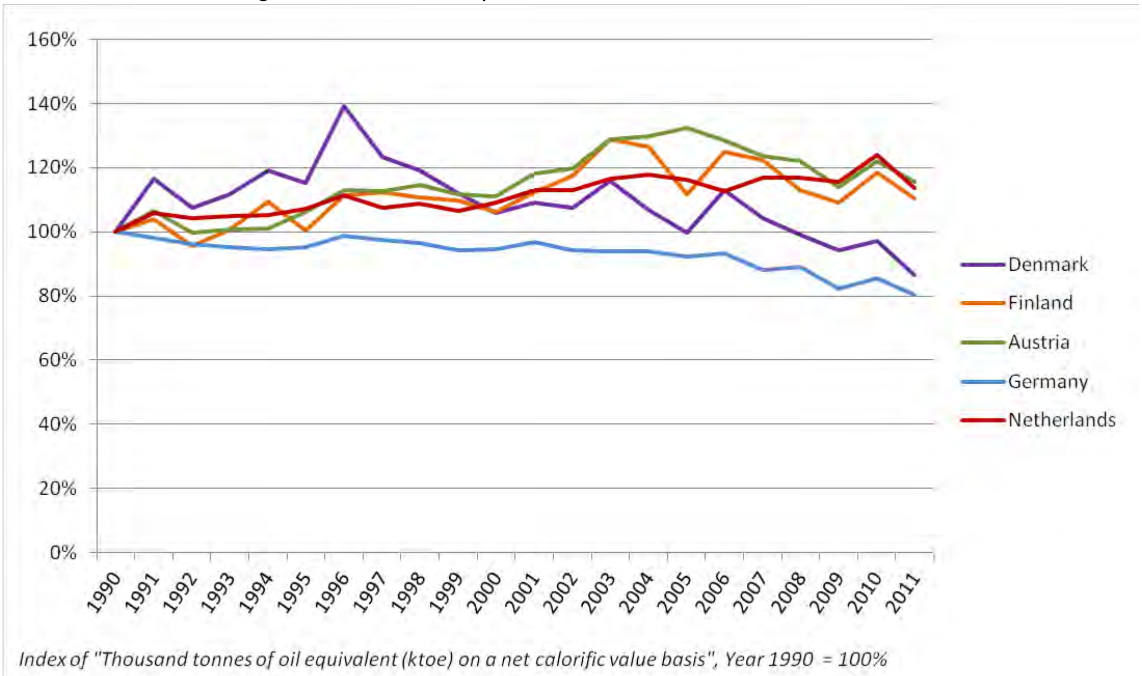


Figure 16: TPES development 1990-2011 – Non-Renewables[65]



4.2 Denmark – Smart City Framework

> *Denmark is a leader among OECD member countries in terms of renewable energy, energy efficiency and climate change policies. Since 1990, Denmark has decoupled economic growth and energy consumption while at the same time reducing greenhouse gas emissions. […] Denmark's long-term energy goal is to become independent of fossil fuel use by 2050.*[66]

To achieve this goal, the Danish parliament approved a new climate bill in June of 2014, setting clear goals for 2020 as well as for 2050 – achieving a 40% reduction of greenhouse gases compared to 1990 levels and a cut in emissions by 80-95% respectively.[67]

> *The climate bill will ensure that climate challenges are kept high on the political agenda regardless of changing governments. It is an instrument to ensure on-going progress in order to achieve the Danish goal of a society based 100% on renewable energy with lower greenhouse gas emissions by 2050.*[68]

This new climate bill includes various actions and measures such as the establishment of an independent climate council as well as the announcement of renewed climate targets in a five-year cycle. Climate targets have a perspective of ten years and are aligned with the 2050 goals.

Prior to the climate strategy, the Danish Ministry of Climate, Energy and Building reached broad political commitment to a green transition for Denmark, which is constituted in an *Energy Agreement*[69]. Besides implications on energy efficiency and sustainable energy supply, the agreements supports the phasing-out of oil-fired boilers by:

- *banning installation of oil-fired boilers and natural gas boilers in new buildings from 2013,*
- *banning installation of new oil-fired boilers in existing buildings in areas where district heating or natural gas is available from 2016,*
- *committing DKK 42 million in 2012-15 to fund the conversion from oil-fired boilers and natural gas boilers in existing buildings to renewable energy.*

Within the above-mentioned climate strategy, cities play a significant part. Therefore, the aim is to make them smarter concerning their consumption of resources and climate-damaging emissions. Consequently, Danish authorities formulated a specification of the term *"Smart City"* which instantly points the way towards research and regulations / policies, which will be essential for the realization of this vision:

> *Smart City can be defined as a city, which systematically makes use of ICTs to turn its surplus into resources, promote integrated and multi-functional solutions, and improve its level of mobility and connectedness. It does all this through participatory governance based on collaboration and open source knowledge.*[70]

ICT management and open data access become an issue or – as the Danish see it – a crucial factor in the future of smart cities:

> *The increased emphasis on open public data will inevitably play a decisive role in future Danish Smart City projects. This is because of the fact that a lot of the data which can be used to create smart solutions is generated in the public sector. Private sector use of public data can generate substantial value.*[71]

At the same time, the importance of the citizens in the greater Smart City picture / vision is acknowledged:

> *In order for the technological and political ambitions of Smart Cities to be implemented successfully, citizen acceptance and inclusion is vital. Citizens are the primary reason for the existence of the city and its policies; it is only by their support that political goals for smarter cities can be achieved.*[72]

> *Consumers will have to use power more flexibly and the entire energy system must be designed to meet the demands of fluctuating solar and energy generation.*[73]

Concerning *Smart Grids* as part of the Smart City concept, Denmark boasts expert knowledge:

> *Denmark has more smart grid projects than any other country in the EU, and it is crucial that this competitive advantage is translated into growth and employment in the future.*[74]

> *Denmark is the leading European country hosting 22% of all European Smart Grid test and demonstration projects.*[75]

4.2.1 Copenhagen

In the following, the City of Copenhagen is analysed as to the implementation of smart city technologies based on the information received during the dialogue interview with Jørgen Bolt (HOFOR).

Fact-Box Copenhagen

Web:	www.kk.dk *(see ANNEX IV for more web links)*
Type:	*Urban transformation; Brownfield development (Port area "Nordhavn")*
Promoter:	City of Copenhagen
Technologies / Goals:	• GHG Reduction (CO_2 neutral by 2025) • District Heating & Cooling • Wind power • Smart Grids

Copenhagen has the ambition of becoming the first carbon neutral capital in the world by the year 2025. Extensive refurbishing of buildings, reorganisation of energy supply and change in transport habits are some of many initiatives the City of Copenhagen will implement in order to realize this vision.[76]

a) Intended and unintended results

Transforming Copenhagen into a carbon neutral city is an ongoing undertaking, which will continue for the next 16 years. Thus, so far no results can be discussed in connection with the overall 2025 goal. However, section "*b) Initial reason for undertaking*" states the parts of the EU's smart city concept that have already been implemented.

An additional remark made by Jørgen Bolt about metering: Electricity and district heating share the same network. Smart meters for heating are already installed at every building. Thus, real time information on demand is available. The data is used to calculate the heat demand and is subsequently used for production planning as well as base for trade at the Nordpool energy market.

b) Initial reason for undertaking

The path towards a CO_2 neutral Copenhagen started in 1973. At that time, Denmark was 100% dependent on oil imports. When the oil crisis hit Denmark, the country was badly affected.

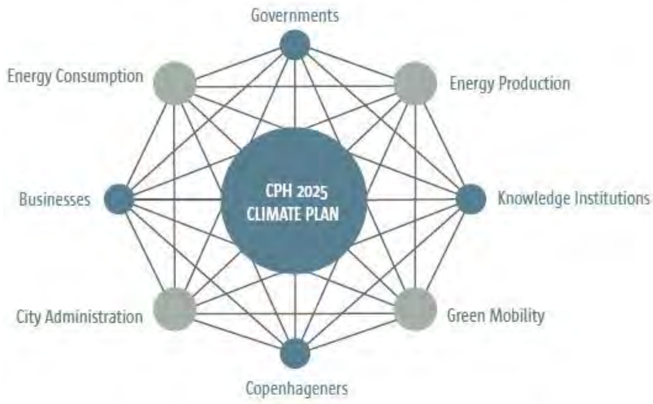
> *The solution was to reduce the city's reliance on fossil fuels by maximising energy generated from waste, biomass and other fuel sources.*[77]

One response to the situation was the promotion of thermal insulation of buildings. Another response was the implementation of a compelling heating strategy, which involved the division of the country into different districts: District heating system for the cities, and natural gas based heating for suburban areas. In 1990, the city council regulated that oil-fired burners or any other heating device were not to be replaced by new oil-fired burners. Instead, connection to the district heating network became mandatory. Interestingly the legislation did not stir up a wave of protests in the media and the public. Some homeowners were not aware of the decree until their old heating systems needed replacement. This drastic measure led to today's proportion of about 2/3 of the heating in housing being supplied by district heating. Heating in suburban areas is now based on natural gas. Rural areas may still rely on oil but are to gradually transition to heat pumps. In this context, *State of Green*, the official information platform for green solutions in Denmark notes, that Greater Copenhagen has already implemented most of the EU's smart energy city concept:[78]

- Optimal zoning of district heating and natural gas
- District heating grids with 98% connection
- Regional district heating grid interconnecting CHP plants and renewable sources – Copenhagen just bought a partly coal-fired power plant from Vattenfall to transform it into a biomass based plant – also due to the fact that fossil fuels are taxed, making biomass a substantially cheaper option.
- District cooling in the city centre
- Large thermal storages for district heating optimizing CHP plants and integrating wind energy
- Efficient use of renewable energy from waste, biomass and geothermal
- Natural gas grid to serve industries, CHP and households for cooking
- Natural gas storages to ensure available capacity
- Efficient power grid interconnecting CHP plants, wind farms and consumers
- Efficient buildings with low temperature heating systems

To continue these achievements, the *CPH 2025 Climate Plan* was specified. This holistic plan includes a collection of specific goals and initiatives within four focus areas – Energy Consumption, Energy Production, Green Mobility, and City Administration. Figure 17 depicts these focus areas and puts them into relation with the relevant stakeholders.[79]

Figure 17: Focus areas and stakeholders contributing to the CPH 2025 Climate Plan[80]



> *It is about finding solutions that are smarter, greener, healthier and more profitable: solutions that do not make it more expensive to be a Copenhagener, yet promote green growth and enhance the quality of life for the individual citizen. […] Copenhagen is ready to make the city available as a green laboratory.*[81]

The major goals related to the above presented focus areas in the 2025 plan are summarized by becoming carbon neutral by 2025 through a significant reduction in energy consumption, which is fully covered by a green energy production (mainly based on wind and biomass). In order to compensate for further emissions e.g. from transport, a surplus in green energy must be generated. To achieve this, more than 100 wind turbines alone are to be installed before 2025 – some of which will be financed through community ownership.[82]

c) Pushbacks against implementation

One issue that has not yet been solved successfully is *building refurbishment*, which is regarded as quite difficult to justify and initiate, as the owners are generally not the beneficiaries. This is especially true for areas of the city where heating is very cheap due to district heating. In order to motivate proprietors to invest in thermal refurbishment, they are allowed to increase the rent for energy efficiently refurbished dwellings – although clear regulations and limitations exist. Still, this is regarded as motivation for investments in thermal refurbishment.

d) Important supporters of the undertaking

No additional support was necessary since the base of the strategy has been set already as early as 1990 through the legislation on oil-fired burners.

e) Key success factors

In a case study on the sustainable development in Copenhagen, the Canada Research Chair on Sustainable Community Development identifies **three critical success factors** in advancing the sustainable development:[83]

- *Broad political commitment. Collaboration and unity are considered cultural norms in Denmark. In Copenhagen, significant efforts were made to collaborate across party lines and between government departments, thereby gaining approval from both the city council and the public.*
- *A long-term vision that reaches beyond mainstream initiatives. As the Copenhagen case study shows, ambitious, large-scale projects, that in some cases span decades, are possible and can provide many benefits.*
- *Priorities and initiatives based on facts and sound science. In Denmark, education is highly valued and free to all citizens, resulting in a well-informed public and an educated workforce. The city employs experts and scientists and engages external expertise, when needed.*

The above-mentioned essential success factor of collaboration was also mentioned by Jørgen Bolt during the interview. As is noticeable in other Nordic countries as well, cooperative business and cooperative thinking are a major part of the Danish culture. It is a clear driver for ventures such as the realization of a smart or CO_2 neutral city where multiple ministerial departments, agencies and companies (power utilities, grid operator, etc.) are required to work together towards a collaboratively targeted objective.

f) Modifications from original concept to final implementation

No modifications have been made so far regarding the overall goal of a carbon neutral Copenhagen by 2025.

g) Future development

The process of realizing a carbon neutral city will continue for the years to come, following the development specifications laid out in the CPH 2025 Climate Plan.

e) Lessons learnt

The explicit regulation regarding new investments and the long-term climate plan were essential as they make up a clear and transparent framework for the industry to orient itself about future investments.

On the overall social scale, the oil crisis of 1973 left a lasting impression on the population, which resulted in a positive attitude / consent of the public towards the announced climate targets and the necessary changes associated with it.

4.2.2 *ECO-City*

In the following, both ECO-City areas – Helsingør / Helsingborg and Tudela – are analysed based on the information received during the dialogue interviews with Reto M. Hummelshøj (COWI; DK) and Laura Sesma (Zabala; ES).

Fact-Box Eco-City

Project duration:	*2005-2012*	
Web:	http://www.ecocity-project.eu/ *(see ANNEX IV for more web links)*	
Type:	*Refurbishment*	
Project coordinator:	COWI AS; http://www.cowi.dk	
Technologies / Goals:	**Use of Renewable Energy Sources** • Wind energy • Solar thermal energy • Photovoltaics • Micro wind turbines • Geothermal energy • Biomass heating • Biogas heating from waste • Polygeneration from biomass and biogas **Low Carbon Technologies** • District heating • Heat pump • Insulation • Mechanical ventilation with heat recovery • Specific façade solutions • Monitoring and targeting • Efficient lighting incl. LED • Reduction of embedded energy in building construction	
Site facts:	Population involved: approx. 7,000 Geographical area coverage: 30,000 ha Approx. energy saving: 30% Approx. energy from RES: 60%	
Consortium (for DK & SE project area):	*Consultant: Energy, Engineering, Environment, Economics and management (initiator)*	COWI A/S (DK)
	Research Institute	Lund University (SE)
	Energy utility of the region	Öresundskraft (SE)
	District heating company	Helsingør Forsyning (DK)
	Waste company of the region	NSR (SE)
	Municipal housing company	AB Helsingborgshem (SE)
	Municipalities	Helsingør Kommune (DK); Helsingborg Stad (SE);

ECO-City was a large demonstration project supported by the CONCERTO Initiative of the Sixth EU Framework Programme. In this project, the communities of Helsingør (DK) and Helsingborg (SE), the community of Tudela (ES) and the community of Trondheim (NO) joined to demonstrate innovative integrated energy concepts and to share experiences and expertise. Training and dissemination were also coordinated together. The overall focus of the project was on refurbishment of existing buildings and on construction of new eco-buildings in as many variants and aspiration levels as possible in order to establish competences via **learning by doing**.

In the following, the description and analysis of this project focuses on those parts of ECO-City that were realized in Denmark/ Sweden and Spain.

a) Intended and unintended results of the undertaking

Helsingør (DK) and Helsingborg (SE)

The cities of Helsingborg (SE) with 97.122 inhabitants and Helsingør (DK) with a population of 46.279 are separated by only 4 km of water. Since both cities have ambitions towards a more energy efficient future, the area complies with the goals of the Concerto program. At the time of the start of the project, the municipality of Helsingborg pursued goals to reduce the total energy consumption per inhabitant by four percent by 2010 (based on 1990 levels), while reducing the fossil fuel input to the district heating and power system by 20%. In Helsingør, the aim was to realize a 30% reduction of energy consumption for heating, hot water, lighting, ventilation and cooling of new eco-houses. The specific technologies that were included to realize the Eco-City project and to achieve these broader municipal goals are listed in the fact-box above.

The project set a reference for new standards in refurbishment, new buildings, energy supply, and the use of polygeneration. The following graph gives a brief summary of the overall achieved objectives for the Helsingør / Helsingborg area. For more detailed information on the technical objectives see the *ECO-City Final activity report*[84].

Figure 18: Objectives Helsingør (DK) and Helsingborg (SE)[85]

A **new type of comfort metering and control system** was implemented in selected newly constructed buildings of Helsingborgshem (municipal housing company). The system has increased the tenants' awareness about energy consumption as energy consumption is visualised on a screen. This led to energy savings. Besides energy consumption, the metering system also handles comfort metering, burglar alarm, fire alarm etc. improving the tenant's attention to the monitoring screen.[86]

An **innovative billing procedure** (comfort metering) was also implemented by Helsingborgshem to motivate tenants to save energy in space heating: The basic rent allows for a room temperature of 21°C, a lower temperature leads to a discount in the rent, a higher temperature results in a rent increase.

> *A computer system translates the temperature into kronor for each degree it differs from the set level. "We should be able to reduce heat consumption by around 15-17 per cent. We also intend to monitor hot water consumption. We have found that it falls by an average of about 30 per cent if we monitor consumption by tenants saving hot water," says Kjell Persson of Helsingborgshem. The aim is for the system to be installed in approximately 600 apartments per year. "Apart from lower housing costs, carbon dioxide emissions will be reduced owing to lower heating and water consumption. The size of the reduction depends on the type of energy used, but in the first phase we expect to reduce emissions by around 74 tonnes," Kjell explains.*[87]

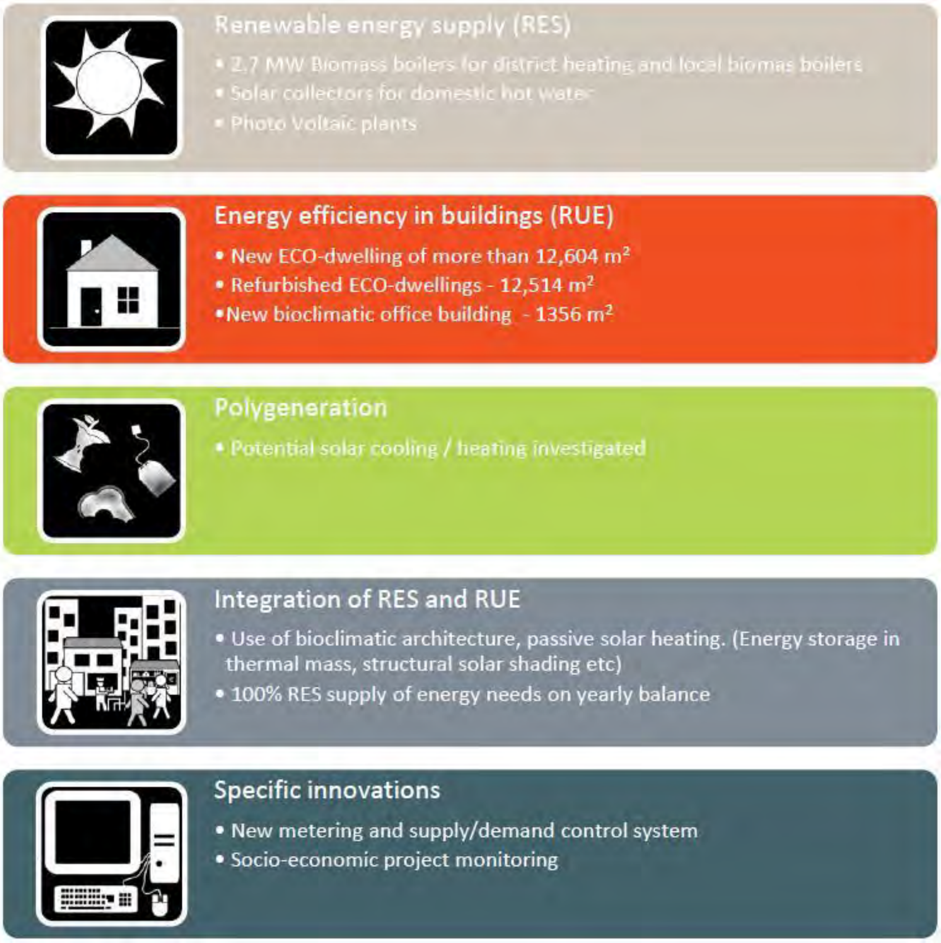
Another specialty of ECO-City was that it included **housing projects in different parts of the cities** while other projects of this kind often focus on one district only.

Tudela (ES)
The situation of this community during the project was especially complex on several economic, political, and administrative levels:
The international economic crisis with its climax in 2008 led to an implosion of an enormous speculation bubble of the Spanish construction sector. The criteria of economic sustainability of buildings changed drastically as the market for new constructions – except for social housing – broke down. The focus of the construction sector shifted to refurbishment projects. Consequently, the original project goal for the area, the construction of a whole new quarter with a luxury apartment complex and golf course, was abandoned. Due to administrative and political reasons, the municipality changed the entire project and its location several times. In addition, a change in personnel left the project unsupervised for a long period. The resulting stagnation caused project partners to discontinue their participation.
After more sustainable project goals were adopted – namely construction of social housings and refurbishment of an old quarter – a new project partner was introduced, responsible for refurbishment and community involvement. Only then did the project progress towards attainment of the original goal: To achieve a sustainable and energy efficient city through reduction of emissions and promotion of renewable energy sources.
Community involvement was achieved by setting-up a project office for the public / residents, several dissemination activities and participation of the coordination team at public events (e.g. market day). These measures invited the residents to participate actively in the process by expressing desires and ideas about what aspects to maintain and what to change in the quarter. In parallel, the technical analysis of the buildings started and representatives of each neighbourhood community were interviewed to collect information on the social situation of the respective community, existing conflicts between neighbours, etc.[88]

Concerning overall energy efficiency, seven blocks of buildings with 122 new ECO-dwellings were constructed. A public building and 146 dwellings participated in the refurbishment of the thermal insulation, including facades, roofs, and windows. The project also included the complete renovation of a central heating system (installation of a biomass boiler) for 486 apartments distributed in 30 buildings.
Objectives that could not be fulfilled in Tudela (e.g. wind turbines and energy efficient buildings) were transferred to the areas in Scandinavia to comply with the initial scope of the project.
For the residents some results are directly relevant. Prices of the ECO-apartments are not substantially higher compared to conventional ones. The new / refurbished buildings are less costly due to the energy savings achieved. The ECO-dwellings guarantee a high level of comfort as the temperature in the apartment is stable throughout the year and residents do not need individual air conditioning units.

The following graph gives a brief summary of the overall achieved objectives for the Tudela area. For more detailed information on the technical objectives see the ECO-City Final activity report[89].

Figure 19: Objectives Tudela (ES)[90]



For details on the achieved energy and CO_2 savings for the ECO-City project as a whole see the *ECO-City Final activity report*[91].

b) Initial reason for undertaking

The project was initiated by COWI in Denmark, who found support for the project within the municipality of Helsingør and within the community in Helsingborg.
The initial idea behind ECO-City was to **stimulate the market by constructing state-of-the-art eco-buildings** and thus to create a market pull. Perception was that in this field of technology huge amounts of money are spent on research and papers with little or no effect on the market. Therefore, the idea was to use a different approach by **gathering key actors** and **inducing collective work** over the course of some years. Despite the high administrative burden, the EU-Concerto programme was used as a kickstarter – also for finding adequate partners in other EU countries.

COWI, which was founded in 1930 by engineering professors, has a strong background in the planning and construction of bridges, marine constructions, airports and (energy efficient) buildings/ housing. Its range of services includes environmental impact studies. The energy efficiency of buildings including intelligent metering played a significant part in the ECO-City project, while the integration/ implementation of smart grid was not an objective.

c) Pushbacks against implementation

Helsingør (DK) / Helsingborg (SE)
There were no major resistances on behalf of the authorities since the areas were already committed to achieving ambitious climate targets.

The (initially) selected buildings were inhabited by tenants with low income since the rents were low due to the low standard of the buildings. As tenants did not want to move out, rents could not be raised to make investments in energy efficiency economically reasonable. No agreement with the tenants could be reached during ECO-City project.
Additionally, the selected buildings eventually displayed more technical problems than was assumed at first. A review of the initial site selection identified other areas more suitable for achieving the project goals.

Tudela (ES)
It was hard to convince the residents to agree to the refurbishment since they had little knowledge on energy efficiency. Prior to the project, they had not monitored their individual consumption (district heating). Today they pay for their actual consumption and are therefore more conscious about it.
What helped in dealing with this resistance was the participation strategy (project centre in the concerning area, dissemination activities, etc.) that was put into practice by the coordination team. Monitoring and evaluation showed that the majority of the communities' residents and stakeholders[92]

- identify themselves with their district and like to live or work there;
- appreciate the changes brought by the project;
- are satisfied with the better image of the district / block of flat;
- welcome the better comfort level;
- are positive about the perceived effects and planned measures because of expected overall economic benefits.

d) Important supporters of the undertaking

The district heating company of Helsingør (DK) was one of the main supporters. The company was granted support for the construction of a new power plant but had to make investments in the ECO-City project concerning the hours of work needed for planning, meetings, and learning with each other. Thus, the company was interested in the project from the beginning on but also benefitted from participation in this project – in terms of the new power plant as well as regarding knowledge and competences gained.

e) Key success factors

Helsingør (DK) / Helsingborg (SE)
Main driver was that Sweden had set climate and energy targets (e.g. the decommissioning of nuclear plants). Hence Helsingborg based its climate goals on these national targets but set even more ambitious goals for the region. Helsingborg aims to be self-supplying (biomass and hydropower) concerning energy production and therefore converted coal fired power plants to biomass. Concerning tons of CO_2 per capita, the national goal is to reduce emissions to 7 to/capita while Helsingborg has set the more ambitious goal of 4 to/capita.

Another contributory factor was that the housing sector in Helsingborg has a tradition of renting. Furthermore the housing company which is municipality owned constructs approximately 300-400 new dwellings per year and refurbishes the existing. This allowed for a certain flexibility regarding the selection of the construction sites – see also the remarks made under "Pushbacks against implementation".

In addition, the different players (power utility, university, consultant, waste company, municipality) were all deeply involved the project and had to meet on a regular basis for reporting, which contributed positively to developing a meeting culture as well as mutual understanding.

Other factors that supported the successful execution were timing, flexibility, enthusiasm (personal) and continuity of coordinators in the communities. The latter is especially important because the project could otherwise loose drive or be dismissed due to a "not invented here" effect. The factor "flexibility" also refers to the various changes in the ECO-City project as a whole: Everything that was planned was eventually implemented, but the sites were changed or transferred to another participating country.

Drivers as identified by the project coordinator (COWI) are:[93]

- Personal relations between eager persons – consulting company and municipality
- Prior network relations, Helsingør + Helsingborg collaboration
- Anchoring project at high level influential key persons => commitment of all partners

<u>Tudela (ES)</u>

An important success factor was that the objectives of the country, the area, and the city involved had to be aligned from the beginning. Moreover, all relevant ministries and organizations needed to be involved from the beginning on to be efficient in the goal setting. Besides, when getting involved and designing such a project, *"it has to be an add-on to something you want to do anyhow! Also, the partners that are inquired to participate should feel the same about the project."*[94]

> *The analysis of the activities carried out reveals that accompanying socio-economic activities have had positive effects on the implementation of the demonstration activities. […] Understanding the target groups, inhabitants, homeowners, etc. was one key to successful refurbishment activities. […] accompanying activities should aim to provide an increase in both cognitive and emotional involvement. Empowering schemes addressing inhabitants acting as liaison with other tenants or establishing district agencies are very effective and should be enhanced*.[95]

Further Key success factors as identified in the monitoring of the overall project are:[96]

- *Political commitment at regional and local level: Divergent political interests should remain behind the common goal of sustainability and improvement of live conditions of the community.*
- *Initial stakeholder analysis: This analysis helps to detect potential conflicts of interests or other barriers to the attainment of project goal and permits to apply preventive measures.*
- *Interdisciplinary team*
- *Adequate user's participation: Future end-users should be informed and consulted about aspects that affect them, and feel that their opinions are seriously taken into account.*
- *Flexible financing models: Without flexible financing models, adapted to the income situation of end-users that they can afford their part of costs, the project would not succeed.*

f) Modifications from original concept to final implementation

Helsingør (DK) / Helsingborg (SE)
Due to the challenges described in the elaboration on "Pushbacks against implementation", the selection of housing areas changed. In the end there were no dwellings constructed or refurbished in Denmark. The planned m^2 were transferred to Helsingborg.

Tudela (ES)
A change in feed-in-tariffs for photovoltaic installations and a change in legislation prohibiting further wind power development in the area led to adaptations of the project plan. Instead of the envisaged wind turbines, other RES were taken into consideration.
The original tender to Concerto included a new smart district in Tudela but the municipality argued that there was currently no demand due to the economic situation of the country and instead suggested to refurbish existing buildings to achieve energy saving standards (see also the description of the Spanish part of the ECO-City project above).

g) Future development

Although the project already ended in 2012, the transformation of the three participating communities will carry on.

Helsingør (DK) / Helsingborg (SE)
Helsingborgshem (housing company, SE) continues to build 300-400 low energy buildings. Both municipalities continue to work towards reaching higher energy efficiency. Neighbouring municipalities in Denmark have also shown interest in ECO-City activities. Drawing on the experiences gained in the project, COWI is now involved in the energy planning processes of other cities in Denmark.

ECO-City also led to a new energy standard for new-built and refurbished buildings at Helsingborgshem. When the project started in 2005, only minimum requirements regarding energy consumption were in effect. ECO-City greatly contributed to the increased awareness of Helsingborgshem concerning advantages of low energy buildings and eco-refurbishment. Today, several passive house and low-energy-building neighbourhoods have been erected in the ECO-City area of Helsingborg and thus helped to improve the quality of life of inhabitants.[97]

Eco-Life[98], a follow-up project of about the same scope in another area in Denmark is currently being coordinated by COWI.

Tudela (ES)
The Spanish part of the ECO-City project also had a huge impact and made a lasting impression in the region due to the achieved high quality of the buildings. Thus, the city of Tudela intended to promote more projects / activities similar to ECO-City but because of the economic crisis, all such activities are stopped / delayed.

Regarding the implementation of solar power, a clear disadvantage to the desired expansion of adoption of this technology by homeowners is that the power surplus cannot be sold. In addition, due to a change in legislation the installation of PV panels is no longer eligible to public funding.

h) Lessons learnt

The learnings pointed out are already included in the description of "*e) key success factors".*

Addressing the energy efficiency principal agent problem

In Denmark, rent and heating are generally separate. In addition, the buildings included in the Danish part of ECO-City are all municipality buildings so that introducing a new billing procedure was not relevant.

Some new apartment buildings in Sweden have metering for heating as well as for hot and cold water consumption. Displays in the common areas of the buildings show the consumption details for each apartment. The system also offers an *alarm / security feature*. The additional costs for this metering and security system amount to about € 75 per apartment, which is accepted by the tenants as they tend to consider only the rent in total and do not analyse its components. In addition, the security / alarm feature was an incentive for the tenants. The municipal housing company Helsingborgshem (SE) introduced a new billing procedure (comfort metering) where the rent is based partly on a pre-determined general room temperature. However, surveys in which the concept of comfort metering was compared with regularly heated apartments did not reveal a significant difference concerning energy savings. This may be due to the climate / windy weather and the natural preference to keep the windows closed.

4.3 Finland – Smart City Framework

In 2013, the Ministry of Employment and the Economy issued the *National Energy and Climate Strategy*, which offers a vision towards 2050. The overall direction is in line with EU targets and aims towards an overachievement.

> *The transition to cleaner technology and a low-carbon society in general could open up major opportunities for Finnish trade and industry.*[99]

> *The target will be to decrease mineral oil's share of Finland's total energy consumption below 17% by 2025.*[100]

In June of 2014, the government approved the proposal for a new Climate Change Act, which makes the emission reduction target of 80% by 2050 legally binding:

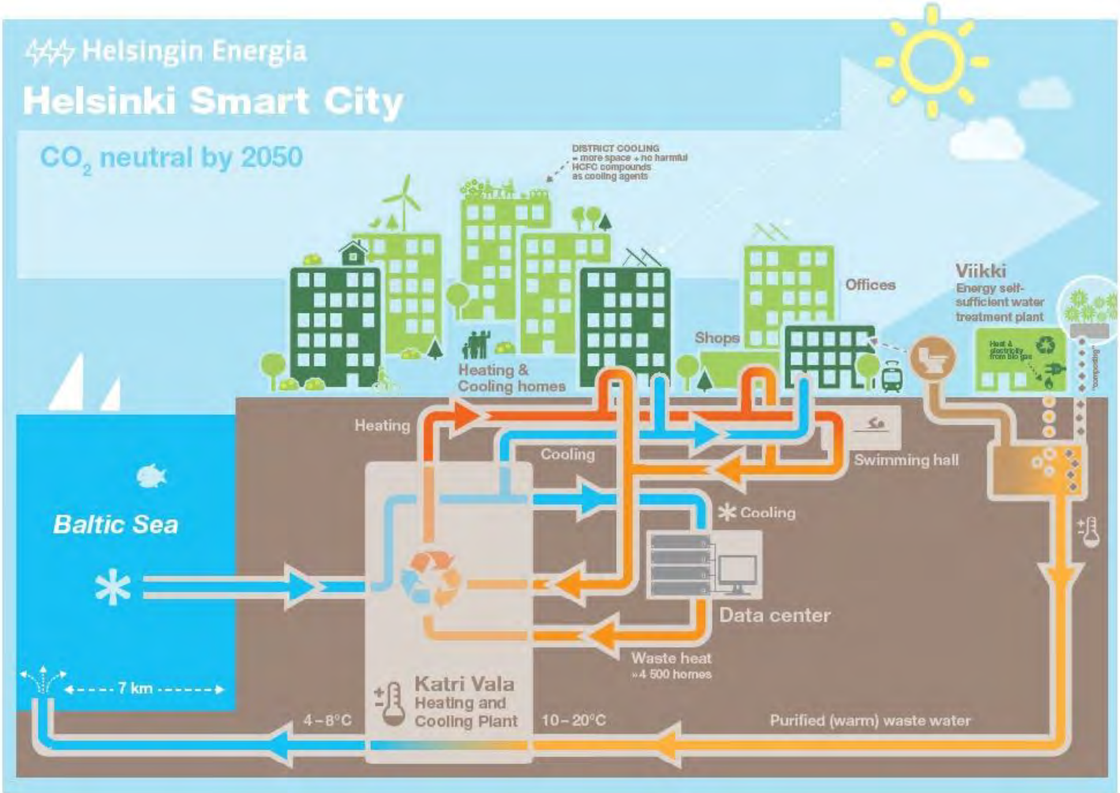
> *Finland has already made a political commitment to implementing an emissions reduction target of at least 80% by 2050, but elevating it to the legislative level will ensure that the emissions reductions are planned and predictable, and that the gap between short-term and long-term targets will be bridged in a sustainable manner.*[101]

> *Through the Climate Change Act, Finland strives to be at the forefront of building a successful low-carbon society. The act merges ambitious climate policies with economic success and the improvement of well-being. Climate change and the efforts to mitigate it will change the world and human activities substantially in the coming decades. The Climate Change Act will improve the operations of the public sector in terms of smart societal planning, so that Finland will still remain competitive while we work to reduce climate emissions.*[102]

> *When the preparation of climate policy is done in an open democratic process, the opportunities for public participation also improve. For companies, on the other hand, predictable climate policy will create an excellent platform for identifying low-carbon solutions for emissions reduction. Bolstering the dialogue on research data and policy is also important.*[103]

In line with the National Energy and Climate Strategy and the new Climate Change Act, the local energy company Helsingin Energia (electricity supply, district heating and cooling) drafted the vision of a CO_2 neutral energy production by 2050.[104] Figure 20 illustrates this vision of a carbon neutral future where district heating and cooling plays a big part. Already more than 90% of the houses in Helsinki are connected to the district heating service, which also provides district cooling.

Figure 20: Energy efficient district heating and cooling in Helsinki[105]



The Finnish Funding Agency for Innovation (Tekes) supports the aforementioned climate targets through various funding programmes and initiatives, which emerge out of three general focus areas:[106]

- Intelligent living-environment,
- Vitality of people,
- Natural resources and a sustainable economy.

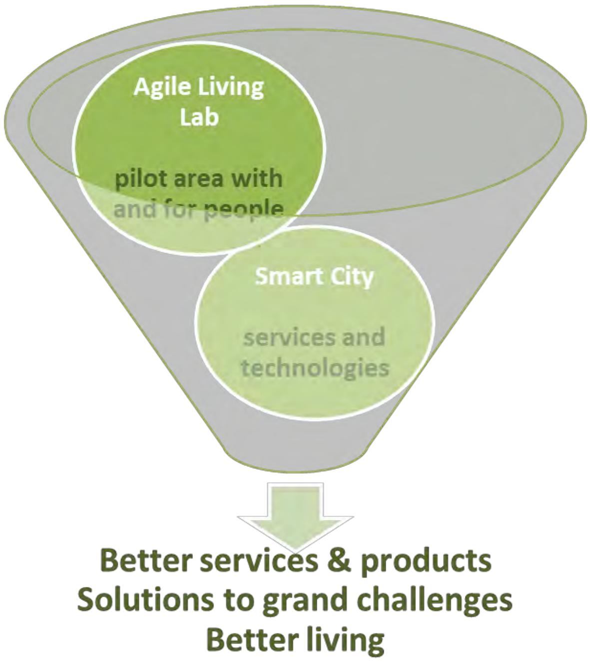
Concerning the concept of *Smart City*, Tekes is currently managing "Fiksu Kaupunki / Witty City (2013-2017)" which is the follow-up programme for "Sustainable Community (2007-2012)" both aiming towards creating smart / intelligent / sustainable cities.

The goals of the Witty City programme are:[107]

- *Encourage cities to open their investments and urban development projects to test beds for companies*
    - *Help innovative SMEs to get first commercial references for new solutions and modes of operation*
- *Integrate knowhow from different disciplines and industries*
    - *New business and cooperation networks to create integrated solutions*
    - *Renewal of industrial branches, new business and earnings models*
- *Focus on demand side innovation*
    - *Especially to bring supply and demand together*
- *Create ability and readiness for international business*
    - *Networks and references for new solutions*
    - *Witty city offers smooth, seamless everyday services*

Besides these goals, strong emphasis is put on the involvement of the public. The following graph summarizes the underlying approach to achieve adoption and sustainability.

Figure 21: Agile Smart City[108]



The programme offers the possibility for solution providers to test innovations. In this context, the cities are expected to open up the market and give space to the innovations, which emphasizes the program's focus on demonstrations.
Municipalities in Finland are very eager to become more sustainable / eco-efficient in order to stand out. Consequently, finding cities that want to be part of the programme has not been difficult.

Working hand in hand with "Witty City" is the "Smart Procurement" programme.[109] Its overall aim is to create smart demand, which will provide prerequisites for new market creation and growth. Smart demand will allow companies to develop their competitiveness through first commercial references, providing the best possible solutions to many of society's major challenges. The vision is for Finland to be known as a model country of smart demand – one in which smart customers create new markets for internationally competitive innovations.
Key lessons learned so far from the Smart Procurement programme concerning the promotion of innovations through public procurement are:[110]

- *Need identification, outcome-based specification (long term perspective, functional specifications), procuring results*
- *Focus on procurement methods, contract models, incentives, competitive dialogue*
- *Market dialogue prior bidding process, openness for unexpected and innovative solutions, engage suppliers broadly at the early stage*
- *Engage end-user and other stakeholders in the process*
- *The buyers are unaware of the possibilities of procurement of innovation – if you ask for innovation you get innovation!*
- *Need to allocate resources to the pre-procurement / development phase*
- *Markets are not changed by one single project, the market need a signal of continuity in order to keep developing*

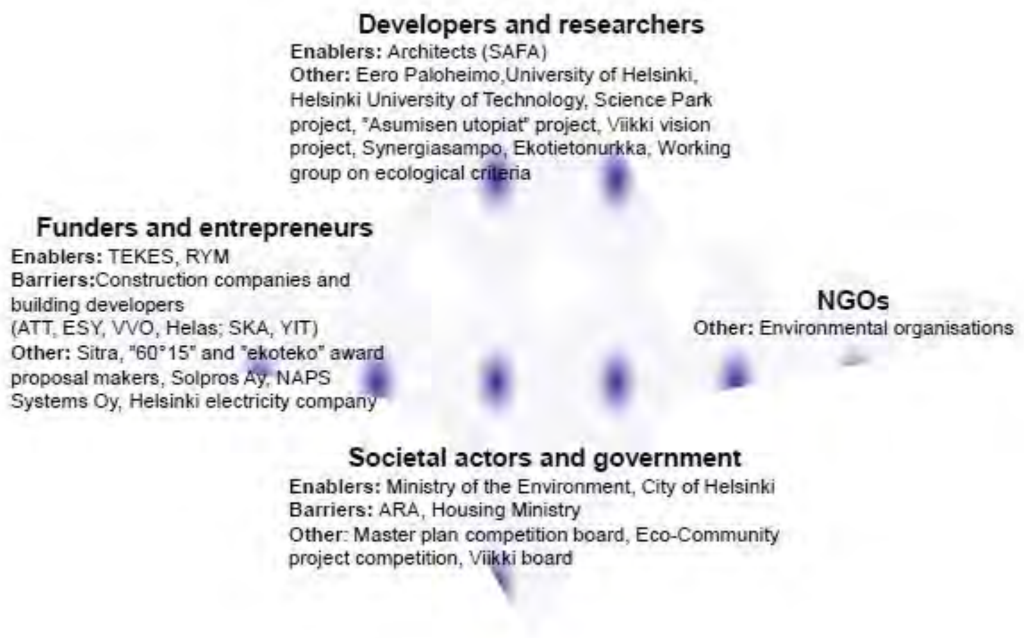
4.3.1 *Eco-Viikki, Helsinki*

The Eco-Viikki project is analysed based on the information received during the conducted dialogue interviews with Heikki Rinne (City of Helsinki), Riitta Jalkanen (City of Helsinki) and Virpi Mikkonen (Tekes).

Fact-Box Eco-Viikki

Construction time:	*1999-2004*
Web:	http://en.uuttahelsinkia.fi/sections/5/environment/areas/156/viikki *(see ANNEX IV for more web links)*
Type:	*Greenfield Development; New Urban Quarter*
Promoter:	City of Helsinki
Technologies / Goals:	**Energy:** • Energy efficient Buildings • Geo-thermal heating • Low temperature technologies • RES – solar energy • Wind- and solar-energy-boosted natural ventilation • Wood-heated communal saunas • Novel cold-storage solutions • Reduction of CO2 emissions by 20% • Water saving technologies (target: 40-50 l/person/day) **Waste:** Reduction by 20% (max 160 kg/person/year)
Site facts:	Population involved / Inhabitants: 2,000 Geographical area coverage: 6,400 m^2
Consortium:	see figure 22 below

Figure 22: Actors of the Eco-Viikki process[111]



Shortly after including sustainable building into the *Finnish Building Act* in the year 1990 *(§1 "The use of land and water areas has to be planned and prepared in a way that promotes sustainable development.")*, the Ministry of Environment together with the Finnish Association of Architects (SAFA) began working on establishing an Eco-Community Project. In 1994 it was decided that Viikki – situated about 8 km from the city centre of Helsinki – would become the pilot area for this Eco-Community Project. The selected region is in close proximity to an extensive area of open farmland encircling an important wetland nature reserve, The Viikki Science Park and Helsinki University's Biocenter.
In order to find the most suitable detailed plan for the new area in Viikki, a large open-ideas competition was initiated which received great response (91 proposals).
Following the selection of the detailed plan for the area, another competition was announced at the neighbourhood and building level with the aim to find ecological innovations. The guideline gave clear specifications on the composition of the workgroups in order to be eligible:

> *Each workgroup had to include an architect, a structural engineer, a HVAC and electrical engineer and an expert in ecology, as well as a building developer*.[112]

Building developers had to be part of the team in order to ensure that the selected projects would actually be implemented.
During the preparation phase for Eco-Viikki, eco-criteria ("PIMWAG criteria") were drawn up, by which the individual housing projects could be assessed according to their level of ecology. Comparable criteria were not available in Finland at that time and criteria from other countries could not be directly applied to Finnish conditions. The following set of criteria was defined and put into action (for more details on the criteria see *Aims, implementations & results*[113] and *Ecological Building Criteria for Viikki*[114]*)*:

- Reduction of pollutants (CO_2, waste water, site debris caused by construction, domestic waste, eco-labels)
- Use of natural resources (reduce fossil fuels, multi-purpose use of space)
- Healthiness (indoor climate, moisture risk control, noise, the wind-free and sunny qualities of the site, alternative floor plans)
- Biodiversity (plant choices and habitat types, storm water)
- Nutrition (cultivation of useful plants; soil)

Some plots in the area were also reserved for self-built projects of groups of residents consisting of 3-5 families each. The site features the generic mix of housing types in Helsinki: approximately 50% of the homes are owner-occupied, 15% are rented, and the remaining homes are right-of-occupancy homes. The construction was realised between 1999 and 2004.

a) Intended and unintended results of the undertaking

All the approved construction projects surpassed the minimum environmental standards set for Eco-Viikki.

Energy:
- 2 local solar heating schemes cover a total of 10 properties
- Low energy housing design
- Co-generation based district heating network
- 200 m^2 of solar energy panels
- 1.400 m^2 of heat-collecting panels (largest project in Finland)

Materials:
- Flexible and innovative timber construction techniques

- Use of natural construction materials

Soil:

- Allotment plots for market gardening
- Combined housing areas with parks and green spaces

Water:

- Rain water use for gardening and green spaces

Waste:

- Reduction by 10% of building site waste

Social:

- Renting of allotment gardens for residents
- Creation of Viikkari Park for children and young people
- Shared sauna and laundries in apartment blocks
- Construction of kindergartens
- Local commercial centre, various shops and restaurants
- Varied green spaces

A monitoring study of Eco-Viikki was carried out in 2003, which included a residents' survey where a participation of 67% of the households could be reached. It revealed that, *although environmental features have been used in marketing Viikki, ecology hasn't usually been the most important reason for moving into the area.*[115] The close proximity to nature was seen as a much more important asset. It was also expected that Eco-Viikki would particularly attract ecologically inclined people but the clear majority of the residents consider themselves as having only little knowledge of ecological living. In addition, the move to Viikki did not have an effect on the ecological behaviour to the degree expected.

> *All in all, Eco-Viikki differs surprisingly little from other new residential areas in terms of residents' profile. This is, on the other hand, how it should be; ecology should indeed be embedded as a part of a "normal" lifestyle, not an alternative or exceptional one.*[116]

b) Initial reason for undertaking

The rising ecological consciousness in Finland raised the question *"How can we build more ecologically?"* A decision was made to explore different ideas and approaches through experimental building within the scope of an Eco-Community project. The city of Helsinki thus determined an area for ecological building. Funding for the programme came from the Ministry of the Environment as well as the National Technology Agency TEKES.

Specifically, the following events nurtured the ecological consciousness that in the end led to the realization of the Eco-Viikki project:[117]

- Brundtland Report 1987 ("Our Common Future") which defined the concept of "sustainable development" (*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*[118])
- Signing of Agenda 21 agreement in 1995 by the city of Helsinki
- The **rise of ecological thinking among architects** at the beginning of the 1990s and thus the organisation of various conferences worldwide, which focused on sustainable architecture.
- **Eco-Villages emerge** in various countries.
- The **green profile** of Viikki: Large areas in Viikki were property of the University of Helsinki and were used as research farm since the 1930s.

- Government: **sustainable development** was first **included in the Finnish Building Act** in 1990, which led to research programmes in order to ascertain the parameters of sustainable development in urban planning and building. In 1991: two ministers in the Ministry of the Environment; personal interest of the minister in ecological construction;
- The **composition of the executive group** included representatives of the City of Helsinki, the Ministry of the Environment, the Finnish Association of Architects SAFA, the National Technology Agency Tekes, the Ministry of Trade and Industry and the Confederation of Finnish Construction Industries, which aimed to ensure that the project goals would be implemented.

c) Pushbacks against implementation

Before Eco-Viikki, there were no pilot projects of this kind in Finland, so no criteria of what ecological building should encompass were available at that point in order to evaluate the proposals. Because of the scope of the Eco-Viikki project, little extra money was available for establishing this set of criteria (PIMWAG criteria – see above). The task was then accomplished by a group of specialists on ecological building who defined the criteria, which consist of both, quality and performance criteria (see above) with an underlying award for points. Not covered by these criteria is the behaviour of the inhabitants, which also has an effect on the ecology of a building.
For the evaluation and subsequent selection of the projects, the idea was to allocate the highest grants to those projects that reached the most points. The rating of the projects was later found to be impossible due to the diversity of the included ecological solutions and the overall high quality of the tenders. Thus, it was decided on a different allocation of the grants so that more of the proposed projects could be realized, which would consequently increase the knowledge gain in the end. The biggest challenge for the applicants were the calculations needed to make sure they reach the most points, which was essential in order to get a site at Eco-Viikki.

The given (legal) parameters also posed a challenge to the realization of Eco-Viikki: The price of the new apartments was restricted to the standard price for apartments in the area. Only an increase in price of 5-10% was allowed as this percentage could still be justified by the occurring energy savings during usage over time.
Due to the tight budget, no “real” inventions were enabled: *No big leaps were possible; we had to keep the costs in mind*.[119]

d) Important supporters of the undertaking

> *The Environment Minister, the city of Helsinki, SAFA and other supporters acted as lobbyists in the process.*[120]

e) Key success factors

The rising ecological consciousness and the described change in legislation (Finnish Building Act) guaranteed the support of government and together with the commitment and the support of the city of Helsinki; these were the most important drivers of success for Eko-Viikki. Another important factor, pointed out during the interviews was the open-ideas competition allowing for and encouraging various creative solutions for ecological building.

f) Modifications from original concept to final implementation

Concept and implementation differ only to a minor degree. The concept included the area-wide implementation of wind powered street lamps, which were tested and monitored in a few locations but the large-scale implementation was abandoned due to unsatisfactory performance.

g) Future development

Currently, Viikki houses more than 11,000 inhabitants. It is still growing as new residential areas are completed in the coming years.

> *The next stage would include, among other things, the development of billing practices so that the fair targeting of costs would serve energy- and water-saving goals.*[121]
>
> *Several building projects focusing on the energy efficiency of the structures have been, and, in the next few years, will be, carried out in Viikki. Additionally, other kinds of construction-related development will be taking place: the building of wooden houses and issues associated with apartment building living will be solved in new ways.*[122]

Besides the advancement of Viikki, there are a couple of development projects in the planning or already in the construction phase in the Helsinki area that feature different aspects of the smart city concept. The objectives for Helsinki's "Kalasatama" district for example comprise of smart traffic solutions including the use of electric cars, an underground waste collection system, open data applications and great emphasis on renewable energy and the integration of individual houses as energy producing units into a smart grid. More information on this project as well as the other current smart / eco city projects can be found on the website: http://en.uuttahelsinkia.fi/ (available in Finnish, Swedish and English)

Subsequent projects that are not driven by the municipality or other public institutions did not follow from Eco-Viikki to the expected extent. Due to high demand for apartments in Helsinki, developers are not forced by market to implement smart city solutions. *The effects on the dominant practices of the Finnish building sector remained limited.*[123]

Today the state has released a strict building code – based on the results and learnings of Eco-Viikki – which includes strict regulations for energy consumption (heating) and energy efficiency in general[124]. For Helsinki, stricter regulations are in place and these regulations get even stricter. This poses a big challenge for developers.

h) Lessons learnt

In the beginning, the available infrastructure did not match with the daily needs of the increased population: no banking or postal services were available in the area; the only grocery store in the area could not meet the demands of a population of almost 2,000. In addition, the area was quite underdeveloped in terms of public transportation, with only one bus line connecting the area with the city centre.

> *According to residents, the bus is too slow and too crowded during rush hours. Consequently, many residents have considered buying or have even bought a car. Obviously, such a situation is not in harmony with the goals and the basic idea of Eco-Viikki. Today, as*

a solution, a shopping centre was built near Eco-Viikki, featuring the most important public services – although not quite within easy reach for all pedestrians.[125]

Even though building is a slow route to achieving new solutions for a wider application, it is obvious that without development projects and experimental building, new ideas and solutions would never even be born. Research, development and practical testing are of decisive importance for the steerage of building. More extensive changes in the regulations should indeed always be tested through experimental building before their more widespread application.[126]

The experiences from Eco-Viikki show that ambitious goals and ecological criteria do not automatically create the desired end result, unless there is a sufficiently concrete monitoring and feedback system or if the knowledge, goals and responsibilities don't permeate the whole production chain. The development work entails a long-term commitment to goals, and in the building sector the central committing factor seems to be money.[127]

The weakest performance in the Eco-Viikki case was by the knowledge development and knowledge diffusion functions. […] existing habits and old structures of construction and energy clusters created barriers to the development. The problems of knowledge diffusion and resource mobilization were related to these old structures and habits. The design of the new buildings and the whole residential area was done based on old models, and the needs for new solar energy technology were not considered. As a result, the solar panels were difficult to maintain because of their placement in location that could not be accessed easily. The existing district heating system also decreased the perceived benefit of the solar heating solutions.[128]

The Eco-Viikki study showed that in order to make the transition to renewable energy solutions it is not enough to obtain public subsidies, risk financing […] and support from legislation and international agreements, including permission conventions […]. Knowledge development and diffusion, and resource mobilization are also needed.[129]

If a regime change is going to happen, all […] the actors operating at the different levels have to go in the same direction. It is impossible to change the system with only financial incentives or other economic instruments, e.g. feed-in tariffs, because that would not increase the knowledge of stakeholders. Hence, a societal system change is needed: a techno-economic solution is not enough on its own.[130]

Addressing the energy efficiency principal agent problem

In a pilot-project in the Viikki area of Helsinki, base heating at 18°C is provided via district heating, the additional heat is generated by electricity. This allows for different temperatures in different rooms of the apartment by utilizing the ventilation system rather than radiators. This concept divides the cost for space heating into two separate bills: the share for district heating is paid per square meters, the share for the additional heat (above the 18°C base) is included in the overall electricity bill of the tenant.

4.3.2 *Smart Grids and Energy Markets (SGEM)*

In the following, the *Smart Grids and Energy Markets* programme is analysed more closely based on the information received during the conducted dialogue interviews with Jani Valtari (ABB), Jatta Jussila-Suokas (CLEEN), Pertti Järventausta (Tampere Universiy of Technology) and Jarmo Partanen (Lappeenranta University of Technology).

Since this section covers a research program, the focus of the description will be on how the Finnish market and politics supported the implementation of smart meters and subsequently the programme on smart grids.

Fact-Box SGEM

Programme duration:	*2010-2015*	
Web:	http://www.cleen.fi/en/sgem *(see ANNEX IV for more web links)*	
Type:	*Strategic Centre for Science, Technology and Innovation (SHOK)*	
Consortium:	*Public sector (funding)*	*Tekes*
	20 Industry / Energy suppliers (DSOs; TSO):	ABB; Aidon; Alstom Grid; Elektrobit Wireless Communications; Empower; Emtele; Fingrid; Fortum Sähkönsiirto; Helen Sähköverkko; Nokia Siemens Networks; Cybersoft; Suur-Savon Sähkö; Tekla; Telia Sonera Finland; The Switch Engineering; There Corporation; Vantaan Energia Sähköverkot; Vattenfall Verkko; Viola Systems
	8 Research partners	Aalto University; Lappeenranta University of Technology; MIKES (Centre for Metrology and Accreditation); Tampere University of Technology; University of Eastern Finland; University of Oulu; University of Vaasa; VTT

As shown in the fact box, SGEM categorizes as a "SHOK". SHOKs (from Finnish "Strategisen Huippuosaamisen Keskittymät) – Strategic Centres for Science, Technology and Innovation – were initiated by the Finnish Funding Agency for Innovation (Tekes) and the Academy of Finland / the Science and Technology Policy Council in 2005 with the aim to speed up innovation processes through public-private partnerships in various branches of industry.[131] The following focuses on the strategic centre "CLEEN Ltd." (Cluster for Energy and Environment) which was established *to facilitate and coordinate world-class industry driven research in the field of energy and environment* and acts as an *open innovation platform for joint research between industry and academia*.[132]

CLEEN's mission is *to create value for global companies and research institutes by offering a continuously evolving but solid and trustworthy open innovation ecosystem between industry and academia*.[133]

Along with the SRA [strategic research agenda] update and new programs, CLEEN will enter a new development stage in 2014. In view of high standards, the quality processes are now in-built from the very beginning. This should mean, e.g. an increasing amount of top research, stronger interaction between industry and academia, internationalization, and greater visibility. Together, all of these will increase CLEEN's effectiveness. As a result, the competitiveness of enterprises will be strengthened and products will be renewed.[134]

Currently seven ongoing programmes are coordinated within this SHOK, focusing entirely on energy and environmental research: Smart Grids and Energy Markets (SGEM); Future Combustion Engine Power (FCEP); Measurement, Monitoring and Environmental Efficiency Assessment (MMEA); Carbon Capture and Storage Program (CCSP); Distributed Energy Systems (DESY); Efficient Energy Use (EFEU); Sustainable Bioenergy Solutions for Tomorrow (BEST).
Due to its relevance in the context of smart cities, in the following the "Smart Grids and Energy Markets" programme will be expanded on in more detail.

The SGEM programme was the first of the CLEEN programmes to start since the set up phase could be kept short due to existing and functioning contact and communication base between the participating university and industry partners. The research consortium aims to develop international Smart Grid solutions that can be demonstrated in a real world environment utilizing Finnish R&D&I infrastructure.[135]

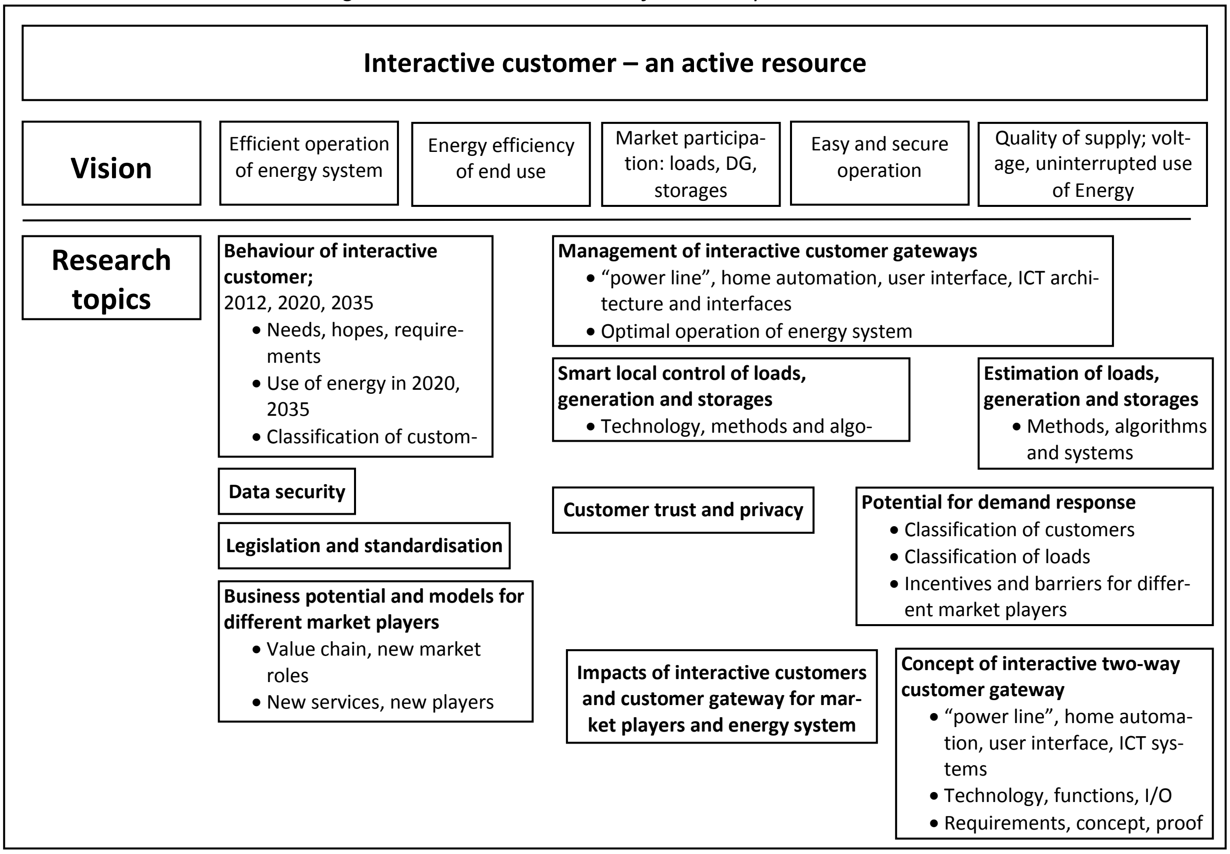
The consortium consists of 20 industry and eight research partners. The industry is represented by six companies operating in the energy technology area, five local Distribution System Operators (DSOs), the Finnish national Transmission System Operator (TSO) Fingrid, and eight companies operating in the ICT sector. This mix of partners enables research through direct industry guidance (applied research). In order to receive funding from Tekes, project tenders have to be proposed. Therefore, SGEM is subject to general Tekes funding criteria as well as SHOK specific qualitative criteria. The funding covers 70% of academia expenses and 50% of company expenses, which are higher funding rates than for other Tekes programs. Among other things, the guideline for SHOK funding specifies the involvement of all important industry players of the Finnish market in the programme as well as shared IPR access rights. The programme is scheduled to run for five years, and its total budget was set at € 55 million.[136]

Key areas of research are:[137]

- Smart grid drivers and scenarios, market integration and new business models
- Future infrastructure of power systems
- Active resources of the smart grid
- Customer interface for the smart grid
- Intelligent management and operation of smart grid

Figure 23 depicts the identified research potentials / needs concerning smart grids.

Figure 23: Smart Grids Needs for Development[138]



a) Intended and unintended results of the undertaking

As can be derived from figure 23, SGEM has still a strong focus on the research behind Smart Grids. After the end of the programme in late 2014, work in the field of Smart Grids will be continued in future programs with a much stronger focus on the creation of demonstration projects. In addition, the follow up programme will be actively involved in the various smart city initiatives in Helsinki (Kalasatama, Jätkäsaari, etc.) and will thereby draw on their practical experiences gained during the course of SGEM.

While in Austria the discussion on the actual contribution of smart meters is still ongoing (see for example article in *derStandard,* February 2014: "Vom Streit, wie smart die Zähler sind"[139]), the big rollout has already been completed in Finland in 2013, as smart metering is now required by law. Fortum (electric utility) alone invested EUR 31 million into the replacement of old meters by new, smart meters.[140]

> *With the installation of smart meters, there has been a switch to billing based on actual electricity consumption. In particular, switching to hourly-based metering, the correctness of billing after meter replacement, and discontinuing the instalment billing have caused uncertainty and discussion among customers. The bigger bill resulting from increased consumption during winter has come as a surprise to some people.*[141]

In the course of integration into the Nordic market, the electricity market in Finland was opened to competition in 1998 allowing all customers to select freely their preferred electricity supplier.[142] In 2009 a law on the electricity market was passed, demanding the implementation of smart meters on a big scale until the end of 2013 and thereby complying with the 2006 EU-directive on energy efficiency and energy services.

> *In 2009 the Finnish Government passed act 66/2009 concerning electricity markets. It states that at least 80 % of the customers of each DSO must have Smart Metering implemented by December 31, 2013. This requirement for Smart Metering also included that hourly consumption data is to be collected and the possibility of controlling customer load must be included in the meter. The remaining maximum 20 % can also be handled manually. This announcement caused an increase in the demand for metering systems and most of the DSO´s started to study Smart metering solutions.*[143]

According to the information provided in the interviews with the people responsible for the SGEM program, soon after the law was passed, the rollout started. It was also determined that the network provider was to be held responsible for the implementation.

The department of Electrical Engineering at Tampere University of Technology already researched in the field of smart meters long before they became politically relevant. The research was related to Vattenfall's (distributor) interest in the meters due to their associated advantages (load control, fault detection, etc.). Vattenfall's focus thus was more on utilizing the smart meters for their own processes while billing only played a minor part. So far, finding new ways of smart meter utilization by focusing on the customer side – providing added value through user-friendly processing of consumption data and gaining additional profit from generating new services related to these data – was not pursued much, and thus had a major role in the research of SGEM. Besides these new business models / opportunities, another focus of SGEM research was on distribution and the reliability of the network in general. Finland is large but only sparsely populated, which is a reason why distribution was also integrated in the research.

Remarkable in connection with the implementation of the smart meters is not only the political, but also the public acceptance. The installation has not been discussed as much publicly in Finland as in Austria. This might be related to the fact that the market leaders really wanted these new meters to be installed – as mentioned, to use them primarily for their internal processes.

Finland has a competitive energy market – 18 electricity-distributing companies – thus the market is different to e.g. France where there is only one distributor. Since the companies are small, a culture of working together to solve a problem developed. As the Finnish market is small, companies aim to create solutions that are applicable on a global scale. CLEEN and SGEM were created to support export. Consequently, research focussed not only on electrical engineering and on ICT but also included business topics (see figure 23 above):

> *What SGEM has made possible is that we now have an understanding of where to direct development and which features and processes to focus on in detail.*[144]

b) Initial reason for undertaking

Besides the already mentioned reasons that led to the SGEM program, the motivation was to create an impact in the market (for end-users as well as utilities), which is measured by these key impact indicators for programme efficiency:[145]

1. Active customer participation in the market
2. Energy and capacity efficient use of electricity
3. Self-sufficiency of resources

4. Operation of electricity system and market
5. Uninterrupted use of electricity, grid reliability

c) Pushbacks against implementation

No specific pushbacks were mentioned during the interviews.

d) Important supporters of the undertaking

As described above, due to the opening of the energy market in 1998, suppliers / distributors had to face competition on the market and sought solutions, which would provide them with an advantage already long before the smart meters became politically relevant on the European level. Thus, the industry – energy suppliers as well as companies that produce appliances for those energy suppliers – very much welcomed the undertaking.

e) Key success factors

Key in the successful implementation of the program is the huge consortium consisting of academia and all major players of the industry (specifically network providers and energy producers). The already existing open communication base between them as well as their long history of collaboration proofed to be beneficial in the process of establishing the programme. Adding to this, is the firm culture of working together to solve a problem, which as the interviewees mentioned, is a characteristic of the Finnish culture in general. Companies in Finland are aware of their relative size and thus are more inclined to collaborate with others to generate solutions that are applicable on a global scale and to be fit for international competition.

f) Modifications from original concept to final implementation

The programme was implemented as planned, focussing on the research topics depicted in figure 23.

g) Future development

The follow up programme of SGEM will be actively involved in the various smart city initiatives in Helsinki (Kalasatama, Jätkäsaari, etc.) and will thereby draw on their practical experiences gained during the course of SGEM.

h) Lessons learnt

The organisation of SGEM within a SHOK achieves the required continuity in the overall strategy and approach of the involved consortium as well as a consent over unresolved research questions, which drives development. For that reason, SHOKS have proven to be a very valuable transfer of the idea of *technology platforms* from the European level to the national level.

Additional information on specific issues related to smart grids in Finland

Tariffs

In Finland, there are different tariffs for day- and night-hours. Some suppliers even offer hourly-billing based pricing-models with varying tariffs throughout the day but customers question its advantage because in order to gain real benefit from this model a flexible time schedule is a pre-requisite.

Data transmission

Consumption data is collected on an hourly basis; data transmission via mobile connection takes place once per day. Customers can access their consumption statistics online. In the future, the online access will also provide a comparison feature where electricity consumption of previous periods can be compared to current demand. As the new meters generate a huge amount of data on the consumption, a big part of the SGEM research went into determining how to process the data into valuable information to the customers: what kind of data is important to the customers in order to adjust demand; how to best illustrate this information.

The meters are provided by the network providers and are standardized. A switch to another electricity supplier can take place very smoothly and does not require the exchange of meters. Because of this, customers could technically change the supplier every month. In reality though, the contract includes respective restrictions.

Safety, Security & Privacy

IT / data related safety and security issues are included in the SGEM programme (as can be seen in figure 23), but these topics were / are generally not a big issue in Finland and were not discussed as much in the media / publicly as they were in Austria.[146] Still, customer surveys conducted by SGEM revealed customer's concerns regarding data security and privacy.[147]

In connection with Smart Meters, new services that will be facilitated by this new generation of meters and their connection to the internet (e.g. interface via which the users can keep track of their energy consumption on a daily basis) are mentioned. This however requires that the data collected from the meters can be made available to third parties who provide the respective applications and subsequent services. Due to ICT and privacy policies, this sharing of data with third parties to create and make available new services is prohibited for the time being. Here, SGEM works to push legislation towards third party sharing of energy consumption data to enable further services and advantages for both, consumer and supplier.

4.4 Germany – Smart City Framework

In 2008, the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety initiated the *National Climate Initiative*. The objective of this initiative is to contribute significantly to the national climate targets and to the realization of the energy transition in Germany. It aims at developing innovative concepts for climate protection in a collaborative process, which involves citizens as well as various players of society, economy and science. The main task of this initiative is to fund projects that contribute to the specified national target of significantly decreasing greenhouse gases in Germany by 2050. The various funding programmes support projects ranging from the development of long-term strategies – such as communal climate master plans – to investment projects that are more specific such as the procurement of hybrid-busses.
The measures for the realization of the energy transition as well as national and international climate protection are funded by the initiative's budget, which is composed partly of the revenues from emissions trading. Since the start of the initiative, 19.000 projects have been supported.[148]

In the thematic priority "*master plan 100% climate protection*" municipalities, which specify a legally binding master plan targeted at the reduction of greenhouse gas emissions by at least 95% by 2050 compared to 1990 levels, are eligible for funding. Municipalities that commit themselves to these targets act as role models and are to share their experiences on a broad basis.

> *Cities produce 80% of all greenhouse gas emissions. Thus, comprehensive measures must be designed and implemented right there. Within "master plan 100% climate protection", we are now able to test strategies for achieving the zero emissions target in differing communities. These practical experiences will support cities and municipalities nationwide in successfully mastering the challenges of the energy transition.*[149]

Hamburg, besides 19 other communities drew up such a master plan as part of this thematic priority. In the following, the climate master plan for Hamburg will be examined further.

4.4.1 Hamburg

In the following, the City of Hamburg is analysed more closely concerning the adoption of smart city technologies based on the information received during the conducted dialogue interview with Ulf Skirke (Behörde für Stadtentwicklung und Umwelt).

Fact-Box Hamburg

Web:	*http://www.hamburg.de/* *(see ANNEX IV for more web links)*
Type:	Climate protection master plan
Promoter:	City of Hamburg; Federal State Government
Technologies / Goals:	Climate protection, adaption to climate change

Continuing on previously set climate targets (within "*Klimaschutzkonzept 2007-2012*"), and in the light of the various publications by the IPCC on the ongoing climate change and the correlating challenges to reach the two-degree goal, the "*Masterplan Klimaschutz*"[150] was drafted and passed by the federal state government. The master plan merges the two pillars of Hamburg's climate policy: *climate protection* and *adaption to climate change*.[151]

> *This master plan is not limited to the energy sector. Rather, climate protection must be an interministerial action on all levels of the city government, which is integrated into a whole range of different targets.*[152]

The master plan comprises of a dynamic approach towards realizing a low carbon emission city by 2050. The term "*dynamic*" in this context refers to the open design of the master plan, which acknowledges the possibility of advances in technical solutions as well as changes in the political framework in the future and allows for appropriate adaption and further specifications at later stages.
The included measures are designed such that the available budgetary means are used effectively and economically to achieve the desired reduction in CO_2 emissions. The thereby pursued principles are:[153]

- High achievement of CO_2 reductions at the least costs possible
- Economic and social benefit for the city of Hamburg
- Promising pilot and potential for commercial launch

Besides various funding programmes targeted towards a reduction of energy consumption, an increase in energy efficiency and the development and integration of renewables, the measures include the realization of a cooperation agreement between the city of Hamburg and the two energy suppliers E.ON and Vattenfall. This should ensure the implementation of the energy turnaround in Hamburg through a 25% share the city holds of these suppliers. The industry is encouraged to invest in achieving energy reduction goals through investment grants and reinforced networking of the players. In addition, the implementation of energy-saving measures for private and public buildings is also more specifically detailed in the master plan. Specifications on mobility and consumption and waste management are also part of the master plan as are reflections on research and science.

The implementation of the master plan rests on various pillars:

- strong civil society (the public successfully demanded the repurchase of the heat- and power grids in 2013);
- voluntary self-commitment (e.g. to redevelopment in the real-estate game);
- guarantee of planning certainty (Hamburg grows at a pace of 6.000 new dwellings per year);
- creation of a virtual competition between the various stakeholders (who is better at achieving the goals?).

Challenging for the implementation are the different interests of the stakeholders and the still developing new economic and business models. Accelerators are often young entrepreneurs who place reliance upon preservation of the environment, the World Future Council with its main office in Hamburg, and other environmental protection promoting networks.

A biennial monitoring will be implemented, to ensure regular adjustment of the master plan to new trends and developments.[154]

Masterplan Klimaschutz is an interesting approach to promote the adaption of smart city technologies, which is to some extent similar to the Danish approach in Copenhagen. However, the implementation of the master plan is still at an early stage and therefore most of the specific research questions of this study cannot be answered yet.

b) Initial reason for undertaking

The initial trigger for the *Masterplan Klimaschutz* in Hamburg was the funding programme in the thematic priority "*master plan 100% climate protection*". As described above, municipalities, which specified a legally binding master plan targeted at the reduction of greenhouse gas emissions by at least 95% by 2050 compared to 1990 levels, were eligible for funding. Hamburg, as well as 19 other communities drew up such a master plan as part of this thematic priority.

d) Important supporters of the undertaking

The local economy has a positive attitude towards the master plan and its associated challenges. They regularly take on contracts as suppliers from the city of Hamburg and in order to keep this important client, are more willing to comply with the new requirements and plan investments accordingly.

4.5 The Netherlands – Smart City Framework

The key energy policies of the Dutch government aim to achieve a low-carbon economy by 2050, keeping in mind safety and the safeguard of the environment. The following three paragraphs summarize the core energy policies.[155]

> ***1. The transition to a cleaner supply of energy***
> *Achieving a low carbon-emission economy by 2050. An international approach to climate is the only way of achieving this and a transition to sustainable energy management is necessary.*
> ***2. Economic perspectives of the energy sector.***
> *The transition must be beneficial to the Dutch economy. In the government's vision, the choice is not between green or growth, but green and growth. The government wants to capitalise on the strength of the energy sector and build on this strength by cooperating with entrepreneurs and researchers on new energy technologies. Only then can the Netherlands develop renewable energy further and continue to distinguish itself on the international stage as a leading energy producer. This will generate growth, income and jobs.*
> ***3. Ensuring a reliable supply of energy.***
> *The government aims for a balanced mix of grey and green energy produced domestically and abroad. The fact is that, for the time being, Europe is dependent on fossil fuels. Gas offers flexible capacity reserve for a large share of renewable energy, and fossil fuels can be made cleaner by investing in CCS technology. The Dutch economy can benefit greatly from this area, as the Netherlands is a gas-producing country and global leader in the area of CCS. Nuclear energy is also necessary, as it contributes to the diversification of energy sources and does not produce CO2.*

Concerning renewable energy, the government's short-term objective is to increase the percentage of 4% of the national energy use in 2010 to 14% in 2020. To achieve this target, the government has earmarked an annual sum of € 1.4 billion from 2015 for the stimulation of renewable energy production. Mandatory co-firing of biomass in coal-fired plants will be introduced in addition to the sustainable energy schemes.[156]

4.5.1 Amsterdam Smart City (ASC)

In the following, *Amsterdam Smart City* is analysed based on the information received during the conducted dialogue interview with Bob Mantel (City of Amsterdam).

Fact-Box ASC

Project duration:	*2009 – ongoing*	
Web:	http://amsterdamsmartcity.com/ *(see ANNEX IV for more web links)*	
Type:	*Diverse (includes urban development, apps, etc.)*	
Promoter:	*Amsterdam Smart City*	
Technologies / Goals:	Diverse technologies (focus on: Energy, Mobility, Data); Energy saving, CO_2 emissions reduction	
Consortium:	**Founding partners:**	
	Amsterdam Economic Board (former Amsterdam Innovation Motor)	Made up of representatives from governmental agencies, research institutes and business
	Gemeente Amsterdam	
	KPN	Telecommunications and IT service provider
	Liander	Energy grid operator
	Strategic partners:	
	Afval Energie Bedrijf (AEB)	Waste and Energy Company
	Waternet	Water company (Amsterdam & surroundings)
	Vattenfall-Nuon	Energy supplier
	Cisco	Network solutions (IT)
	Accenture	Consultant
	+ 71 project partners	
Results:	36 smart technologies, 16 subprojects	

Amsterdam Smart City is a unique platform that serves the underlying aim to transform Amsterdam into a Smart City. The goals of the activities supported by the programme are on the one hand a positive contribution towards achieving certain CO_2 emission targets, on the other hand an economic benefit for the Amsterdam metropolitan area. The tasks of ASC comprise of matchmaking, fund raising and submission of EU-project-applications.

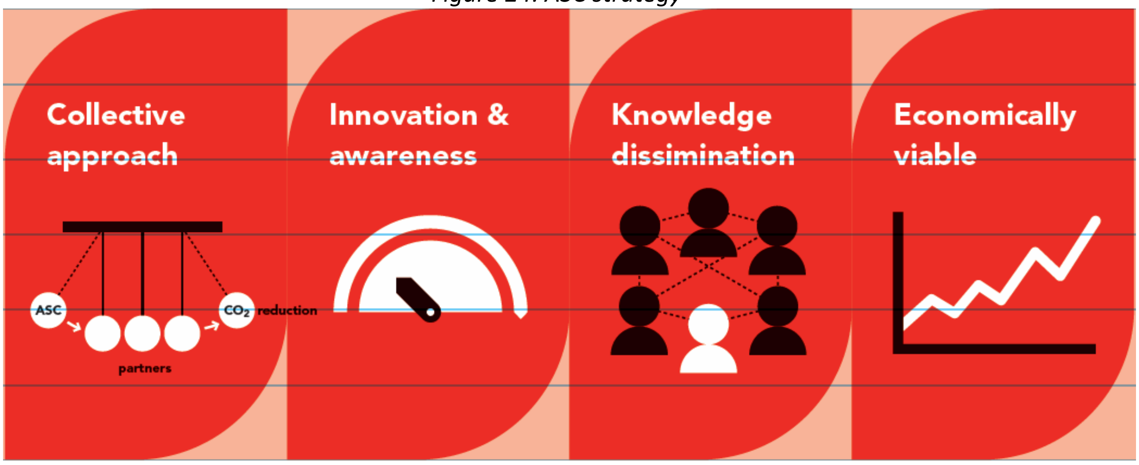
Concerning the CO_2 emission targets, Amsterdam has set ambitious goals, which are clearly communicated to the public: The ambition of the city of Amsterdam is to have reduced emissions by 40% in 2025, based on the 1990 CO_2 emissions of 4.134 kton CO_2. In other words, the ASC programme is to contribute greatly to achieving the emissions target of 2.480 kton by 2025.[157] ASC aims to support the achievement of these targets by focussing on enabling and facilitating projects in the area of energy (e.g. *"Nieuw-West – Energy storage for households"*) and ICT (e.g. "Apps for Amsterdam").

In the initial phase of the Amsterdam Smart City Project (2009-2011), the budget was approximately € 4 million, which was partly funded through the European Regional Development Fund (€ 1,564,140). The second largest financier is Liander. KPN also funds a large part of the project in the second phase.[158]

The pursued approach of the Amsterdam Smart City initiative focuses on creating partnerships between the people of Amsterdam, businesses, knowledge institutions and local authorities that together develop ways to save energy. Since its formation in 2009, the platform has acquired more than 70 partners from various lines of business.

The concept of ASC revolves heavily around the idea of fostering innovation / development by bringing people / partners together – triggering communication and exchange (of desires / needs, ideas). This collective approach is part of the four-pillar, **bottom-up operational strategy** depicted in figure 24.

Figure 24: ASC strategy[159]



The strategy is described by ASC referring to the above pillars:[160]

1. *Cooperation at every possible level is essential to achieve viable results. It could be a public private partnership, but must incorporate the close involvement of the (end) user.*
2. *Driven by smart technology and the need to bring about behavioural change.*
3. *Knowledge exchange: All the acquired knowledge and experience will be shared via ASC.*
4. *Only economically viable initiatives will ultimately be rolled out on a large scale.*

a) Intended and unintended results of the undertaking

Projects that were initiated by Amsterdam Smart City contextually range from working, living, mobility to public space. ASC also allows for the funding of start-ups and high-risk companies or projects. Tenders are selected based on their expected impact. The first three years of the programme focused primarily on collaborative models and creating insight / access to data for users – with the citizens at the core.

b) Initial reason for undertaking

As the interviewee joined ASC at later stage, he did not have specific knowledge on the underlying national developments that eventually led to the establishment of ASC.

c) Pushbacks against implementation

No specific pushbacks were pointed out during the interview.

d) Important supporters of the undertaking

The founding and strategic partners (see *Fact-Box ASC*) constitute the most important network for information on unfulfilled and latent demand and potential supply on which the work of ASC is essentially based.

e) Key success factors

Major contributors to the success of the programme as seen by Bob Mantel are on the one hand to create an environment of trust and support which is essential for evolving new markets. On the other hand, it is essential for market players to **collaborate**. Therefore, ASC matches the different players and also facilitates meetings and enables them to create the market together. Willingness to communicate is another key factor for all stakeholders when it comes to developing a common picture.

f) Modifications from original concept to final implementation

No specific modifications were reported.

g) Future development

The focus of the second phase, which began in 2012, was shifted more towards creating scalable new business models that facilitate on-demand products and services and possibilities for users to act. Therefore, different approaches, aimed at involving the city's inhabitants are applied within the projects. Lessons learned and acquired experience are incorporated into subsequent projects. By doing so, ASC hopes to act as an accelerator of climate and energy programmes.[161]

h) Lessons learnt

Table 2 on the next page summarizes the various experiences of the programme so far, categorized into the different focus areas.

Table 2: Lessons learnt per focus area[162]

	Behaviour	**Technology**	**Knowledge sharing**	**Cooperation**
Living	• Engage households before offering solutions • Getting insight and simple tricks in energy use is highly appreciated • Benchmark information (neighbours/ friends/ appliances) is crucial • Neighbours and local influentials are "trusted advisors" • Communication via children is useful	• Don't bother with technology • Simplicity (self-installation) • Easy use is essential • Standardisation of smart meter and interface is crucial • Technology is complex and needs a lot more attention: one person to install all • Help desk/ support needs to be professional from the start	• Knowledge sharing can boost enhancement programs • Involve children to make contact with parents • Lots of (international) interest in how projects are running and how consumers are engaged	• More than 4 partners is often necessary but makes cooperation challenging at times • Open communication, clear structures, clear responsibilities are essential for all partners • Signing of collaboration agreement upfront • Cooperation <> Collaboration • Social housing: less interest in energy saving products than house owners
Working	• Start with technology and energy reduction: involvement of end user at later stage • Internal regulation (e.g. selection of lease car) can help • Spill-over effect can stimulate companies to join • Total service concept (building management) is needed	• User (building manager) should be incentivized and trained to properly use the tools • LED light can be an enormous energy saver • Technology is available • Because of the low costs of energy, saving money is not an incentive • Or people are not aware of the potential savings that can be made	• Who is responsible to act? • No clear overview of financial benefits and potential possibilities • Consortium can be a stimulator	• Early involvement of building manager/ owner and direct stakeholders is essential • Trusted advisor role can accelerate initiatives • Lack of sense of responsibility (neither tenant nor owner feel responsible)
Mobility	• Ability to change will only start if all barriers are removed • Legislation and financial incentives are main drivers	• Technology exists but needs more development	• Lots of international interest in electrical solutions • The ultimate goal of sustainable mobility made is possible for all stakeholders to join forces and cooperate	• City can really drive change • For effective roll out it is important to align all stakeholders
Public Space	• Ambassadors program, use of local influentials and peer pressure work • Users of smart technologies should be fully facilitated and supported during implementation	• A lot of innovative technologies with great saving potential available	• Climate street has international exposure (added value for Amsterdam) • Effects (financial and other) should be communicated	• Alignment of stakeholders is crucial • Define who's in charge • Finding common goals is important • Collective approach to end user is essential

4.5.2 *PowerMatching City*

Fact-Box PowerMatching City

Project duration:	*2007-2014*	
Web:	http://www.powermatchingcity.nl *(see ANNEX IV for more web links)*	
Type:	*Smart grid living lab*	
Promoter:	*DNV KEMA Energy & Sustainability (now: DNV GL)*	
Technologies / Goals:	Smart Grid Smart appliances	
Consortium:	DNV Kema	*Electrical Engineering, Consulting*
	Humiq (now: ICT Automatisering)	*System integrator*
	Enexis	*Network operator*
	Essent	*Energy provider*
	TNO	*Research organisation*
	Gasunie	*Gas infrastructure company*
	Delft University of Technology	*Research institute*
	Eindhoven University of Technology	*Research institute*
	Groningen University of Applied Sciences	*Research institute*
Site facts:	Virtual power grid including: 42 households 12 electrical vehicles Solar PV, heat pumps, microCHP with storage, smart devices 2 smart distribution transformers	

a) Intended and unintended results of the undertaking

The leading Dutch smart grid project started in 2007 as part of an EU-funded project.[163] The goal is to develop, build, and demonstrate an integrated smart grid solution in Hoogkerk, near Groningen. The implementation takes place in two phases:

- *Phase I; Duration: 2007-2011*
  Twenty-five participating households are equipped with a mix of decentralized energy sources (PV and microCHP), hybrid heat pumps, smart appliances, smart meters, and electric vehicles. Additionally, a wind park provides wind energy to the grid. Stabilization and optimization of the network is realized by trading energy on a local market based on a real-time price signal using the PowerMatcher concept. Technical feasibility of the concept has been successfully proven in the first phase (see also figure 25).
- *Phase II; Duration: 2011-2014*
  Building on the experiences and participator's feedbacks, phase II focuses on the generation and demonstration of business models for new energy-services for the end-users, making use of the concept of real-time pricing. The number of participating households has been increased to 42.
  The market model of PowerMatching City will be integrated into regular energy market processes like allocation, reconciliation, and billing. Capacity management and control of a distribution station will be demonstrated by scaling up the living lab environment to 50-75 households and extending the number of electric vehicles with smart charging services.

In addition, an open innovation platform will be created, allowing third parties to test and demonstrate their innovative technologies and smart grid solutions in a real-life demonstration environment, thereby accelerating the innovation process.

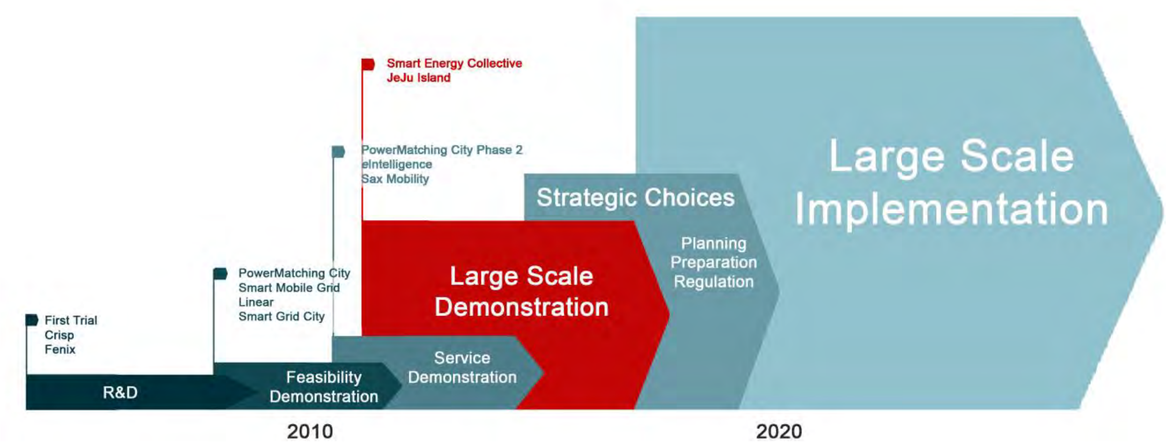
In the following, *PowerMatching City* is analysed closely based on the information received during the conducted dialogue interview with Frits W. Bliek (DNV Kema) and Albert van den Noort (DNV Kema).

b) Initial reason for undertaking

The EU-funded *INTEGRAL* project (http://www.integral-eu.com/) was the starting point for the later following PowerMatching City concept. This project included three field tests: the R&D demonstration of a smart grid (in the Netherlands), an islanding mode (in Spain) and a near black-out situation (in France). In 2011, *INTEGRAL* was completed but the research part in the Netherlands continued and realigned its activities towards a new set of goals aiming at a feasibility demonstration, which should include a larger set of participating energy consumers.

The following figure shows the approach to implement a smart grid as pursued by the PowerMatching City Consortium. The first three stages – R&D, Feasibility Demonstration, Service Demonstration – are completed fully (INTEGERAL, PowerMatching City Phase I) or for the most part (PowerMatching City Phase II). *PowerMatching City Phase 3*, which will address the next stage “Large Scale Demonstration”, has already started.

Figure 25: Smart Grid Implementation Roadmap[164]



The implemented smart grid in PowerMatching City focuses on integrating already existing houses into a smart grid. A new building project was originally also designated to be included in the project, but the completion date of the new dwellings did not fit the schedule of the PowerMatching City project.

c) Pushbacks against implementation

Presently, the legal framework in the Netherlands poses an insurmountable obstacle to a smart grid implementation. As in Austria, the trading of electricity among end-users is prohibited. Therefore, the bookkeeping of the energy flows of and among all grid users were used to create a virtual grid. Advantages for the households could not be fully accomplished due to the non-variable electricity rate. Thus, no economic incentive is available to stimulate energy conscious behaviour.

At the beginning of the project, energy companies were rejecting the proposed project. They argued that based on the current legal framework in the Netherlands the planned *transfer of energy grid concept* was not admissible.
What was convincing in the end was the possible future business case the participating companies identified for themselves (see Figure 25). They acknowledged the change in the energy market and thus their participation was based on strategic grounds. The knowledge generated in smaller demonstration projects will be crucial at later stages when not only the local market but also the bigger European market will be the target.
The high involvement of ICT posed a technical challenge, which resulted in a temporal resistance due to slower implementation: The companies responsible for installing the new heating systems and smart appliances in the homes of the participants struggled with the novelty of the technologies and the unusual but necessary IT connection. This was due to lack of experience with ICT and such interconnected concepts in general.

d) Important supporters of the undertaking

For DNV being the initiator it was essential to motivate grid operators to participate in the project who were subsequently to take on a leading role. Equipment developers on the other hand who did not have the competence to create the whole system where motivated to participate by the attainable *first mover advantage.*
Another challenging aspect was to get the desired amount of participating households. These not only needed to agree on being monitored but also since the project included the integration of smart devices needed to be willing to exchange some of their household equipment. To provide an incentive to the partakers, the project consortium supplied the whole infrastructure. The project partners provided the smart appliances and now own the grid. In return for their participation, the households were supplied with the appliances and only had to pay a small fee to cut out free riders. These smart devices and other equipment (new heating systems) will pass into the ownership of the participating households upon completion of the project.
This offer was announced in the local news. It subsequently attracted 60 applicants for the first Phase of PowerMatching City. The targeted 25 households were then selected based on constructional feasibilities and on the total energy demand, which needed to be large enough to justify the installation of a microCHP.
The communication with the grid (transmission of data) works via wire – therefore the provided appliances needed to be wired which also posed some technical / constructional difficulties.

e) Key success factors

The key success factors pointed out are already included in the description of "d*) Important supporters of the undertaking".*

f) Modifications from original concept to final implementation

The change in behaviour of the end-users could not be explored due to the lack of economic incentives (see "*c) Pushbacks against implementation*").

g) Future development

PowerMatching City Phase 3 has already started in 2013 and will be addressing the next stage of the Smart Grid Implementation Roadmap – Large Scale Implementation (see Figure25).

h) Lessons learnt

General valuable information on the findings made during the first phase of the project:[165]

> *Some lessons learned are that collaboration is crucial for smart grids […]. The collaboration not only applies to the participating parties, linking the various systems must also be done properly. Sometimes this means small adjustments, sometimes however a new design to make equipment suitable for the system. But this takes time. The learning curve will therefore come to a conclusion during the second stage.*

Retrospectively, slightly different approaches would be followed concerning

- Time (management),
- the amount of targeted sub-goals,
- communication with participating households

When attempting a comprehensive project like PowerMatching City, one is tempted to address all open questions at once. Thus *"Try not to solve all problems in one project!"* is one key learning.
A project the size of PowerMatching City also involves many people – on the consortium side and regarding the involved households – and coordination of working steps consumes a lot of time. Besides the planned activities, a significant number of additional problems occurred throughout the project duration, which were not predictable in the planning stage. Dealing with these new problems added to the overall time-issue. In the opinion of the project manager, smaller projects would be better.

Claiming more budget for communication with the participating households is another important learning from the project so far. In the end, the households have to accept the new appliances and live with them. To guarantee as trouble-free a performance of the introduced grid as possible it is important to really listen to the participants' problems and arising questions.

5 SMART CITY MARKET- / DEMAND-PULL – FINDINGS, HYPOTHESES, RECOMMENDATIONS

Based on the conceptual considerations of chapter 1 and 2 as well as the empirical investigation of chapter 4, this chapter addresses the findings and hypotheses concerning the three key questions of this study:

- What are indicators for market- / demand-pull in the context of smart city projects?
- Which are important factors for market- / demand-pull in the context of smart city projects?
- How can demand for smart city be strengthened such that market pull effectively supports technology push?

To answer these three questions it is necessary to understand the timeline that led to smart city becoming an issue within the European Union:

25 April 2002
: Approval, on behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments thereunder. Council decision

22 November 2007
: A European strategic energy technology plan (SET-Plan) – Towards a low carbon future. Communication from the Commission, prepared by Directorate-General for Energy

23 April 2009
: On the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. Decision No 406/2009/EC

8 March 2011
: A Roadmap for moving to a competitive low carbon economy in 2050. Communication from the Commission

8 March 2011
: Energy Efficiency Plan 2011. Communication from the Commission

10 July 2012
: Smart Cities and Communities – European Innovation Partnership. Communication from the Commission

25 October 2012
: On energy efficiency. Directive 2012/27/EU, prepared by Directorate-General for Energy

In the SET-Plan in 2007 it is stated:

> *Since the oil price shocks in the 70s and 80s, Europe has enjoyed inexpensive and plentiful energy supplies. The easy availability of resources, no carbon constraints and the commercial imperatives of market forces have not only left us dependent on fossil fuels, but have also tempered the interest for innovation and investment in new energy technologies. This has been described as the greatest and widest-ranging market failure ever seen.*
>
> *The transition to a low carbon economy will take decades and touch every sector of the economy, but we cannot afford to delay action. Decisions taken over the next 10-15 years will have profound consequences for energy security, for climate change, for growth and jobs in Europe. The cost of action may be high, but the price of inactivity much higher. As an illustration of the scale of the problem, the Stern report estimates that the cost of ac-*

tion could be limited to around 1% of global GDP per year, while inaction could result in losing 5-20% of global GDP annually.

Whereas in Decision No 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions it is stated:

> *Developed countries, including the EU Member States, should continue to take the lead by committing to collectively reducing their emissions of greenhouse gases in the order of 30% by 2020 compared to 1990. They should do so also with a view to collectively reducing their greenhouse gas emissions by 60 to 80 % by 2050 compared to 1990.*

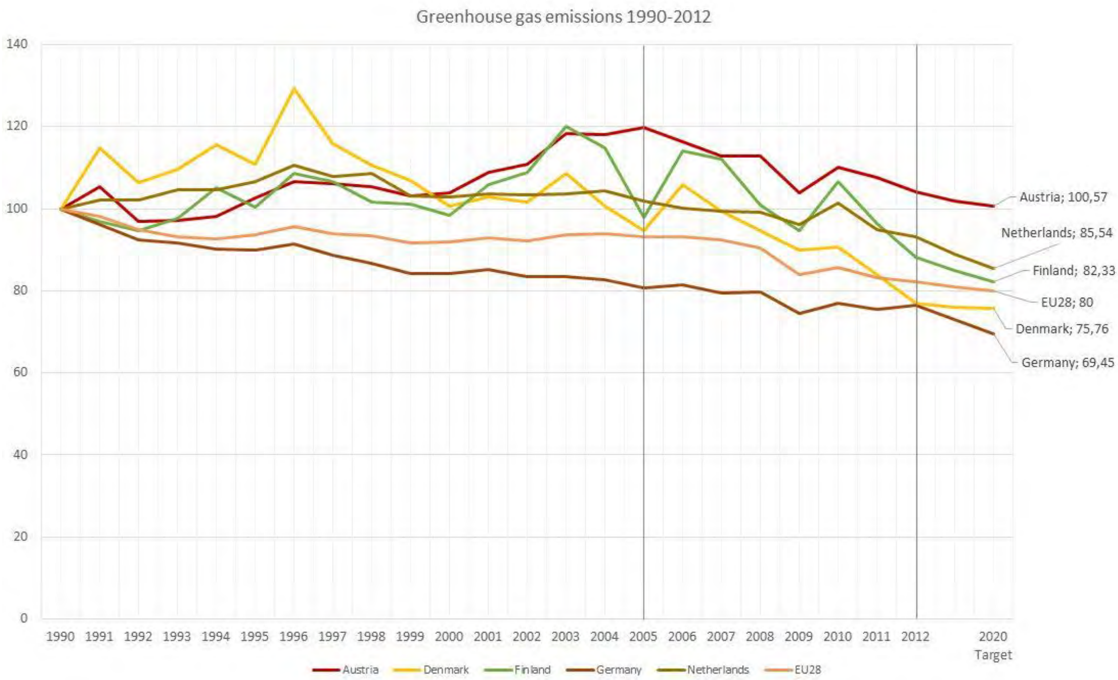
This leads directly to the statement in Smart Cities and Communities – European Innovation Partnership:

> *The SCC (Smart Cities and Communities European Innovation Partnership) aims at accelerating the deployment of innovative technologies, organisational and economic solutions to significantly increase resource and energy efficiency, improve the sustainability of urban transport and drastically reduce greenhouse gas emissions in urban areas.*

For sure, Smart City is more than just the drastic reduction of greenhouse gas emissions. However, at the core of the European Initiative on Smart Cities is the Commission's policy to stabilise greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous anthropogenic interference with the climate system, which implies that global greenhouse gas emissions should be reduced to at least 50 % below 1990 levels by 2050.

As described in chapter 4, smart city initiatives are well underway in Denmark, Finland, Germany and Netherlands – many of them started soon after the European strategic energy technology plan came into being in 2007. However, it still too early to expect measurable results in terms of greenhouse gas emissions. Additionally, Smart City is but one technological answer to greenhouse gas emissions, even though a very important answer. Nevertheless, results of effective actions in terms of greenhouse gas emissions are already clearly visible on national levels as can be seen in figure 26:

Figure 26: Greenhouse gas emissions 1990-2012[166] and Targets 2020



Particularly Denmark and Germany are doing extremely well while Austria is performing rather poorly since 1990, the reference year of the Kyoto Protocol. Thus, it is obvious that Austria and other European Member States may learn a lot from the success of Denmark, Germany, Finland, and Netherlands. How to induce market pull for a collectively necessary but individually not sought after new technology? A closer look at the history of vehicle emission control may shed some light on that question.

5.1 The case of catalytic converters in Europe

The introduction and, eventually, required use of catalytic converters to reduce vehicle emissions is a story of successful market- / demand-pull. It started with the US Clean Air Act of 1963 – the first US legislation regarding air pollution control – and ended with the European Council accepting new standards, which were valid for new vehicles with effect from 1993 within the European Union. This landmark was and is important because the all-encompassing reduction of vehicle emissions gives some insight into the question how to reduce successfully greenhouse gas emissions within the European Union:

> *Much later than in the USA and in Japan, that is, not until the end of the 1970s, the discussion about stricter emission standards began in Europe. […] The costs of installing catalytic converters were criticised by the automobile industry, so that corresponding standards were strictly rejected in the beginning. Small car producers, especially, were afraid of disadvantages on the basis of relatively higher prices for catalytic converters in small cars compared with bigger vehicles. The industry also argued that the conversion of the three-way catalyst for European vehicles would be technically demanding. Simultaneously, the catalytic converter's technology had undergone considerable development because of the American and Japanese requirements, and even European producers exporting to US markets had been compelled to deal with this solution. […] As far as the position of producers was concerned, the catalytic converter solution discussed in Europe was, after the German government had been at first heavily criticised for pressing ahead with the issue in 1983, initially and mainly favoured by the German mid-range and top-class car industry. Above all, BMW, Mercedes-Benz, Porsche (and to some degree VW / Audi) had already been delivering cars with catalytic converters to the USA for ten years. Thus they had gained experiences in the use of open-loop catalysts and, since 1981, also in the use of the technically more demanding three-way catalytic converters.*
>
> *Not until the beginning of the 1980s did the discussion about stricter standards in Europe gain renewed impetus. However, the ensuing legislation process was characterised by opposing interests on the part of member states, which can be put down mainly to two factors. On the one hand, the respective domestic automobile industry and its structure determined national positions and, on the other, the pressure of environmental problems was perceived differently. The initiative for stricter emission standards was taken by Germany submitting a memorandum to the Council of Ministers of the Environment on 27 May 1983, which demanded incorporation of lead-free fuel as a requirement for the use of catalytic converters and also stricter emission standards such as the US model. Increasing public awareness triggered this initiative. […] The German proposals met with bitter resistance – predominantly from the UK, France and Italy. In these three countries, the topic of air pollution did not have a high priority on the political agenda, since its effects were less serious than that of the dying forests in Germany. Furthermore, the connection between vehicle emissions and acid rain was predominantly regarded as controversial. Also disadvantages for the national automobile industry were feared; while the German auto-*

mobile industry had already gained experience by exporting vehicles to the USA, this advantage did not apply to the other European vehicle producers.
[…], in 1984, the European commission made a proposal for a new directive on emission standards. The Commission's proposal provided for a gradual rise in US-equivalent limits until 1995. […] The reaction of the member states was not long in coming and two interest groups emerged. On the one hand, there were Germany, Denmark and the Netherlands, who wanted early adoption of the US standards. The main players in the opposing group were France, the UK and Italy, who asked for a postponement of stricter standards. After tough and controversial negotiations, the states finally reached an agreement in the form of the so-called Luxembourg Compromise of 1985. However, this compromise did not have much in common with the initial proposal. For one thing, it introduced a distinction between three different cubic capacity classes, each of them underlying certain extensions and limits. For small cars […], the limits were at first tightened only slightly and it was agreed to work out stricter limits for a second level by the end of 1987. This compromise was justified with the arguments that it would be technologically easier to install catalytic converters in big vehicles and that the price of catalytic converter would be unreasonable for customers with small cars.
[…] in February 1988, the European Commission presented proposals for new limits for small cars […] which was forwarded to the European Parliament (EP), which had been strengthened since the passing of the Single European Act. Under rising eco-political pressure, even from countries like Italy and France who were not inclined to accept stricter emission standards at first, and in the face of forthcoming elections, the EP flexed its muscles and, instead of taking on the Commission's proposals, countered with its own proposals based on the US standards. After a shift of coalitions between member states and with opponents' resistance getting weaker, the Council accepted these new standards, which were to be valid for new vehicles with effect from 1993. This surprising turn in EC environmental policy, amid the […] economical situation, can be put down to two factors: first, a "greening" of the formerly "slowing-down" states of the UK, France and Italy, which was recognisable in a growing public awareness of environmental problems, in the election results for green parties and in the formation of eco-political NGOs. Secondly, the institutional changes (Single Europe Act) within the EC benefited the decision. [167]

5.2 Market- / demand-pull indicators in the context of Smart City projects

An indicator is an observation that is considered as a reflection of a variable being studied[168]. Thus, for example, attending religious services might be considered an indicator of religiosity. While "indicator" is a technical term in social science, "output measure" is a technical term in control theory their meaning being the same. The variable / state of a system is often multi-dimensional and not observable – as is the case with "Smart City market- / demand-pull" – an indicator / output measure is one-dimensional and observable. A good indicator / output measure correlates strongly with the variable / state of a system. Indicators are particularly useful to observe the behaviour / dynamics of the variable / state of a system. Indicators can, however, not be used to control a specific variable, like "Smart City market- / demand-pull" because indicators are consequences and not causes of the state of a system. As such, indicators are prerequisites to control / steer / influence a system in the right direction and to specify measurable goals.

The timeline that led to Smart City becoming an issue within the European Union – see chapter 5 – suggests that the key indicator of "Smart City market- / demand-pull" is the dynamics of greenhouse gas emissions. While data on cities are not available, it is likely that they highly correlate with emissions per country. Thus, this key indicator – see figure 26 – gives a clear indication in which countries Smart City market- / demand-pull is successful over the years. In all projects studied, this key indicator received high attention.

Rarely mentioned, the indicator “greenhouse gas emissions” has a twin: “Annual amount of consumed (burned) fossil fuel”. Additionally, because EU Member States produce little fossil fuel themselves, this indicator is very similar to “annual amount of imported fossil fuel”.

Further indicators per city in the analysed projects are:

- Percentage of houses connected to district heating and cooling
- Percentage of district heating and cooling produced by renewable energy
- Percentage of electricity generated by renewable energy
- Percentage of houses having smart meters
- Percentage of low-energy houses
- Percentage of houses with mechanical ventilation with heat recovery
- Percentage of efficient lighting incl. LED
- Amount of total energy consumed per resident and per year

A rather special indicator mentioned in connection with Smart Grids and Energy Markets (SGEM) is:

- Fraction of Smart City products and services of total annual exports

All these indicators are not only important to monitor the dynamics of Smart City market- / demand-pull but they are also partially used to specify (and monitor) goals, both at city as well as at national level – see also chapter 4:

- *Denmark’s long-term energy goal is to become independent of fossil fuel use by 2050.*[169]
- Copenhagen has the ambition of becoming the first carbon neutral capital in the world by the year 2025.
- *The target will be to decrease mineral oil's share of Finland's total energy consumption below 17% by 2025.*[170]
- In the thematic priority "*master plan 100% climate protection*" German municipalities, which specify a legally binding master plan targeted at the reduction of greenhouse gas emissions by at least 95% by 2050 compared to 1990 levels, are eligible for funding.
- The ambition of the city of Amsterdam is to have reduced emissions by 40% in 2025, based on the 1990 CO_2 emissions.

Finally, the European Initiative on Smart Cities specifies as goals[171]:

- *To trigger a sufficient take-up (reaching 5% of the EU population) of energy efficient and low carbon technologies to unlock the market.*
- *To reduce by 40% the greenhouse gas (reference year 1990) emissions by 2020, that will demonstrate not only environmental and energy security benefits but also to provide socio-economic advantages in terms of quality of life, local employment and businesses, and citizen empowerment.*

In case of Austria, this would mean that cities with 425.000 residents in total (5% of the Austrian population) should achieve a reduction by 40% of greenhouse gas (reference year 1990) emissions by 2020.

Given figure 26 *Greenhouse gas emissions 1990-2012*, Copenhagen, Helsinki and the German cities could successfully establish Smart City market- / demand-pull while Austrian cities are lagging behind, likely to miss the EU smart city objectives for 2020 by far.

5.3 Key factors for effective market- / demand-pull

Unlike demands for IT products, e.g. computers, smart phones etc., experience suggests that demand for emissions control technologies be it the catalytic converter – see chapter 5.1 –, be it smart city – see chapter 4 – is not created by market mechanism alone. Reasons for that phenomenon are given in chapter 2.

Nevertheless, all the countries (including their smart city ventures) are doing considerably better than Austria as far as greenhouse gas emissions since 1990 is concerned. Why is that so? This chapter states findings, hypotheses, and recommendations on that issue.

5.3.1 Policy consistency

Particularly in Denmark which was hard hit by the 1973 oil crisis a common understanding among its citizens emerged that Denmark needs to become independent from fossil fuels imports as soon as possible. As a result, Copenhagen has the ambition of becoming the first carbon neutral capital in the world by the year 2025, making use of extensive refurbishing of buildings, reorganisation of the energy supply and change in transport habits.[172] This energy policy seems to be successful because it is executed at all levels from the legal framework at national and regional level down to decisions which research and innovation projects to support and which investments to undertake or forbid. Already in 1990, the Copenhagen city council banned new oil-fired heating systems. Instead, district heating had to be utilized. These actions altogether resulted in a decrease of greenhouse gas emissions in Denmark by 40% since it peaked in 1996. Since then, Denmark also became a global technological leader in wind turbines as well as in engineering. Additionally, as the Danish government did not hold shares of any oil and gas company, it had no economic conflict of interest in deriving and executing a consistent policy. *Those who cause the problem also seek to provide a solution*[173] – see chapter 1.1. – is less relevant in Denmark than in other EU member states.

Austria's energy policy differs to the Danish one in nearly every aspect. Maybe because Austria was not hit so hard by the 1973 oil crisis as it relied substantially on hydropower from its abundant water resources no consistent policy to reduce substantially greenhouse gas emissions emerged. Quite the contrary: While obtaining new oil-fired heating systems was already banned in Denmark, it was still subsidised in Austria. Large Austrian greenhouse gas emitters like OMV and Verbund[174] continued to invest heavily in fossil fuel technology. This resulted in Verbund's stranded assets of thermal power stations worth 1.030 million EUR[175]. Both, OMV and Verbund are partly owned by the Austrian government and this adds to the wickedness of the problem – see chapter 1.1. In the new Bundes-Energieeffizienzgesetz – the first of its kind in Austria – the terms "Treibhausgas" (greenhouse gas) and "fossile Brennstoffe" (fossil fuels) are not mentioned once. On the other hand, the Austrian Klima- und Energiefonds is funding projects towards the goal „Zero Emission Austria". A policy that encourages and supports both, the demand for fossil fuel based technologies as well as the demand for smart city technologies is neither efficient nor consistent and thus ineffective. The measures as specified in the Klimastrategie Österreichs[176] have not produced the targeted results.

5.3.2 First-mover advantage

In 2009 the Finnish Government passed act 66/2009 concerning electricity markets. It states that at least 80 % of the customers of each DSO must have Smart Metering implemented by December 31, 2013. However, the nation-wide rollout of smart meters has already been completed in Finland in 2013 – see chapter 4.3.2. The speed of this rollout is part of Finland's policy to become a global technology leader in smart grids because smart meters are seen as a prerequisite. Finland's policy is straightforward: Push the demand for smart meters nationwide early on by law then let the market mechanism take over to offer useful apps (application software) and speed up innovation processes through public-private partnerships in the smart grids and energy markets domain to become a global technological leader in smart grids. The Finnish smart grids and energy markets consortium designed as a European Technology Platform (ETP) consists of 20 industry and 8 research partners. The industry is represented by six companies operating in the energy technology area, five local Distribution System Operators (DSOs), the Finnish national Transmission System Operator (TSO) Fingrid, and eight companies operating in the ICT sector. The research consortium aims at developing international smart grid solutions.[177] Unlike in the smart phone business it seems that Finland wants to avoid that fate in the smart grid business. This is a very effective policy to address lock-in as well as to make use of network effects.

Meanwhile in Austria the discussion on the necessity of smart meters is still ongoing[178] even though the European Union directive states that *at least 80 % of consumers should be equipped with intelligent metering systems by 2020*[179]. Austria is primarily concerned with data security issues of smart meters, an issue addressed in Finland by the Technology Platform Smart Grids and Energy Markets (SGEM) as one important issue among others – see figure 23 *Smart Grids Needs for Development*. What seems to be assumed in Finland is that demand for smart grids is triggered by smart meters thus giving high priority to the nation-wide rollout of smart meters. As Austria is installing smart meters at just the pace required by the European directive on energy efficiency, it will be lagging behind Finland at least 6 years and thus misses the opportunity to become a technological leader in smart grids. It is likely that apps based on smart meters will be offered by Finnish rather than by Austrian companies. *Life punishes those who delay* is a famous quote by Mikhail Gorbachev.

5.3.3 Creating partnerships between suppliers and users

There are two lines of thinking about demand-pull. One is that demand is not there yet and thus has to be created through technology push, including research and development, and other means. The other less common thinking is that there are always people with a specific new demand, with a new need, with a new problem but they just do not meet those people who would have an answer, a (technological) solution for such potential end users. In the latter case, one does not have to create demand-pull. Rather it is necessary to cope with such an imperfect market due to imperfect market information.

The purpose of the Amsterdam Smart City (ASC) initiative as described in chapter 4.5.1 is precisely this: To match new demand with new supply in the imperfect market of smart city technologies. The concept of ASC revolves heavily around the idea of stimulating innovation and development by bringing people and partners together – triggering communication and exchange of desires, needs, and ideas. ASC fosters cooperation at every possible level to achieve viable results. The first three years of ASC focused primarily on collaborative models as well as on creating insight and data access for potential users. The focus of the second phase, which began in 2012, is more about creating scalable new business models that bring about demand driven products and services and enable users to afford them.

ASC is quite a unique social experiment that addresses most of the barriers to diffusion of smart city technologies described in chapter 2. As such, it resembles the concept of effectuation[180]. What makes it particularly attractive from a public policy point of view is that it requires little funding for research and development as compared to the number of innovative ventures being created. Thus, this approach has high leverage with one caveat: ASC's success depends on its staff members having very good social skills, strategic thinking, and up to date overview of the tacit demands and supplies in smart city technology.

Interestingly enough, the European Parliament's Committee on Industry, Research and Energy requested a study on Mapping Smart Cities in the EU. This study, undertaken by a consortium of RAND Europe, Danish Technological Institute, WiK and TNO, came to the following conclusions:

> *Four broad findings regarding the wider dissemination of Smart City initiatives emerge. First, the potential for expanding the scale of existing projects (adding participants or areas) or creating duplicate projects in other areas can be reinforced by strong governance, sustained sponsorship and the right stakeholder mix. Second, citizens are important stakeholders in 'Smart Neighbourhoods' and 'participation platform' initiatives, so should have strategic roles in development and execution. Third, the participation of a private company (ideally national or pan-European) as a key player alongside the city authorities and local firms can provide an institutional base for scaling, although this can also risk the accumulation of too much market power in such companies. Fourth, cooperation among cities to create common Smart City platforms for large-scale development and testing is needed.*[181]

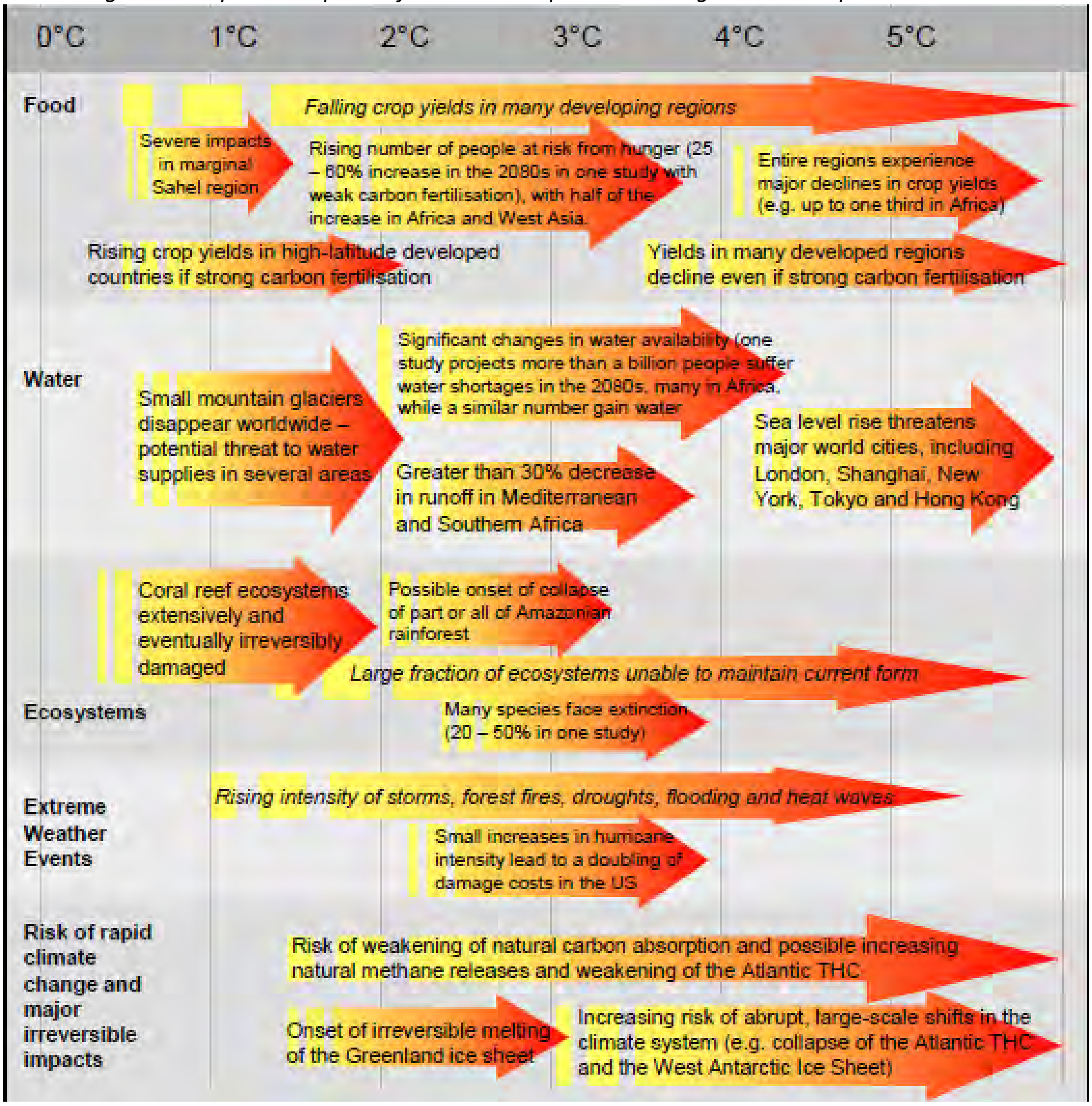
5.4 Strengthening market pull by penalising inaction

Time is of the essence. This statement is elaborated further in the SET-Plan and in line with the notion of a super wicked problem as discussed in chapter 1.1:

> *The transition to a low carbon economy will take decades and touch every sector of the economy, but we cannot afford to delay action. Decisions taken over the next 10-15 years will have profound consequences for energy security, for climate change, for growth and jobs in Europe. The cost of action may be high, but the price of inactivity much higher. As an illustration of the scale of the problem, the Stern report*[182] *estimates that the cost of action could be limited to around 1% of global GDP per year, while inaction could result in losing 5-20% of global GDP annually*.[183]

The Stern report further describes the range of impacts expected at different levels of warming.

Figure 27: Expected impacts of eventual temperature change relative to pre-industrial[184]



Because these consequences of inaction are long-term and global, some governments are enticed to act as free rider in the short-run by doing nothing. This in turn aggravates the problem in the long-run, creating a typical tragedy of the commons situation. Particularly Denmark, Finland, Germany and The Netherlands have realized that faced with the inevitable, it is best to take the bull by the horns and enforce demand for smart city technologies and for other technologies to drastically and rapidly reduce greenhouse gas emissions and at the same time become a global technological leader in this domain similar to the way it worked with the enforcement of the catalytic converter.

For sure, some companies like oil and gas companies as well as electric power companies that depend heavily on fossil fuels will suffer greatly unless they already seek to avoid their creative destruction by moving into technologies that do not emit greenhouse gases.

In addition, the competition for one of the most important resources of a greenhouse gas-free economy has just begun: Storage for electricity. It is yet too early to assess impacts on smart city ventures of endeavours like the $5 billion Tesla battery factory which, by 2020, will produce more

lithium ion batteries annually than were produced worldwide in 2013 and will have driven down the per kWh cost of batteries for cars by more than 30 percent.
Because not all governments of the member states of the EU have realized the perseverance, with which the SET-Plan is and will be implemented, the European Commission has just released a new communication[185]. There it is stated:

> *A key objective of future climate and energy policy is to keep energy affordable for business, industry and consumers. It follows that the 2030 framework, and the targets it contains, is underpinned by the need to meet climate and energy objectives in the most cost-effective manner. Such an approach requires that the Member States have flexibility in how they meet their commitments, taking their national circumstances into account. On this basis, the Commission has proposed binding targets to reduce greenhouse gas emissions by 40% in 2030 (relative to emissions in 1990) and for energy consumed to comprise of at least 27% from renewable sources in 2030. These represent staging posts on the cost-effective pathway to a competitive low-carbon economy in 2050.*

For governments and for industries (and their shareholders) in EU member states who have not yet taken the Energy Policy for Europe and the European Strategic Energy Technology Plan seriously it is high time to reconsider their policies and their strategies.

5.5 Strengthening market pull by resolving the energy efficiency principal agent problem

None of the countries and of the projects analysed in this study has addressed thoroughly the principal-agent (PA) problem as described in chapter 1.3. However, in the directive on energy efficiency it is stated in *Article 19 Other measures to promote energy efficiency*:

> *Member States shall evaluate and if necessary take appropriate measures to remove regulatory and non-regulatory barriers to energy efficiency, without prejudice to the basic principles of the property and tenancy law of the Member States, in particular as regards:*
> *the split of incentives between the owner and the tenant of a building or among owners, with a view to ensuring that these parties are not deterred from making efficiency-improving investments that they would otherwise have made by the fact that they will not individually obtain the full benefits or by the absence of rules for dividing the costs and benefits between them, including national rules and measures regulating decision-making processes in multi-owner properties.*[186]

In less legal terms, the directive acknowledges the potential barrier of the PA problem and directs the member states to cope with it. Even though the ECO-City project – see chapter 4.2.2 – as well as the Eco-Viikki project – see chapter 4.3.1 – addressed this issue, the resulting business models did not have much impact in other circumstances. Yet the study by the IEA showed that the potential of investments in energy efficiency not undertaken due to the PA problem is huge. What it requires is the removal of regulatory barriers as regards the split of incentives between the owner and the tenant of a building or among owners, with a view to ensuring that these parties are not deterred from making efficiency-improving investments.

> *To reap the benefits of energy efficiency in buildings, the biggest challenge is to accelerate and finance upfront investments and speed up the renovation rate of the existing stock from 1.4% – today's average – to above 2% annually.*[187]

The IEA study finds that over 3 800 PJ/year of energy use is affected by PA problems in the case studies examined – equivalent to around 85% the total energy use of Spain in 2005.

Four main policy lessons can be drawn from the case studies to help policy makers reduce the energy efficiency gap. First, small things add up. While PA problems affect little amounts of energy use at the individual level, whether landlord-tenants or in vending machines, when aggregated, the problem is significant.

Second, PA problems are pervasive, disbursed and complex. As such, no single policy instrument is sufficient to overcome PA problems. Neither regulatory mechanisms, (e.g. minimum energy performance standards, or regulated contract design), nor information-based instruments (i.e. awareness campaigns) alone will resolve them. Instead, governments should help design well-targeted policy packages to address PA problems in their specific national contexts, and within the particular constraints of a given sector. These packages should include measures to: a) address contract design to ensure end-users face energy prices, b) regulate the level of energy efficiency in appliances and buildings, c) improve access to information about energy efficiency performance.

Third, the national context plays a key role in the potential success or failure of energy efficiency policy. Important contextual factors include institutional support for energy efficiency, the price of energy and public awareness of the importance of energy efficiency. The latter two points in particular have emerged as important influences on PA problems.[188]

Unfortunately, this is an area where experiments with different business models are needed most and yet rules and regulations are strictest and near to impossible to come by. The Austrian Bundes-Energieeffizienzgesetz does not refer to Article 19 of the EU directive on energy efficiency.

The good news about the existing energy efficiency principal agent problem is that there is a wide gap to Pareto efficiency. Thus, governments can easily speed up the renovation rate of the existing buildings by specifying rules for dividing the costs and benefits between the owner and the tenant of a building or among owners.

6 SUMMARY

Project findings
The European Community's approval of the Kyoto Protocol in 2002 triggered the 2007 "Energy Policy for Europe" which in turn gave rise to a number of initiatives, the European Initiative on Smart Cities being prominent among them. Its objective is to reduce by 40% the greenhouse gas emissions (reference year 1990) by 2020, that will demonstrate not only environmental and energy security benefits but also to provide socio-economic advantages in terms of quality of life, local employment and businesses, and citizen empowerment.

Particularly Denmark and Germany but also Finland and Netherlands are doing extremely well while Austria is performing rather poorly since 1990, the reference year of the Kyoto Protocol. Indicators to monitor the output / results of Smart City initiatives in these countries are:

- Amount of total energy consumed per resident and per year
- Fraction of Smart City products and services of total annual exports
- Percentage of district heating and cooling produced by renewable energy
- Percentage of efficient lighting incl. LED
- Percentage of electricity generated by renewable energy
- Percentage of houses connected to district heating and cooling
- Percentage of houses having smart meters
- Percentage of houses with mechanical ventilation with heat recovery
- Percentage of low-energy houses

Unlike demands for IT products, e.g. computers, smart phones etc., experience suggests that demand for smart city technologies is not created by market mechanism alone:

- Denmark's long-term energy goal is to become independent of fossil fuel use by 2050. This energy policy is consistent at all levels from the legal framework at national and regional level down to decisions which research and innovation projects to support and which investments to undertake or prevent. Already in 1990, the Copenhagen city council banned new oil-fired heating systems. As a result, greenhouse gas emissions dropped by 40% since it peaked in 1996 and Denmark became a global technological leader in wind turbines.
- In 2009, the Finnish Government decided that at least 80% of all buildings must have smart meters by December 2013. However, the nation-wide rollout of smart meters has already been completed in Finland in 2013. The speed of this rollout is part of Finland's policy to become a global technology leader in smart grids because smart meters are seen as a prerequisite. Finland's policy is straightforward: Push the demand for smart meters nationwide early on by law then let the market mechanism take over to offer useful apps (application software) and speed up innovation processes through public-private partnerships in the smart grids and energy markets domain to become a global technological leader in smart grids.
- There are two distinct approaches to strengthening demand-pull. One is based on the hypothesis that demand does not exist yet and thus has to be created. The other approach assumes that there are always people with a specific new demand, with a new need, with a new problem but they just do not meet those people who would have an answer, a (technological) solution. The purpose of the Amsterdam Smart City (ASC) platform is precisely this: To match new demand with new supply in the imperfect market of smart city technologies. ASC revolves around the idea of stimulating innovation and development by

bringing people and partners together thus fostering cooperation at every possible level to achieve viable results.

While these findings are reassuring there is one issue not yet systematically explored: the energy efficiency principal agent problem. Even though the projects ECO-City and Eko-Viikki addressed this issue, no generative business model emerged. What became clear, however, is that regulatory barriers as regards the split of incentives between the owner and the tenant of a building need to be removed such that these parties are not deterred from making efficiency-improving investments. The good news is that there is still a wide gap to Pareto efficiency. Thus, governments can easily speed up renovation rate of buildings by specifying rules for dividing costs and benefits between owners and tenants of a building.

In 2007, the European Commission asserted: *Time is of the essence. The transition to a low carbon economy will take decades and touch every sector of the economy, but we cannot afford to delay action. It has been estimated that the cost of action could be limited to around 1% of global GDP per year, while inaction could result in losing 5-20% of global GDP annually*. Denmark, Finland, Germany, and The Netherlands have realized that faced with the inevitable, it is best to enforce demand for smart city technologies similar to the way it worked with the enforcement of the catalytic converter.

Beneficial utilisation

Austria's energy policy and thus smart city policy differs from these findings in more than one aspect. No consistent policy to substantially reduce greenhouse gas emissions emerged. Quite the contrary: While obtaining new oil-fired heating systems was already banned in Denmark, it was still subsidised in Austria. Large Austrian greenhouse gas emitters like OMV and Verbund continued to invest heavily in fossil fuel technology resulting in Verbund's stranded assets of thermal power stations worth 1.030 million EUR. In the new Bundes-Energieeffizienzgesetz the term "greenhouse gas emission" is not mentioned once. On the other hand, the Austrian Klima- und Energiefonds and the Austrian Ministry for Transport, Innovation and Technology are funding projects towards the goal „Zero Emission Austria". A policy that encourages and supports both, the demand for fossil fuel based technologies as well as the demand for smart city technologies is neither efficient nor consistent and thus ineffective.

In Austria, the discussion on the necessity of smart meters is still ongoing even though the European Union directive states that at least 80 % of electricity consumers should be equipped with intelligent metering systems by 2020. In Finland, it is assumed that demand for smart grids is triggered by smart meters thus giving high priority to the nation-wide rollout of smart meters. As Austria is installing smart meters at just the pace required by the European directive on energy efficiency, it lags behind Finland at least six years and thus misses the opportunity to become a technological leader in smart grids. *Life punishes those who delay* is a famous quote by Mikhail Gorbachev.

The Finnish invention of SHOK – Finnish for Strategic Centres for Science, Technology and Innovation – could be a very useful structure to be explored in Austria in the context of Energy and Environment. Strategic Centres are public-private partnerships for speeding up innovation processes. Their main goal is to renew industry clusters and to create radical innovations. Centres develop and apply new methods for cooperation, co-creation, and interaction. International cooperation also plays a key role in the operation of the Strategic Centres. Testing and piloting environments and ecosystems constitute an essential part of the Strategic Centres' operations.

Experimenting with the Amsterdam Smart City concept in some Austrian cities could also be worthwhile pursuing. Amsterdam Smart City is a platform that focuses on enabling and facilitating projects in the area of energy (e.g. “Nieuw-West – Energy storage for households”) and ICT (e.g. “Apps for Amsterdam”) thus creating partnerships between the people of Amsterdam, businesses, knowledge institutions and local authorities that together develop ways to save energy.

Finally, Austria could still take a leading role in addressing the pervasive energy efficiency principal agent problem as mentioned in Article 19 of the European Union’s directive on energy efficiency:

> *Member States shall take appropriate measures to remove barriers to energy efficiency as regards the split of incentives between the owner and the tenant of a building, with a view to ensuring that these parties are not deterred from making efficiency-improving investments that they would otherwise have made.*

Because consequences of inaction are long-term and global, some governments including Austria are enticed to act as free rider in the short-run by doing as little as possible. This in turn aggravates the problem in the long-run, creating a tragedy of the commons dynamics. However, Austria could learn from the Zwentendorf Nuclear Power Plant experience and from the Danish example: Accept the inevitable and prohibit investments in fossil fuel based technologies for heating, cooling, and electricity generation now. With such a bold move, demand for smart city technologies will follow suit, enabling Austrian industry to become a global technological leader in this domain. It may not be too late yet.

7 KURZFASSUNG

Projektergebnisse

Die Zustimmung der Europäischen Gemeinschaft zum Kyoto Protokoll im Jahr 2002 gab den Anstoß zur 2007 veröffentlichten “Energiepolitik für Europa”. Diese wiederum führte zu einer Reihe von Initiativen, wobei die Europäische Initiative für Smart Cities zu den bedeutsamsten zählt. Ihr Ziel ist es, die Treibhausgasemissionen bis zum Jahr 2020 um 40% zu reduzieren (Bezugsjahr 1990). Die damit verbundenen positiven Auswirkungen sind nicht allein auf die Bereiche Umwelt und Energiesicherheit beschränkt, sondern spiegeln sich auch wider in Lebensqualität, lokaler Beschäftigung und lokalen Unternehmen, sowie Bürgerbeteiligung.

Besonders Dänemark und Deutschland, aber auch Finnland und die Niederlande schneiden hinsichtlich der Erreichung dieses Ziels extrem gut ab, während Österreich hinterher hinkt. Als Indikatoren zur Messung der Ergebnisse der Smart City-Initiativen in den genannten Ländern dienen:

- Anteil der entstandenen Smart City Produkte und Dienstleistungen am jährlichen Gesamtexport
- Anteil von Strom aus erneuerbaren Energien
- Gesamtenergieverbrauch pro Einwohner pro Jahr
- Prozentsatz der effizienten Beleuchtung inkl. LED
- Prozentsatz der Fernwärme und Fernkühlung aus erneuerbaren Energien
- Prozentsatz der Häuser mit Anbindung an Fernwärme und Fernkühlung
- Prozentsatz der Häuser mit mechanischer Lüftung und Wärmerückgewinnung
- Prozentsatz der Häuser mit Smart Meter
- Prozentsatz der Niedrigenergiehäuser

Im Gegensatz zur Nachfrage nach IT-Produkten, z.B. Computer, Smartphones, etc., zeigt die Erfahrung, dass Nachfrage nach Smart City Technologien nicht allein durch Marktmechanismen entsteht:

- Dänemarks erklärtes Energieziel ist, bis 2050 unabhängig von fossilen Energieträgern zu werden. Diese Energiepolitik zieht sich konsequent durch alle Ebenen, von rechtlichen Rahmenbedingungen auf nationaler sowie regionaler Ebene bis hin zu Förderentscheidungen betreffend Investitionen und Forschungs- und Innovationsprojekte. Bereits 1990 verbot der Stadtrat der Stadt Kopenhagen die Erneuerung von Ölheizungen. Als Folge sanken die Treibhausgasemissionen um 40% nachdem sie im Jahr 1996 ihren Höhepunkt erreicht hatten, und Dänemark wurde zu einem globalen Technologieführer im Windenergie-Sektor.
- Die finnische Regierung beschloss 2009, dass zumindest 80% aller Gebäude bis Ende Dezember 2013 mit Smart Meter ausgestattet sein müssen. Dieses Ziel wurde schließlich deutlich übertroffen, da 2013 der nationale Roll-Out bereits komplett abgeschlossen wurde. Diese Einführungsgeschwindigkeit ist Teil der finnischen Strategie, ein globaler Technologieführer bei Smart Grids zu werden. Smart Meter gilt dafür als wesentliche Voraussetzung. Die finnische Strategie ist schnörkellos: Frühes Anstoßen der Nachfrage nach Smart Meter auf nationaler Ebene durch entsprechende Gesetze sodass der Markt anschließend selbständig entsprechende unterstützende Apps hervorbringen kann, und Beschleunigen des Innovationsprozesses durch Initiieren von Public-Private-Partnerships im Bereich Smart Grids und Energiemärkte mit dem übergeordneten Ziel, globaler Technologieführer für Smart Grids zu werden.
- Es gibt zwei unterschiedliche Ansätze zur Stärkung des Demand-Pulls. Der erste basiert auf der Hypothese, dass Demand / Nachfrage noch nicht existiert und daher erst geschaf-

fen werden muss. Der zweite Ansatz geht von der Annahme aus, dass es immer Marktteilnehmer mit einem spezifischen neuen Bedarf, einer neuen Nachfrage, einer neuen Herausforderung gibt, jedoch treffen sie einfach nicht auf jene Marktteilnehmer, die genau diesen Bedarf durch neue (technologische) Lösungen bedienen können. Die Plattform Amsterdam Smart City (ASC) fokussiert auf letzteren Ansatz und hat für sich die folgende Aufgabe daraus abgeleitet: Das Zusammenführen von neuem Bedarf mit neuem Angebot im unvollkommenen Markt von Smart City Technologien. Die Idee der Stimulation von Innovation und Entwicklung durch das Zusammenführen von Personen und Geschäftspartnern und somit die Unterstützung von Kooperationen auf allen Ebenen, um brauchbare Ergebnisse zu erzielen, steht im Mittelpunkt des ASC-Ansatzes.

Eine Frage, die noch nicht systematisch erforscht wird, betrifft das Prinzipal-Agent-Problem im Bereich Energieeffizienz. Zwar wurde dieses in den beiden, im Bericht vorgestellten Projekten ECO-City und Eko-Viikki adressiert, jedoch entstand daraus kein generatives und somit übertragbares Geschäftsmodell. Deutlich wurde indes, dass regulatorische Barrieren in Bezug auf die Aufteilung der Anreize zwischen Eigentümer und Mieter eines Gebäudes beseitigt werden müssen, sodass diese Parteien nicht vor Investitionen zur Energieeffizienzsteigerung zurückschrecken. Die gute Nachricht dabei ist, dass noch viel Spielraum hin zu Pareto-Effizienz vorhanden ist. Regierungen können deshalb die Sanierungsrate von Gebäuden enorm beschleunigen, indem sie klare Regeln zur Aufteilung der Kosten und Nutzen zwischen Eigentümer und Mieter festlegen.

Im Jahr 2007 tätigte die EU-Kommission folgende Aussage: *Zeit ist von fundamentaler Bedeutung. Der Übergang zu einer kohlenstoffarmen Wirtschaft wird zwar noch mehrere Jahrzehnte dauern und dabei jeden Sektor der Wirtschaft berühren aber wir können uns nicht leisten, Maßnahmen zu verzögern. Es wird geschätzt, dass die Kosten der Maßnahmen auf rund 1% des globalen Bruttoinlandsproduktes eingegrenzt werden können, Untätigkeit könnte hingegen zu einem jährlichen Verlust von 5-20% des globalen Bruttoinlandsproduktes führen.* Dänemark, Finnland, Deutschland und die Niederlande haben erkannt, dass, wenn mit dem Unvermeidlichen konfrontiert, es am besten ist, die Nachfrage nach Smart City Technologien unverzüglich zu erzwingen, ähnlich dem Vorbild der gesetzlich verpflichtenden Einführung des Katalysators bei Kraftfahrzeugen.

Nutzenanwendung

Österreichs Energiepolitik und somit auch die Smart City Strategie unterscheidet sich von den oben präsentierten Erkenntnissen in mehrerer Hinsicht. Bislang entstand noch keine konsistente Rahmenstrategie zur bedeutenden Verringerung von Treibhausgasemissionen. Im Gegenteil: Während Neuinstallationen von Ölheizungen in Dänemark schon lange verboten sind, werden diese in Österreich noch immer gefördert. Große österreichische CO_2-Emittenten wie OMV und Verbund investieren weiterhin stark in Technologien, welche fossile Brennstoffe benötigen, was bei Verbund bereits zu verlorenen Vermögenswerten bei Wärmekraftwerken in der Höhe von 1.030 Mio Euro führte. Im kürzlich beschlossenen Bundes-Energieeffizienzgesetz kommt der Begriff „Treibhausgas-Emission" nicht vor. Gleichzeitig werden seitens des Österreichischen Klima- und Energiefonds und des Bundesministeriums für Verkehr, Innovation und Technologie Projekte in Richtung „Zero Emission Austria" gefördert. Eine Politik, die sowohl die Nachfrage nach Technologien basierend auf fossilen Brennstoffen als auch die Nachfrage nach Smart City Technologien gleichzeitig stimuliert und unterstützt, ist weder effizient noch konsistent und daher ineffektiv.

Die Diskussion über die Notwendigkeit von Smart Meter ist in Österreich noch nicht abgeschlossen. Dies obwohl die Richtlinie der Europäischen Union klar vorgibt, dass bis 2020 mindestens 80% der Stromverbraucher mit intelligenten Messsystemen ausgestattet sein sollen. Finnlands Strategie hingegen basiert auf der Annahme, dass die Nachfrage nach Smart Grids durch Smart Meter erst so richtig ausgelöst wird, und räumte deshalb der raschen Einführung von Smart Meter höchste Priorität ein. Da Österreich die Installation der Smart Meter nur mit dem von der EU-Richtlinie zur Energieeffizienz geforderten Tempo umsetzt, hinkt es hinter Finnland mindestens sechs Jahre hinterher und verpasst somit die Chance, bei Smart Grids Technologieführer zu werden. *Wer zu spät kommt, den bestraft das Leben* ist ein bekanntes Zitat von Michail Gorbatschow.

Die finnische Erfindung der SHOKs – Strategische Zentren für Wissenschaft, Technologie und Innovation – könnte auch für Österreich eine sehr nützliche Struktur zur Stimulierung der Nachfrage neuer Energie- und Umwelttechnologien darstellen. Die strategischen Zentren sind Public-Private-Partnerships mit dem Zweck, Innovationsprozesse zu beschleunigen. Hauptziel ist, Industriecluster zu erneuern und radikale Innovationen hervorzubringen. Die Zentren entwickeln neue Methoden für Kooperation, Ko-Kreation und Interaktion und wenden diese an. Internationale Kooperationen spielen ebenfalls eine Schlüsselrolle. Test- und Pilot-Vorhaben sowie die Schaffung und Nutzung von Technologieökosystemen bilden einen wesentlichen Teil der Aktivitäten der strategischen Zentren.

Die Amsterdam Smart City Plattform bietet einen weiteren, für österreichische Städte interessanten Ansatz, mit dem es sich lohnt zu experimentieren. Das dahinter liegende Konzept von ASC fokussiert auf das Ermöglichen und Unterstützen von Energie- und ICT-Projekten (z.B. „Nieuw-West – Energy storage for households“ oder „Apps for Amsterdam“). Dies bewirkt das Entstehen von Partnerschaften zwischen der Bevölkerung, Unternehmen, wissenschaftlichen Einrichtungen und den öffentlichen Behörden zur Entwicklung von Methoden zur Energieeinsparung.

Noch kann Österreich eine führende Rolle bei der Bewältigung des Prinzipal-Agent-Problems im Bereich Energieeffizienz einnehmen, auf das Artikel 19 der EU-Richtlinie zur Energieeffizienz verweist:

> *Mitgliedstaaten ergreifen geeignete Maßnahmen zur Beseitigung der Hemmnisse für die Energieeffizienz, insbesondere in Bezug auf die Aufteilung von Anreizen zwischen Eigentümer und Mieter eines Gebäudes, damit diese Parteien nicht deshalb, weil ihnen die vollen Vorteile der Investition nicht einzeln zugutekommen oder weil Regeln für die Aufteilung der Kosten und Vorteile untereinander fehlen, davon abgehalten werden, Investitionen zur Verbesserung der Energieeffizienz vorzunehmen.*

Die vor allem langfristigen und globalen Folgen der Untätigkeit bezüglich Reduktion von Treibhausgasemissionen verleiten einige Regierungen, darunter Österreich, dazu, Trittbrettfahrer zu spielen und so wenig wie möglich zur Emissionsreduktion beitragen. Dies wiederum verschärft das Problem auf lange Frist gesehen und schafft somit eine Tragik der Allmende Dynamik. Österreich könnte aber aus der Erfahrung mit dem Atomkraftwerk Zwentendorf und dem dänischen Vorbild lernen: Akzeptanz des Unvermeidlichen verbunden mit sofortiger, konsequenter Unterbindung von Neuanschaffung / Investition von Heizungs-, Kühlungs- und Stromerzeugungs-Technologien, welche fossile Brennstoffe verbrauchen. Ein solch mutiger Schritt wird die Nachfrage nach Smart City-Technologien massiv verstärken, sodass die österreichische Industrie die Möglichkeit hat, zu einem globalen Technologieführer in diesem Bereich aufzusteigen. Vielleicht ist es dafür noch nicht zu spät.

ANNEXES

ANNEX I – ABBREVIATIONS

AMI	Advanced Metering Infrastructure
AMR	Automatic Meter Reading
ASC	Amsterdam Smart City
CHP	Combined Heat and Power
DEMS	Distributed Energy Management System
DER	Distributed Energy Resources
DG	Distributed Generation
DMS	Distribution Management System
DR	Demand Response
DSO	Distribution System Operator / Grid Operator
EEGI	European Electricity Grid Initiative
EV	electric vehicle
FIT	Feed-in Tariff
GHG	Greenhouse Gas
HEM	Home Energy Management
IEA	International Energy Agency
JRC	Joint Research Centre
KPI	Key Performance Indicator
microCHP	Micro combined heat and power
MSP	Multi-Sided Platform
PHEV	Plug-in Hybrid Vehicles
PV	Photovoltaic
RES	Renewable energy source
RET	Renewable Energy Technology
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SET-Plan	Strategic Energy Technology Plan
TPES	Total primary energy supply
TSO	Transmission System Operator
V2G	vehicle to grid (service)
VPP	Virtual Power Plant

ANNEX II – TABLE OF FIGURES

Figures

Tables

ANNEX III – INTERVIEWEES

Project	Name	Organisation
TRANSFORM	**Robert Hinterberger** Robert.hinterberger@energyinvest.at	Energy Capital Invest; *(AT)*
TRANSFORM	**Ulf Skirke** Ulf.Skirke@bsu.hamburg.de	Behörde für Stadtentwicklung und Umwelt; *(DE)*
TRANSFORM	**Bob Mantel** b.mantel@dro.amsterdam.nl	City of Amsterdam, Physical Planning Department; *(NL)*
TRANSFORM	**Jørgen Boldt** jobo@hofor.dk	HOFOR; *(DK)*
Eco-City	**Reto M. Hummelshøj** RMH@cowi.dk	COWI; *(DK)*
Eco-City	**Laura Sesma** LSesma@zabala.es	Zabala *(ES)*
PowerMatching City	**Albert van den Noort** Albert.vandenNoort@dnvkema.com	DNV KEMA Energy & Sustainability; *(NL)*
PowerMatching City	**Frits W. Bliek,** Principal Consultant Smart Energy Frits.Bliek@dnvkema.com	DNV KEMA Energy & Sustainability; *(NL)*
Aspanggründe / Eurogate	**Hans Peter Graner** hans-peter.graner@wien.gv.at	MA 21; *(AT)*
Aspanggründe / Eurogate	**Silvia Hofer** silvia.hofer@wohnfonds.wien.at	Wohnfonds Wien; *(AT)*
SGEM	**Jani Valtari,** Programme Manager jani.valtari@cleen.fi jani.valtari@fi.abb.com	ABB; *(FI)*
SGEM	**Jatta Jussila-Suokas**, CTO jatta.jussila@cleen.fi	CLEEN; *(FI)*
SGEM	**Pertti Järventausta**, pertti.jarventausta@tut.fi	Tampere University of Technology; *(FI)*

Project	Name	Organisation
SGEM	**Jarmo Partanen**, jarmo.partanen@lut.fi	Lappeenranta University of Technology; *(FI)*
Eco-Viikki	**Heikki Rinne,** Head of project (retired) heikki.j.rinne@gmail.com	City of Helsinki; *(FI)*
Eco-Viikki	**Riitta Jalkanen,** Project manager; Currently also Head of Project for *Kruunuvuorenranta* riitta.jalkanen@hel.fi	City of Helsinki; *(FI)*
Witty City	**Ms. Virpi Mikkonen,** Programme Manag-er virpi.mikkonen@tekes.fi	Tekes; *(FI)*
n/a	**Dr. Harald Proidl,** Head of Renewable Energy and Energy Efficiency harald.proidl@e-control.at	E-Control Austria; *(AT)*

ANNEX IV – KNOWLEDGE BASE

IV.I General

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Council of the European Energy Regulators:
    http://www.ceer.eu

Agency for the Cooperation of Energy Regulators:
    http://www.acer.europa.eu/

Other

2050 Targets / Roadmap:
    http://ec.europa.eu/energy/energy2020/roadmap/index_de.htm
    http://www.roadmap2050.eu/
    http://www.roadmap2050.eu/attachments/files/Volume1_fullreport_PressPack.pdf

Overview of the EU 2020 targets:
    http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/targets/index_en.htm

The EU climate and energy package:
    http://ec.europa.eu/clima/policies/package/

CONCERTO Initiative:
    http://concerto.eu/

Smart Cities and Communities Calls featuring specific challenges / topics:
    SCC-2014:
    http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/calls/h2020-scc-2014.html
    SCC-2015:

http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/calls/h2020-scc-2015.html

SET-Plan:
http://ec.europa.eu/energy/publications/doc/2010_setplan_brochure.pdf

SET-Plan Implementation:
http://setis.ec.europa.eu/implementation

EERA:
http://www.eera-set.eu/index.php?index=6

Joint Programme on Smart Cities:
http://www.eera-set.eu/index.php?index=30
http://www.eera-sc.eu/

Joint Programming (ERA-NET) – general description and list of joint programming initiatives:
http://ec.europa.eu/research/era/joint-programming_en.html

Joint Programming Initiative Urban Europe:
http://jpi-urbaneurope.eu/

IV.II Smart City Initiatives / Projects by country

EU Projects

Transform: http://urbantransform.eu/

Denmark

Official website of Denmark: http://denmark.dk/en/
Ministry of Climate, Energy and Building: http://www.kebmin.dk/en
Danish Intelligent Energy Alliance: http://www.ienergi.dk
Ea Energy Analyses: http://www.ea-energianalyse.dk/uk/index.html
Energy Policy:
http://www.iea.org/publications/freepublications/publication/Denmark2011_unsecured.pdf

Climate bill:
http://www.rtcc.org/2014/06/10/denmark-set-to-approve-new-climate-change-law/
http://www.theccc.org.uk/blog/denmark-follows-uk-example/
http://www.stateofgreen.com/en/Newsroom/Broad-Danish-Agreement-on-Climate-Bill-and-Ambitious-Climate-Goals
http://www.stateofgreen.com/en/Newsroom/Danish-Climate-Bill-Ensures-Climate-Responsibility
http://www.kebmin.dk/nyheder/helveg-tager-ansvar-klimaet

Copenhagen

City of Copenhagen: www.kk.dk
Smart City project *Nordhavnen*: http://www.nordhavnen.dk/
Copenhagen Cleantech Cluster: http://www.cphcleantech.com
Interview with Hans Christian Christiansen (City of Copenhagen):
http://www.youtube.com/watch?v=wqcLGE4-Ewg

CPH 2025 Climate Plan:
http://cityclimateleadershipawards.com/copenhagen-cph-climate-plan-2025/
http://subsite.kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/Business/Growth_and_international_affairs/~/media/F5A7EC91E7AC4B0891F37331642555C4.ashx

Sustainable Development in Copenhagen:
http://crcresearch.org/community-research-connections/climate-change-adaptation-and-mitigation/city-copenhagen-denmark
http://www.stateofgreen.com/en/Profiles/Ramboll/Solutions/Smart-Energy-Cities-(2)
Sustainable Solutions from Copenhagen:
http://subsite.kk.dk/Nyheder/2012/Maj/OKF_SustainableSolutionsFromCopenhagen.aspx
Smart Grids:
http://www.copcap.com/Newslist/2013/Danish_Government_launches_smart_grid_strategy

Eco-City
Project website: http://www.ecocity-project.eu/index.html
Project description at CONCERTO: http://concerto.eu/concerto/environmental-technologies/technologies-renew-technologies/technologies-renewable-technologies-seach-by-site/tech-sites-ecocity-helsingborg.html
ECO-Life (follow-up project): http://www.ecolife-project.eu

Finland
Tekes – the Finnish Funding Agency for Technology and Innovation: http://www.tekes.fi/en/
Tekes *Smart City* Program: http://www.tekes.fi/en/programmes-and-services/tekes-programmes/witty-city/
Tekes *Smart Procurement* Program: http://www.tekes.fi/en/programmes-and-services/tekes-programmes/smart-procurement/
Ministry of the Environment: http://www.environment.fi/
Ministry of Employment and the economy: http://www.tem.fi/en/energy
Transparenzdatenbank: http://www.hankegalleria.fi/
Finnish Environment Institute: http://www.syke.fi/en-US
Forum Virium Smart City Project: http://www.forumvirium.fi/en/project-areas/smart-city
SHOK – Strategic Centres for Science, Technology and Innovation: http://www.shok.fi
SHOK-Programme at TEKES: http://www.tekes.fi/en/programmes-and-services/strategic-centres/

Helsinki
Smart City / Urban Development Projects in Helsinki: http://en.uuttahelsinkia.fi/
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Smart Grids
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http://de.slideshare.net/SchneiderElectric/fortumfinland-2012

Germany

<u>Hamburg</u>

„Masterplan Klimaschutz“ for Hamburg: http://www.hamburg.de/masterplan-klimaschutz/3959472/masterplan-klimaschutz.html

Klimaschutzkonzept:

http://www.hamburg.de/masterplan-klimaschutz/3959612/fortschreibung-klimaschutzkonzept.html

http://www.hamburg.de/contentblob/4050236/data/masterplan-klimaschutz.pdf

The Netherlands

Energy Policy: IEA Key Policies:

http://www.iea.org/publications/freepublications/publication/Netherlands2008.pdf

Energy Report 2011: http://www.government.nl/files/documents-and-publications/reports/2011/11/01/energy-report-2011/energierapport2011-170x240-engels.pdf

Energy Valley Foundation: http://www.energyvalley.nl/

<u>Amsterdam</u>

Amsterdam Smart City: http://amsterdamsmartcity.com

Founding Partners:

Amsterdam Economic Board (http://www.amsterdameconomicboard.com/)

Gemeente Amsterdam (http://www.amsterdam.nl/)

KPN (http://www.kpn.com/)

Liander (http://www.liander.nl/)

Smart Stories: http://issuu.com/amsterdamsmartcity/docs/smart_stories

Article on ASC by Ger Baron:

http://amsterdamsmartcity.com/data/file/MeteringInternational_BottomUp_GB.pdf

Sustainability Programme 2011-2014 (in dutch only):

http://greenmetropole.nl/images/Documenten/Duurzaamheidsprogramma_2011-2014.pdf

<u>PowerMatching City (Groningen)</u>

Project website: http://www.powermatchingcity.nl

Project description on the project leader’s website (DNV KEMA):

http://www.dnvkema.com/innovations/smart-grids/powermatching-city/default.aspx

Talk by Dr. Frits W. Bliek (DNV KEMA) on the Smart Grid living lab at PowerMatching City:

http://www.youtube.com/watch?v=L3vYksP2R7g

Smart Grids (DNV KEMA): http://www.youtube.com/watch?v=qti0BvZ_PR0

ANNEX V – NOTES

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