

Policy paper

From dream to reality: sharing experiences from leading European Smart Cities

Miguel A. Garcia-Fuentes⁽¹⁾, Lisa Enarsson⁽²⁾, Trinidad Fernandez⁽³⁾, Sigrid Granström⁽²⁾, Gustaf Landahl⁽²⁾, Cristina de Torre⁽¹⁾, Sonja Stöffler⁽⁴⁾, Simon Clement⁽⁵⁾, Esben Pejstrup⁽⁵⁾, and Carsten Rothballer⁽⁵⁾

(1): Fundacion CARTIF, Valladolid, Spain

(2): City of Stockholm, Stockholm, Sweden

(3): Fraunhofer Institute for Industrial Engineering (IAO), Stuttgart, Germany

(4): University of Stuttgart IAT, Stuttgart, Germany

(5): ICLEI

1 Introduction

Many European cities are forerunners in the transition towards a low carbon and resource efficient economy. According to the 2018 Revision of World Urbanization Prospects (UN DESA) a rapidly increasing part (currently 74%) of the EU population lives in urban areas, accounting for 60 to 80% of global energy consumption¹. Urban life attracts people as environments for learning, innovation, opportunities for new businesses.

The focus for smart and sustainable cities' projects is to provide solutions, which significantly increase cities' overall energy and resource efficiency. These initiatives address climate change challenges through the improvement of the existing buildings, energy and mobility systems, water or air quality. Such actions should bring deep economic, social and environmental impacts that lead to a better quality of life (including health and social cohesion) and competitiveness of the cities.

1.1 The Smart Cities and Communities lighthouse projects

The Smart Cities and Communities (SCC1) lighthouse projects are funded by the European Commission through the Horizon 2020 research and innovation programme. The aim is to bring together cities, industry and citizens to demonstrate solutions and business models that can be scaled up and replicated. The implementation of smart city solutions leads to multiple measurable benefits in energy and resource efficiency, economy, social aspects, environment and new markets.

1.2 GrowSmarter, REMOURBAN and Triangulum

The first lighthouse projects, GrowSmarter, REMOURBAN and Triangulum are the frontrunners from the family of SCC1 projects that today represent 14 EU-funded projects involving 40 lighthouse cities and 51 follower cities.

Many experiences and knowledge were gained throughout these five years of work. These are presented as a set of policy recommendations that build upon the lessons learned from these

¹ https://ec.europa.eu/clima/policies/international/paris_protocol/cities_en

initiatives. The main goal of this document is to support other EU cities in their transition towards smart and sustainable cities and communities.

The three projects GrowSmarter, REMOURBAN and Triangulum have been working since 2015 towards two main objectives:

- ▶ Build capacity and share knowledge to show other cities how to transform their ecosystems into smarter and more sustainable environments.
- ▶ Facilitate the implementation of certain Smart City technologies through demonstrating how they work technically, financially, socially and environmentally.

The lighthouse cities are Stockholm, Cologne, Barcelona in GrowSmarter, Tepebasi/Eskisehir, Valladolid, Nottingham in REMOURBAN and Stavanger, Eindhoven and Manchester in Triangulum. The follower cities are Suceava, Cork, Valleta, Porto, Graz in GrowSmarter, Seraing, Miskolc in REMOURBAN and Sabadell, Leipzig and Prague in Triangulum.

1.3 Our joint impacts

These three projects together have achieved the following:

- ▶ 228 067 sqm have been retrofitted in the 9 cities involved, leading to more than 16 GWh/yr of energy savings and more than 7000 tons of CO₂e avoided.
- ▶ 194 alternative fuelled buses, vehicles and bicycles have been implemented transporting citizens as well as delivering goods and services.
- ▶ 9 urban platforms have been deployed, including services as: energy and mobility games, energy and mobility maps, car and bike-sharing apps and retrofitting and urban planning tools.
- ▶ In total 52 000 citizens have directly benefited from the projects' actions.
- ▶ 3 new companies (start-ups, spin-offs) have been created, 20 new projects and 13 initiatives as a consequence of the activities in the Lighthouse cities and follower cities.

Overall, the three projects have contributed to create more sustainable environments in the partner cities, which are now recognised as frontrunners in urban transformation for achieving the EU Sustainable Development Goals.

1.4 Policy recommendations to the EU

In the three projects ambitious demonstrations have been carried out. To achieve this, they needed to comply with national and European legislation. They have also faced the possibilities and barriers of implementing local, national and European goals. Ambitious political statement on a local, national and EU level is needed to reach smart and sustainable cities. At the EU level the suggestion is to reduce the GHG emissions by 55% until 2030 and to reach the climate neutrality by 2050.

The cities involved in the projects have shown a strong political commitment that has established long-term strategies that go beyond the temporality of the governments. For example, in the city of Stockholm has decided to become fossil fuel free by 2040, and on national level net emissions by 2045. The city of Eindhoven has created a vision to become the largest Dutch and European innovation and technology hub, so called "Brainport" until 2020 bringing ecosystems including academia, businesses, cities and citizens together. One of the follower cities, the city of Seraing, has also created a long-term revitalisation plan aiming at regenerating the former industrial areas of the city to deliver a more liveable and sustainable city.

These political decisions have affected each element of intervention: low energy districts, sustainable mobility and ICT. All of the cities have identified that there is a need to address a mix of requirement and encouragement in order to optimise the delivery and sustainability of urban development.



1.4.1 Low Energy Districts

- ▶ Enable requirement in terms of building regulations that accept and expect green construction techniques and materials for new buildings as well as in retrofitting.
- ▶ Ensure all countries building codes accept and support local ambitions on energy efficiency, thus not restrain the development of near-zero buildings for new buildings as well as in retrofitting.
- ▶ Demand that national building codes are moving to near-zero buildings in acceptance with European ambitions and directives.
- ▶ Ensure National Government Policy that is consistent in pricing around external retrofitting with stable incentives and programmes for deep retrofits.
- ▶ Reconfirm that national taxes and regulations support and do not restrain the production of local sustainable energy from photovoltaics, wind, biogas and encourage uptake of excess heat.
- ▶ Introduce CO2 tax.
- ▶ Ensure education of energy efficiency workers and citizen engagement.

1.4.2 Sustainable Mobility

- ▶ Ensure electricity comes from 100% renewable sources (Directive 2001/77/EC)
- ▶ Enable sufficient charging infrastructure to ensure that users are more likely to be encouraged to use electric vehicles and demand national strategies including costs.
- ▶ Empower the establishment of ultra-low emission zones and congestion charges in urban areas by local regulations in order decrease traffic, encourage walking and ensure electric vehicles and bikes are used by both commercial and private owners.
- ▶ Ensure through legislation the growth of sustainable biofuel supply from waste and derelict farmland in Europe in order to accelerate alternatives to fossil fuelled vehicles.
- ▶ Design and facilitate standards that guarantee batteries to be used for vehicle to building (V2B)
- ▶ Empower national electric legislation to effectively support vehicle to grid (V2G).
- ▶ Encourage eco driving education and citizen engagement.

1.4.3 ICT

- ▶ Ensure good digital governance and enable public authorities to keep up with technology developments so that personal data is dealt with correctly and people feel that they are safe in using digital technologies and services.
- ▶ Ensure fast and reliable internet connection and infrastructure.
- ▶ Analyse and ensure implementation of smart meters where viable in Europe also ensuring proper handling of personal data.
- ▶ Empower and capacitate citizens and businesses to have the necessary experience and expertise to use smart technologies as a tool to strengthen the transition towards sustainable cities.
- ▶ Ensure common ICT reference architecture for Smart City implementation projects. The individual and partial solutions must constitute a normalized evidence base for describing a generic ICT Reference Architecture.
- ▶ Implement standards to measure the impact and performance of Smart City projects. A well-defined method to support standard gap analysis and its presentation is required.
- ▶ Update regulations on data sharing and GDPR.



2 From cities to cities: experiences gained

2.1 Phases and challenges of the urban transition

The following subsections provide an overview of the main challenges addressed when implementing smart and sustainable technologies and strategies in cities. Aspects as social behaviour, legal and normative issues and financial barriers are tackled.

2.1.1 Social and cultural barriers and opportunities

How to communicate the actions needed for a transition to smart sustainable cities in order to overcome the cultural and social obstacles: key messages, tools, channels and indicators.

Sustainable urban development is complex and multi-faceted. It requires appropriate governance structure and an integrated management approach in order to channel capital more effectively for building low energy districts, active and alternatively fuelled mobility and to integrate ICT in the urban infrastructure. Cities also need to pay more attention to the softer, behavioural elements in order to be successful and to optimise the opportunities for people, businesses and organisations.

A holistic, integrated and sustainable approach and a positive outcome will be ensured by the following supporting interventions:

- ▶ Optimisation of low energy buildings will be achieved when residents are aware of the reasons behind, how their behaviour affects the outcome and their individual as well as societal benefits. Financial incentives are also needed. Optimisation will be achieved if the national energy policy is focused on affordable prices as well as highly efficient and renewable performance.
- ▶ Optimisation of mobility and urban traffic systems will be achieved if the necessary infrastructure is in place and people can use it easily and simply for example with mobile applications or by smart cards.
- ▶ Optimisation of ICT and integrated infrastructure for providing public or private services will be achieved if data is shared securely in a standardised way through platforms following agreed protocols. Optimisation will be achieved if data protection issues are clear to citizens and there are no uncertainties about the data collection and the use of the data. Therefore, sufficient digital governance and governmental support is needed to guide the implementation of ICT technologies.

Most of these urban developments are underpinned by regulatory and behavioural elements. Aligned to this, though, is the need for public procurers to have an entrepreneurial mind-set – to seek, encourage and deliver innovative means of procuring goods and services and to build sustainable, beneficial outcomes, based on performance, not necessarily price, in order to maximise the benefits for citizens, businesses and organisations.

Social and cultural barriers are the most difficult to overcome, but present opportunities for new services such as innovation market dialogues, trainings and education or stakeholder facilitation. The transition to a smart and sustainable city will be successful, if effectively engaging citizens by large, and not only involve selected technicians, public officials and scientists. Awareness-raising campaigns to communicate, inform and activate citizens are key to overcome related barriers. For clear and targeted communication the following actions were identified and are recommended:

- ▶ Foster and educate citizens to become more conscious and well-informed citizens about climate change and urban challenges. A focus on public campaigns to raise awareness and educate them on relevant topics in the smart sustainable city agenda;
- ▶ Place the communication with citizens/target groups high in the smart sustainable city agenda; Devote more resources (staff, finance, time...) to communication about the smart solutions at the planning, implementation and evaluation phase;



- ▶ Communication has to be “local” and work as a dialogue, not monologue: close to the place where the actions are implemented.
- ▶ Be aware that when implementing European projects in which different cities and SCC stakeholders engage, different cultures, different socio-economic environments, and people with different attitudes and Smart City approaches come together. Therefore communication has to take the diversity into account and be able to adapt to the local context. A communication partner who is not directly involved in the implementation of actions can be ineffective. Local communication partners should be involved as well with sufficient resources depending on the measure.
- ▶ Key messages to the public should be focused on the benefits of the actions (economic, social, environmental, quality of life for the individual). A particular focus should be on the advantages brought to the local community, and should be presented in a graspable way. Deliverables are written for experts, officials and academia. For the local society communication tools like “YouTube” videos, infographics, local events like open doors days, using innovative tools like co-creation, urban labs, eco-teams, are proven successful.
- ▶ Establishing a public dialogue with the citizens concerned is the best approach when communicating interventions. This allows these citizens to become “ambassadors” able to share their experiences with other citizens.
- ▶ Surveys and interview studies before, during and after the interventions can be used to capture public opinion and knowledge about the actions and its benefits.

What role do the stakeholders (public administration, companies, academia and NGO) play?

Interdisciplinary cooperation, preferably in a regional or local ecosystem, is a key success factor for current leading cities. All entities of a project have to work together and in a coordinated way in order to ensure synergy. Normally, people trust public administrations and NGO´s more than private companies, which are seen as more concerned by making profit. Academia should be more oriented towards addressing the real needs of administrations and the private sector. Public administrations should have experts in communication and public participation and devote more resources to these issues. This is also referred to as the "triple helix" (cooperation between research, business and administration), and the "quadruple helix" when citizens are taken into account for social innovations and further urban transformations. It is essential to pursue the establishment of this collaborative local ecosystem to ensure a resilient and inclusive partnership. It can start by an event organized by all the partners, moving forward to common projects and programmes. These actions finally end up creating an ecosystem, where partners trust each other, have a common goal, and can benefit from this collaboration.

To create this innovation environment, it is crucial to overcome the following existing barriers:

- ▶ Often no real partnership between cities and companies exist, since some procurement regulations prevent close partnerships, in other cases the ways of thinking and acting are very different.
- ▶ Many companies have not realized that own smart city products and business solutions need to be embedded within larger systems. New forms of collaboration, open innovation and co-creation need to be learned by these companies
- ▶ Companies fail to address the real demand of cities, because they think in product categories, not in integrated solutions. Eco-systems of businesses, technologies and services become more important.

2.1.2 Legal and normative barriers

Regarding public procurement, how can we find the right balance between transparency and efficiency?

Public Procurement processes for Smart Cities have been identified as another critical cross-cutting issue. The points that weaken a suitable implementation of sustainable solutions are:



- ▶ Heavy procurement procedures: The procedures, in many countries, are very heavy and complex (involve too many stakeholders, at federal, regional and local level);
- ▶ "Lowest price" against "best offer": It is difficult to identify the best value for money;
- ▶ Delays in the public procurement process: Changing anything in the public procurement process takes a lot of time as it requires so many level of validation at federal/regional and local levels.
- ▶ Despite of benefits, no emphasis on Public Procurement of Innovation (PPI) and Pre-Commercial Procurement (PCP): Weak experience and knowledge of municipal staff on the methodology to be applied for PPI and PCP, lack of knowledge on benefits.

Some of the proposed solutions are:

- ▶ Accelerator programmes to support mechanisms from district authorities that issue challenges rather than dictate the detailed specifications required. In Nottingham there are regional energy technology development centres and accelerator programmes between universities whose goals include assisting promising technology owners with successful courting of procurement tenders.
- ▶ The establishment of entities that share risk and cost can encourage SMEs to engage more actively in low energy district interventions.
- ▶ Community ownership of low energy solutions or even group approaches to energy market transactions are other solutions that can side-step slower moving decision-making processes or restrictions that exist within local authorities' procurement apparatuses.
- ▶ Also it has been noticed a significant uptake of solutions that improve aesthetics and savings by neighbours that see it working next door. Marketing is a scalability tool in this situation to generate interest at district level.

Regarding ICT platforms for data collection, how can we find the right balance between privacy rights and sustainable economic development using big data as an input for new businesses?

The implementation of an ICT platform for the collection and storage of data involves security aspects that legislation effectively preserves. In this sense, the normative compel to create procedures and certifications for security control.

People are in many cases sceptical not only about the correct enforcement of this law but also as far as concerns the use of information obtained, over data security. In order to avoid such scepticism, both good control procedures and adequate/transparent communication are required (about the use of data, benefits and improvements expected, etc.).

Besides, Municipalities currently have no protocol for contracting companies on open data requirements, taking into account that these organizations are not obliged to offer the data they handle to open data platforms.

2.1.3 Financial barriers

Which are the main financial barriers and how can we overcome them?

Financial issues have been highlighted, as one of the most critical ones as high initial investment cost are common in low energy districts and mobility solutions. Main aspects are:

- ▶ High investment and up-front costs;
- ▶ No long term guarantee for heat and electricity prices;
- ▶ Lack of financial institutions participating at the early stage of projects; lack of public funds for the deployment and maintenance of infrastructures;
- ▶ Long payback period;
- ▶ Political priority on new buildings and not on renovating existing buildings as there is a low recognition of the financial benefits from renovating existing buildings.
- ▶ Scepticism and lack of experience with emerging markets (e.g: Emerging mobility markets, for example: electrical mobility solutions do not always reach economic feasibility within a short term).

- ▶ Integration of innovative technologies has often not been tested and standards are missing. This lacking precedencies means high risk for investment an unsecure Return of Investment (ROI).
- ▶ Cash-flow models are not clear yet – especially in complex stakeholder constellations, which are characteristic for smart and distributed solutions. In addition, different national landscapes for incentivising technologies like renewable energies (like feed in tariffs) or electric vehicles prevent consortia from developing one-size-fits-all solutions.
- ▶ In economic terms the largest benefits of smart and sustainable urban technologies are achieved in reducing external effects such as indirect impacts on health and well-being. This leads to difficult cash-flow models and unsecure investments. In addition to calculating ROI companies and cities need to develop holistic value models that reflect the complex benefits of smart city solutions for environment, society, economy and a resilient city.

Within the three projects, some interesting proposals have been identified and implemented to reach financial sustainable solutions and reduce the effects of the existing barriers:

- ▶ Training programmes for an ideal local skill development to the new technologies (municipality staff including planners, district level regeneration management and economic development teams, etc.)
- ▶ Assistance to promote initiatives of crowd-sourcing, microfinance, community projects;
- ▶ The establishment of entities that share risk and costs, such as public-private consortiums/associations, encouraging small and middle-sized enterprises (SMEs) to engage more actively as solution providers and help mechanisms such as public private partnerships (PPPs).
- ▶ Instead of supporting tax reductions/exemptions/rebates, seeking support for first adopters to allow the required teething and scalability lessons to be learnt.
- ▶ Externalization of investment costs and risks through innovative contracting or service models to overcome economic barriers. In such a case, an external operator takes care of planning, installation and operation of the smart energy network.
- ▶ Incentives to citizens and local governments willing to exploit potentials for smart energy solutions, for example in the form of investment supports, tax concessions or reductions in energy-related fees. From a macroeconomic perspective, this may be an efficient way to quickly tap into flexible potentials. As a side effect, it could lead to the additional creation of high-level jobs in knowledge intense business sectors and local installation companies, much like the successful development of the renewable energy sector through feed-in tariffs. The implementations might just be enough to fulfil subsidy criteria instead of market needs.
- ▶ Identify the most suitable business model and financial scheme for the type of intervention (energy, mobility and ICT). The benefits for the environment or aspects that are not so relevant at first sight but with a major impact on medium or long term should also be considered.

2.2 Evaluation supporting the smart, sustainable urban transition

Why is the evaluation of demonstration projects important and how can it be used?

Demonstration projects testing new innovative solutions are important, to show citizens, public officials, politicians and investors how it works when implemented. It is much easier to understand when it is done in real than to explain the benefits in theory. The implementation is also relevant to provide a secure and reliable feeling by investing in these solutions. Therefore, the evaluation of these projects is essential. The results must be concise and clear so decisions for the further deployment of these solutions can rely on facts. An example is the Test of the congestion charges in Stockholm. Before the test the majority of the citizens where against the solution while after testing it one season, seeing the effects and communicating the evaluation results of 25% less traffic in the city centre, there was a referendum voting for the congestion charges.

Cities need to use the results of the evaluation more strategically intercepting innovative solutions with good results regularly and mainstreaming them in new and existing urban areas.



What are the main difficulties for cities in the implementation of an evaluation scheme?

- ▶ Difficult to access data, barrier of data collection requiring permission from individuals. Conflicts on data ownership for open data (private and public);
- ▶ Cities are normally overwhelmed with long lists of indicators and information to collect but not with support to understand the requirements of the information requested; thus, they cannot act alone to understand and process all this data, being essential the involvement of academia;
- ▶ Lack of resources (staff, time and cost) and specific personnel assigned to collect data. Data normally disperse in different departments/institutions and not properly communicated;
- ▶ Lack of understanding the purpose and benefits from the data collection,
- ▶ Mix of different qualitative criteria;
- ▶ Lack of understanding and potential for the evaluation results to be used to engage with citizens;
- ▶ Predominance of the political and economic rather than ecological, social and cultural criteria.

How evaluation can support cities and business at different stages of Urban Transformation?

- ▶ Evaluation results can help to prioritize actions and to assess these priorities (quantitative and qualitative) aligned with the city strategy/vision;
- ▶ Develop evaluation methods to support the cities to prioritize actions by providing clear and meaningful analysis of the status of the cities;
- ▶ Design flexible evaluation and assessment methods that can be applied to different cities, their objectives and needs (with the flexibility to select their priority areas) to measure and track their progress towards their goals;
- ▶ Develop evaluation and assessment methods to adapt to the different stakeholders needs, as the information to be presented/analysed/ in different ways;
- ▶ Communicate the need and purpose of the data collection within the consortiums in an early stage. This will improve the efforts invested, data quality and engagement among all the stakeholders;
- ▶ Set a communication plan on how and to whom fruitful results and to what extends these should be communicated to the citizens, public actors and further stakeholders.

How can evaluation help cities/business to engage with citizens and stakeholders and to bring cities and business together?

- ▶ Public and private sector must work together. While cities need guidance on how to apply these evaluation procedures, the private sector can help by providing mechanisms to assist the decision making process. They can also provide training about the implementation of such mechanisms and guidance on the analysis needed to understand the results;
- ▶ Academia plays an essential role in the analysis and evaluation of the implemented technologies and therefore must be involved in the training and guidance processes. It is recommended that academia lead these processes as a neutral stakeholders;
- ▶ Evaluation can help cities to engage with citizens by providing objective information that can help citizens to participate on the decisions making;
- ▶ Communicating results from smart cities evaluation to citizens can help cities and business to maximise the awareness of the value to the actions showing, for example, the indirect long-term impacts, and in particular to those that are not economically attractive. Cities and the private sector need to link the communication of sustainability to the financial evaluation;
- ▶ Provide not only data values but also analysed data. E.g. providing value to the results in a form of prediction or real time services among others. Academic institutions research and analyses the data and foster innovation in cities.

2.3 Replication and upscaling of smart solutions

How easy is replication – or does the success of replication depend mainly on common factors (e.g. demographics, energy systems, urban morphology, building characteristics)?

In general, true copy-paste replication is very rare. The simplest answer to any question about the feasibility of true replication is "it depends" ... on a variety of factors. We can likely determine which are the most relevant factors influencing the success or failure of a replication attempt, but mapping out the order and magnitude of these factors is difficult and variable – as they also depend on a number of variables. City administrations still often think and act in silos. They are structured in silos and to be successful in implementing smart and sustainable solutions cross-coordination between departments is needed. Only very few companies see themselves as system-integrators of smart city technologies and services, thus there is a vacuum when it comes to coordinating and leading integrated smart city projects and cities need to take that role.

Political leadership is essential pointing in the direction toward development of smart and sustainable cities and prioritising resources to make it happen.

Smart solutions can be replicated by adapting the original idea to a new context, creating a comparable or analogous project in another location. There are two important aspects to increase the probability of success: i) determine transferrable units, and ii) find the window of opportunity. Transferrable units refers to viewing the project as the sum of its parts and determining which of those parts are able to be transferred directly, and which need to be adapted. These parts could then be repackaged as a new solution customized to the new location, with a higher chance of success. Windows of opportunity refer to the changed probability of successful replication over time, including factors such as project progress, existing city development and preconditions, as well as city economic and policy cycles.

However, is it really replication the right approach? Within these projects, follower cities had the opportunity to get access and gain knowledge by following the implementation process of the lighthouse cities. But not always the solutions tested matches the challenges the follower cities are facing. It is difficult to adjust and try to assess the replication of solutions that are not relevant in such different contexts. Nevertheless within these programs, different approaches regarding further implementation strategies have been developed sustained by the transferability of concepts, approaches and experiences more than replication of solutions. By the trial-error, cities are gaining the baseline knowledge to produce their own implementation plan for further smart city projects.

Demonstration project testing innovative solutions in a triple helix (Public, private and academia) collaboration is very successful using the individual knowledge and different point of views. The involvement of citizens (quadruple helix) as the final users is crucial.

