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Participative Foresight for Smarter Cities: From Vision Seeds to the Development of Scenarios

Vicente Carabias-Hütter, Tobias Kuehn, Alexander Sokolov, Harry Spiess

(MSc Env.Sci. Vicente Carabias-Hütter, ZHAW Institute of Sustainable Development, Switzerland, cahu@zhaw.ch)
(BSc Tobias Kuehn, ZHAW Institute of Sustainable Development, Switzerland, kueo@zhaw.ch)
(Dr Alexander Sokolov, HSE Institute for Statistical Studies & Economics of Knowledge, Russia, sokolov@hse.ru)
(Prof Harry Spiess, ZHAW Institute of Sustainable Development, Switzerland, muad@zhaw.ch)

1 ABSTRACT

Recently, the smart city concepts have gained increasing importance in current energy and city planning. Various smart city projects which have been realized show that a systemic, integrative approach is crucial. However, in the projects the delineation of boundaries for integrative planning and the realization of systemic local solutions are challenging as the prevailing conventional planning tools and routines are limited. They usually propose top-down and short-term approaches with limited interactions with the stakeholders and limited interdisciplinary research (in particular involving areas of sociology).

To tackle these challenges, a Swiss-Russian cooperation aims to **enhance the existing planning routines** by developing and testing systemic tools for **multi-level stakeholder participation processes** as well as for **future-oriented thinking in city development**. For this purpose, two Swiss and two Russian cities were selected, namely Winterthur, Zurich, Moscow and Kazan. These cities will be examined from the smart cities perspective with current and future applications at different implementation levels. Ideas and instruments will be developed to support their **ongoing or planned smart city projects** at district or city level by introducing participative and long term perspectives.

In a series of workshops, participants' visions, goals and interests will be elicited, compared with each other and contrasted with available data applying participative foresight methods and group model building techniques. Tools such as a GIS and a system dynamics simulation model will be developed to support the planning process, allow the integration of data and serve as a test-bed for proposed solutions. The systemic intervention and participation techniques will be continuously monitored and systematically evaluated. Moreover, a **stakeholder-based scenario development** process will be applied to envision future developments towards a smarter city and to distil roadmaps for the most desirable scenarios.

Selected city processes in Switzerland and Russia among them Winterthur and Zurich, Moscow and Kazan which are all closely linked to the Smart City concept, will be supported by tailored **vision-building**, **scenario development**, **system thinking techniques** and simulation tools. In a first step, the prevalent situation concerning planning processes and instruments in the participating cities will be addressed with a specific focus on smart city objectives and current ongoing projects (e.g. stakeholder involvement, integrating smart energy concepts such as smart housing, smart grids, micro hubs in ongoing city and district planning and implementation processes). Moreover, we will analyse which planning processes and instruments are actually used to steer future energy provision and city development in participative and integrated manners, such as the interdepartemental management teams in the city of Winterthur spreading vision-seeds to come up with a variety of smart city scenarios.

2 INTRODUCTION TO THE PARTICIPATIVE FORESIGHT APPROACH IN SMART CITIES

In recent years, the concept of "smart cities" gained increasing importance as several initiatives, networks and projects were realized (Caragliu et al. 2011). However, the concept and its targets are still diffuse, and it is rather unclear how it can be implemented in the current administrative planning routines of cities. Many smart city projects still focus on single measures in the areas of mobility or smart housing and fail to provide systemic local solutions (Moser et al. 2014). In addition, smart city projects have shown that a systemic, integrative view is demanding and that the participation of the local stakeholders and the incorporation of their knowledge can be improved – for instance through vision-building, scenario development towards smart cities, and the realisation of their respective roadmaps.

Finally, there might be different barriers and drivers, which hamper the implementation of smart city concepts. To tackle these challenges of smart city approaches, a joint research project of ZHAW and HSE aims to develop services and tools for systemic planning and implementation. To this end, a variety of smart city processes at different stages will be selected within the scope of the proposed project. Through vision-building, scenario development (cf. fig. 1) and roadmapping, system thinking methods and the

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implementation of GIS and system dynamic simulation tools, the authors would like to improve the outcomes of smart city projects.

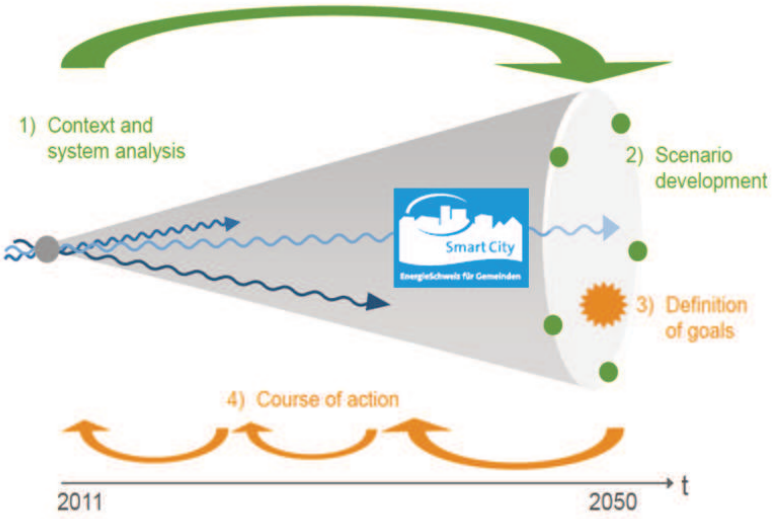

Fig. 1: Scenario development towards smarter cities (scenario trumpet from Bernath et al., 2012)

Therefore, the project has three main goals:

(1) to deliver integrated planning principles (incl. vision-building, scenario development, system-dynamic modelling, roadmapping) for policy-making support through participative foresight;

(2) to empower stakeholders and to support the planning and implementation of projects at the local level to advance the integration of comprehensive smart city solutions;

(3) to derive scientific, profound conclusions about promising approaches for implementing smart city concepts (policy formulation) in existing planning and implementation routines.

Carabias et al. (2012a, 2013) see strategic and technology foresight as a means to manage inclusion of different stakeholders' perspectives in providing solutions, to steer and adapt innovation systems in response to grand challenges, and to support the development of smart specialisation strategies to generate robust Science & Technology and innovation agendas in a globalised era.

We want to explore and compare if foresight has the potential to function as a means to face politics and not turning away from critical issues that will determine and influence our future. The research will investigate if foresight can in fact provide some room for articulation to address even complex and technologically sophisticated issues. Furthermore, the identification of best practice models from empirical evidence will support other foresight practitioners to contribute to more transparency in the debate of critical future issues, such as the progressive development towards smarter cities.

2.1 Empowering of stakeholders and process support

When visioning and developing scenarios for smarter cities, therefore designing and applying group model building moderation techniques together with stakeholders (i.e. representatives of research community, city administrations, local energy suppliers, companies, NGOs and the local inhabitants), important systemic solutions should be identified and visualized. In a series of workshops, participants' goals and interests will be elicited, compared with each other and contrasted with available data applying group model building techniques. Facilitators guide the stakeholder group through the workshops and monitor the process without intervening on the content level. Tools such as a GIS-model and a system dynamics simulation model will be developed to support the moderation, allow the integration of data and serve as a testbed for proposed solutions (smart solution simulation lab). A first version of a system dynamics simulation for the transition of regional energy systems (called TREES) is currently under development at the ZHAW.

2.2 Derive profound conclusions

The single interventions and the process advancement will be continuously monitored and evaluated. The research consortium will meet and discuss intervention design, results and process improvements in separate

workshops. At the end of the project, the pros and cons of the future-oriented and system thinking approaches will be evaluated from the point of view of the different stakeholders. Different dimensions of impacts will be considered for the evaluation: effects on the individual, group, organisational and methodological level (Rouwette et al. 2002). The evaluation results will highlight benefits and limitations of system thinking approaches for Smart City planning processes and similarities to other transition processes (Ulli-Beer, S. 2014a/b) and will be disseminated through publications and presentations at events.

2.3 Deliver integrated planning principles

The project will devise **services** and **tools** for an integrative approach for Smart City planning. An **implementation roadmap** supporting a participative and integrative perspective on Smart City urban planning will be developed. It will provide information for major stakeholders in a user-friendly manner. For example, changing roles of different stakeholders within a changing environment of a Smart City will be discussed and new business models for specific applications will be highlighted. It will be based on the overall research results and learning from all cases and projects. Fig. 2 depicts the envisioned smart city process.

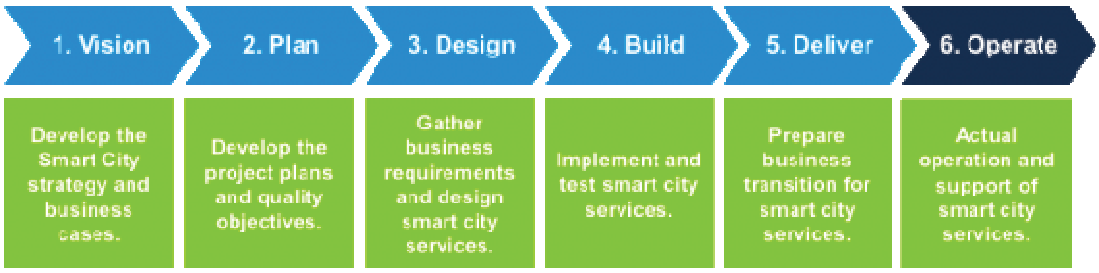

Fig. 2: Smart City Process and project procedures (EPIC, 2011)

APPLIED METHODOLOGY

The research methodology will include desk research, participative foresight, incl. scenario development, modelling and simulation, local case studies, futures analyses, roadmapping, stakeholder workshops and survey, expert validations.

Desk research: Literature and Internet research will be conducted to screen current and planned policy as well as recent academic and practitioner-oriented publications, investigating the development of smart cities through the combination of most appropriate action areas and elements from behaviour change programmes, business initiatives, policy measures, strategies, concepts, and technologies. Based on this, the scenario development for smarter cities will be prepared with the identification of the relevant subsystems and impact variables but also the indispensable stakeholders.

Case studies: The case studies will serve, amongst other, as empirical basis to refine the framework for ideal-type participative foresight for smarter cities. For the local exemplary case studies, a short period of field research will be undertaken, consisting of interviews with local stakeholders; attendance at meetings and events; and analysis of relevant documents, promotional material and websites in order to identify also important context factors.

Case studies of specific projects identify a variety of rationales amongst participants, whilst policy interest suggests a more instrumental concern for facilitating additional, larger-scale sustainable energy transitions. Bottom-up, community-based projects deliver energy savings and behaviour changes that top-down policy instruments cannot achieve, due to the greater local knowledge and engagement they embody (Hielscher et al., 2011).

Scenario development: A scenario can be defined as a description of a possible future situation, including the path of development leading to that situation (cf. fig.3). Scenarios are not intended to represent a full description of the future, but rather to highlight central elements of a possible future and to draw attention to the key factors that will drive future developments. Many scenario analysts underline that scenarios are hypothetical constructs and do not claim that the scenarios they create represent reality.

Stakeholder Validation: Project findings shall be evaluated / validated by stakeholders (representatives from policy, practice, industry, and academia) participating in expert surveys creating awareness of the

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importance of broader drivers and barriers behind the implementation of low carbon technologies and smarter cities. Additional expert validation will be ensured through stakeholder workshops and interviews to elicit visions for smarter cities. Moreover, surveys are already a way of disseminating project findings and usually initiating the knowledge transfer.

Roadmapping: The roadmap methodology itself is based on four key questions: (1) what is changing in the domain of smart cities; (2) what is the future vision for smart cities based on the developed scenarios; (3) what are the challenges and gaps to be addressed for realizing the vision; (4) what are the niches of novel solutions to the envisaged gaps and challenges. The innovation roadmap methodology is based on Könnölä (2007) and considers four dimensions of upcoming trends: technological changes, business changes, policy changes, and societal changes.

2.4 Comparative case-study approach

In order to develop, test and evaluate such system thinking approaches and tools, a comparative case-study approach has been chosen. Selected city processes in Switzerland and Russia among them Winterthur and Zurich, Moscow and Kazan which are all closely linked to the Smart City concept, will be supported by tailored vision-building, scenario development, system thinking techniques and simulation tools. The following case-studies will be supported and analysed:

2.4.1 Case-study Winterthur with smart city projects

- A simulation platform (based on the TREES-model) will be refined and applied in order to analyse new promising business models and new roles of energy suppliers of smart cities, taking into account the changed business environment of utility companies. This applied research activity supports the planning of future smart cities projects focusing on smart energy solutions in Winterthur.
- The Thalgut-Quarter in Winterthur is a residential area of 260 apartments initiated and managed by three different social housing cooperatives. Most of the buildings are low or three-stories high and were built in the 1950s. Accordingly, there is a need for smart retrofitting. Currently, an initial design plan was developed.
- Analysis of smart metering data to determine the factors explaining the levels of electricity consumption and load profiles. Exploring the role of social interaction in triggering active participation in energy conservation and behavioural change.

2.4.2 Case-study Zurich with an initial project set-up

- The city of Zurich supports the implementation of a 2000 Watt society. So far the concept of smart city has been initiated but has not yet fully taken up. With the participative foresight approach the smart city activities shall get a boost.
- IBM Switzerland and the utility ewz are interested to move towards a smarter city of Zurich.
- ZHAW is involved in setting up the process, introducing to the concepts of smart city and participative foresight.

2.4.3 Case-study Moscow with smart city projects

Smart city applications in Moscow have four main pillars:

- Quality of Life: In the areas of healthcare, education and social protection (techn. sensors)
- City Management: To achieve public service quality and promptness. For instance, smart traffic management system with intelligent parking using a dynamic pricing system depending on the congested zones and times, monitoring the state of the municipal facilities
- IT Infrastructure: Provision of equal broadband access to the modern ICT environment and creation of favourable conditions for the development of the local ICT industry
- Media and Advertising: Enhancement of the level of information availability to public; city information products popularization and quality upgrade

2.4.4 Case-study Kazan with smart city projects

Kazan is one of the largest and industrial cities of Russia. The city aims to be an international business hub with ideal living and working conditions. Kazan has recently started a large Smart City project on a 598 ha area with 220 investment projects. Being one of the examples of holistic and urban planning, the project is designed with sustainability and modern infrastructure solutions, including a 88 ha of parkways and waterways, water reuse and infrastructure systems.

Among the future potentials for smart city applications identified by the HSE for Russia include:

- Autonomous and/or alternative sources of electric & heat energy generation in cities (micro grids)
- Smart (innovative) motorways built with nano-particles in asphalt for increased grip, durability under extreme weather conditions, and lower noise
- Technologies to improve microclimatic and ecological conditions for living, working, production and storage
- Smart navigation and time management technologies for public transport
- Smart and environmentally friendly food packaging and pneumatic transport of solid waste

3 CONCEPTUAL APPROACH

3.1 … to participative planning and implementation

The first project step will address the prevalent situation concerning planning processes and instruments in the participating cities with a specific focus on smart city objectives and current ongoing projects (e.g. stakeholder involvement, integrating smart energy concepts such as smart housing, smart grids, micro hubs in ongoing city and district planning and implementation processes). The following research questions shall be addressed: Which planning processes and instruments are actually used to steer future energy provision and city development in participative and integrated manners? What are their strengths and limitations? An overview on challenges of integrated planning of smart energy futures and smart city development approaches is expected.

Close contact will be established with relevant meta-evaluation and information exchange programmes on a regional, national and European level.

3.2 … to integrative modelling and simulation for smarter cities

In the second step integrative planning support tools will be developed such as system dynamics models in order to visualize important interactions of systemic solutions, target states and different implementation pathways, also highlighting major drivers and barriers of smart city districts development patterns. The systemic understanding of the stakeholders, the multi-dimensional and multi-level (district) development objectives will be represented in the modelling and simulation tools. In an iterative process, the inputs of the stakeholder workshops from other WPs and case-studies will be utilized to improve the use of and further develop the simulation tools in Winterthur, Zurich, Moscow and Kazan. The modelling tools enhance the understanding of decision-making criteria and goal conflicts. The result of this process will provide the stakeholder with data supporting the decision-making (including information on financing structures and future business models). Research questions comprise: Can system thinking approaches, spatial modelling and simulation of city districts support smart city planning and implementation projects? How should such tools be applied and improved to enhance stakeholder involvement? At the end of this step an integrative modelling and simulation of city district development will be completed.

3.3 … to scenario development: validation of steps towards a smarter city

The purpose of the third project step is to evaluate the conceptual model and context-tailoring measures determined in previous project activities by exploring the realities of an established or planned smart city. Stakeholder workshops will help to validate the findings from previous research on a specific local level. The exemplary case studies in the field will make it possible to detect the relevant barriers and the drivers along the paths towards implementing a smarter city, such as in conjunction with local planning processes, socio-

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economic framework conditions, and scenario development for future smart solutions while acknowledging the influence of context factors.

Different scales of case study (cf. Stauffacher et al., 2012; Scholz et al., 2002) will be considered that can either be rolled out at local scale, or that can be replicated across a city or are larger scale projects that will have a regional impact (e.g. smart metering). Amongst other, the exemplary case study will serve as empirical basis to refine the framework for ideal-type participative foresight for smarter cities. To sum up, the case study will allow for a comprehensive analysis of how drivers and barriers interfere in the development towards smarter cities.

Moreover, paths for smart city scenarios will be explored to shed light on future uncertainties and options. Today a scenario can be defined as a description of a possible future situation, including the path of development leading to that situation. Scenarios are not intended to represent a full description of the future, but rather to highlight central elements of a possible future and to draw attention to the key factors that will drive future developments (cf. fig. 3).

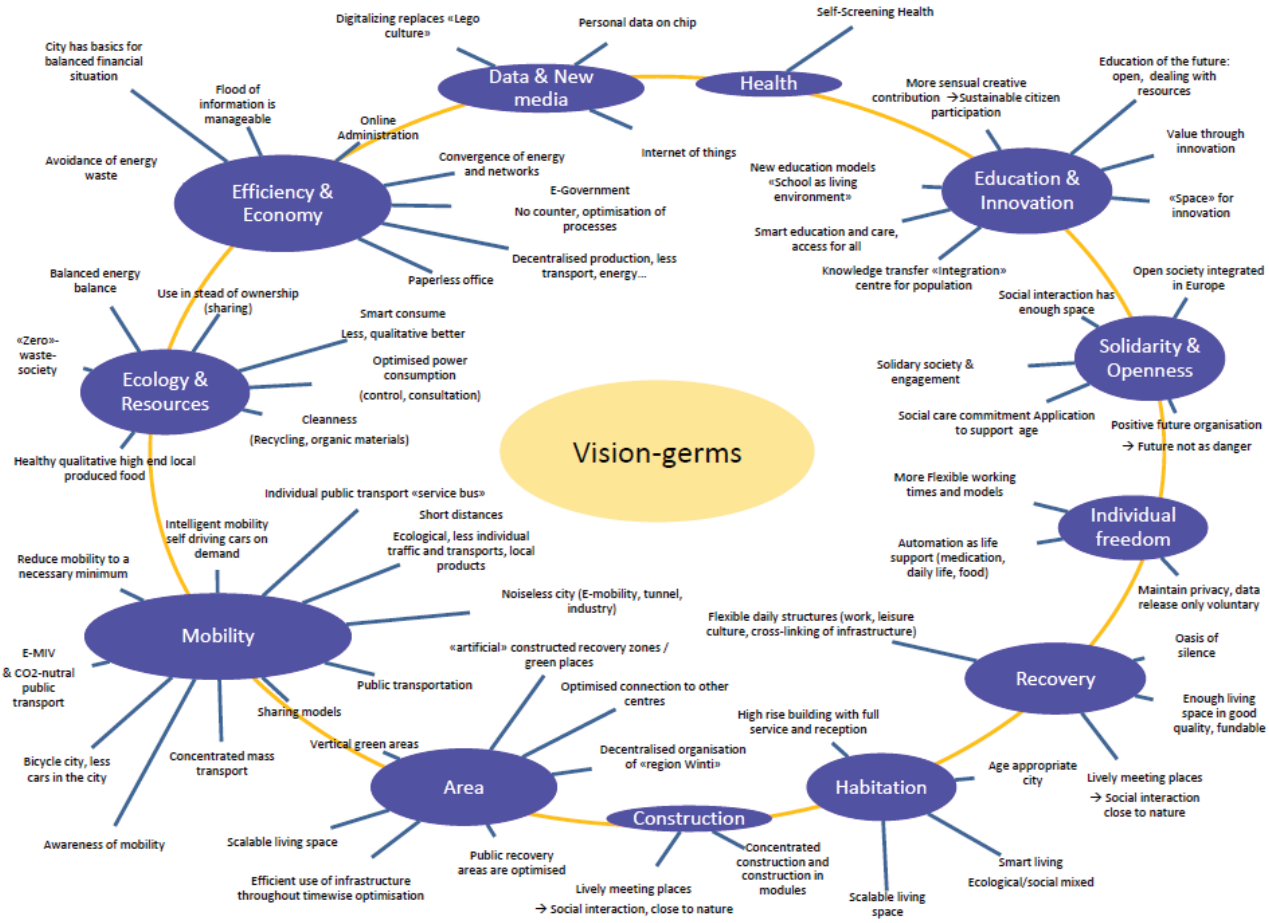

Fig. 3: Vision-germs for Smart Cities discussed in a city management group (own picture)

As final product of this project step an over-all case-study report will be delivered on the support to cities that take pioneering measures to progress towards a smarter future, describing the developed scenarios and its assessment against plausibility and desirability.

3.4 … to roadmapping towards smarter cities

This working step will address the strengths and limitations of the chosen system thinking approach with regards to systemic smart city planning and implementation, considering different planning and implementation levels and objectives. Recommendations will highlight new elements concerning urban planning routines and the role of participative foresight and modelling. A scientifically sound evaluation of the chosen approaches will be the basis of this analysis. The main insights will support the development of a generic implementation roadmap that will be illustrated with project examples.

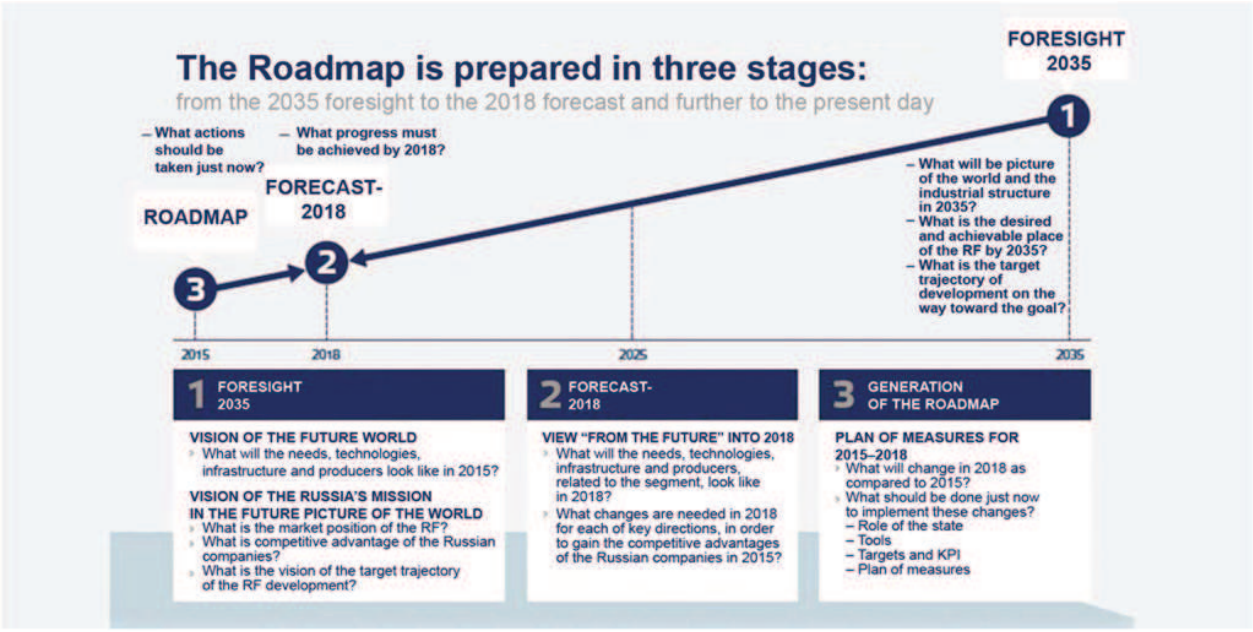

Fig. 4: Roadmapping approach proposed by the Russian National Technology Initiative (2016)

The roadmap will provide systemic visual presentation of key areas of smart-city development taking into account challenges and windows of opportunities, as well as a set of potential alternative innovation trajectories of "smart city" development in the four selected cities. Recommendations for implementation will include the decision-making criteria, financing structures and promising business models.

Therefore the following research questions will be addressed: What are the strengths and limitations of system thinking approaches and tools for planning and steering smart city projects? What are the lessons learnt from each case-study? Finally, stakeholder recommendations on urban and energy planning routines, and on implementation of roadmap are expected.

Successful transfer of smart practices requires an understanding of the cultural conditions for and barriers to the transfer of practices from one context to another. This working step aims to provide such understanding by combining practical experiences from the case-studies. Context is therefore defined in the broadest possible sense. It entails, among others, culture on the level of a country or city, culture on the individual level of people's specific positions and ways of life. By looking for those practices that have worked pretty well, one tries to understand exactly how and why they might have worked, and evaluates their applicability to one's own situation.

Investigating the regional framework conditions, strategies, concepts, and context factors will result in recommendations on appropriate policy measures facilitating the development of smarter cities and for decision makers on how to design an effective roadmap towards a smarter city.

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