Analysing the potential for wide scale roll out of integrated Smart Cities and Communities solutions

Final Report

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Abstract

Cities worldwide are growing fast. Over half of the global population lives in urban areas, and this share increases every year. Urban population growth means that services need to reach more and more individuals. Technology is of great help in this race against urbanisation, providing innovative and more efficient ways to respond to the increasing demand for more sophisticated and complex services. To exploit technological opportunities, city planners, administrators, citizens, entrepreneurs and all other stakeholders must reconsider the way they have approached urban service provision up until now.

This report outlines the results of the analysis performed on evidence from smart cities and solutions cases, assessing the main features impacting the roll-out opportunities of integrated smart city solutions.

The assignment was commissioned by the European Commission Directorate-General for Energy (DG ENER) to contribute to the knowledge base of the European Innovation Partnership by analysing Smart Cities and Communities (SCC) solutions and initiatives that are linked to the Strategic Implementation Plan (SIP) of the European Innovation Partnership on Smart Cities and Communities (EIP-SCC). It ultimately aims to use the analysis of SCC solutions to promote a better understanding of success factors for their deployment and roll-out.

Executive summary

This document is the Final Report of the study analysing the potential for wide scale roll-out of integrated SCC solutions, carried out by PwC, DTI, ISIS, SigmaOrionis, with the support of Sinergis and HIT.

The objective of this study is to support the European Commission in contributing to the knowledge base of the European Innovation Partnership by analysing Smart City solutions and initiatives that are linked to the Strategic Implementation Plan (SIP) of the European Innovation Partnership on Smart Cities and Communities (EIP-SCC), thereby promoting a better understanding of success factors for their deployment and roll out.

To support the understanding and sharing of the best practices for the roll-out of integrated SCC solutions, the following activities were carried out:

- Screening and review of the most **relevant literature** on SCC solutions;
- Identification of **300 examples of SCC solutions,** of which approximately 200 are European, while the remaining examples come from the rest of the world;
- Analysis and description of **80 best practice examples of SCC solutions,** selected from a list of **300 examples of SCC solutions** (see second bullet point);
- In depth analysis of **10 case studies** (selected from the 80 examples of SCC solutions), putting particular emphasis on their **business models,** so as to make evidence available for other possible SCC solution initiators.
- Identification and analysis of **10 examples of "failure" of SCC integrated solutions,** to identify the most typical patterns of failure;
- Analysis of **synergies between the most relevant SCC groupings and organisations,** and insight into how to successfully use these synergies to further advance the concept and roll-out of Smart Cities;
- Investigation of the **commonalities between the SCC settings of the EU and China,** which could be leveraged to increase replication and market potential for European Smart Cities in China.

For the purpose of collecting the sample, multiple sources were used to identify leading examples of SCC solutions. The main data sources were the literature analysis carried out across all SCC key domains, relevant international Smart City benchmark studies and rankings to identify the most prominent cities implementing SCC solutions and, finally, the EU-funded initiatives supporting the development and implementation of Smart City solutions.

The context of the study

Technological development has led to a changing approach to business practices in urban infrastructure development, allowing for accurate and reliable measurement of socio-economic and environmental impacts. It is therefore possible to quantify – and, consequently, to price – the externalities generated by investments in urban infrastructure. This opens up new sources of revenue for projects, new business models for recovery and value capture, and new opportunities for investors.

Specifically, the cases analysed made it possible to identify commonalities in the value created to communities, depending on the sector they referred to (as reported in the table below).

Type		Value proposition
Sustainable Urban Mobility	***Real-time road user information***	Enable people to take informed decisions about their mobility, saving time and energy.
	ITS-based enhancements of public transport	Reduce waiting time as well as emissions, and facilitate intermodal commuting.
	ITS for traffic monitoring, management and enforcement	Optimise fleet management and route scheduling.
Sustainable Districts & Built Environment	***Smart technologies for the built environment***	Pursue better living, resource efficiency and waste reduction.
	Sustainable districts	Reduce emissions and resource consumption by embedding integrated energy efficiency technologies.
	Place making	Create communities of interest that can be key to support integrated SCC solutions.
Integrated Infrastructure & Processes	***Smart City Platforms***	Allows real time monitoring and preventive steering of cities.
	Intelligent City Services	Co-ownership of local matters and outcomes. Efficiency savings for city administrations. Stimulate involvement at local level.
	Smart grids	Collected information and insights may serve planners and managers, but are often also shared with users, who can take more informed decisions and can also become *prosumers*, i.e. users that can switch from being energy consumers to becoming producers based on the circumstances.

Across the sample of analysed cases, city-wide integrated solutions were rare. Instead, solutions with higher levels of integration are emerging in smart districts, across some energy efficiency projects as well as in various mobility projects. These are generally encountered in urban development investments sustained by real-estate business cases, where the integrated SCC solutions are ancillary to more traditional business cases.

To ensure a comprehensive study, different aspects of SCC solutions' business models and deployment are assessed, namely:

- Ways and tools to govern SCC solutions, in particular for cities, which are faced with the challenge of exploring the economic return in SCC investments;
- How SCC solutions can be funded and which opportunities for financing arise from these new technological opportunities;
- Procurement process practices and tools are analysed in the context of SCC solutions.

- The importance of involving citizens and communities into SCC solutions.
- Features and conditions that favour and hinder the roll-out potential of SCC solutions;
- The opportunities for the EU to leverage the international dimension of SCC deployment by partnering with China.

Governance of integrated SCC solutions

City planning activities are changing due to technological development. The role of private companies shaping the development of cities has been increasing, whereby they act as investors, service or components providers, and users.

Budgetary constraints and the increasing complexity of urban investments for SCC solutions has lead city administrations to require the involvement of private players and, consequently, to adapt the governance of cities in order to attract them.

From a governance perspective, the following actions are suggested.

Manage the shift towards a collaborative operating model. Static and public administration-centred governance systems collide with the integrated SCC solutions approach. Collaboration must be favoured at different levels, specifically:

- **Integrating solutions enhancing coordination at city-governance level.** The analysis of SCC cases has shown that there still is a limited share of integrated solutions, as these tend to be developed at sectorial level. Although reasons are numerous, the separation at city government and planning level hinders coordination and collaboration among departments. This could be resolved by creating a centralized coordination office for integrated SCC solutions and by supporting city planning with appropriate tools/guidelines for SCC strategies and initiatives;
- **Strengthening multi-stakeholder partnerships at all levels.** SCC solutions are complex; they require the public sector to partner with private parties, which have the interest, capacity and skills to develop the projects. Thus, the governance of cities as well as that of specific SCC solutions should enhance the participation of the different parties, in partciular private companies and universities/research centres;
- **Enabling framework conditions for new business models**. Flexibility should be ensured in shaping roles and responsibilities related to SCC solutions. The public sector may consider taking charge of the management of project design and initial phases, but should ensure that this is done by maximising the involvement of the private sector and – potentially – users/universities, etc.

Establish a blueprint for an open, city-wide, service-oriented, interoperable IT platform, which would provide an agreed architecture on which city partners and suppliers can converge over time and establish a multi-level competitive landscape at the platform, services and application layers.

Manage data: data ownership and management is key in any digital process. As integrated SCCs make extensive use of data, which is collected, processed and shared in real-time, it would be advisable to **ensure that data is as free as possible.** Indeed, the more information is available, the higher the opportunities to use it for

solutions. However, **data must be protected, controlled and assessed in terms of quality.**

Funding and financing opportunities

Current budget limits and constraints (e.g. stability pact rules) are forcing public authorities to look for alternative sources of capital to support the development of SCC solutions on a wide scale. At the same time, the possibility to create value through innovative technologies opens interesting business opportunities for private investors as well.

However, limited access to finance affects small innovative companies and start-ups, especially those engaging in innovative and risky projects. This limits both their capacity to develop innovative solutions and their ability to bring their products to the market.

The following recommendations arise from the analysis undertaken.

Rationalize the supporting role of the EC to SCC projects, depending on whether these can potentially generate revenues or not. In order to increase efficiency in the allocation of public resources, it is recommended that a clear distinction should be made between projects that are developed for RDI purposes and those that are not. RDI projects – including small-scale projects contributing to larger scale ones – should necessarily be supported via grants, as it is unlikely that they could pay back the investments made. Conversely, SCC projects that aim to be replicable – and hence commercially viable – entail neither the risk level of RDI projects, nor the purpose, but are business oriented. Therefore, it is recommended that an assessment and definition of the various SCC project types be carried out, in order to organize the support the EC can provide.

Centralize EU competences and roles both for the provision of grants and forms of financing and other support (e.g. technical assistance). There are a number of opportunities that support SCC initiatives. The number of different sources and opportunities may create complexity in achieving an efficient support to SCC projects. A single entity managing the different possible types of support would facilitate the allocation of resources, the access to them as well as the selection of the most appropriate support for each case. Considering that not all sources of support are directly managed by the EC (i.e. some funds are managed at local level) this recommendation may be complicated to realise. However, it could still be possible to envisage the involvement of a single, centralised intermediate entity managing or co-managing the support at least at national level.

Create forms of technical assistance for project design and implementation. SCC projects do not require the same type of support (e.g. commercial-oriented solutions should not be supported with grants, etc.). It is expected that a relevant number of projects would not necessarily require capital to be granted, but could rather benefit more from assistance in designing and implementing the project. Hence, the recommendation consists in considering the creation of a dedicated Technical Assistance Unit (similar to ELENA for energy projects) that could support stakeholders from SCC project origination to development. This is relevant in particular for those projects that can potentially be replicated, and therefore be of commercial value. Further, although the ELENA initiative is expected to soon embrace the mobility sector as well, there is no Technical Assistance model currently active,

which goes beyond (or across) sectorial boundaries. Oppositely, it has been widely reported that SCC solutions tend to integrate energy, transport and ICT domains. Potentially, a coordinated and infra-sector Project Development Assistance (PDA) could be effective filling the current gaps arising from the current silo approach to Technical Assistance.

Develop business accelerators in the field of SCC initiatives, bringing together private and public investors and entrepreneurs. A central role that the Commission might want to play supporting SCC projects and initiatives is to make easier and more efficient for all interested players to share their contribution, increasing SCC projects' odds of success. However, these parties are often limited in their potential involvement due to uncertainties and risks related to such innovative projects. Different activities could be envisaged:

- Creating a physical space for stakeholders to meet at specific dates, but also through on-line platforms that facilitate cooperation and co-development;
- Sharing practices and recommendations on the basis of experiences, to target future efforts on the success stories;
- Using the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) as an effective tool convening: cities – large and small; with industry – large and small; with investors of all types; and trusted associations, academics and intermediaries.
- Organising dedicated sessions within SCC-related events for project promoters to open discussions on their projects with potentially interested private and public investors.

Support solutions to enable smaller companies and small-scale projects to receive appropriate finance. Further opportunities are yet to be consolidated in the new investment environment. Among the most promising opportunities, **investment platforms ensure access to finance to small-size promoters involved in SCC solutions.** These are co-investment arrangements – which can be supported by EFSI – that aim to reduce transaction costs and provide for more efficient risk allocation through the aggregation of thematic-focus (or geographic-focus) investments.

Procurement models

Cities strongly rely on external suppliers, as local authorities increasingly define themselves as commissioners and not deliverers of services. The creation and development of a SSC solution requires a continuous innovation process involving high numbers and different categories of stakeholders. In this context, public procurement becomes an opportunity for the public administration to foster the innovation process, stimulating innovation from the demand side, thereby supporting state-of-the-art SC projects and solutions.

The following recommendations arise from the analysis undertaken.

Foster the exchange of best practices also creating synergies between platforms. As Public Procurement of Innovation (PPI) models have recently been introduced, the EC should map each SCC solution that adopted a PPI model and spread the information; this would foster the exchange of best practices (including templates adopted for bids) among MS and city authorities and ensure that the

procurement models and practices that proved to work best are shared and known among practitioners. A specific focus should also be placed on how to make better use of standards in public procurement in order to resolve ICT lock-in (i.e. the public authority is unduly dependent on a single supplier, vendor or developer beyond the timeframe of the initial procurement contract, damaging competition for future procurement).

Support the development of user-friendly guidelines, templates and standard text to facilitate procurement. Also in terms of fostering the exchange of best practices and supporting the dissemination of knowledge, the EC should keep investing in developing guidelines for the effective take-up of SCC solutions. Guidelines should be practical, including examples showing how suggestions could be translated into reality.

Assess standards and specifications. The European Commission should assess standards and specifications in order to make sure that selected standards and specifications foster interoperability and reduce lock-in. This is currently organised on a national basis (e.g. within the context of MSs' National Interoperability Frameworks); however, there has been an effort at a European level to adopt a common framework that fosters collaboration between MS. It would be useful not only to map all standards available in the field of SC, and develop new ones when necessary, but to promote an awareness campaign towards the procurers to inform them on the use of platforms based on open standards and full interoperability.

Review procurement policies to ensure they are aligned with SC contracting principles. As anticipated in the governance section, the approach of public authorities towards urban development solutions requires a change. Data should be owned by the city and not by the supplier, or clear requirements on data availability via open standards should be included in the procurement; contracts should ensure that contractual arrangements encourage collaboration with other players to create new value, and the sharing of common city assets.

Put in place practices and agreements to avoid supplier lock-in. Potentially by integrating interoperability requirements into all ICT procurement, using commercial off-the-shelf products and open standards wherever possible, and factoring in the costs of exit from the outset.

Involving citizens and communities

There is a rich literature on the benefits of participatory approaches to city design, yet there is little consensus on what exactly these benefits are. Integrated solutions must acknowledge the different views and harmonize approaches effectively to maximize the impact for Smart City solutions.

Different possibilities are possible to ensure SCC solutions' success involving citizens and communities; the main ones are suggested below.

Enable community empowerment for the development of sustainable business models. Communities have a particular role to play in the development and success of smart solutions, yet, evidence shows that in most cases there is only a traditional citizen involvement strategy in place, involving promotion, recruitment of participants and community participation to a limited extent, and that little systematic data is available to assess these efforts. Successful solutions tend to be embedded in

a comprehensive smart city vision. Collaboration, co-creation and co-development are key conditions for success. Possibly, it would also be positive to insist on a consistent citizen engagement strategy and on making citizens, businesses and communities co-owners of integrated solutions in procurement processes.

Integrate citizens, businesses and communities into the entire project cycle, from development to implementation of integrated SCC solutions. The evidence of the best practise case studies shows that the multiple roles residents could play in regional and urban living labs are not utilized. In fact, emphasis is often placed on the innovative technological aspects but not on innovating the engagement process. Conversely, ensuring inclusive innovation in integrated SCC solutions, and working with stakeholders to ensure a shared understanding of citizen engagement in the process of designing, testing and implementing integrated SCC solutions would facilitate the match between the demand for solutions and their provision.

Create an open innovation ecosystem between different experimentation set-ups. The investigation of best practices has shown that there are bottom-up as well as outside-in solutions that are community-driven or driven by ICT-enabled business innovation. Furthermore, sharing economy solutions are emerging and innovating business models in integrated SCCs. The sharing economy is a topic of much discussion amongst city leaders as cities weigh the pros and cons of the disruption of traditional services with the benefits of potentially improved and expanded shared services.

The roll out of SCC solutions

Applying smart solutions to limited-scale contexts would certainly enable the testing of SCC technologies, governance approaches, etc. However, it would not serve the purpose of responding to the global needs arising from urbanisation. What is thus needed is to ensure that solutions can be scaled (increase in size) and replicated (rolled-out in an environment other than the one they have been applied to in the first place).

The analysis performed shows that there is no single element that represents more than others an obstacle or an enabler to the roll-out of SCC solutions. Instead, it is the joint action of different elements that would limit or facilitate the possibility for a project to be successfully implemented at a higher scale or in other contexts. These refer to the i) technological context (the presence of a technological support network for the SCC solution to function); ii) the socio-cultural context (the ability to respond to citizens' needs and make them a part of developing the solution); iii) the political-institutional context (level of required support from the public administration); and the iv) economic-business context (which refers to the business models and relative environment). The presence of an ecosystem, which is able to converge political institutions, investors, industry players and – to the extent required – citizens, facilitates the implementation of projects that have been successful elsewhere.

An effective way for a solution to succeed has proven to be testing it on small groups of citizens and stakeholders, adapting it and then scaling it to the whole city.

While demonstration projects seem to be a good tool to cope with the risk of project failure, which would otherwise be an obstacle for a public administration to endorse

innovative Smart City solutions, they also represent the risk of being endless tests, which never reach an operational status. The safe area represented by research projects does not have to lead to endless demonstrators, which may represent a form of failure in themselves if the specific solution does not become economically viable or if it keeps being based on different small projects without scaling up to the operational phase. On the other end, demonstration projects may serve the need of showing quick gains and encouraging stakeholders in taking actions.

Partnering with China

SCC solutions are not limited to the European context. It is widely acknowledged that the Asia-Pacific area – in particular China – will experience a significant increase in the number of SCC solutions being developed, becoming the leading region in this sector. For this reason, particular attention has been devoted to exploring the Chinese Smart City context and market – a growing potential source of opportunities for EU businesses – focusing specifically on three different levels of EU-China collaboration: industrial, research and policy-dialogues.

Partnering with Chinese companies – as well as with the Chinese institutions – would give European companies and research centres the opportunity to expand their business and cooperate towards innovative solutions. However, there are still questions on how to achieve the benefits offered by the Chinese market without running the risk of compromising competition.

The recommendation here is to **support the introduction of EU companies into the Chinese Smart City market by also providing the necessary protection frameworks.** The global race towards efficient solutions for urbanisation-related service demand will strongly benefit from international partnerships. Specifically, China seems to represent one of the key players for Europe to establish valuable cooperation and sharing of best practices. The Chinese side expressed a strong interest in having a platform to collaborate with the EU in the energy field at policy, technology and business levels. Such a platform may also be used for "matchmaking," which would provide insights into business options for both Chinese and European partners. What is important is to first define and agree on the necessary frameworks to ensure that competition stays fair both in China and in Europe.

Specifically, the main concern seems to be that foreign companies may replicate solutions developed by EU R&D centres and firms. To avoid this, **a supportive legal framework should be established for IP protection.** A good smart city regulatory environment will provide the protection that EU companies (especially SMEs and start-ups) need while being adaptable enough to allow for the risk-taking and trial-and-error that innovation requires. This means EU public entities may step in and agree with their Chinese counterparts on creating the right Intellectual Property (IP) protection laws and a supportive legal framework for companies wishing to provide their solutions on the Chinese market.

1. Introduction to the study and its methodological approach

1.1. Objectives and structure of the report

This is the final report of the study *Analysing the potential for wide scale roll out of integrated Smart Cities and Communities (SCC) solutions*.

This report was commissioned by the European Commission Directorate-General for Energy (DG ENER) to contribute to the knowledge base of the European Innovation Partnership by analysing Smart City solutions and initiatives that are linked to the Strategic Implementation Plan (SIP) of the European Innovation Partnership on Smart Cities and Communities, thereby promoting a better understanding of success factors for their deployment and roll out.

This study contributes to the identification and dissemination of Smart City solutions across and beyond Europe, which could represent the key to creating scale and reducing uncertainty among political decision makers as well as investors, thereby **smartening up Europe's cities.**

Smart City

In this report, and throughout the entire study, the definition of Smart Cities and Communities applied is that of the Strategic Implementation Plan of the EIP-SCC: *"Smart Cities should be regarded as systems of people interacting with and using flows of energy, materials, services and financing to catalyse sustainable economic development, resilience, and high quality of life; these flows and interactions become smart through making strategic use of ICT infrastructure and services in a process of transparent urban planning and management that is responsive to the social and economic needs of society."*

(European Innovation Partnership on Smart Cities and Communities (2013) Strategic Implementation Plan)

In short, it supports the **identification, exchange and dissemination of experiences and best practices of integrated, scalable and sustainable SCC solutions.**

This document is structured as follows:

- **Chapter 1 | Introduction to the study and its methodological approach,** which describes the overall context characterising SCC solutions as well as the approach and limitations to the study.
- **Chapter 2 | Analysis of integrated SCC solutions,** which presents:
    - How and under what conditions SCC solutions reshaped the urban infrastructure investment context;
    - How the business changed and adapted to new technologies (focusing especially on governance models, funding and financing mechanisms, procurement approaches and the role of citizens and communities in SCC solutions);
    - Key reasons behind the failure of SCC solutions (and, thus, lessons learned).

- **Chapter 3 | Analysis of the potential roll out of integrated SCC Solutions,** which describes:
    - The elements, factors and conditions that allow or hinder making the transition from a R&D and demonstration phase to actual wide-scale deployment of SCC solutions;
    - The replicability factors in different geographical contexts and how SCC solutions interface with the surrounding environment;
    - The external factors that support SCC solution roll-out;
    - The challenges and opportunities linked to collaboration between the EU and China, and the conditions for harnessing the power of an effective Smart City EU-China partnership.
- **Chapter 4 | Conclusions and Recommendations** presents the main conclusions and the key recommendations drawn from the whole study.

The main body of the report is complemented by the following annexes:

- **Annex I** presents the mapping of SCC solutions against the EIP-SCC "Strategic Implementation Plan" (SIP) priority areas.
- **Annex II** presents the mapping of the roll-out potential of 10 integrated SCC solutions. This section also acts as a short summary of each of the 10 cases presented in full in Annex IV.
- **Annex III** presents a toolkit for replicability assessment in specific geographical contexts.
- **Annex IV** presents the 10 case studies of best practices, which have been analysed in greater detail, in particular with respect to their business model.

This document builds on a number of connected reports that have been delivered throughout the engagement and, in particular:

- An initial status report reviewing the **most relevant literature** on integrated solutions for Smart Cities in the EU and globally;
- A report focusing on **why integrated SCC solutions fail;**
- A thematic report focusing on the **role of citizens and communities** in SCC solutions;
- A thematic report on **funding and financing mechanisms** for SCC solutions;
- A thematic report on **public procurement models** for SCC solutions;
- A thematic report on **governing successful SCC solutions** and creating the right framework conditions;
- A report focusing on **EU/China partnerships** in the Smart City domain;
- A report analysing the potential for **synergies between key SCC actors;**
- **80 examples of European and global successful SCC solutions** (50 EU-based and 30 non EU-based solutions, each one presented in the form of a brief case study, connected to a GIS Smart City solutions database);

- A workshop report, presenting key insights emerging from the **expert workshop** held in Berlin in the initial phases of the engagement.

1.2. Overall context

1.2.1. Smart Cities and EU policy

The Europe 2020 Strategy, launched by the European Commission (EC) in 2010,[1] focused on technological solutions that could help in delivering "smart, sustainable and inclusive growth." Seven flagship initiatives have been proposed, including one calling for a "resource-efficient Europe."[2] To support this initiative, the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) was launched by the EC[3] targeting the **intersection between energy, transport and information and communication sectors.**

Seven challenges have been identified as the most prescient, three of which are directly related to the Smart Cities policy area: (i) secure, clean and efficient energy; (ii) smart, green and integrated transport; (iii) climate action, environment, resource efficiency and raw materials.

To represent this integration and in order to activate the EIP-SCC, a **Strategic Implementation Plan**[4] and an **Operational Implementation Plan**[5] (SIP and OIP, respectively) have been published by the EC. The SIP sets the domains and the strategic relationships between eleven different priority areas (thee vertical and eight horizontal, as shown in Figure 1 below), whereas the OIP defines the enablers and the intersections between these elements. The SIP priority domains are overarching and encompass many spheres of urban living, including knowledge sharing, technology, and a focus on people.

In order to meet this ambitious overarching goal, the Commission's Communication COM(2012)4701[6] states that "*this will be achieved through the wide-reaching roll out of **integrated, scalable, sustainable Smart City solutions** – specifically in areas where energy production, distribution and use; mobility and transport; and information and communication technologies, are intimately linked.*"

[1] European Commission (2010), Communication from the Commission, Brussels, 3.3.2010 COM(2010) 2020 final. Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF

[2] European Commission (2010), Communication from the Commission, Brussels, 26.1.2011

COM(2011) 21. Available at http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf

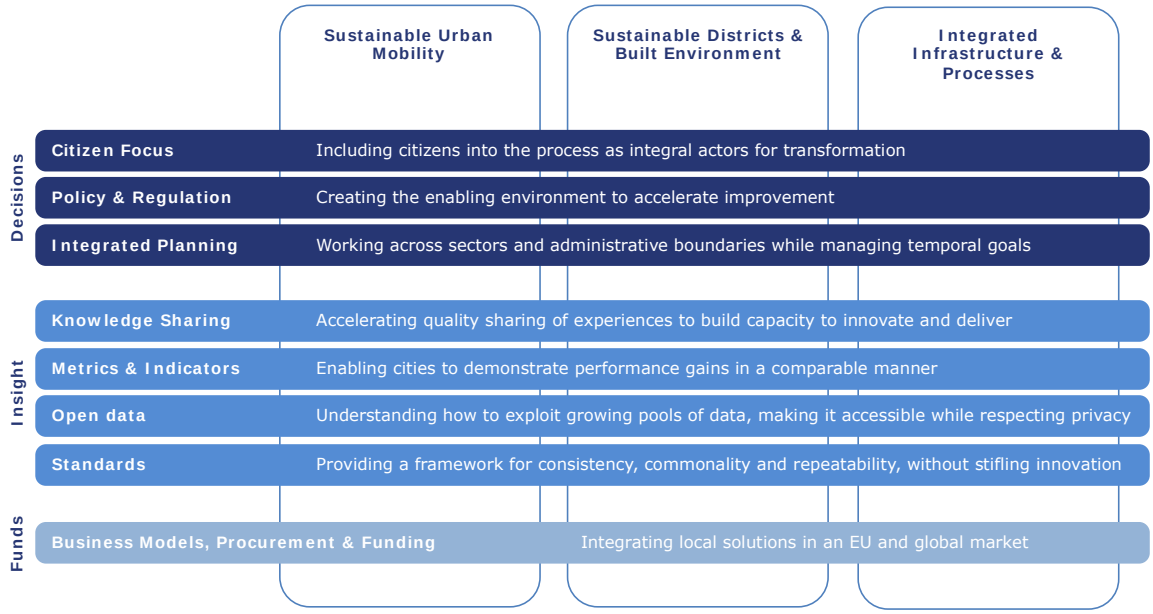
[3] European Commission (2012), Communication from the Commission, Brussels, 10.7.2012, C(2012) 4701 final. Available at http://ec.europa.eu/energy/technology/initiatives/doc/2012_4701_smart_cities_en.pdf

[4] European Innovation Partnership on Smart Cities and Communities, Strategic Implementation Plan: First Public Draft, 2013. Available at http://ec.europa.eu/eip/smartcities/files/sip_final_en.pdf

[5] European Innovation Partnership on Smart Cities and Communities, Operational Implementation Plan: First Public Draft, 2013. Available at http://ec.europa.eu/eip/smartcities/files/operational-implementation-plan-oip-v2_en.pdf

[6] Communication from the Commission on "Smart Cities and Communities – European Innovation Partnership", of the 10th of July 2012, setting the basis shortly after for the launch of the European Innovation Partnership on Smart Cities & Communities (March 2013).

Figure 1: EIP-SCC Strategic Implementation Plan Priority Areas



1.2.2. Smart cities to address future challenges

Global urban population is increasing and is estimated to double by 2050: consequently, the number of urban residents is growing by nearly 60 million every year.[7] Major urbanisation requires new and innovative ways to manage the complexity of urban living; it demands new ways to target the problems of overcrowding, energy consumption, resource management and environmental protection. It is in this context that Smart Cities emerge not just as an appealing trend for future urban living but also as a **strategy to tackle resource management** and, more generally, to better manage the needs of growing cities.

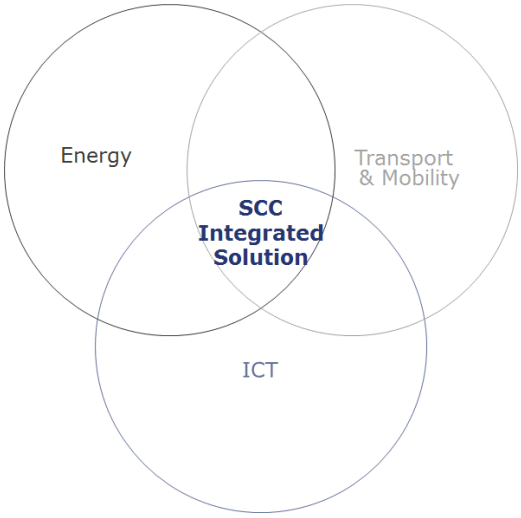
Smart City solutions apply digital technologies to address social, environmental and economic goals. They typically combine physical and digital infrastructure but can also be based on digital infrastructure alone. **Smart Cities evolve along with new modes of value creation through the intermediation of public-private partnerships, cross-sectorial collaboration, city-led "open innovation marketplaces" and other forms of governance.**

Smart Cities comprise a portfolio of initiatives, projects and solutions, with different (but often overlapping) focus areas, modalities, participants and constituents.

For the purpose of this study, we focus mainly on solutions that combine ICT-enabled energy, transport and mobility, and are governed to reach common goals, and that place particular emphasis on initiatives that actively involve citizens and communities. In short, the study focuses on crosscutting initiatives that create an intersection between technological solutions and the "softer" aspects of a Smart City.

[7] Who Urban population growth - The rise of modern cities. (2015). Available at: http://www.who.int/kobe_centre/publications/hiddencities_media/ch1_who_un_habitat_hidden_cities.pdf

Figure 2: Key domains of integrated SCC solutions



Examples of cross-cutting initiatives[8] are smart buildings (e.g. ICT solutions to design and operate new buildings, renewable energies, etc), smart services for better informed citizens (e.g. real-time energy usage information, demand response, smart metering, etc), sustainable urban mobility solutions (e.g. alternative energy carriers for public transport, freight distribution, etc) and smart and sustainable digital infrastructure (e.g. smart grids, smart city portals, etc).

In a nutshell, some key highlights about these initiatives include:

- They **optimise resources** through better information on where resources are being consumed in a wide range of domains (i.e. government, transport, energy, etc.). This enables better monitoring and management from the energy utility side and allows consumers to make more informed use of resources, lowering consumption. In turn, this reduces utility operating costs and extends the operating life of existing infrastructure.
- They are **disruptive technologies** that require system-wide deployment to yield the most benefits and **demand changes in existing processes.**
- Their successful deployment usually requires **collaboration between multiple actors in the value chain** which could be a barrier in some vertical markets/departments where there is little incentive for established players to change.
- Due to the **fragmented vision** that typically characterises them (especially when it comes to taking advantage of smart technologies) and a reluctance on the part of city authorities to deploy **untested but innovative products and services,** they usually create difficulties for innovative companies (especially SMEs) to deploy them, especially at a large scale.
- Their integration has a **strong technological component,** although it cannot be decoupled from softer implementation aspects. ICT layers applied on top of existing applications and services or developed to support data and information

[8] European Commission (2012), Communication from the Commission, Brussels, 10.7.2012; C(2012) 4701 final. Available at http://ec.europa.eu/energy/technology/initiatives/doc/2012_4701_smart_cities_en.pdf

management for various objectives (i.e. better service delivery, more efficient management or lower environmental impacts) constitute the technological components, whereas softer aspects of integration relate to governance, actors and financing factors.

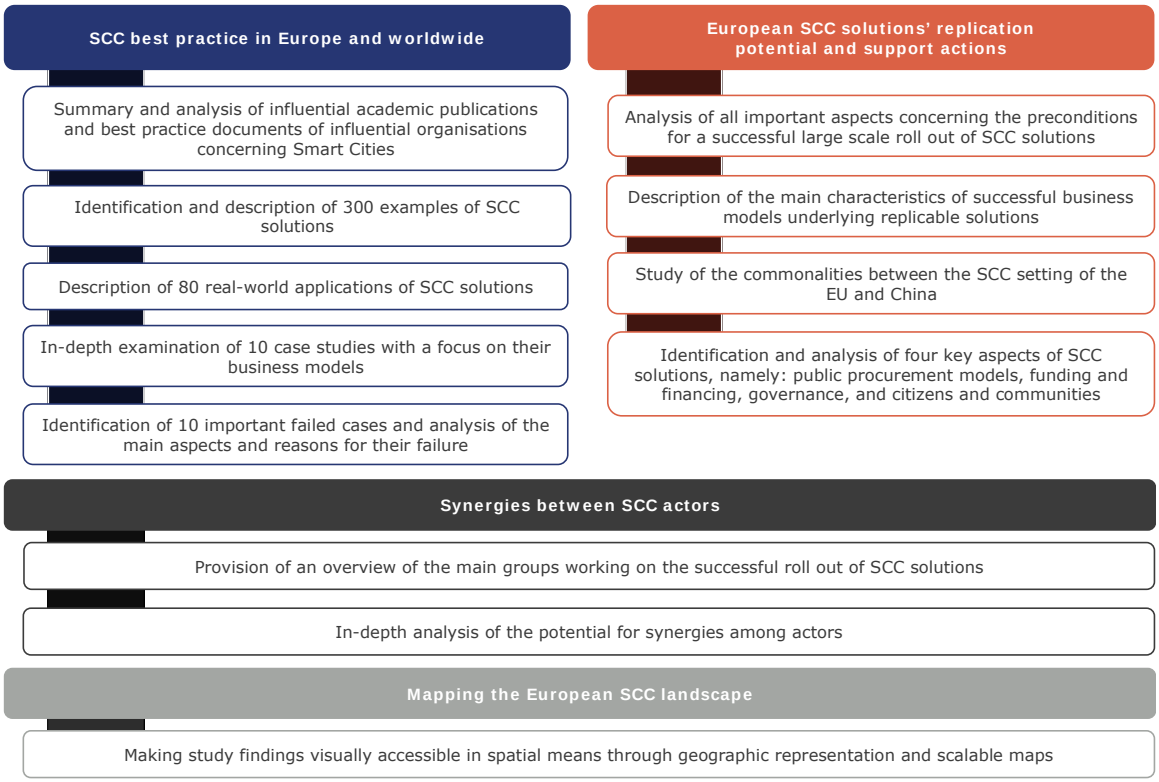
Moreover, successful solutions demonstrate that **higher impacts** are achieved when:

- The solutions' development and implementation involves a **large number of coordinated actors and stakeholders,** which have positive effects on securing financing mechanisms as well as on building the necessary critical mass in terms of ideas and thematic areas to address.
- The solution **tackles one prevailing issue in particular, but is also flexible enough to integrate various dimensions** and to scale and differentiate its outputs.
- The solution **interacts with other technologies** which is also ensured by the capacity of actors **not to work in silos.**

1.3. Overall approach to the study

The approach of the study has envisaged a unified methodology, illustrated in Figure 3 below and explained in greater detail in the following paragraphs.

Figure 3: Overall study approach



The study focuses in particular on the scalability and replicability of SCC solutions, as well as on a number of key factors such as funding and procurement mechanisms, public sector transformation to enable relevant governance, and the active engagement of citizens and communities.

The analysis has been articulated in the following steps:

- Screening and review of the most **relevant literature** concerning SCC solutions;
- Identification of **300 examples of SCC solutions**, of which approximately 200 are European, while the remaining examples come from the rest of the world;
- Selection,[9] analysis and description of **80 best practice examples of SCC solutions;**
- Identification and analysis of the key dimensions characterizing business models underlying SCC solutions, namely:
    - **Public procurement** models for SCC Solutions;
    - **Funding and financing** mechanisms of SCC Solutions;
    - **Governance** of SCC solutions;
    - **Citizen and community involvement** in SCC solutions.
- A more in-depth examination of **10 case studies** selected out of the 80 examples of SCC solutions, putting particular emphasis on the their **business models,** so as to make evidence available for other possible SCC solution initiators. In this respect, a business model is meant to generate added value that could entail economic revenues or even the internalization of externalities;
- Elaboration of a **Geographic Information System (GIS) database** that includes information on the identified examples of SCC solutions;
- Detection and analysis of **10 examples of "failure" of SCC integrated solutions,** carried out also through a dedicated web-based survey launched to identify examples of failed integrated solutions as well as the most typical patterns of failure;
- A specific investigation on the **commonalities between the SCC settings of the EU and China** which could be leveraged to increase replication and market potential for European Smart Cities in China;
- Elaboration of **synergies between the most relevant SCC groupings and organisations**, followed by the elaboration of recommendations on how to successfully use these synergies to further advance the concept and roll-out of Smart Cities.
- Elaboration of **recommendations,** developed on the basis of the previously mentioned pieces of analysis and meant to provide advice on how to support sustainable integrated SCC solutions, how to boost large scale roll-out of these, and – finally – what the European institutions' role in all this could be.

For the purpose of collecting the sample, multiple sources were used to identify leading examples of SCC solutions. The main data sources were the literature analysis

[9] Starting from the 300 long-listed examples, 80 "best practice" examples have been selected on the basis of: the level of integration of the SCC solution (at least 5 out of 11 SIP priority areas, of which at least 2 out of the 3 vertical technology driven pillars relevant to that SCC solution), the maturity level, potential replicability, use of particular financing and deployment models to allow for the investigation of different market and support mechanisms, focus on the integration of citizen/community involvement or activation, impact and relevance to EU 20/20/20 key goals.

carried out across all SCC key domains, relevant international Smart City benchmark studies and rankings to identify the most prominent cities implementing SCC solutions and, finally, the EU-funded initiatives supporting the development and implementation of Smart City solutions.

1.4. Limitations of this study

Determining the level of success for a Smart City solution, as well as its key characteristics, is limited by the availability of data and the implementation status of Smart City initiatives, as well as the clarity of definitions associated with Smart Cities.

Table 1 below presents some of the most significant limitations of such an approach from a methodological standpoint, as well as the strategies put in place to mitigate them.

Table 1: Main limitations and corresponding mitigation strategies

Main limitations	Mitigation strategies put in place
▪ The study relies on searching through and analysing available literature and online material, which is inevitably affected by the lack of: o Common terminology; o Time for successful SCC solutions to be published (particularly for the more recently implemented cases); o Consistent data across SCC solutions.	▪ A number of types of solutions have been identified and the most relevant areas in which SCC solutions are likely to emerge – like mobility/transport, smart neighbourhoods/districts, built environment or energy/smart grids – have been systematically reviewed.
▪ Some cities may over-emphasise the current level of activity of SCC solutions implemented, making it hard to provide a consistent approach in the measurement of impacts. ▪ The limited amount of available detailed information on SCC solutions at different lifecycle levels makes it less feasible to concretely connect the assessments made with statistical evidence from empirical observations.	▪ Where possible, data produced by cities and/or countries in which the cases are located has been validated though direct contact with the SCC solution representatives.

Finally, although this study provides general guidelines for Smart City managers and Smart City stakeholders, these should also always be adapted to the local context, as no two cities or communities are ever the same.

2. Analysis of integrated SCC solutions

Technological development has changed the approach to business practices in urban infrastructure development. Significant new opportunities arise from this evolution: for example, smart technology now allows for accurate and reliable measurement of socio-economic and environmental impacts. **It is therefore possible to quantify and price the externalities generated by investments in urban infrastructure.** This opens up new sources of revenue for projects, new business models for recovery and value capture, and new investment opportunities. This is the context where SCC solutions arise.

This section of the report researches and analyses this new business dimension in urban development investments. To ensure a more comprehensive analysis, different aspects of SCC solutions' business models are assessed:

- As previously mentioned, the creation of new business models is a consequence of technology enabling the internalisation of positive externalities in smart urban development. Coherently, sub-section 2.1 looks at **the conditions under which value is created in SCC solutions;**
- After assessing value creation, a closer look is taken at **how business models are evolving in SCC solutions** (sub-section 2.2), focusing on these aspects:
    - The **governance** of SCC solutions;
    - How SCC solutions are **funded and financed;**
    - The **procurement strategies** and opportunities;
    - The actors of these new models and, specifically, the role played by **citizens and communities.**
- Defining new models and business opportunities does not necessarily entail success. An analysis of cases where new patterns have been underestimated or misunderstood is reported in the **analysis of failures** (sub-section 2.3).

2.1. Creating value with integrated SCC solutions

Throughout this study, a wide range of ICT-driven Smart City solutions has been mapped and analysed to identify the elements, characteristics and contexts that enable the creation of the highest value. When assessing value creation, it is important to consider that solutions impact different urban areas. Therefore, the projects analysed in this study have been mapped following **the three SIP "vertical" priority areas**: (1) sustainable urban mobility, (2) sustainable districts and built environment and (3) integrated infrastructure and processes. By breaking these down further into homogeneous sub-categories, **9 main types of SCC solutions** w**ere identified.**[10] A short description of these categories, including examples of solutions and the associated value proposition can be found in Table 2 below.

[10] In addition to being associated with a main SIP vertical domain of reference, each mapped solution also embeds elements of at least one other SIP vertical priority area, so as to meet the minimum requirement to be considered an "integrated" example. In particular, to be considered an integrated SCC solution best practice in this study, each example had to be related to a minimum of 5 SIP priority areas: at least 2 vertical and 3 horizontal.

Table 2: Overview of solutions types and their relative value proposition

	Type	Short description	Examples of solutions	Value proposition
Sustainable Urban Mobility	***Real-time road user information***	Deliver real-time traffic information to road users.	Deployed technologies include variable message signs displaying traffic and parking information, bus stops with neighbourhood-specific information, dynamic pricing updates and mobile applications showing the location of the closest taxi stop and providing updates about train arrivals.	Enable people to take informed decisions about their mobility, saving time and energy.
	ITS-based enhancements of public transport	Public transport provider uses intelligent transport systems (ITS) as a support for the management of its assets and to enhance its service for the users.	Examples of technologies include contact-less public transport cards, sharing economy concepts for public fleets as well as applications for mobile payment.	Reduce waiting time as well as emissions, and facilitate intermodal commuting.
	ITS for traffic monitoring, management and enforcement	Collection and central processing of information to adjust traffic flows in urban areas.	Sensors for traffic monitoring, such as automatic traffic counting, cameras, vehicle location or even satellite imaging linked to central traffic control centres.	Optimise fleet management and route scheduling.
Sustainable Districts & Built Environment	***Smart technologies for the built environment***	Involve technologies and approaches for smart and intelligent management of assets and resources within the built environment.	Typical solutions integrate ICT to increase the level of automated monitoring and control of equipment, such as smart meters and appliances, home automation and outdoor automation, and intelligent waste collectors. Included here are also smart streets, i.e. limited geographic areas that concentrate a variety of technologies such as open Wi-Fi, building energy management, smart lighting, traffic or air quality measurement, smart waste management, electric vehicle charging and bike sharing.	Pursue better living, resource efficiency and waste reduction.
	Sustainable districts	Has a wider geographic scope and entails district energy systems, energy efficient neighbourhoods and eco-urban developments.	Smart waste water networks, district-wide building energy management solutions, district heating and cooling networks, EV integrated infrastructure, district-level smart lighting, interconnected systems of decentralised energy sources, urban	Reduce emissions and resource consumption by embedding integrated energy efficiency technologies.

	Type	Short description	Examples of solutions	Value proposition
			development projects that re-qualify entire districts based on state-of-the-art technologies.	
	Place making	Focus is clearly on community engagement, favouring the communication between the public entities and the single citizen.	Smart places that stimulate the valorisation of community data, community development and collective awareness platforms to promote sustainability and social innovation or mobile-based civic engagement and empowerment.	Create communities of interest that can be key to support integrated SCC solutions.
Integrated Infrastructure & Processes	***Smart City Platforms***	Integrate large amounts of data and information collected by distributed sensors within the city, possibly including humans as sensors, which are then used by city managers or urban planners to guide the Smart City development process as a whole.	Typical solutions in this area are large-scale, transversal ICT platforms able to collect and analyse large amounts of data coming from a variety of sensors, common digital infrastructures that in a sense connect the entire city.	Allows real time monitoring and preventive steering of cities.
	Intelligent City Services	ICT-enhanced public service provision mechanisms.	Examples of solutions in this area are city open integrated data hubs, GIS applications, technologies bridging different sources of data such as social media and real-time monitoring tools, smart IT-based toolkits to ensure reciprocal communication between city authorities and citizens.	Co-ownership of local matters and outcomes. Efficiency savings for city administrations. Stimulate involvement at local level.
	Smart grids	Address energy issues with innovative ICT and data related components.	Analysed smart grids range from modernisation of distribution networks to more advanced, fully automated systems that include smart meters and appliances at the household level. Some reviewed solutions also integrate electric vehicles as storage units or develop parallel energy markets where prices try to reflect real-time demand and supply status.	Collected information and insights may serve planners and managers, but are often also shared with users, who can take more informed decisions and can also become *prosumers*, i.e. users that can switch from being energy consumers to becoming producers based on the circumstances.

Across the sample of analysed cases, **city-wide integrated solutions were rare.** Instead, **solutions with higher levels of integration are emerging in smart districts, across some energy efficiency projects as well as in various mobility projects.**[11]

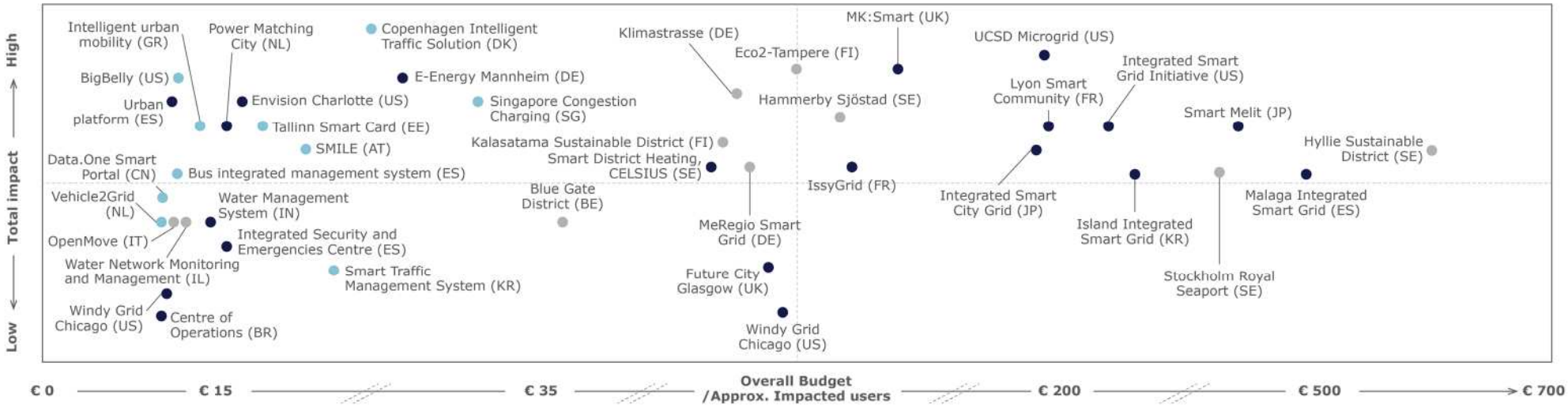
Although the sample of cases has been categorised based on the purpose of the study, another analytical step was necessary to assess value creation. Coherently with the data and information available and following thorough research, each project has been evaluated assigning a score ranging from 1 to 5, where 1 is a perceived low level and 5 is a high one. This assessment is summarised for each of the case using a dashboard format, as depicted in Figure 4 below.

As technology enables the internalisation of externalities, the higher the positive impact, the higher the value created and the possibility to transform such value into business opportunities.

Figure 4: Example of an SCC solution assessment dashboard

[11] An overview of the 80 examples of successful SCC solutions analysed across this study, with indication of their prevalent SIP vertical priority technological dimension, covered secondary domain/s, and different degrees of integration of the panel of selected cases is included in Annex to this report.

Figure 5: Positioning of the analysed SCC solutions in respect to their overall impact and their budget per impacted user



Source: Our elaboration, based on the 80 analysed examples of SCC solutions for which data was available

Note:

The following data assumptions apply to the analysis presented in the scatterplot:

(i) ***Overall total impact*** *is the sum of economic, environmental and social impacts, as estimated in each solution's assessment dashboard;*

(ii) ***City population levels*** *refer to 2014 available data. In the case of solutions impacting only part of the city population, when the number of affected users was not identifiable in any other way, a flat-rate of 20% of the total city population has been used. When only the number of impacted "households" was available, an average of 3 people/users per single house has been used.*

The analysis shows **3 main clusters of integrated SCC solutions:**

- ***High cost/high impact (top-right quadrant):***
  District level demonstrators of energy efficiency and Smart Grid projects
  Both brownfield and greenfield developments show high degrees of integration of the energy, mobility and smart built environment agenda combined with a clear emphasis on including and activating the relevant communities living and working in these districts. What could be improved is the systematic working relationship and scaling of successful solutions to the rest of the city and/or region. Furthermore, most Smart Grid solutions fall in here: whilst most smart grid projects experiment with EV vehicles and therefore integrate all three key SIP "vertical" priorities, they do not aim to create sustainable solutions directly. Aspects of these solutions then scale up by being integrated in future large-scale roll outs.

- ***Low cost/high impact (top-left quadrant):***
  Intelligent transport solutions
  While these usually start as pilot projects, intelligent transport solutions are increasingly integrating energy efficiency considerations and linking to the smart built environment to offer customers and citizens more personalized services. However, the link to energy efficiency needs to be strengthened to guide smart mobility solutions and integrate them better.

- ***Low cost/low impact (lower-left quadrant):***
  Data solutions
  An emerging cluster of solutions are data platforms and data centres at city level. These are looking for innovative and new ways to manage energy efficiency at city level as well as offer improved transport conditions.

Together with the analysis at cluster level, the mapping and assessment of solutions helped to identify certain **common features of high value-added integrated SCC solutions:**

- **Data-driven transformation:**
  An aspect common to most integrated solutions is the emergence of data centres and, more generally, they use of data to steer integrated solutions, personalise services and manage the solution. Data enables both the creation and provision of entirely new Smart City services, and the integration of siloes across city government structures.

- **A fast-growing "sensor environment" across cities:**
  Most of the SCC solutions mapped share the common feature of an increasing number of sensors being deployed. Although it is only in a limited number of cases that these devices are collecting personal information, there is still a missing overall regulatory framework in place to govern them. As a fundamental part of a Smart City's Internet of Things infrastructure, these sensors should be subject to city guidelines on the type of data they collect and how this is used.

- **Open standards**
  To avoid vendor lock-in and enable the procurement of the best technologies available, many cities employ open standards both on the technological and on the business level.

- **Involvement of the local community and of local businesses**
  Integrated SCC solutions aiming to be sustainable have a strong focus on community involvement and the activation of local businesses. To create lasting impact in the context of Europe 20/20/20, integrated solutions require collective awareness and commitment to develop services that support behavioural change and more energy efficient solutions for the future.
- **Sustainable solutions with a triple bottom line**
  Meeting local needs and demands as well as contributing to higher objectives such as CO_2 reduction or making daily travel more efficient and safer, are the driving factors behind integrated solutions.

The results of the analysis helped to understand the key dimensions that create value. Simplifying to the greatest possible extent, what emerges is that the **level of integration** and the **role of citizens** are the key factors that affect value creation.

Key finding

Cities that focus on **integrated** Smart City solutions create the most value.

The study shows that **the best results have been registered when solutions are integrated and dynamically designed or informed by the users.** As in the EIP-SCC vision, this integration runs mainly across the areas of energy, transport and ICT, but it also embeds more transversal enabling factors.

Integration can create considerable opportunities for added value in any city. The best practices of integrated solutions mapped through this analysis have shown that – in most cases – these can actually help cities to improve efficiency, enhance economic potential, reduce costs, open the door to new businesses, and improve the living conditions of their citizens. The inter-linkage between areas concerning energy production, distribution and use; mobility and transport; and information and communication technologies offer **new interdisciplinary opportunities to improve services while reducing energy and resource consumption.**

Similarly, the involvement of citizens is crucial to identify the issues to be tackled by SCC solutions, therefore offering the first best option to match supply (i.e. the services offered) and demand (i.e. the benefit for final users), ensuring the creation of value added for these innovative urban systems.

The citizen focus (bottom-up approach) does not exclude the need for an organised approach to SCC solutions, which is often ensured through a **centralised management** (top-down approach).

In summary, the successful development of a Smart City has been often found when a **bottom-up system approach is combined with top-down service development and a data-centric strategy.** Integrated resource management, governance capabilities and supporting ICT infrastructure are essential for implementing SCC solutions successfully; this integrated approach was found in several examples of SCC solution best practices and has shown itself to create advantages for the entire system.

2.2. Business models of integrated SCC solutions: Success factors and support mechanisms

As mentioned at the beginning of section 2, technological development has enabled new opportunities, which have reshaped the business approach to urban investments.

Although technology is the key enabler in the rise of new business models, the analysis shows that, without a coherent approach to new business opportunities, solutions are likely to fail (see sub-section 2.3). **Local stakeholders must think beyond the technological aspect, and be realistic about planning aspects, required inputs and sustainable initiatives, also in terms of governance and funding.** City decision-makers should start to define a rigorous business approach and to stimulate the commitment of investors and stakeholders from the early phases of the planning stage.

The identification of success factors in the literature review phase of this study has revealed a number of recurrent enabling factors for successful integrated Smart City solutions. These **key dimensions characterizing business models underlying SCC solutions are:**

- **Governance:**
  Governance relates to the mechanisms, relations and approaches to direct and manage integrated SCC solutions. As SCC solutions tend to involve public entities, it is often the case that public entities define the approach to, *inter alia,* cooperation levels between departments and/or different actors, data management, etc.

- **Funding and financing:**
  Financing and funding represent two key elements in the creation and roll out of a Smart City initiative. Current budget limits and constraints are forcing public authorities to look for the right financial and funding mechanisms that support strategic planning and integration across municipal departments, as well as the procurement processes necessary to develop SCC solutions on a wide scale. Similarly, financial constraints affect private technological players as well (especially small innovative companies and start-ups developing risky projects), limiting both their capacity to develop innovative solutions, and their ability to bring their products onto the market.

- **Procurement:**
  The complexity of cities, in terms of stakeholders involved and processes, including procurement, represents one of the main barriers towards the adoption of SCC integrated solutions. This complexity emerges in many areas (policy, regulatory, governance, economic and organisational) of local governments and may create difficulties for city leaders and stakeholders to agree on the methodologies for implementing SCC solutions. From the analysis carried out, it appears that a crucial factor able to accelerate the deployment of SCC solutions is an open and collaborative market, which is able to bring into it the greatest number of SCC solutions, and which – as a direct consequence – assures lower implementation costs. Procurement, and, more specifically, procurement of innovation, is a factor that can create this type of open and collaborative market.

- **The role of citizens:**
  There is growing recognition amongst Smart City practitioners and policy

makers that the shift required to achieve sustainable SCC solutions that produce outcomes such as higher resilience of cities, increased liveability of cities and lower resource consumption, is a momentous paradigm shift for most cities. At the heart of this paradigm shift is the role of citizens, local businesses and communities in developing, implementing and maintaining sustainable and high-impact SCC solutions.

The following sections give a summary of the main findings of a series of background reports developed as part of this study, focusing on the above-mentioned four key dimensions.

2.2.1. Governance tools to manage integrated SCC solutions

City governments are faced with the challenge of exploring the economic return in Smart City investment, the business models, the value that it brings to citizens and the role that they should play within an ecosystem of delivery partners and stakeholders. Further, they **must be responsive to the changing context**, understanding how new opportunities for investments align to existing local and national political priorities and strategies.

Researching how governance tools manage and enable SCC solutions to succeed, within this study, we have identified and analysed governance models across the sample of integrated SCC solutions.

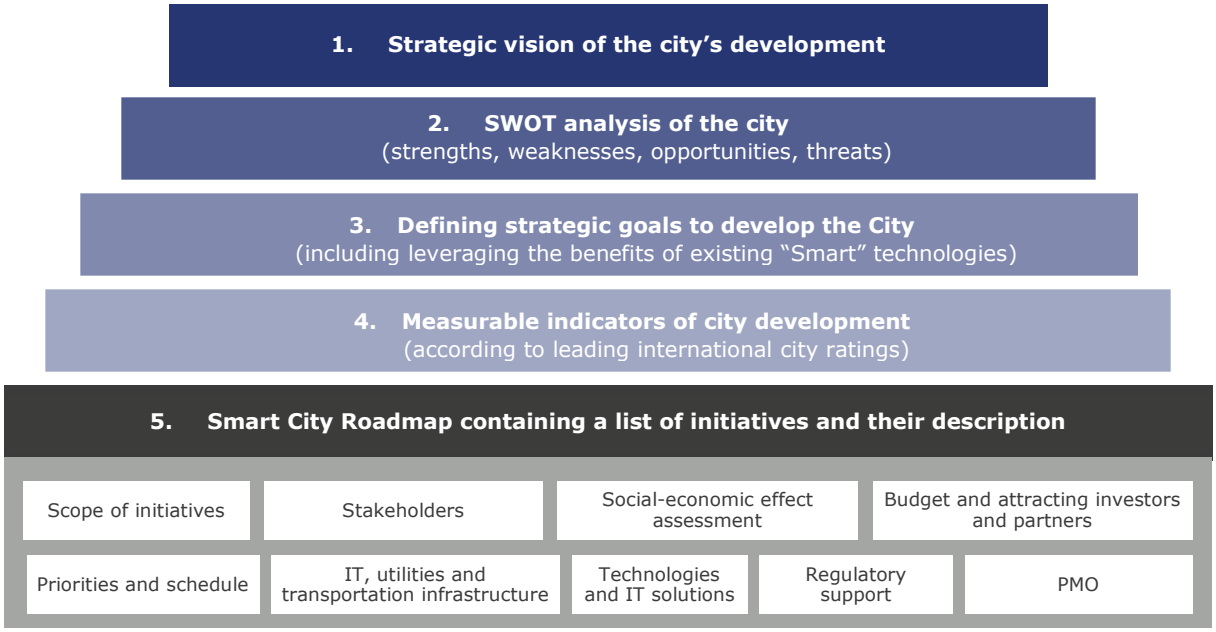
Governance

Governance relates to the institutional capacity of cities to develop, pilot and deploy integrated Smart City solutions.

At a first analysis, governance appears to rely on the public sector. This is expected as SCC solutions are generally managed as part of urban development planning projects. In this sense, governance represents the management of the planning of city development interventions.

Evidence of the analysed cases of both successful and failing SCC initiatives demonstrates the **importance of structuring the approach to SCC solutions from the definition of a coherent and shared strategic visions down to the definition of the city needs, to initiatives roadmap definition** (see Figure 6).

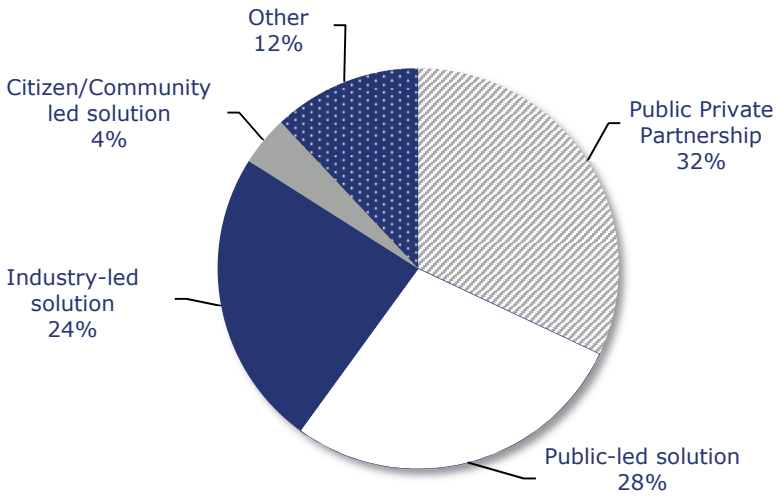
Figure 6: Comprehensive planning and strategy for SCC solutions integrated in urban development



Source: Own elaboration based on PwC strategy toolbox for operational roadmap of initiatives for smart and resilient city development

Empirical evidence from the sample of integrated solutions analysed shows a strong reliance on public leadership, rather than on private parties, as is expected due to the integration of city planning and SCC solution governance within the same organisation. **More than half of the analysed sample of integrated solutions is driven by the public sector and by public financing,** whereas 28% of the solutions is mainly driven by the industry or even directly by the community.

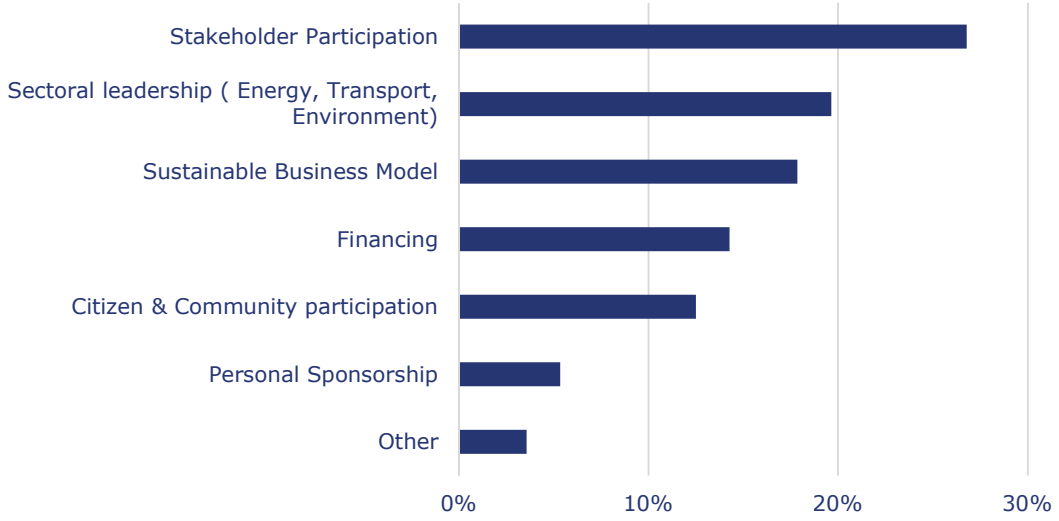
Figure 7: SCC solutions' distribution according to prevalent funding / financing model (sample)



Source: Outcomes of the analysis on a sample of SCC solution representatives (25 different respondents)

Furthermore, the relevance of a strong and efficient governance is reaffirmed by the stakeholders involved, who state that **the capacity to manage partnerships and sectoral leadership are essential for integrated SCC solutions to succeed** (see Figure 8 below). This requires integrated, multi-party and flexible governance models.

Figure 8: Most important factors for implementation and SCC solution sustainability



Source: Outcomes of the analysis on a sample of SCC solution representatives (25 different respondents). The table is based on answers to the question "Which of these were the most important success factors for the implementation of the solution and for its sustainability?"

From the analysis of the integrated SCC solutions, three emerging governance models may be identified:

- **Strong cross-departmental Smart City governance:**
  In particular, larger cities and cities with strong leaders and an established focus on Smart City projects have developed governance entities to manage the digital transformation required by SCC solutions.
- **Sectoral leadership with strong supportive Smart City co-ordination mechanisms:**
  Most cities operate in silos and demonstrate a weak SCC solution governance and co-ordination structure. This is a barrier to integrated solutions, as innovation leaders develop solutions that only fit into the innovation profile of their own sectoral priorities.
- **Open governance model (platform model):**
  Data is transforming cities as it is becoming available in increasingly large quantities and qualities.

There is no best governance model for integrated SCC solutions, as the context plays a great role in determining the adaptability of each model to a given SCC solution. The following table outlines some of the strengths and weaknesses of key types of governance models of integrated SCC solutions.

Table 3: Strengths and weaknesses of key types of governance models of SCC solutions

Type	Strengths	Weaknesses	Example cities
Strong cross-departmental smart city governance	▪ Allows the city to become a more involved partner in integrated solutions. ▪ More agile and responsive structure, which means barriers can be more efficiently addressed.	▪ Very dependent on the leader and thus possibly not sustainable.	**Boston, Lyon, Tallinn, Vienna**
Sectoral leadership with strong supportive Smart City co-ordination mechanisms	▪ Fits cities with a multi-departmental set-up. Collaboration is established based on need and political will. ▪ Benefit of integrated solutions starting in a sector is the focus, and thus the often higher cost benefit analysis (CBA).	▪ Difficult to identify responsibility and leadership ▪ Difficult to manage all interests ▪ Budget risks due to other budget priorities at sectorial level	**Amsterdam, Copenhagen, Seoul**
Open governance model (platform model)	▪ Allows a higher degree of integration with citizens and the private sector and particularly local businesses ▪ Innovation is driven by the private sector and the market ▪ Creates a framework that fosters competitiveness within the integrated solution framework	▪ Government has less power and becomes more of an enabler ▪ City governments need to be willing and prepared to change.	**Barcelona, Chicago, Helsinki, Manchester, Milton Keynes**

Source: Our elaboration

The governance models help to define SCC solution features, such as the level and type of collaboration and the data ownership and governance.

All the governance projects that are arising show Smart City solutions shifting away from silo-based delivery of services. Instead, an integrated, multi-channel governance approach is preferred. This **facilitates a whole-city-view of the customer and an ability to deliver services to citizens and businesses where and when they need them the most,** including through one-stop services and private and voluntary sector intermediaries.

Smart City experimentation partnerships require strong cross-departmental governance

In the case of **Lyon**, a project team working under an innovation director is in charge of the Lyon Smart Community project. They are not located within any specific administrative domain, but rather they bring in actors from the domains with specific knowledge in traffic, energy and environment if necessary. This cross-departmental governance structure ensures the integration of the Lyon Smart Community in terms of mobility, built environment and infrastructure and processes.

Another key feature governance models are required to manage in SCC solutions is **data.** As already mentioned in this report, data is transforming cities as it is becoming available in increasingly large quantities and qualities. City data platforms are an essential tool to achieve the goal of ensuring data sharing and availability and enhancing efficiency and coordination across different administrative domains/partners/agents. Data platforms make it possible to connect, standardize and automate processes across domains. When it comes to data integration, however, the governance can strongly differ.

The analysis performed makes it possible to identify two main different data integration approaches:

- One that focuses on the alignment and standardization of data within each silo in order to bring in more integration in the future (bottom up-approach);
- Another that looks to collaborate with ICT partners to establish an overall city IT architecture from the beginning (top down approach).

Bottom-up approach: Open data management across city departments with future integration in mind

In **Copenhagen,** all data on mobility is gathered and monitored by a traffic data management centre. Copenhagen is now developing data integration systems that can combine data from all administrative domains, such as the integration of data on mobility and energy in the city service development. The basic idea is that data is the main foundation for future integrated solutions in Copenhagen, but the right data sources must be in place before data integration can be possible and successful. Therefore, the first task is to build a common set of data collection tools in each silo, which is not an easy task due to the difference in data format, data type etc. Afterwards, it will be possible to integrate these systems into one city data dashboard.

Top-down approach: The establishment of an overall city platform

In the case of **Barcelona,** the Urban Platform is a transversal technological programme through which city information can be collected, managed and communicated in a common way. Barcelona collaborates with its technological partner to create a service provision platform for more efficient management of the city through a holistic vision of all available municipal services. Compared to the case of Copenhagen, the Urban Platform stands out as a basic infrastructure ICT tool that needs to be established before further integration will be possible.

Overall, the analysis performed demonstrates that there is no blueprint for city governments investing in smart technology, and no universal approaches that are

relevant to all jurisdictions. Instead, city governments must forge their own paths that respond appropriately and effectively to their individual needs and opportunities.

However, common trends have been identified. These are:

- The need to embrace a more cooperative governance system than that of traditional projects and programmes, which facilitates stakeholder involvement;
- Sustainable smart city solutions need to be citizen-centric;
- Governance needs to adapt to the key role played by data (e.g. data-sharing, ownership, management).

2.2.2. Funding and financing to enable and support integrated SCCs

Financing and funding represent the central driver of any SCC solution's business model. Budgetary constraints are forcing public authorities to look for alternative sources of capital to support the development of SCC solutions. Similarly, limited access to finance also affects small innovative companies and start-ups, especially those engaging in risky projects. This limits both their capacity to develop innovative solutions and their ability to bring their products to the market.

The empirical analysis carried out as part of this study has emphasized the **central role played by PPPs in funding and financing SCC projects.** Moreover, large and complex solutions in the domain of **Sustainable Districts & Built Environment** appear to be those more significantly financed by a mix of public and private funds. The larger amount of capital made available through PPPs may explain this.

Public funds appear to be a very common funding option for Sustainable Urban Mobility and Integrated Infrastructure projects. A possible reason for this is the availability of specific funding schemes both at regional, state and EU level for projects focusing on these domains.

Private financing is equally distributed among the different SCC domains. It is worth noticing that some SCC solutions adopted less traditional sources of financing, such as crowdfunding and venture philanthropy.

Finally, several funding and financing instruments/opportunities offered by public entities, development banks, financial intermediaries and private investors make a wide offer and **provide relatively easy access to capital** both in terms of financing and funding for SCC projects across Europe.

Funding

Government-supported programmes and funds – at EU, national and regional level – represent one of the main sources of capital for SCC projects. At EU level, a macro distinction can be made between European Structural and Investment Funds (ESIF) and other EU Programmes.

Besides the funding opportunities available at EU level, single MS have also established their own funding schemes with the aim to support solutions in the SC domain.

Financing

Financing, which typically takes the form of debt, equity and guarantees, can come either from the government and public institutions or from private entities. A distinction ought to be made between the following:

- Financial products supported by **public funding** (including, for example, European Funds for Strategic Investments (EFSI), InnovFin and Financial Instruments);
- Financial products provided by **commercial banks;**
- Specific programmes supported by **development banks** or similar (e.g. European Investment Bank, *Cassa Depositi e Prestiti, Kreditanstalt für Wiederaufbau*).

Another interesting form of financing consists in **financial instruments that translate part of the resources made available via ESIF into financial products such as loans, guarantees and equity.** The main innovation is that, as opposed to grants, final recipients are supposed to repay the contribution received. Projects expected to generate the necessary income to pay back the support received are the recipients of such products. Financial Instruments may be managed by European (i.e. EIB), national or regional financial institutions and support a range of investment areas, including: RDI, EE, Rural and Urban Development, ICT and last mile infrastructure.

As for additional financing sources, a distinction should be made between:

- **Bond financing,** which includes a wide spectrum of different bond options issued by states, local authorities, or corporates to finance different projects;
- **Pension fund private placement bonds,** which is a peculiar case of bond financing that entails pension funds with large amounts of capital to invest through non-public offerings.
- **Equity investment and infrastructure fund managers,** which includes investments made as part of a e.g. diversified securities portfolio.
- **Venture capital (VC),** which includes money provided to seed, early-stage and emerging growth companies. Venture capitalists invest in companies in exchange for equity in the companies they invest in;

Funding

Funding is the long-term cash inflow to pay for the implementation of a project. It does not imply any repayment. Instead, it represents the payment of benefits (both direct and indirect) from those that primarily benefit from the project. Typical examples of sources of funding include government bodies and the corporate sector through their corporate social responsibility programmes.

Financing

Financing is the source of capital to pay for a specific project (in other words, who lends or invests in the project). Financing is a temporary provision of cash-flow resources that is expected to be paid back at a specific point in time. Sources of financing may be multiple, such as bank loans both from commercial banking institutions or governmental banks, or development banks such as the European Investment Bank (EIB). Other options include bonds, equity, leasing and vendor financing solutions.

- **Crowdfunding,** which enables groups of individuals (i.e. financiers) to financially support a certain solution by pooling their resources. It uses the internet as a major channel whereby financiers are able to fund a project according to their geographical interests or emotional preferences;
- **Venture philanthropy** refers to private investors, foundations or private-equity firms using VC approaches to provide financial support to viable projects with high levels of social interest.

Different types of financing schemes: Project financing and public-private partnerships (PPP)

Project financing consists of a financial transaction used by public administrations or banks to finance public works, especially large-scale infrastructure projects. Compared to more traditional forms of lending, project financing focuses on the financial assessment of a given project, rather than on the business/enterprise as a whole. The remuneration is set according to the estimated cash flows and profits generated by the project. Some of the positive outcomes include the fact that it mitigates government risks and it allows them to acquire precious skills that may not be available.

Within a **Public-Private Partnership (PPP),** private sources of financing along with funding from a public source come together to support the development and implementation of SCC solutions. One of the main aspects that has to be taken into consideration while implementing an SCC solution is the level of risk (from market risk to policy risk) embedded in the initiative which could discourage private partners from actively participating and could limit access to finance. The advantage of a PPP is that it allows for a balanced allocation of risks among private and public partners.

When it comes to SCC solutions, the following types of PPP contractual models should be mentioned:

- **Build-Operate-Transfer (BOT):** This involves an agreement between the private and public counterparts committed to covering the design, building and operational phases of the investment project. Revenues for the operator company are usually obtained in the form of a fee charged to the community/government;
- **Design-Build-Finance-Operate (DBFO),** whereby a single contractor with financing capabilities designs, builds and operates the project for a certain period of time;
- **Build-Own-Operate (BOO),** which involves a private sector partner taking under its responsibility all the phases in a project from building and financing to operations. The main difference with other models, especially DBFO, is related to the fact that a company could build, operate but also own a project for all its physical lifecycle;
- **Energy Service Companies (ESCO):** Thee provide direct financing to the investment and use their in-house expertise and know-how to develop projects further. The main steps that are usually followed by ESCOs in relation to projects involve: a first analysis of data gathered, contracting, designing, execution, monitoring and maintenance;

- **Financial Lease** involves three main actors; a financing entity, the contractor (private entity) and the principal (public entity). Under this contractual form, capital is provided to the contractor by the financing entity, which is then repaid by the public entity through lease payments;
- **Sponsorship Agreement,** which allows public entities to cooperate with the private sector in order to promote innovative projects in the government sector and to execute public works, increasing the quality of services. The role played by the private entity is usually related to the provision of capital or goods, whereas the public entity is mostly focused on setting goals and objectives for the project.

Investment platforms

Investment platforms are co-investment arrangements – which can be supported by EFSI – structured with a view to catalysing investments in a portfolio of projects (as opposed to individual projects) with a thematic or geographic focus[12].

Investment platforms aim to **reduce transaction and information costs** and provide more efficient risk allocation between various investors. Ultimately this enables financing solutions to be spread over a wider range of projects, some of which would otherwise not be reached by other means (e.g. the EIB).

The range of products that can be provided through platforms is vast and includes:

- **Equity and quasi-equity** investment in projects or funds;
- **Loans** to projects, including subordinated loans to those provided by, for example, National Promotional Banks or private investors;
- **Guarantees,** which can include both guarantees directly to projects or guarantees and/or counter-guarantees to intermediaries who invest in projects.

Investment platforms are flexible instruments also in terms of sectoral scope (in this case, reference is made to mono-sector focus versos multi-sector focus), thus providing a unique window of opportunity for combinations of, for example, energy and mobility SCC projects. Investment platforms are also best suited to providing financial products to support small or medium-size projects, which would not otherwise be able to benefit from the opportunities offered by the wide range of financing solutions available on the market[13].

Common trends across integrated SCC solutions

Looking at the panel of analysed integrated SCC solutions, an initial categorization has been made by dividing the different financing/funding options into the following six major clusters: i) EU funds (both ESIF as well as other EU programmes); ii) State grants; iii) Regional funds (funds made available by single regions from national budget); iv) mix of public funds (including the use of one or more of the previously mentioned funding options); v) private financing; vi) both private and public

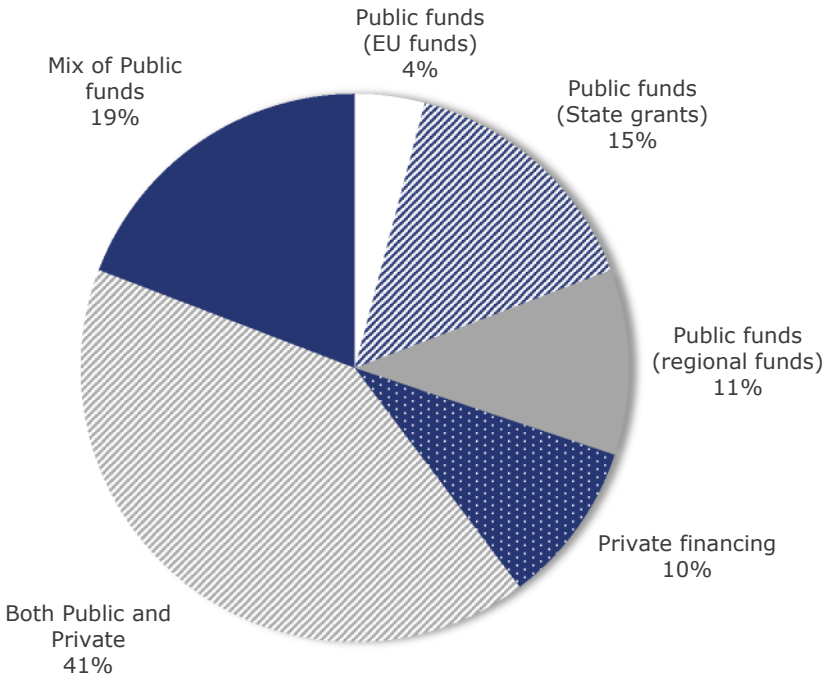
[12] http://ec.europa.eu/economy_finance/financial_operations/documents/efsi_rules_applicable_to_operations_en.pdf

[13] http://ec.europa.eu/regional_policy/sources/thefunds/fin_inst/pdf/efsi_esif_compl_en.pdf
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1017&from=EN

financing/funding (mix of private financing including for example loans and public funding in the form of EU funds, State grants, Regional funds).

These categories were used to group the funding/financing options chosen by SCC solutions, as is illustrated in Figure 9 below.

Figure 9: Funding/financing options chosen by SCC solutions



Source: Our elaboration

The majority of solutions analysed have adopted a mix of public-private funding/financing (e.g. Hafen City Hamburg, University of California San Diego, Hudson Yards New York, etc.) in order to sustain SCC projects.

Example of a mix of public funds
New Fleet Management System, Donostia, San Sebastian (ES)

The "New Fleet Management System" became fully operational in 2010 and currently enables the efficient planning and management, via an ICT platform, of the public transportation system in the city. The solution was funded through a mix of public resources, with 70% coming from EU funds while the remaining part was made up of from regional funds. The funding coming from the EU was raised through the 7th Framework Research Programme.

Public-private funding/financing is followed by a mix of public funds (e.g. Bus integrated management system in Donostia, San Sebastian; MnPass Minneapolis), which consists of state grants (e.g. MeRegio, Future City Glasgow), regional funds (e.g. Citizens Connect), private financing (e.g. Vienna Citizens' solar power plant) and the use of individual EU public funding options (Interoperable open platform – Iscope, 3eHouses).

Example of private financing
Green Bond financing of Smart City projects, Gothenburg (SE)

The City of Gothenburg became the first city in the world to use **Green Bonds** for financing projects in 2013. The total amount of green bonds issued for the City of Gothenburg in three years amounts to € 353 Mln. Examples of projects that have been financed via Green Bonds include: Energy Celsius Project (district heating system), *Lokalforvaltningen* (several projects related to sustainable housing and schools) and other investments in deploying approximately 100 electric cars across the city.

Example of EU fund
Efficiency financing via EFSI (FR)

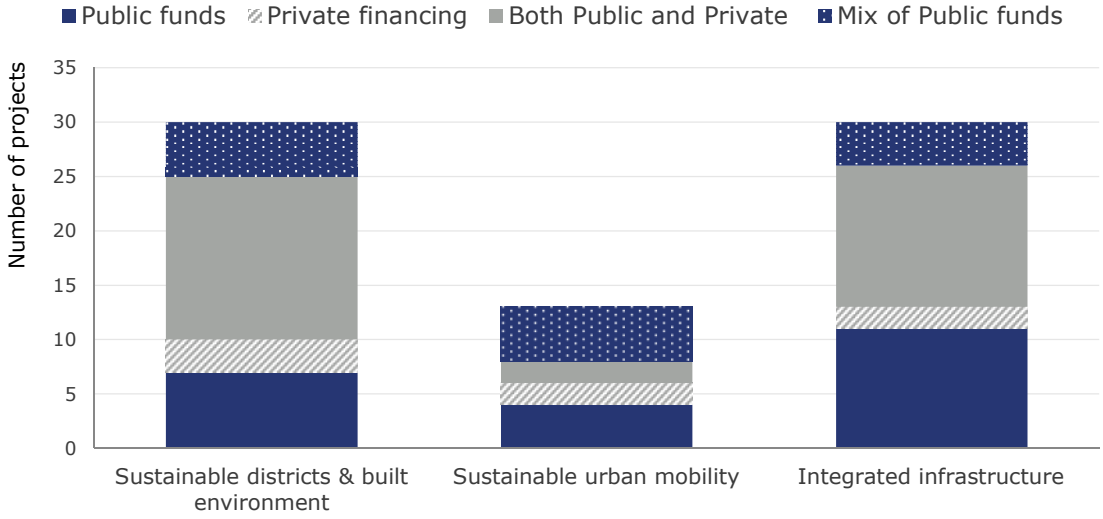
One of the main projects involving the deployment of EFSI funds relates to the plan to improve EE performance in more than 40,000 houses and flats across France.

The aim of the project is to improve the insulation as well as to renovate the heating and ventilation system, therefore reducing energy consumption.

The overall capital received by the EIB amount to € 400 Mln and cover half of the total project cost. The capital will be provided by the EIB via local intermediaries.

It is worth noting that, according to the data available in relation to the 80 best practices, **PPP seems be especially popular in SCC projects focusing on the Sustainable Districts & Built Environment domain.** The bar chart in Figure 10 below shows the distribution of the above-mentioned funding/financing options,[14] applied to the three major domains of SCC projects.

Figure 10: Funding/financing options for each domain[15]



Source: Our elaboration

[14] To make the chart more readable, the wide range of public funding options have been clustered into the more general "public funds" definition.

[15] The bar chart was made using the data available from approx. 70 best practice examples of SCC solutions.

The widespread use of PPP to fund Sustainable Districts & Built Environment projects may be due to the complexity of these projects, which often require access to a larger amount of capital and resources. Moreover, since they often involve large urban redevelopments, specific institutions become operational in order to oversee the different project phases. Therefore, **the presence of a solid, but also dynamic organisational structure, results in a more direct and effective control over some of the critical aspects of a PPP** including financial management, project evaluation and risk allocation.

Public funds appear to be a very common funding option for Sustainable Urban Mobility and Integrated Infrastructure projects. A possible reason is that such projects are generally characterised by a relatively small size, high risks and limited private involvement. Coherently, specific funding schemes both at regional, state and EU level have been made available for projects focusing on these domains. Regarding private financing, all the three different Smart Cities domains account for similar shares and no major trends can be identified.

Public funding of an integrated infrastructure project
SC Platform, Valencia (ES)

The platform was unveiled by the Valencia City Council in 2014 with the aim of collecting different indicators related to transport management, air quality, waste collection, public lighting and local police.

The solution is entirely funded by the local government. A four-year contract has been established between the Municipality and *Telefonica*, the Spanish telecommunication operator that won the contract. The total budget amounts to € 4.8 Mln. It is estimated that the project will produce a high amount of savings that will cover the cost of the service.

The city administration is analysing three different financial models to ensure the long-term sustainability of the platform. These are: i) introduction of a fee in the specification of the urban services offered by the platform, during the bidding process; ii) introduction of a mix of contributions from local public authorities; iii) introduction of a fee for all service providers.

In conclusion, the analysis of funding and financing mechanisms for SCC solutions has showed that in this case, too, there is no **"one-size-fits all"** approach, and that one of the main drivers to succeed, is to properly **balance the short-term pressures to deliver results with the long-term benefits of partnering with the private sector.**

Common trends have also been detected with respect to the scale of SCC solutions (where scale means the overall amount invested in the initiative):

- **Small scale projects** find it difficult to access the main funding and financing sources, mainly due to a limited awareness of what the financial market offers, and to the fact that they are usually not very interesting to banks (i.e. too small to be relevant). The most common funding/financing approaches for them include crowdfunding, venture philanthropy and specific EU/national funds.
- **Medium-sized projects,** depending on the context and type of solution, can benefit from certain dedicated public support mechanisms, but mostly rely on venture capitalists to have their solutions financed. The most common

funding/financing approaches in this case include venture capital and EU/national funds.

- **Large-scale projects,** which are usually real-estate driven, are those that find it easier to access finance. This is because promoters generally know the market and the range of products offered, and also due to the fact that they usually involve major private sector companies that blend SCC solutions into other businesses (real-estate). The most common funding/financing approaches in this case include bond financing and financial products provided by commercial banks.

2.2.3. Procurement models for cities to enable integrated SCCs

Municipal authorities strongly rely on external suppliers, a trend that is growing as local authorities increasingly define themselves as commissioners and not deliverers of services. In the field of Smart Cities, **the creation and development of a SCC solution requires a continuous innovation process involving high numbers and different categories of stakeholders**. One way the public administration can foster this kind of innovation process is by using **public procurement as a tool to stimulate innovation from the demand side,** thereby supporting state-of-the-art SCC projects and solutions.

This is particularly true for Smart Cities, which are characterized by areas of application where public authorities have a strong potential to stimulate demand (e.g. the transport and the energy sectors). Moreover, public authorities may not only buy a product, they can also make a request for products that are not available yet, generating innovative dynamics and solving market failures.

Therefore, it is clear that **Europe has an enormous and overlooked opportunity to spur innovation by using procurement.** However, as SCC solutions are by definition multi-component systems, their procurement may sometimes be complex. These issues have all created barriers to new players accessing this market. Combined with the need for integrated solutions such as those of SCCs, this presents a major challenge to local authorities, which have traditionally developed responses through a silo approach.

Evidence for the relationship depicted above is that, historically, it has been difficult for newly founded firms to win business from public bodies like municipal governments. Therefore, it seems that **public sector procurement practices themselves can represent an obstacle to accelerating the growth of SCC solutions.** From both the public and private sector sides of the market, there is some evidence that traditional procurement of city services is stifling innovation and inhibiting the ability of cities and industry to jointly undertake real life R&D and to pool intellectual property for mutual benefit. Equally, there is an increasing consensus on new, smarter approaches to public procurement, which are already starting to develop and should be more widely adopted.

Avoiding lock-in

Vendor lock-in is a phenomenon that takes place when **a public authority is unduly dependent on a single supplier, vendor or developer** beyond the timeframe of the initial procurement contract, damaging competition. This happens in cases such as: i) Long contracts that encourage up-front capital investment to build bespoke tools and that depreciate over a number of years; ii) One supplier entrenched over a number of years to provide mission critical systems, requesting backward compatibility with systems of which only few suppliers have knowledge.

By limiting the procurement choices of public authorities to certain vendors and the suppliers of their products, lock-in can reduce the ability of other market participants to compete in contracts for public procurement. This in turn can lead to lower levels of innovation, and higher prices. **Lock-in, as well as increasing costs, excludes new and innovative companies from providing alternative solutions and causes the market to stagnate.**

ICT standards may play an important role in preventing reliance on single vendors for products and system components that implement desired technologies by **identifying the key element of the technology required and ensuring that its use is not limited to a specific product or service.** Procuring a product from one supplier that is based on standard technology helps to ensure that future purchases are not limited to the original supplier, as others are also able to implement the technology.

High-performing city governments increasingly recognize the value of acting as customers of innovation. **Opening up procurement mechanisms to make them accessible to younger, smaller businesses allows cities to access a wider range of new ideas and technology than traditional market procurement.** As a result, cities have been looking for new ways to ensure innovation is built into the actual procurement process, as is explained in the following paragraphs.

In the procurement of SCC products and services (e.g. retrofitting of public sector buildings, smart energy grids, electric vehicle charging infrastructure, installation of heat networks, renewable energy generation), cities may essentially adopt two models: i) Traditional procurement, or ii) Public procurement of innovation (PPI).

Before carrying out one of these two traditional forms of procurement, cities may carry out a **preliminary market consultation**, whose aim is to gather information from the market and inform potential suppliers about future procurement opportunities.

Common trends across integrated SCC solutions

A categorisation has been made dividing the different procurement models adopted by the case studies analysed into eight major clusters, namely: i) Preliminary market consultation; ii) Pre-commercial procurement; iii) Competitive dialogue; iv) Competitive procedure with negotiation; v) Innovation partnership; vi) Open procedure; vii) Restricted procedure; viii) No procurement.[16]

[16] This may be for a variety of reasons, including the fact that the consortium includes players able to provide components or expertise, which therefore did not need to be acquired from the market. It might also be due to the fact that some SCC solutions are privately owned, and therefore do not require public procurement.

The majority of the SCC solution examples analysed through this study (72%)[17] report that PPI procedures were relevant for their solution. Within the three major domains – from a technological-prevalence point of view – of SCC projects (i.e. Sustainable Districts and Built Environment, Sustainable Urban Mobility, and Integrated Infrastructure), **a particularly popular model appears to be the innovation partnership for Integrated Infrastructure.** The Sustainable Districts and Built Environment[18] as well as the Sustainable Urban Mobility domains are characterized by a similar distribution of procurement models.

It is worth noting that none of the solutions analysed use the restricted procedure, and that most of the solutions that do not use public procurement are in the domain of Integrated Infrastructure. In the Sustainable Districts & Built Environment and the Sustainable Urban Mobility domains, it seems that most solutions were purchased using PPI approaches.

Also notable is the fact that PPI adoption was reported in 61% of cases, whereas traditional forms of procurement were employed in only 10% of cases. Indeed, 23% of respondents reported that they did not use it. As illustrated in the figure below, this phenomenon is substantiated by the **innovation partnership model representing the largest share of procurement models adopted** in the case studies. Coherently with this, preliminary market consultations, competitive procedures, negotiations and competitive dialogue follow in terms of market share.

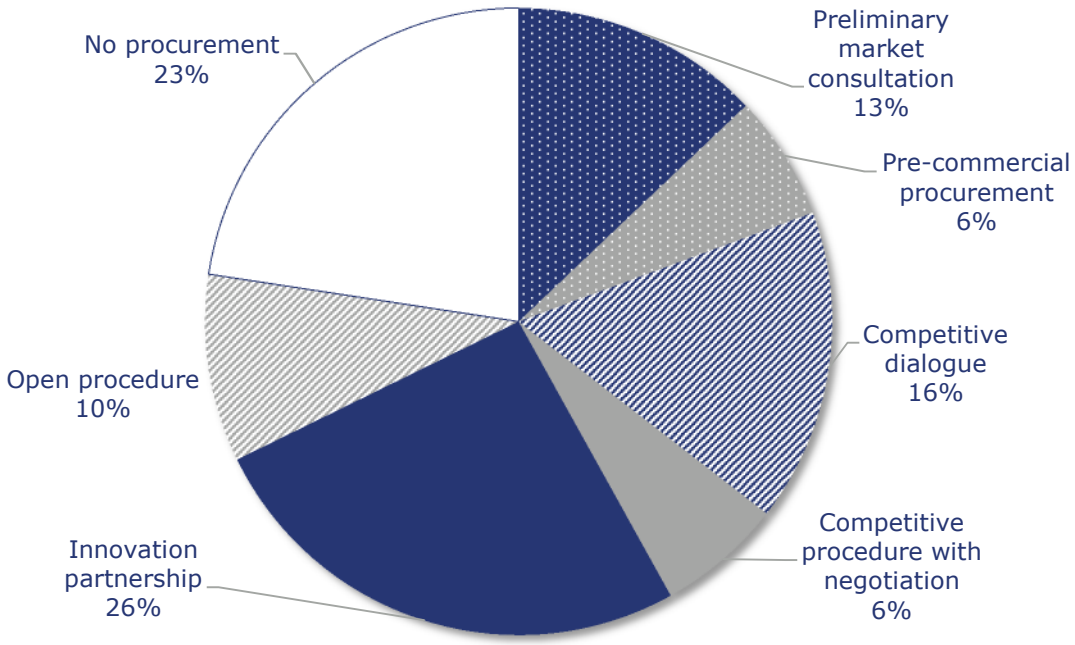
Besides market consultation – which is not a "pure" procurement method, given that it aims to gather information from the market with a view to later procurement – all others are innovative procurement models, particularly suited to SCC solutions. Their extensive use (according to these statistics) means that, when a public authority sought a SCC solution, it felt "sufficiently" uncertain (e.g. legal and financial set-up of the contractual relationship with the supplier) even after a market consultation.

Such models, although more slowly implemented, especially if the authority is using them for the first time or does not have adequate capacity, have the clear advantage that they allow **greater interaction with the market** in order to refine requirements and award a contract, compared to open or restricted procedures.

[17] This percentage is calculated as the number of cases that used the PPI models (i.e. PCP, competitive dialogue, competitive procedure with negotiation, and innovation partnership), over the total number of cases that used procurement.

[18] This includes projects that involve intervening on the existing building stock with the aim of improving energy efficiency, generating low carbon energy, modernizing infrastructure and creating high quality living environments. Interventions to find energy efficient, low carbon solutions for new buildings and districts are also included.

Figure 11: Procurement models adopted by SCC solutions



Source: Our elaboration

With regards to the innovation partnership model, **innovation platforms** (also called participation platforms) are of particular interest: public authorities are increasingly adopting these tools to facilitate their procurement procedures. The example case presented in the box on the following page shows the use of an innovation platform in the city of **Copenhagen.**

The use of an innovation platform in Copenhagen, Denmark

By 2025, Copenhagen's ambition is to become carbon neutral. With this aim in mind, in October 2013 the Copenhagen Cleantech Cluster and the City of Copenhagen established a strategic partnership to explore new methods for using public procurement. The result of this was the setting up of a platform where companies could meet and get to know each other, and where they could apply their specific knowledge and skills to create solutions together.

The project was based on a **Public-Private Innovation,** a model that can be divided into several phases:

- **Identifying and prioritizing challenges**: The public authority identified and prioritizes challenges.
  In this case, Copenhagen's ambition to become a SC was set as the grand challenge.
- **From grand challenge to specific problems:** The public authority collects information about the challenge, as well as ideas on how it might be solved.
  In Copenhagen, experts, entrepreneurs and other stakeholders were invited to help to understand the grand challenge in more detail, and break it down into more specific problem areas. The first finding was that citizen engagement and data availability were the most important issues, thereby making it possible to give the platform a better focus.
- **Innovation teams:** Partners and stakeholders with the competencies to contribute to solving this more specific challenge are identified, and possible solutions and barriers are explored in greater detail.
  The topics addressed in Copenhagen included data availability, open versus closed standards, business models for establishing a digital infrastructure, waste management, water management, transportation, energy consumption, etc.
- **Procurement and implementation:** Based on the information collected, the next step is to issue a tender for a new solution. The identity of the procurer is not given; it might be a public authority, or an association with public sector backing.
  In the case of Copenhagen, a test case was developed in the area of traffic. The city wishes to reduce CO_2 emissions produced from traffic generated by looking for available parking spots.

As previously mentioned, not only the innovation partnership but also the **competitive procedures with negotiation and the competitive dialogue[19] are flexible procedures used in complex projects** where there is a need for the contracting authority to discuss all aspects of the proposed contract with potential suppliers.

These models allow for **discussion with suppliers and innovators during the tendering procedure, enabling them to develop a solution based on a better understanding of the exact needs of the authority**. Generally, these approaches provide structured tendering processes with more flexibility to develop innovative solutions, allowing for a constructive dialogue between suppliers and contracting authorities. However, **the process requires skilful management:** as it often takes longer than other processes, making it extremely **resource-intensive**, as a dedicated project team will need to meet regularly and for extended periods of time. Moreover, the process of constantly refining the proposals during the dialogue phase requires considerable investment for the economic operators concerned. Accordingly, it is

[19] The only difference between these two is that the competitive procedure, unlike the competitive dialogue, requires that the authority can specify the required characteristics of the goods or services prior to the competition.

advisable to foresee an adequate reimbursement for the economic operators participating, through, for instance, stipulating in the contract the conditions of payment or prices for the participants at the dialogue. The example below provides some insights on how the **competitive dialogue** was carried out in the case study of the city of **Barcelona.**

The competitive dialogue procedure adopted in Barcelona, Spain

Given the lack of similar products in the market, the city of Barcelona decided to adopt the competitive dialogue procedure in order to obtain the most appropriate **City OS Urban platform,** a type of ICT architecture that provides a transversal service that interconnects the entire city. Barcelona adopted this model to innovate and develop the requirements for this system jointly with companies. The competitive dialogue procedure was carried out in stages:

- The process began in April 2013 and 23 enterprises applied; some presented themselves individually and others formed Joint Temporary Ventures. This process continued with the final selection of 13 candidates.
- During the next stage, the procurement body evaluated the documents received from the various bidders and invited a maximum of six candidates – the ones with the highest scores – to take part in a dialogue stage.
- This was followed by the opening of the development stage, an interaction with candidates to determine and establish the most suitable solution or solutions to meet the needs of the procurement body.
- Once these stages were completed, the procurement body called on the candidates to submit their final tenders, based on the specific solution or solutions presented during the dialogue stage. The candidates presented their tenders, which were evaluated under the initially established contract-awarding criteria, ending with the proposed contract award in April 2015.

Pre-commercial procurement is designed to steer the development of solutions towards concrete public sector needs. In order to do so, PCP occurs through a number of phases that focus on R&D activities, and it involves different suppliers competing through different phases of development. In spite of the fact that, among the SCC solutions analysed through this study, PCP was not used as much as the other PPI models, on the basis of a literature review, it appears that it is one of the models increasingly adopted by municipal authorities when procuring SCC solutions. As a result, **PCP has now become quite a popular procurement tool, although the process that needs to be followed by public procurers is not so simple.**

Examples EU-funded FP7 projects fostering PCP

ENIGMA is a FP7 project that aims to implement a joint transnational PCP procedure in the field of public lighting. Coordinated by the city of Eindhoven, the project's partner municipalities cooperate on procuring innovation and testing in a real life environment the technologies that their commercial subcontractors develop. Through a learning platform, ENIGMA encourages city-to-city learning and exchanges on PCP methodologies and public lighting innovation. Other interesting examples include: **P4ITS** (a network focusing on developing PCP solutions for innovative ITS and services); **Smart@Fire** (procurement of innovative fire fighting equipment, aimed at reducing risks and better handling city emergencies); **V-CON** (procurement of a virtual modelling road infrastructure solution).

PCP is applied when market consultation activities indicate that there is currently no solution to the city needs. Since R&D services for new technologically demanding solutions, such as those for SCC solutions, require considerable funding, **PCP necessarily requires collaboration with authorities and bundling of demand.**

A clear advantage of such a model is that, by leaving a clear separation between the pre-commercial R&D phase and the roll-out of commercial end-products resulting from the R&D, it enables public purchasers to filter out technological R&D risks before committing to procuring a full-blown innovative solution for large-scale commercial roll-outs. Importantly, any follow-up procurement of commercial volumes of end-products most likely requires a **competitive tendering procedure** in accordance with the EU Procurement Directives. The **Klimastrasse** case illustrates how PCP was carried out outside the FP7 framework.

PCP outside the FP7 framework - Klimastrasse, Cologne, Germany

The Klimastrasse project focuses on the development of sustainable streets and neighbourhoods and it concentrates on several areas, including: optimized building insulation, renewable energy, innovative use of electricity, intelligent energy management, etc.

The project procurement was conceived as a PCP. The key market consultation instrument was held in September 2012, in the form of a workshop with regional industry and local companies. The project co-ordinator RheinEnergie drafted an invitation list out of a "business directory" with Cologne and long-time RheinEnergie partners in other projects (e.g. Bayer, Siemens, Alstom).

However, not all cases adopt PPI models. The example below illustrates how a traditional procurement model was adopted for the development of the **Valencia SC Platform.** Based on the exchange with stakeholders, it appears that **the traditional model is best when the will of the city's authority as well as the objectives of the SCC solution are clear since the very beginning.**

The open tender procedure adopted for the Valencia SC Platform

The Valencia SC Platform (VLCi Platform) enables the city to centralize information on municipal services thanks to the use of a technological solution. The Platform compiles key indicators of city management and urban services and it aims to improve and rationalize the governance model and encourage greater participation by civil society, organisations and companies in municipal service provision.

In November 2013, the ICT Service of Valencia City Council opened a public tender for the development of an **integrated City Platform.** Out of the seven companies that presented their proposal, Telefonica I+D obtained the best score in the evaluation process and in July 2014, it won the public tender. Given the requirements of the tender, which envisaged an "open" platform based on recognised standards, **the winning proposal was based on the European open standard Fi-Ware.**

A 4-year contract was established for the development of the platform with a budget amounting to c. € 4.8 million. The contract also defined **the obligation of the private company to transfer the technological solutions to municipal staff according to a training plan approved by the Municipality.**

2.2.4. Involving citizens and communities to create sustainable SCCs

Citizens, businesses and communities play a central role in the development and sustainable implementation of integrated SCC solutions. The literature agrees on the benefits of participatory and engagement approaches to city design, but research shows that there is a **lack of consistency** in how the role of citizens, business and communities is perceived by stakeholders.

Citizens

In the context of this study we have chosen to interpret "citizens" widely, to include local business partners and the role of communities.

Generally, in **most of the successful SCC solutions analysed, it is claimed that participation from the citizenry should increase,** as citizen participation and engagement are key to ensure the development of sustainable solutions and business models. **However, evidence shows that the actual approach is to have only piece-meal involvement of citizens and communities**.

This study has investigated a variety of methods used to engage citizens, local businesses and local communities during the key stages of project design and implementation for integrated SCC solutions. These are:

- **Co-developing city solutions:** Giving citizens a voice in local matters;
- **Crowdsourcing the city:** Citizen-led issue reporting, data crowdsourcing, crowd-funding;
- **Co-designing tomorrow's cities:** The role of the citizen in living labs, test-beds, demonstrators;
- **Community-driven SCC solutions:** Citizen-owned energy grids, grassroots community projects, sharing economy;
- **Smart neighbourhoods and districts:** Regeneration projects with the vision and design of smart districts;
- Ensuring inclusive innovation;
- **Outside-in innovation:** Tapping into collective community action.

These participatory and engagement approaches have been identified through a keyword clustering exercise across the 80 best practise examples of SCC solutions. The models of key approaches that describe the role of the citizen in more detail have either been derived from the sample of 80 best practice examples, or they have been identified through the literature review/desk research.

This mapping exercise lead to the identification of **methods used within the context of integrated SCC solutions** in the three main phases of deployment: (I) the design and development phase; (II) the implementation and management phase; and (III) the roll out phase (see Table 4 below).

Table 4: Examples of methods used to engage citizens, businesses and communities in integrated Smart City solutions

	(A) Design & Development Phase		(B) Implementation & Management		(C) Roll out phase	
	Methods	**Examples**	**Methods**	**Examples**	**Methods**	**Examples**
(I) Providing insight, information & resources	Design-thinking & user-led research; crowd-sourcing; civic crowdfunding; participatory planning	Integrated bus management system, San Sebastian, Spain; App-based reporting of issues, Citizens Connect, Boston, USA	Customer insight and action research; data analytics and solutions; awareness raising, promotion and education	Real-time 2-way communication for traffic and emergency management, Rio, Brazil	Crowd-sourcing; city level data analytics; awareness raising, promotion and education	Impact data to help change behaviour gathered around multiple cities, Urban Ecomap, San Francisco, USA
(II) Co-design, co-creation, collaborative problem solving	Design-thinking approaches applied in pilots and demonstrations; Living labs; participatory planning & policy making	Early user inclusion in master planning, Barangaroo District, Sydney, Australia	Dynamic master planning; co-creation of services; civic technologies; open data	Co-creation of public services, Santander City Brain, Urban Platform, Santander, Spain; Establishment of open data community groups & events, Hong Kong	Incubation and acceleration techniques; Public sector research laboratories; city collaborations	Mindlab, Copenhagen, Denmark; European city network projects
(III) Collaborative governance; open innovation; Joint decision-making	Crowdsourcing of ideas; participatory budgeting; Civic crowd funding	Common goal-setting of the fossil free Växjö programme, Växjö, Sweden;	Multi-sided business models; multi-stakeholder partnership models (PPPPs); representation of citizens on local boards	Co-ownership & governance of renewable energy plant; Vienna, Austria	Holistic Smart City vision; representation of citizens on national boards; city collaboration; cross-border Smart City services	Stakeholder Advisory Committee (SAC), Waterfront, Toronto, Canada; Permanent consultation in Lyon Smart Community, Lyon, France

	(A) Design & Development Phase		(B) Implementation & Management		(C) Roll out phase	
	Methods	**Examples**	**Methods**	**Examples**	**Methods**	**Examples**
(IV) Collective action; social innovation	Idea camps; Community-based solutions	Open Glasgow (Hackathons, mobile engagement hubs, community mapping), Future City, Glasgow, Scotland	Nudging methods	Peer benchmarking and proactive advice on how to be more energy efficient, Issy Grid, Issy-les-Moulineaux, France; Fare saver to encourage walking, Octopus Card, Hong Kong	Impact investing; shared Smart City manifesto; support & investment in independent community solutions	Contests aimed at specific communities such as minorities & women owned businesses, Fiber Optics Smart Grid, Chattanooga, Tennessee, USA

Source: Our elaboration

The above-mentioned **key approaches to citizen engagement** and evidence of their application across the SCC solution best practise examples are outlined below.

Co-developing city solutions: Giving the citizens a voice in local matters

Technological innovations allow for new and diverse forms of participation and the co-development of city solutions. Of particular relevance are those applications that provide new ways of collecting data, gathering feedback, democratizing decision-making and creating built-in sustainability of solutions by creating community ownership. Examples include city idea banks, participatory budgeting, a gaming based methodology to engage citizens in designing new city solutions and ICT enabled deliberation in the context of climate change.

Citizens being involved as active participants in the planning phase

In the case of the **Barangaroo District Renewal Project - Sydney**, the final design was the result of early user inclusion and community consultations to shape the master planning of the area, carried out mainly through stakeholder forums (meetings), an online forum, and a qualitative and quantitative interview-based consultation of over 2,000 people.

Crowdsourcing the city

Crowdsourcing is an umbrella term for a broad range of activities. Crowdsourcing takes place when the public (as opposed to experts, for instance) provide information or means. Examples include citizen-led issue reporting, data crowdsourcing, and crowdfunding. Most intelligent transport solutions, city platform solutions and smart energy solutions include aspects of crowdsourcing data in different ways. The approach to crowdsourcing, however, remains explorative at the moment, as one of the challenges is to ensure that the information collected is reliable and accurate, and that data privacy and security are respected

Getting connected with the city

Recent years have seen a proliferation of online platforms in cities that provide a simple, low-cost way for large groups of citizens to contribute data on their experiences. This enables citizen-lead issue reporting and/or the contribution of citizen data.

For example, in the civic sphere, **FixMyStreet** invites users to report potholes, broken street lights and other issues encountered in their neighbourhood. The app **Citizens Connect - Boston**, gives citizens the opportunity to report problems and issues via their smart phones. The City's work order management system then redirects the message to the person in the city who is supposed to deal with the problem. The German platform **Wheelmap** asks citizens to contribute data on the wheelchair accessibility of public locations such as cafes and restaurants in their city.

Co-designing tomorrow's cities: The role of the citizen in living labs, test-beds and demonstrators

City centres and neighbourhoods increasingly exhibit a number of district level innovation spaces such as large-scale demonstrators, living labs or smart streets, which are ideal platforms to explore the needs of users as residents and citizens. In

theory, these district level innovation spaces operate as intermediaries among cities, regions, firms, the third sector and research organisations, as well as citizens, for joint value co-creation, and rapid prototyping or validation to scale up and speed up innovation and businesses. However, evidence across the best practice examples collected in this study shows that there is generally no co-ordination between experimentation projects, and hardly any systematic reporting on added value reached through citizen engagement across experimentation projects. This means that there is a lack of any resulting principles, rules, standards and guidelines that other cities may benefit from.

Community-driven SCC solutions

Community-driven innovation in cities can have many facets. It can be innovation owned and driven by a community, aimed at a community and more recently has enabled new business models based on community platform applications supported by mobile technologies such as sharing economy services and solutions. Examples include: citizen owned energy grids, grass root community projects, sharing economy.

Community-based business models as part of the Sharing Economy

The sharing economy is also commonly referred to as collaborative consumption, the collaborative economy, or the peer-to-peer economy. This term refers to business models that enable providers and consumers to share resources and services, from housing to vehicles and more. These business models typically take the form of an online and/or application-based platform for business transactions. Cities play a central role in deciding which sharing economy practices are adopted and which are rejected. A feature of many of the best practices reviewed is the emergence of sharing economy business models as an integral part of the integrated SCC solution. For instance, **Lyon Smart Community – France**, launched a car sharing service integrated in a wider Smart City solution. Most major cities also have ride sharing and bike sharing services either as private services or

Smart neighbourhoods and districts

A common feature in Smart Cities is brown-field development – a re-development of an often former industrial estate for mixed use. These are often regeneration projects – for instance harbour redevelopments that come with the vision and design of smart districts and thus become an important feature (and driver) of the Smart City they are part of. Examples include: industrial zones, mixed use redevelopment sites, eco districts. Districts and neighbourhoods can be seen as strong drivers of Smart City ambitions and the development of solutions that then can be rolled out across the entire city or region. The best practise examples show that this level is very effective at delivering integrated solutions, and that efforts already exits to enable better knowledge sharing between districts and neighbourhoods.

Ensuring inclusive innovation

In simple terms, inclusive innovation is the means by which new goods and services are developed for and/or by those who have been excluded from the development mainstream; particularly the billions living on lowest incomes. In the context of integrated Smart City and community solutions this means the city's role and ambition

to make the future city inclusive for all, including the elderly, the marginalized and particularly the poor and unemployed. Examples include energy efficiency pilots in social housing. Whilst the social model is a clear added value for European integrated SCC solutions, evidence suggests that this is a difficult target group to work with, and that research shows mixed outcomes for the adoption of SCC integrated solutions and for the implied support of changing behaviour towards zero emissions.

Inclusive innovation as a driver for SCC integrated solutions

Examples from the best practice cases with elements of social innovation include the **3e-Houses** solution in **Bristol – UK,** which brought ICT-enabled energy efficiency measures in the context of social housing, providing real-time monitoring and management of energy consumption, integration of renewable energies, and creating awareness for lower energy consumption. Likewise, one of the four pillars of the **Smart Community project, Lyon – France** focuses on energy consumption monitoring on a micro level through the instalment of energy monitoring systems in social housing, as well as actions aimed at raising awareness and promoting behavioural change of the inhabitants.

Outside-in innovation - tapping into collective community action

Outside-in innovation is innovation brought into the city by actors other than the city administration (and budgets) themselves. This could be community-lead innovation, or private sector-lead innovation. In particular, the opening up of databases and public sector data in recent years has enabled many more people and actors to access data, combine it with other sources and present it in interesting ways that can reveal new perspectives. Mapped examples include Urban Ecomaps, as well as Open city platforms. Data presents a new way of combining information across silos in city structures, and can include data collected in and around the city too. This seems to be a starting point for service innovation across established actors, SMEs, start-ups and communities to develop integrated solutions for Smart Cities.

Collected empirical evidence has showed that the significance of co-developing SCC solutions lies both in incorporating preferences and local specificities, and in achieving "buy-in" if not "co-ownership" by the key target constituents. **Despite the potential of co-designing approaches, only very few SCC best practice examples show an explicit usage of co-developing approaches,** both at the level of desk researched best practices and at the level of case study research. This indicates that the potential for co-development and the active inclusion of citizens in the planning and development phase of integrated solutions could be further explored.

2.3. Learning from failure: Key reasons why SCC solutions have failed

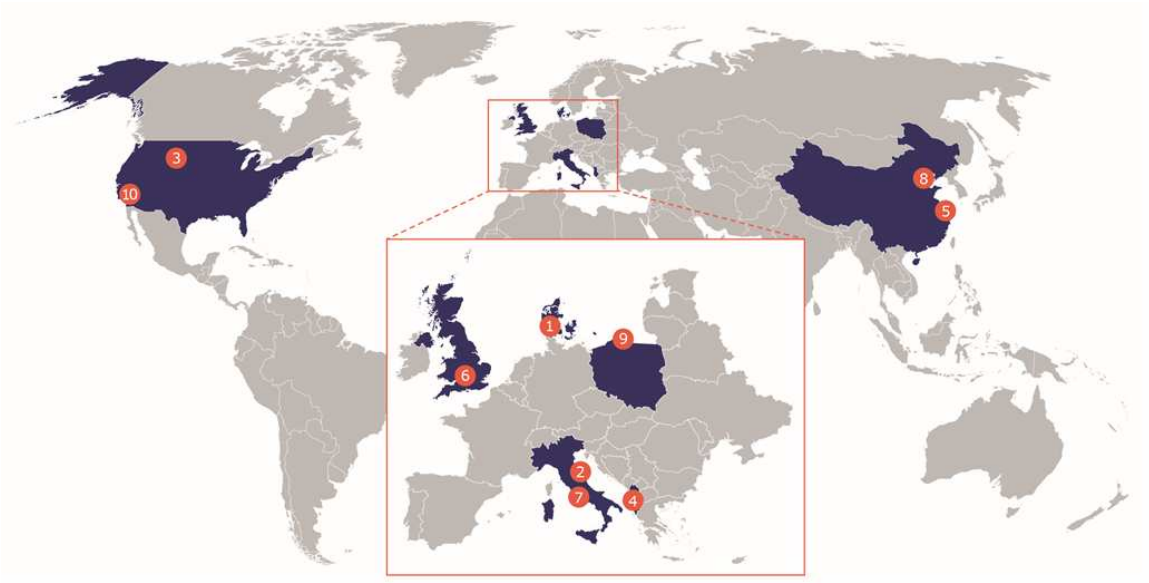
The previous sub-sections presented the analysis of how innovative technologies reshaped the approach to urban infrastructure investments in terms of governance, funding and financing opportunities, procurement models and involvement of actors. This assessment was based on success stories but, as can be expected, this is not always the case. The following pages look at how technology is an enabler for new models but does not implies success *per se*. As demonstrated through case study analysis and as supported by the literature, **cases of failure can often be tracked**

back to a lack of attention to the needs of users, which is independent from the technological development of solutions.

As reported by several academics, SCC projects are not necessarily developed to succeed in the same way a business project would.[20] Therefore, their failure is to be determined differently as well. To solve the impasse of defining the criteria for projects to be considered as failed, it was deemed most appropriate to involve stakeholders, both through dedicated questions within a web-based survey and by asking for their opinion during a workshop held in Berlin. In addition to this, the identified cases had to comply with the scope of the analysis and had to be SCC solutions that failed to integrate at least two out of the following sectors: Energy, ICT and Mobility and Transport.

Each of the ten cases of failures assessed (and shown in Figure 12 below) represents an example of SCC solution that integrates in a different way with the context and environment (technological, political-institutional, socio-economic/cultural, management).

Figure 12: The ten selected examples of SCC solutions presenting elements of failure



More specifically, the analysis looks at the conditions and elements that caused failures to occur in these cases. Empirical findings, confirmed also by the literature review, have shown that SCC solutions often focus principally on the ICT dimension, which is designed around innovative technologies, rather than adapting these to the social and cultural dimensions. **Designing solutions starting from the citizenry is possibly the most relevant lesson that can be learnt from past experiences.**

[20] Stimmel C. L., 2016, *Building Smart Cities. Analytics, ICT, and Design Thinking.* CRC press. Taylor & Francis Group. New York, U.S.

The analysis of cases reported that SCC solutions often fail because they are conceived and planned based on the available technology and on simplified user behaviour. Indeed, cases of failure demonstrate the limits of such an approach. All examples of failure that have been identified are characterised by a limited inclusion of the cultural dimension within the focus of the SCC solution.

In a few cases, issues have been encountered in the selection and use of the technology. In particular, this is the case of the *Better place* (Copenhagen) project, where lack of standardization in several components of the electric vehicle chain (plug and roaming standards, batteries, etc) contributed to the failure of the solution. However, this cannot be considered as a purely technology-related issue, but rather as a case where a failure in integrating existing and well-established technology occurred due to a **lack of appropriate planning.**

Furthermore, the solution was characterised by a **lack of motivation from the citizenry,** which limited its spread. It thus ended up into an overly narrow project that, once political support stopped providing resources, was not backed by any real intention on the part of users to support it.

Several other projects focused on achieving a quasi-utopian long-term vision with limited consideration on the need to involve the citizenry in defining it. This is the case of most projects, such as the electric bus network in Rome, or the smart grid in Boulder. The lack of attention to actual citizenry needs was most perceived where the involvement of the users in the SCC solution was most required. This is the case of new cities being developed as the cases of Tianjin and the Suzhou Industrial Park, which failed to attract their final users.

Key findings:
Lessons learnt on failure of SCC integrated solutions

The joint analysis of the case studies, the literature and the opinions of stakeholders made it possible to identify certain commonalities that unsuccessful integrating SCC solutions shared. These are related to two main dimensions:

- **Inability of solutions to integrate with the urban dimensions** that their success depend on. In particular, this risky element has been recognised when designing and developing solutions without the sufficient involvement of the citizenry and – in several cases – of the political-institutional authorities. This involvement has rarely been constant throughout the project duration; most often it has been focused on the initial phases only.
- Despite a strong vision on how SCC solutions had to evolve and integrate with the urban environment in the long-term, a common **inability to translate the long-term orientation into a coherent action plan** strongly contributed to limit the chances of success of the cases analysed.

The technological dimension was hardly an issue at all.

What is seen when dealing with social phenomena like cities (whether or not they are "smart") is necessarily impacted by them being complex phenomena. As such, they consist of many autonomous, diverse components that are highly interconnected and interdependent. Not understanding the importance of this interdependence has been the reason that ultimately lead the analysed SCC solutions to fail.

The underestimation of the role of interconnections is typical of the traditional approach to analysing complex phenomena: this entails breaking down the object of the analysis into its smallest components and focusing on each of them, as if they

were separate entities. Whether or not it happens voluntarily, this approach has led planners and investors to focus on one specific aspect of the analysed SCC solutions (usually the technology) and **neglect the interrelations that the users of this technology have in creating a functioning system** (at single user level and – to a lesser extent – at community level).

Conversely, this analysis suggests following **a holistic approach to defining the complex phenomena** (i.e. the SCC solutions), and therefore starting from the idea that the success necessarily comes from integrating technology, institutions and, most of all, final users. Indeed, final users are those who have the strongest interconnections with the technology deployed and with the system in general.

While it is key to consider that the interaction with the technology necessarily needs to account for the role played by users, it is at least as important to consider the centrality of the citizenry when conceiving and planning integrated SCC solutions**.**

Cities develop as social entities, which generate an order within which citizens live and carry out their activities. **Changes in the stability that citizens accept and belong to must be supported by the population.** Otherwise, they will be neglected, abandoned or even fought against. Citizens accept the change – or even call for it – when they feel they require a different allocation of resources, a different organisation or set of rules, or when they feel that their needs are unsatisfied. However, in the case of smart cities, this is seldom the case.

In particular, the cases of cities being built ex-novo appear far from being solutions to respond to the needs of citizens for better conditions, organisations, etc. These perfect cities may not be responding to the needs of the people that should live in them, but rather to abstract concepts of what people should need. Eventually, they fail.

Key findings:
Possible approaches to avoid the failure of SCC solutions

- **Simulations:** These can be especially useful to determine how the system reacts to the different stimuli produced by users' interaction. User interaction with the technology is a necessary enabler of integrated SCC solutions. Coherently, the use of simulation models like agent-based models (ABSs) and individual-based models (IBMs) to account for the different scenarios depending on user behaviour can help to identify and prevent situations leading to failure.
- **User Experience (UX):** Also in relation to the central role of humans in SCC systems, UX enables the assessment of what citizens need and what they experience when dealing with any specific SCC solution. As they would determine its success or failure, understanding how and if their needs are (over-) satisfied or neglected by solutions is essential.
- **Round-tables:** By definition, integrated SCC solutions involve different aspects of the urban dimension, which are to be carefully planned and accounted for by experts. What appears to be often lacking is the inclusion of experts such as urban planners, sociologists, transport experts, psychologists and ICT engineers, at least in the planning phase, when identifying the main risks and success factors.

3. Analysis of the potential roll out of integrated SCC solutions

When looking at Europe's urban innovation strategies and initiatives (which Smart Cities and Communities are a large share of), what emerges is the need to invest in solutions that can be implemented at a wide enough scale for them to have a positive effect on citizens. For SCC solutions to achieve this result, they must upgrade from local, pilot experiments and become large, highly replicated projects.

The search for innovative SCC solutions evolving into full-scale projects has become a hot topic both in Europe[21] and overseas.[22] Indeed, this a natural consequence of the significant investments that have been made to constantly develop new projects (which are at an R&D and demonstration stage) and to support their transition into a full deployment phase.

To provide a comprehensive picture on the subject, this section will:

- Report on the outcome of the analysis on replicating and scaling integrated SCC solutions;
- Carry out a macro-level analysis of the the roll-out potential for SCC solutions, with a specific focus on the case of China and its potential partnership opportunities with the EU.

3.1 Replicability and scalability of integrated SCC solutions

3.1.1. Dimensions and definitions

The academic world generally agrees that the roll-out of innovative solutions – no matter how they are defined, as long as they are differentiated from traditional ones – needs to comply with two requirements: scalability and replicability:[23] [24] [25] [26]

- **Scalability** refers to the possibility of increasing the size of a project without compromising its efficiency and effectiveness. Scalability is the characteristic that projects must have to evolve from experiments to full-scale urban projects.
- **Replicability** refers to the possibility of applying the same solution/technology to achieve the same objective in a different city. Replicability may be in terms of both scale (i.e. the extent to which a solution can adapt to the different configurations of the environment) or a specific case (i.e. whether the solution can be replicated in a specific, different context).

[21] Jiménez, M.S.; Onyeji, I.; Colta, A.; Papaioannou, I.; Mengolini, A.; Alecu, C.; Maschio, I. 2012. *Smart Grid Projects in Europe: Lessons Learned and Current Developments*; Publications Office: Luxembourg, Luxembourg

[22] U.S. Department of Energy. 2012. *Leading the Nation in Clean Energy Deployment;* U.S. Department of Energy: Washington, DC, USA

[23] Food and Agriculture Organisation of the United Nations 2014 Evidence-based assessment of the sustainability and replicability of integrated food-energy systems, FAO Rome 2014.

[24] Yaneer Bar-Yam, 2011 *Conepts: Scale* New England Complex System Institute

[25] Sridhar P. and Madni A. M. 2009 Scalability and Performance Issues in Deeply Embedded Sensors Systems *International Journal on Smart Sensing and Intelligent Systems,* vol. 2, n.1, March 2009.

[26] May K. *et al.*2015 Improving Scalability and Replicability of Smart Grid Projects *23rd International Conference on Electricity Distribution*

There is no single way to address SCC solutions' scalability and replicability. However, academics seem to agree on four main dimensions shaping the roll-out potential of solutions: **the technology dimension; the political dimension; the social/cultural dimension and the economic dimension.**[27] These can be assessed depending on whether – from a project management perspective – these depend on endogenous factors, exogenous factors or something in between.

There are various elements impacting scalability and replicabiliy. The main ones identified by experts and researchers in the field are listed in Table 5 below.

Table 5: Replicability and scalability indicators

Dimensions	Scalability	Replicability
Technology	▪ Modularity; ▪ Maturity of technology; ▪ Netting support;[28] ▪ Trialability;[29] ▪ Interface.	▪ Standardisation of the technology; ▪ Maturity of technology; ▪ Interoperability; ▪ Netting support.
Socio-cultural	▪ Social compatibility/ consent; ▪ Interaction.	▪ Social compatibility/ acceptance; ▪ Market demand/ Response to citizenry needs; ▪ IT Literacy level.
Political-Institutional	▪ Regulatory environment; ▪ Institutional support. ▪ Ecosystem	▪ Need to change in rules and regulations; ▪ Regulatory environment; ▪ Institutional support. ▪ Ecosystem
Economic/ Business	▪ Possibility to achieve economies of scale; ▪ Profitability.	▪ Macro-economic factors; ▪ Business model; ▪ Market design.

Source: Consortium elaboration of May et al. 2015, Jiménez et al. 2012, Bosch et al. 2016[30]*.*

[27] see e.g. May K. *et al.*2015 Improving Scalability and Replicability of Smart Grid Projects *23rd International Conference on Electricity Distribution*

[28] Throughout the document, with the term "netting support" it is meant the technological infrastructure and related actors, which support the functioning of a given technology.

[29] As defined by Bosh et al in the CITYkeys study, trialability refers to the possibility of a solution to be experimented on a small scale before being expanded to full scale, without compromising its key features.

[30] Bosh P., Jongeneel S., Rovers V. Neumann H., Airaksinen M. Huovila A. 2016 CITYkeys Deliverable 1.4 Smart-city KPIs and related methodology – final

Technology is hardly ever a limiting factor to the replication of a solution, as increasing globalisation creates homogeneity in terms of technological developments across countries.[31] What matters for the roll-out of SCC solutions is the presence (or absence) of support services, i.e. the set of ancillary technologies, agents, systems, etc. that allow a certain technology to function in a given environment.

As is also outlined in sub-section 2.2.4, **the socio-cultural dimension reflects the fact that projects must be accepted by the population.** To the extent the interaction with citizens and communities is required, SCC solutions have to respond to the population's needs. Paying only limited attention to the socio-cultural differences across countries, cities and districts prevents the successful replication of solutions. This becomes even more relevant when citizens become involved in projects and/or strategies.[32] [33] [34]

The political-institutional dimension refers to the regulatory environment and to the institutional support.[35] Where the regulatory environment is simple and does not represent a limiting factor, the project is more likely to scale up and to be replicated elsewhere. At the same time, the simpler the project, the less it is expected to interact with the political-institutional environment, therefore making it more adaptable.

Finally, **the economic/business dimension relates to how the solution is configured, shaped and developed from a project management perspective.** Therefore, it has an impact on its ability to easily scale up and to interact with different environments without compromising profitability.

The analysis of these dimensions also requires the examination of the interfaces between the solution and the environment, as well as of the internal ability of the solution to adapt to a different size and/or context. As a result, it can be assumed that **the higher the complexity of a project, the higher the required interactions at technological, political-institutional, socio-cultural and economic level.** This relates to both agents that participate in a solution and those that interact with it (i.e. administrators, politicians, citizenry, etc).

As agents interact, they gradually achieve agreement on the desired solutions. In this way, solutions are backed and aided by cooperation.

3.1.2. Analysis

Although the population's involvement shapes socio-cultural complexity, it should be analysed as a separate variable. Indeed, the involvement of the citizenry determines how relevant the socio-cultural dimension is. In other words, a solution that does not involve any action from the population (i.e. "fully automated solution") is more likely to not encounter any culture-related roll-out issue. However, integrated SCC solutions

[31] Archibugi D. and Pietrobelli C. 2003 The globalisation of technology and its implications for developing countries Windows of opportunity or further burden?; Technological Forecasting & Social Change 70 (2003) 861 – 883

[32] Hofstede, Geert: "The Cultural Relativity of Organizational Practices and Theories", Journal of International Business Studies, Fall 1983

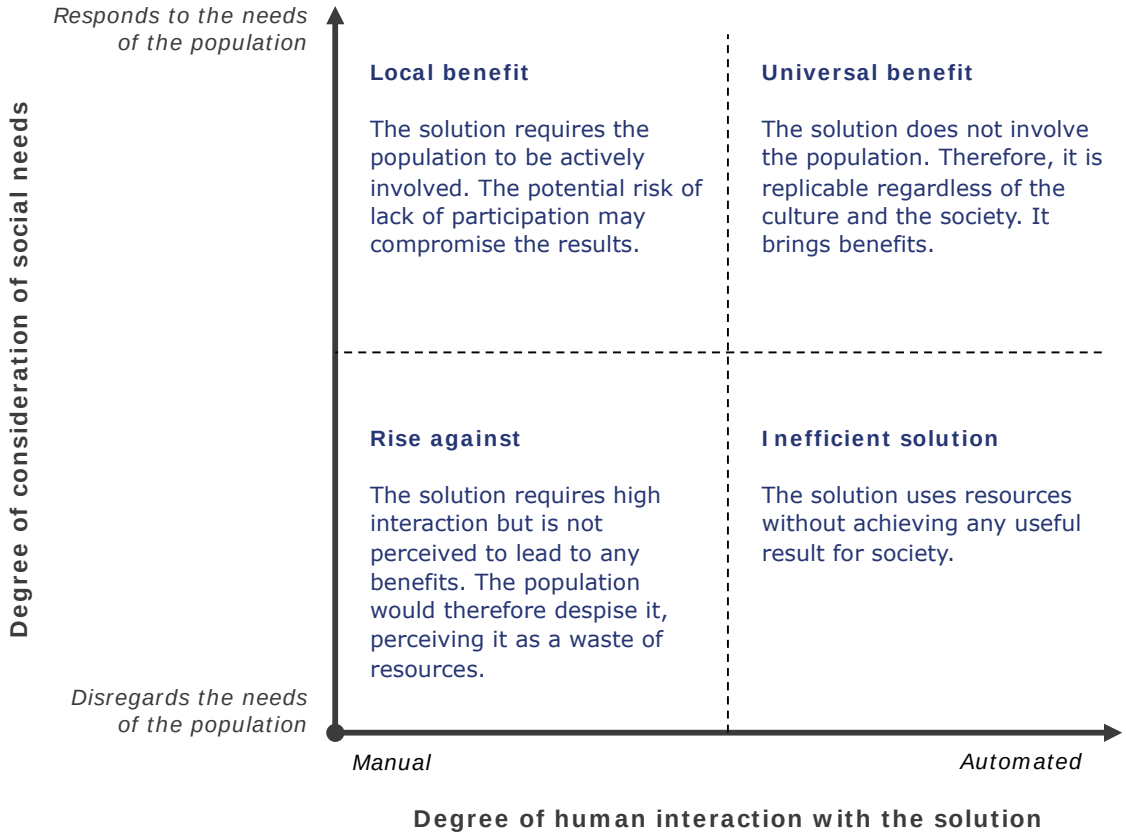
[33] Hofstede, Geert: "Cultural Constraints in Management Theories", Academy of Management Executives, 1993,Vol.7, no. 1

[34] Holden, Nigel: "Why Marketers Need a New Concept of Culture for the Global Knowledge Economy", International Marketing Review, 2004, 21, 6

[35] Please consider that the institutional support does not refer to the financial support provided with public resources, but to the administrative and regulatory support.

are hardly ever fully automated. **When the involvement of the population is required, the more this interaction is focused on shaping the solution's design and development, the higher the chance of replicability success.**

Figure 13: Matrix of user interaction versus response to population needs of solutions



Source: Our elaboration

While the socio-cultural dimension may represent a limiting factor when not sufficiently accounted for, it can also become an enabler in those cases where the interest of the society for SCC solutions is such that it defines a favourable ecosystem. This then requires the institutional-political dimension to follow, as the citizenry would require the political leadership to take concrete steps towards sustainability and smart solutions.

Considering the approach described, the assessment of the potential roll-out of a solution is determined by the criteria outlined in Table 6 below. For the sake of simplicity, roll-out potential is considered as an indicator of both scalability and replicability.

Table 6: Assessment criteria for roll-out potential

Dimension	Roll-out potential evaluation criteria
Technology	▪ Is the technology well-established? ▪ Is the technology standardized and/or interoperable with different IT systems? ▪ How big and complex is the netting support required to sustain the project from a technological perspective?
Socio-cultural	▪ How relevant is the involvement of the society for the solution to work? ▪ Is the solution responding to a pressing need (general perspective)? ▪ Would the solution require a radical change in the users' habit?
Political-institutional	▪ Is the project requiring strong political commitment to be developed (general perspective)? ▪ Would the administration need to be directly involved?
Economic/ Business	▪ Is the project able to achieve economies of scale if its size is increased? ▪ Can the project benefit economically from international implementation (e.g. standardization of technology/ equipment/ solutions, etc)? ▪ Is the business model flexible to changes?

It should be noted that responding to these criteria would not determine how a specific integrated SCC solution would succeed when rolled-out in a specific environment. Instead, this type of assessment would provide insight on how probable it is that the solution could be adapted to diversified environments.

To determine the roll-out potential in a specific environment, additional analysis on how a SCC solution relates with the specificities of the local culture, infrastructure and institutional context is required. An example of a toolkit that could be used for this is provided in Annex III.

So far, it has been recognised that the environment is key for the successful roll-out (and thus replicability) of integrated SCC solutions. Coherently, the role of agents active in making this environment more SCC-friendly can greatly support the solutions' roll-out. Indeed, in certain cases, industry, academia, institutional players, support organisations, etc, collaborate, creating an ecosystem[36] that facilitates the development of integrated SCC solutions. These ecosystems act as interfaces between the projects and the social/ political-institutional/ economic contexts, contributing to the creation of the right conditions for smart solutions to be successfully implemented, concentrating:

- **Financial resources:** Financiers (i.e. venture capitalists, etc), institutions granting subsidies, etc;
- **Human and technical resources:** A talent pool of knowledge professionals, universities and research institutes, etc;

[36] There is no unique definition of what an ecosystem is. Within this document the term is referred to the network of agents or hubs supporting the development and the operation of SCC solutions. The definition is hereby recalled from Bahrami and Evans, who describe it as "consisting of interdependent institutions, social norms, and communities that create an environment encouraging the evolution of existing firms and, especially, the creation of new firms".

- **A sophisticated service infrastructure,** which includes:
    - Administrative/ institutional entities;
    - Organisations and initiatives by both public and/or private entities;
- **Citizens and communities,** which represent the customers, lead-users, and early adopters of solutions/products.

The box below presents the case of **umbrella organisations,** which are strongly active in ensuring favourable ecosystems for SCC solutions to proliferate.

Organisations shaping favourable ecosystems

As opposed to more traditional businesses, the roll-out of SCC solutions generally requires a stronger commitment at public and private level and can benefit from the role played by a number of key actors acting as facilitators, enablers or supporting coordination bodies. In this context, the so-called **umbrella organisations and initiatives**[(a)] play an important role. Cooperation and collaboration – both internal and external – are key enablers for SCC solutions to be deployed successfully. In more general terms, these organisations enable:[(b)]

- **Organisational synergies,** which relate to collaboration among actors in the social, cultural and political dimensions, e.g. joint training programmes, knowledge sharing practices, as well as joint participation in higher coordination bodies.
- **Policy synergies,** which relate to collaboration among actors in the political-institutional dimension, e.g. joint membership to thematic groups/committees, promotion of country level goals, sharing of organisational strategies.
- **Operational synergies,** which relate to collaboration among actors in the economic/ business dimension, e.g. joint research activities, carrying out projects together to be more effective, co-organisation of relevant events, and collaboration in writing papers.

Overall, collaboration activities contribute to strengthening the institutional and operational foundations supporting the roll-out of SCC solutions.

To effectively achieve their aim, umbrella organisations and key SCC supporting actors must be **attractive** (in terms of the degree to which organisations are interesting for other entities in related businesses to enter into partnership with), and the entities within the environment must be **aware** of the organisations' existence and activities.[(c)] Figure 14 on the next page shows the results of the research on main SCC supporting actors in terms of level of cooperation, presented as a comparison between the attractiveness and awareness dimensions presented against the attractiveness and awareness dimension. According to the analysis carried out, organisations can be clustered into:

- **Most well-known and attractive organisations** (high awareness, high synergy attractiveness, many cooperation activities in place): This category groups actors recognised as the most well-known and attractive in terms of synergy potential (e.g. Eurocities, Iclei, Polis, Covenant of Mayors, EIP-SCC). They are most helpful in shaping the supporting environment of SCC solutions.
- **Organisations with good potential** (lower awareness, high synergy attractiveness): These organisations have been rated with good levels of synergy attractiveness, even though they are less well-known. Other actors who are aware of them appreciate their work and would like to cooperate with them (e.g. Concerto, Epomm, EIT).
- **Single player organisations** (lower awareness, lower synergy attractiveness): This cluster includes organisations that are less known, and which are regarded as slightly less attractive for creating partnerships. As depicted in Figure 14, there seems to be a direct correlation between the ability of organisations to support cooperation – and, ultimately, SCC roll-out – and the degree to which such organisations are known and attractive for stakeholders to partner with.

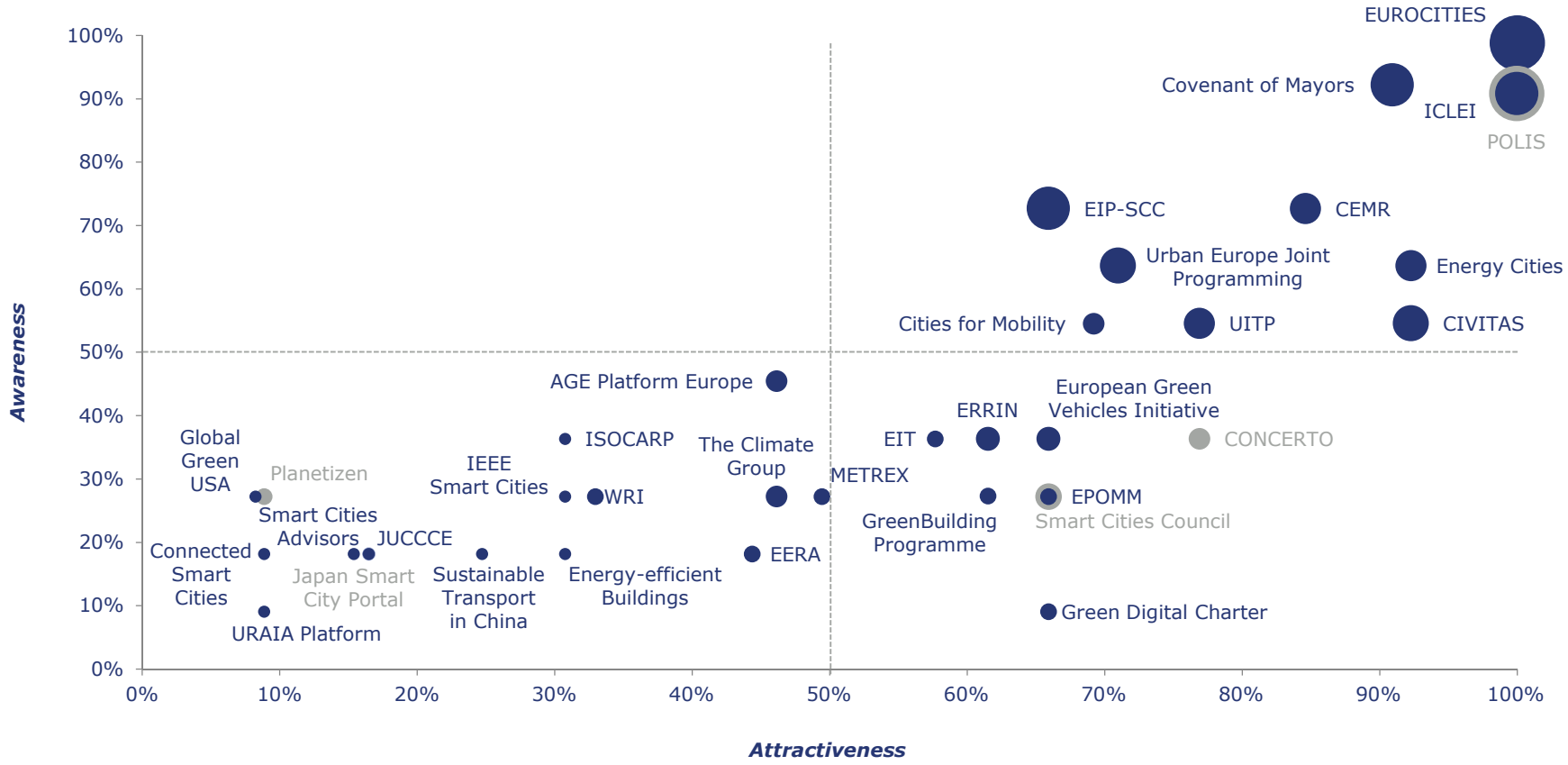
Coherently, SCC roll-out is expected to be most favoured where organisations increase communication efforts, and are characterised by a higher number of links with other organisations/ SCC players.

(a) The term "umbrella organisations" refers to associations of institutions, business players and – more generally – entities that work together to coordinate activities and pool resources.

(b) European Commission, Directorate-General for Regional and Urban policy REGIO DG 02 (2014). *Enabling synergies between European Structural and Investment Funds, Horizon 2020 and other research, innovation and competitiveness-related Union programmes.*

(c) Data on both of these variables was gathered based on the scores provided by the web survey respondents, who were asked to evaluate the level of awareness and potential collaboration in relation to the main organisations/initiatives analysed and listed in the questionnaire. All the scores have been harmonised on a scale from 0 to 100, in order to make organisations comparable.

Figure 14: Main actors' positioning with respect to their level of awareness and the potential for synergies



Source: Our elaboration based on survey results

Note:

The size of the bubbles represents the actual cooperation level, rated according by the respondents.
The sole purpose of the colours is to distinguish one organisation/initiative from the other.

3.1.3. Evidence of roll-out potential across case study examples of integrated SCC solutions

During the analysis of the 10 case studies, an assessment of how projects responded to each dimension was carried out, using the set of criteria listed in Table 6 above.

The analysis shows that **there is no single element that stands out above the others as an obstacle or an enabler to the roll-out of SCC solutions.** Rather, it is the joint action of different elements – categorised in different dimension – that limits or catalyses the ability of a project to be successfully implemented at a higher scale or in different contexts (see Annex II).

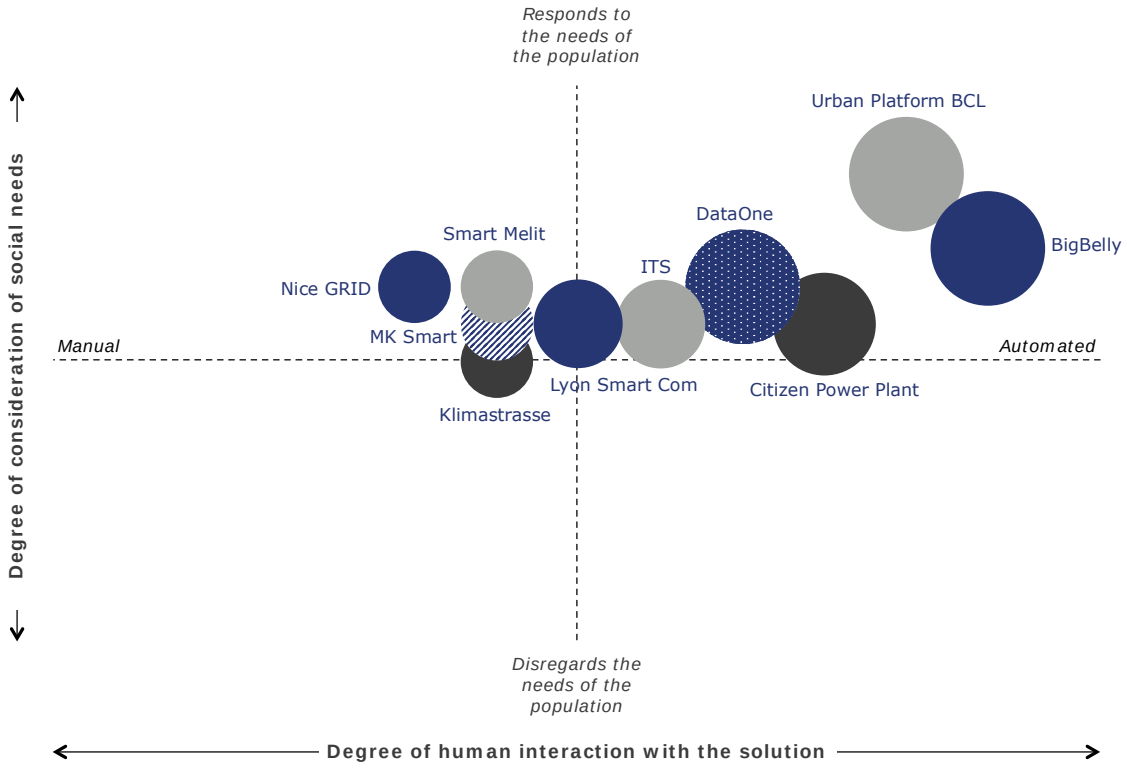
The analysis also shows that the presence of an ecosystem that can bring together political institutions, investors, industry players and – to the extent required –citizens, facilitates the implementation of projects that have been successful elsewhere.

A key element that is also supported extensively in the literature is that **an exclusive focus on technology is not sufficient to guarantee the effectiveness of SCC solutions:** in the past, the absence of technology was used as an excuse not to enforce certain types of policies (e.g. congestion charges); however even though technologies have developed since then, certain policies – for instance, environmental sustainability ones – are not always applied because of political and strategic reasons.

What has emerged from the research is **the strategic role of policies, available alternatives and human behaviour:** there is the need for a human component in smart technologies to effectively improve cities as well as the quality of life of their inhabitants.

As described in the previous sub-sections and as depicted in the matrix in Figure 13 above, solutions may either be useful to responding to citizens' needs, or they will be perceived as failing to do so. This difference identifies how – for the citizenry – the solution represents an efficient or inefficient use of resources. At the same time, citizens can either be directly involved in the solution or they can be the passive beneficiaries. In the first case, behavioural aspects and cultural aspects would strongly contribute to shaping the roll-out potential of a solution. In Figure 15 below, the 10 best practice case studies are mapped onto the matrix developed in Figure 13.

Figure 15: SCC solution case studies and citizen involvement



Source: Our elaboration

Note:

The size of the bubbles indicates the roll-out potential.
The sole purpose of the colours/patterns is to distinguish one case from the other.

Study findings also show that **the presence of a Smart City vision, which contextualises the deployment of a specific solution within an overall smart framework, is generally connected to positive results.** An example is represented by the Smart City vision of Stockholm, which has been developed by the municipality with the aim of committing all the departments and companies to work towards improving the levels of smartness in the city through their activities and operations. An application of this vision is represented by the public-private partnership established for the building of the Royal Seaport of Stockholm, which features major technology players successfully collaborating with academia and the City Council for the development of the project.

A centralised public governance structure is often a positive factor, as public entities are best able to adapt the institutional and political dimension to facilitate the development of SCC solution. However, Smart City solutions do not all follow the same implementation path (e.g. from city vision to effective implementation). SCC solutions can also be implemented following a "bottom-up" approach by individual commercial agents, and then later be integrated into a wider vision. However, these **bottom-up solutions require a business-friendly environment and a stable and trustworthy legal and regulatory framework,** which are exogenous to the solutions' promoters.

An effective route to success for SCC solutions is to begin by testing the project on small groups of citizens and stakeholders, later adapting it and then scaling it up to the whole city. This also makes it possible to concentrate the involvement of citizens, making sure that they are aware of the benefits it can deliver.

While **demonstration projects** seem to be a good tool to cope with the risk of project failure (which would otherwise be an obstacle to public administration bodies wanting to endorse innovative Smart Cities solutions) they also risk becoming an endless test, which never reach operational status. The safe area represented by research projects does not have to lead to endless demonstrators. Indeed, **staying at demonstration phase is in itself a form of failure, as it usually means that the specific solution has not become economically viable, and will continue being based on different small projects without scaling to the operational phase.** Nevertheless, it should also be noted that demonstration projects are useful to show quick gains and encourage stakeholders to take action.

3.2. The potential of key Smart City target markets for roll-out: A better partnership with China

3.2.1. Global urban challenges and trends

In order to understand the target markets for SCC solutions, it is helpful to start from the **greatest regional urban challenges** as identified by the World Economic Forum through a survey carried out end of 2015, focusing on urban services. These challenges (listed in Figure 16 below) contribute to shaping the demand for Smart City solutions, as each region has different priorities and will therefore be concentrating more resources on supporting solutions addressing those needs.

Figure 16: Greatest regional urban challenges

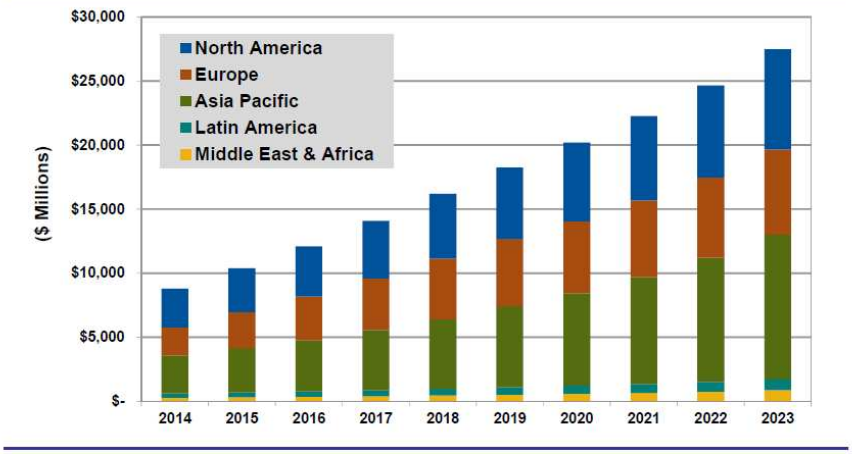
Source: World Economic Forum, Shaping the Future of Urban Development & Series Initiative, Global Survey on Urban Services (Oct.-Dec. 2015)

As already stated at various points in this report, and also according to IDC,[37] **intelligent system integration is a key driver of value in the Smart City roadmap;** the biggest market players – such as IBM, CISCO, Schneider Electric, Siemens and Microsoft – are gaining their competitive advantage thanks to their ability to provide integrated, tailor-made solutions.

However, this roadmap to Smart City implementation and, consequently, the speed of adoption of the numerous solutions, varies widely across regions, depending greatly on the availability of resources dedicated to support actions within a given domain. Furthermore, **integrated solutions embedding diverse components are also usually characterised by different technology maturity levels** of each of these elements, again possibly varying through regions.

Grand View Research estimates that, up until 2013-2014, North America accounted for the largest market share of Smart City solutions.[38] More recently, **the Asia Pacific region – particularly China and India – has seen an expansion in the demand for Smart City solutions due to increasing environmental and energy instability.** The Smart Cities market in Europe is expected to be promising for global market growth through the forecast period, owing to increasing investments in infrastructure to improve public facilities, with Horizon 2020 goals driving many cities to adopt a Smart City strategy to accommodate local climate goals. **Increased demand for smart transport and energy management in Europe has considerably driven regional market growth** (Grand View Research, 2014).

Figure 17: Smart City Technologies, Annual Revenue per Region



Source: Navigant Research, 2014

Gartner indicates that the Asia Pacific region, where the city population is often in the several millions, applies smarter operations and governance to build basic city infrastructure and to connect them with intelligent IT systems for improved service and maintenance environments. Navigant Research data on Smart City technology market revenues confirms the important role that Asian countries have recently

[37] IDC Government Insights 2015, *Methods and practices: IDC Government Insights' Worldwide Smart city Taxonomy*.

[38] Grand View Research 2014, Smart Cities Market Analysis by Application (Smart Energy Management, Smart Security, Industrial Automation, Smart Healthcare, Smart Buildings, Smart Homes, Smart Transportation) and Segment Forecasts to 2020

started to play in boosting demand, followed by North America, and then by Europe (see Figure 17 above).

In terms of regional market trends in the next decade, Navigant Research foresees a constant increase in market revenues for that Asia Pacific, which will continue leading global aggregate demand. Indeed, the revenues generated in the sector by the Asia-Pacific market alone will be worth $11.3 Bln annually by 2023. **Europe has also started investing more in SCC technologies, and will spend more than $5 Bln in 2023, accounting for nearly 18% of the overall global market revenues.**

SCC solution markets are very fragmented, with each city requiring a customized strategy and every Smart City project targeting specific needs coming from the city's individual infrastructure and priorities. Therefore, **companies that cover a wide range of Smart City sectors, products and technologies are best equipped to become distinguished market players,** as they can offer pre-packaged bundled solutions or provide ad-hoc solutions based on a city's key priority, be it smart transportation, energy or infrastructure.

However, despite the huge advantage experienced by these leading market players, **the competition in this market is still lively thanks to fast-paced growth, technological evolution and high fragmentation, which allows smaller and more specialised companies to compete.** This is very much a composite market, where many industries co-exist and that varies widely across regions, based on urbanisation patterns, environmental challenges and region-specific government priorities, sustained by the significant estimated progression pace foreseen for the coming years.

It is widely acknowledged that the Asia-Pacific area – in particular China – will experience a significant growth in the next decade, becoming the leading region driving the market for Smart City solutions and technologies. For this reason, particular attention has been devoted to exploring the Chinese Smart City context and market – a growing potential source of opportunities for EU businesses – focusing specifically on three different levels of EU-China collaboration: industrial, research and policy-dialogues.[39]

3.2.2. Challenges specific to EU-China collaboration

China's new urbanisation development strategy has attracted much attention worldwide. Approximately 300 Mln Chinese rural residents will become city dwellers in the next 15 years and they will find jobs and make their living in cities, which will likely be a key driver for world economic growth in this century. In the draft 13th Five-Year-Plan (2016-2020), China has set clear management goals for economic efficiency, environmental protection, clean energy, utilities management and living security systems for its residents. Implementation of the Plan will potentially attract broader participation from global investors as China's economy continues to grow.

Having established the strategic importance of the Chinese market for European businesses in the field of SCCs, some specific challenges have been identified through

[39] Past and current bilateral collaboration on SCC-related topics between China and EU have been explored as a way to evaluate possible barriers, needs and interoperability. In doing so, ten successful EU-China collaboration initiatives have been selected, analysed and documented, engaging relevant stakeholders via a standardised survey as well as through a number of single interviews, carried out in the Oct-Dec 2015 period.

a number of EU-China collaboration initiatives examined for the purpose of this study. Raising awareness on these challenges, as well as the lessons learned and ways to overcome them, provides valuable inputs to facilitate future collaborations and support policy-makers in their attempt to foster new openings for EU companies in the Chinese Smart City market. The following paragraphs describe the main challenges identified.

Cross-cultural awareness and sensitivity

First of all, both regions can look back on a history of thousands of years and, consequently, ways of doing business have been well established for a long time. Hence, for Europeans it is essential to develop insights into China's business culture and social etiquette to avoid misunderstandings. As an example, oral and (sometimes) written agreements may not be interpreted as binding on the Chinese side. Silences in correspondence and steps backward in collaborations are also not uncommon in China. Equally, Chinese partners have observed an unwillingness to cooperate and share information after an initial agreement to do so from Europeans. The bottom line is that **patience on both sides is a prerequisite for a smooth and successful cooperation.** Relationship building takes time in China and engaging with the Chinese in a purely commercial way is difficult.

Chinese government structure

Also in relation to cultural differences, especially when dealing with public bodies, the centralization of the government of China has to be considered. Additionally, the concept of public versus private institutions has different meanings in Europe and in China. **Accounting for the Chinese government's structure is essential in business collaborations with Europe and initiating Smart City projects requires the involvement of Chinese government officials.** In this sense, engaging representatives of Chinese cities has often proven to be insufficient, as decisions are made at provincial or central government level. Therefore, it is important to understand the Chinese government structure and decision-making process in order to ensure bilateral collaborations are fruitful. The Chinese government also plays a dominant role in Chinese business participation in Smart City development in China. This governmental presence can especially be felt in the field of Smart Cities, as city planners (employed by public bodies) play an important role. This means that **city planners' expertise and involvement from the very early stages are crucial for the success of a project.**

Funding

The government structure of both regions inevitably influences funding possibilities. For example, funding for Chinese companies is especially problematic and is often why cooperation with EU-based projects or companies – even though highly desired – cannot be carried out at all or as fast as one would hope. Likewise, on the European side, funding may also pose difficulties. While there are vast funding opportunities, e.g. the Horizon 2020 programme for research and innovation, access to public funding is highly competitive and also constitutes an obstacle on the European side. Additionally, the study has raised the issue that European funding for EU-China collaborations seems to benefit China more in the long term. Indeed, in the framework

of the analysed collaboration initiatives, European companies have seldom been established in China, whereas Chinese companies have started implementing their Smart City solutions in the EU. This highlights **the challenge of making sure EU funds actually help EU companies break into the Chinese Smart Cities market.**

Replication potential and scaling-up

As has been shown, the premises for EU-China collaborations are quite challenging. When it comes to the actual uptake and replication of European projects in China, the picture becomes even more complex. Examined initiatives show that, generally, **the replication potential is significant and viewed as the most important output of the collaboration.** Overall, it has been noticed that collaboration initiatives are progressing at a different pace, usually starting from a policy dialogue phase and progressively turning into industrial cooperation. As of now, the studied collaborations showed that Chinese companies have 'hit' the EU ground, while EU companies are still trying to find their way into the Chinese Smart Cities market. In parallel, Chinese companies involved in industrial projects in the EU can use the knowledge gained through their European experience back in China, and decrease the need for European counterparts over there. It is crucial that both Europe and China benefit from cooperation and that there is always reciprocity when knowledge is shared and goods are exchanged.

Legal and economic frameworks

Once the collaboration initiatives are over, **it is often unclear to EU partners what the legal and economic implications are regarding the future use of project outputs in China.** For example, information on intellectual property rights and copyright issues appears to be lacking to a large extent in the studied collaboration initiatives. EU companies would need support on these issues, especially if they have formally agreed to co-create and implement Smart City solutions in China.

3.2.3. Opportunities linked to EU-China collaboration

Although there are a number of challenges that need to be overcome, they may also be turned into new opportunities. The studied collaborations feature some of these opportunities, in particular with respect to the Chinese Smart Cities market and research landscape.

Fields of cooperation

First of all, the study has shown that **China is actually in synergy with the main trends of the EU.** Indeed, China has adopted similar terminologies, definitions and goals (cf. Smart Cities, Smart Communities, Eco-Cities). Furthermore, the areas for cooperation – mainly mobility, energy and ICT – are complementary with EU interests. Therefore, with this mutual understanding, target areas can be identified where both regions want to invest in future cooperation projects, e.g. urban planning, energy, smart traffic, smart mobility, and the environment.

Standards

Another point to be raised is **the importance of standards, as well as the favouring of open source solutions and interoperability options.** The majority of survey respondents from both the EU and China acknowledged interoperability as a strategic driver. Open source solutions are also recommended, due to the fact that Chinese parties will give preference to this option over the uptake of European or North American products. The Chinese government has pursued an open source policy, e.g. favouring Linux over Microsoft. The development of shared standards between the EU and China seems especially promising. Shared standards in innovative and only partially regulated areas such as Smart Cities, would give a head start to both the EU and China.

Funding mechanisms

Funding mechanisms do not only pose a challenge (see previous section) but also an opportunity. Innovative mechanisms such as **Public-Private Partnerships (PPPs)** may offer interesting prospects for rolling out Smart City solutions in China, also because this kind of funding model would mean **better risk-sharing between the two regions and public and private entities.**

3.2.4. Harnessing the power of a Smart City EU-China partnership

Both the EU and the Chinese government have included Smart Cities as high priority in their strategic 2020 plans. Therefore, it is expected that there will be many opportunities for funding joint initiatives in the coming years. This gives EU organisations a window for sustaining the initiated collaborations and establishing themselves in China; this is particularly relevant for EU companies, which can use their advanced knowledge in sustainable urban planning to enter the market in China. Indeed, such profiles are highly requested in China to support Smart City development in an integrated way.

With the Chinese Smart City market's huge potential in mind, the main area of concern for Europe is to know how to stay into it while generating profit. Often, collaboration initiatives turn out to be of little profit for European companies; it is therefore recommended that **European companies enter into agreements with China where they can be assured of being involved in a portfolio of operational projects** – ideally with a specific budget and timeline for each project, and a total number of cities to serve as clients. In exchange for these guaranteed contracts over a period of time, European companies can pledge to train a portion of the Chinese staff and work alongside them as a way to transfer knowledge to China.

Furthermore, it is advisable to **target new cities in rural China.** Indeed, there is already an influx of investment within Chinese megacities, and the government needs a way to reverse the trend of overcrowding in these cities. In other words, attracting investment elsewhere would be desirable.

4. Conclusions

Technological progress gives rise to new approaches to the management and the development of cities (and the districts within them). Furthermore, **growing urbanisation and the increased demand for efficiency in the provision of services is calling for more efficient urban management solutions**. Smart Cities therefore emerge as a strategy to tackle resource management and – more generally – better manage cities' needs.

Smart City solutions apply digital technologies to address social, environmental and economic goals. A distinctive feature of SCC solutions is the ability to measure (and internalise) the value created, responding to the modern population's needs (i.e. positive externalities). Consequently, business models are adapting.

Governance of SCC solutions (and of the cities managing them) has been changing towards a more dynamic and open architecture. **Silo-based approaches are being replaced by cooperative governance systems.** Similarly, an unprecedented involvement of private parties managing solutions together with public entities is being encountered.

The possibility to measure and monetize positive externalities from investing in smart infrastructure enables a radical change in the funding and financing opportunities. Budgetary constraints are forcing public authorities to look for alternative sources of capital to support the development of urban solutions. Private involvement through PPPs is increasingly used to raise finance (in particular in larger, more standardised, energy provision contracts). However, most innovative approaches arise from financing solutions, which are either being supported by public funding (e.g. EFSI, InnovFin and Financial Instruments), financial products provided by commercial banks, or specific programmes supported by development banks or similar institutions (e.g. EIB).

Further opportunities are yet to be consolidated in the new investment environment. Among the most promising opportunities, **investment platforms ensure access to finance to small-size promoters involved in SCC solutions**. These are co-investment arrangements – which can be supported by EFSI – that aim to reduce transaction costs and provide for more efficient risk allocation through the aggregation of thematic-focus (or geographic-focus) investments.

New opportunities require new strategies and models to design and develop SCC solutions. The public administration can involve several service providers and stimulate innovation through public procurement. Furthermore, opening up procurement mechanisms to make them accessible to younger, smaller businesses allows cities to access a wider range of new ideas and technology than traditional market procurement. What is however demonstrated is that **there is no best procurement model; new business models must adapt to procurement practices, and each solution requires careful consideration on how to involve service providers.**

The most distinctive feature of SCC technology is the wider involvement of stakeholders, and technology users in particular. **Having citizens and communities participate in SCC solutions enables the best match between the demand and supply of services, ultimately determining their success.** However, not all SCC

solutions share a significant involvement of citizens. This has been demonstrated as one of the most distinctive attributes of failing SCC solutions. Indeed, **although technology makes it possible for SCC solutions to be developed, it is the interaction of this technology with users that determines their success.**

Innovative technologies in urban investments have the potential to reshape the way resources are exploited to provide services to our population. For this to happen, it is necessary for solutions to be implemented at a wide scale. Again, when considering the roll out of SCC solutions (either in different geographical contexts or at different scales) technology is hardly ever the limiting factor. What is more relevant is the involvement of the population and the political-institutional support. As the socio-political dimension is the most important element, determining the roll-out potential of SCC solutions, organisations and entities favouring the SCC solution's development become most relevant (i.e. the so-called umbrella organisations and initiatives). These organisations increase the synergies and the awareness of actors, favouring the involvement of political leadership, the population, (service) providers and investors as well.

Applying smart solutions to a limited-scale context would certainly enable the testing of SCC technologies, governance approaches, etc. However, it would not serve the purpose of responding to the global needs arising from urbanisation. What is thus needed is to **ensure that solutions can be scaled (increase in size) and replicated (rolled out in a different environment than that they have been applied in the first place)**.

The analysis shows that **there is no single element that represents more than others an obstacle or an enabler to the roll-out of SCC solutions.** Instead, it is the joint action of different elements that can limit the possibility for a project to be successfully implemented at a higher scale or in different contexts. These refer to the technological context (the presence of a technological support network for the SCC solution to function); the socio-cultural context (the ability to respond to citizens' needs and to make them part of the solution); the political-institutional context (level of required support from the public administration); and the economic-business context (which refers to the business models and relative environment). The presence of an ecosystem that can bring together political institutions, investors, industry players and – to the extent that it is required – the citizenry, facilitates the implementation of projects that have been successful elsewhere.

Urbanisation is an international concern; coherently, SCC solutions are being developed across continents. It is widely acknowledged that the Asia-Pacific area – in particular China – will experience significant growth in the next decade, becoming the leading region driving the market for Smart City solutions and technologies. For this reason, particular attention has been devoted to exploring the Chinese Smart City context and market – a growing potential source of opportunities for EU businesses – focusing specifically on three different levels of EU-China collaboration: industrial, research and policy-dialogues.

Analysing EU-China Smart City collaboration initiatives standing at the intersection between the energy, transport/mobility and information and communication sectors has led to the identification of opportunities for future EU-China cooperation. **Both EU and Chinese central governments have included smart cities as high priority domains in their strategic 2020 plans.** Therefore, it is expected that there will be

many opportunities for funding joint initiatives in the coming five years. It gives EU organisations a window for sustaining the initiated collaborations and establishing themselves in China. This is particularly relevant for EU companies, which can use their advanced knowledge in sustainable urban planning to conquer market shares in China. Indeed, such profiles are highly "wanted" in China to support the smart cities' development in an integrated and methodical way.

With the Chinese smart cities market's huge potential in mind, the main area of concern for Europe is to know how to enter the Chinese market, and how to generate profit from it. Often, collaboration initiatives turn out to be of little profit for European companies, since **Chinese competitors quickly replicate European know-how and then attract most of the public spending**. It is therefore recommended that European companies enter into agreements with China where they can be assured of being involved in a portfolio of operational projects – ideally with a specific budget and timeline for each project, and a total number of cities to serve as clients. In exchange of those guaranteed contracts over a period of time, European companies can pledge to train a portion of the Chinese staff and work alongside them as a way to transfer knowledge to China.

Furthermore, it is advisable to **target new cities in rural areas of China.** Indeed, there is already an influx of investment within Chinese megacities, and the government needs a way to reverse the trend of overcrowding in these cities. In other words, attracting investment elsewhere would be desirable.

5. Key recommendations

Collaborative operating models should be developed, facilitating the involvement of different actors.

This requires that effort be made at different stages of SCC solution development. More collaboration-oriented operating models may indeed envisage a revision of the approach of the public administrations (usually cities) to urban planning. Generalising to the extent possible, this requires a governance structure that favours the collaboration of the different parties involved.

City-level administrations may consider breaking the boundaries between sectorial offices.

This is in order for the city to be able to respond to potentially inter-sectorial, complex and integrated demand for technological innovations in service provision. For example, this may be achieved through the designation of planning powers to a centralised, dedicated office and a coherently integrated city planning, coherently with the strategic vision of the urban development. The planning could also focus t on cross-sectorial innovations, which would further require the different administration offices to partner. Conversely – in particular for broader urban areas – it might be appropriate for central administration to maintain a certain organising power, but to delegate smart planning at district level. Finally, it is advisable to revise the tools that are supporting urban planning (e.g. guidelines, models,) to embed the innovations brought by the new technologies.

Create the conditions for integrated solutions to be developed based on the same standards.

This is important to favour the involvement of the different players – private sector and SMEs in particular – in shaping the urban innovation. These conditions would also increase the possibility for roll-out and replicability). The possibility to develop solutions on shared standards – and even open standards – creates flexibility in deploying solutions, modifying them and, potentially, in having solutions developed directly by the citizens asking for them.

Enable community empowerment for the development of sustainable business models.

Communities have a specific role to play in smart initiatives; yet, the evidence from the best practice examples shows that in most cases there is only a traditional form of citizen involvement strategy in place, involving promotion, recruitment of participants and community participation to a limited extent. However, in-depth case studies confirmed that citizens and communities are not given a strategic role in the development and execution of integrated SCCs, and that the relevant communities are emerging as a key success factor for a sustainable business model. Different opportunities to involve communities in collaborating, co-creating and co-developing solutions can be leveraged, spanning from increasing communication to creating initiatives bonding smart city actors together.

Create an open innovation ecosystem between different experimentation set-ups.

The multiple roles residents could play in regional and urban living labs is under-utilized. Emphasis is often set on the innovative technological aspects but not on innovating the engagement process, with almost no co-ordination between experimentation projects. Coherently, there is no coordination in the development of principles, rules, standards and guidelines that other cities may benefit from. Different city experimentation set-ups could form an innovation ecosystem consisting of citizens, ICT companies, research scientists and policy-makers. The challenge in this layer is to create a collaborative approach to innovation ecosystems based on sustainable partnerships among the main stakeholders from business, research, policy and citizen groups, and to achieve an alignment of local, regional and European policy levels and resources. Municipal authorities should cultivate an innovation ecosystem across the city and among its suppliers, including: publishing city-level procurement policies, ensuring that changes following reviews are known; publishing and updating a pipeline of major city procurement opportunities, to allow enterprises to plan in advance; involving suppliers in the definition of products, respecting transparent procedures and ultimately enhancing competitiveness.

Investigate the relevance of new ICT-enabled business models, such as the sharing and the circular resource economy for integrated SCC solutions.

In particular, the European Commission is committed to developing a European agenda for the sharing or collaborative economy by 2016. This should include the impact of disruptive business models such as the collaborative economy on cities of the future. Furthermore, cities and regions should promote sharing-economy initiatives addressing the specific needs of local communities.

The importance of data-driven SCC solutions is increasing; it is therefore necessary to learn how to manage them.

Data is transforming cities as it is becoming available in increasingly large quantities and qualities. However cities need to look at the wider digital infrastructure to enable integrated SCCs – this includes the telecommunications infrastructure, publically owned digital infrastructure on multiple levels, sensors and data. In a digitalised environment, the possibility to create an open, service-oriented, interoperable IT platform enables multiple solutions to be developed and modified according to changing population needs. Effort needs to be made to ensure that data is reliable and easily accessible – when needed and for who it is needed by. New capabilities should be developed by administrators e.g. developing (or favouring the development of) standards for data exchange and protection; providing the necessary guidance, frameworks, specifications, protocols and vocabulary to create a common understanding for solutions developers, administrators and users.

Simplified information for SCC actors would support the replication of SCC solutions.

Major SCC players perceive the EU as lacking of a consistent approach concerning Smart Cities. In particular, the European Commission is currently running Smart Cities

projects across a wide number of different Directorates (just to quote the most active: DG Energy, DG Transport, DG Connect, but also DG Regional Policies, DG Environment, DG Research, DG Growth). To help SCC actors identify and focus on their topics of interest – thereby facilitating synergies – it is necessary to simplify and concentrate the available information, by centralising data on all running initiatives and activities. A unique EU point of access on Smart Cities would be useful to all actors seeking information on what is happening across Europe concerning Smart Cities and looking for best practices, support, etc.

Create and share a platform where EU and non-EU actors could jointly discuss SCC solutions.

As SCC solutions do not only concern EU Institutions, but are international and involve private actors as well, it might be useful to create a platform for them to share their main activities, thereby enhancing their mutual awareness. Furthermore, this platform might also facilitate and encourage a proper business matching among key EU and non-EU actors, reducing single efforts and contributing to aligning practices with non-EU countries.

Need to rationalise the management of funding and financing tools for SCC solutions.

The European Commission is a key player in ensuring that solutions receive the necessary resources to develop. However, the support provided may be better rationalised by assessing and defining the various SCC project types (revenue generating vs. R&D projects) and coherently organising the support the EC can provide. Potentially, the **centralisation of the competences for both the provision of grants and forms of financing** – as well as other support e.g. technical assistance – would further increase the efficiency of the EC's support. The number of opportunities to support SCC initiatives is varied and it is managed by different entities/institutions. The number of different sources and opportunities may create complexity in achieving an efficient support to SCC projects. Coherently, a single entity managing the different possible types of support would facilitate the allocation of resources, the access to them as well as the selection of the most appropriate support for each case.

Set up the EC's funding, financing and technical assistance programmes so as to overcome sectorial barriers.

This would be in the interest of achieving an integrated vision of city planning and SCC solution development. Coherently, these programmes are distinguished on a sector-basis; this differentiation would hardly fit into an integrated solution, which – by definition – embraces more sectors.

Develop business accelerators in the field of SCC initiatives, bringing together private and public investors and entrepreneurs.

The European Commission has the possibility of gathering the relevant stakeholders (e.g. financial services providers, promoters of SCC solutions, technology suppliers, etc.) in the same room. Projects in the SCC field have often been integrating the

public and private sectors to succeed. Indeed, more efficient ways to collect capital, skills and partners can be achieved by bringing stakeholders together. Different ways to achieve this cooperation can be investigated by the Commission, also leveraging the experience from previous initiatives, even if they are very distant from the SCC sector:

- Creating a physical space for stakeholders to meet at specific dates, but also through on-line platforms that facilitate cooperation and co-development;
- Potentially using open specifications/ standards, to further facilitate synergies between players and industries.
- Using the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) as an effective tool convening: cities – large and small; with industry – large and small; with investors of all types; and trusted associations, academics and intermediaries.
- Organising dedicated sessions within SCC-related events for project promoters to open discussions on their projects with potentially interested private and public investors.

Support stakeholders in procuring SCC solutions and avoid complex procurement frameworks that inhibit innovation.

For example, this could involve the development of user-friendly guidelines, templates and standards, which also support the exchange of best practices and the dissemination of knowledge. In this context, the EC can play a relevant centralising and standardising role.

Develop procurement and supplier management strategies.

Municipal authorities should develop procurement and supplier management strategies that enable rather than block their vision for more citizen-centric and integrated service delivery. Also, when developing integrated solutions requiring a certain degree of interfacing with several contractors, municipal authorities should consider designing Service Level Agreements (SLAs) that clarify how contractors interact with one another. The European Commission should assess standards and specifications in order to make sure that the selected standards and specifications foster interoperability and reduce lock-in. This is currently organised on a national basis (e.g. within the context of MSs' National Interoperability Frameworks); however, there has been an effort at a European level to adopt a common framework that fosters collaboration between MS.

Support the introduction of EU companies into the Chinese smart city market along with providing the necessary protection frameworks.

The global race towards efficient solutions for urbanisation-related service demand will strongly benefit from international partnerships. Specifically, China seems to represent one of the key players for Europe to establish valuable cooperation and sharing of best practices. The Chinese side expressed a strong interest in having a platform for collaborating with the EU in the energy field both at policy, technology and business

levels. Such a platform may also be used for "matchmaking." which would provide insights into business options for both Chinese and European partners.

Provide a supportive legal framework for IP protection.

A good smart city regulatory environment will provide the protection that EU companies (especially SMEs and start-ups) need while being adaptable enough to allow for the risk-taking and trial-and-error that innovation requires. This means EU public entities may step in and agree with their Chinese counterparts on creating the right Intellectual Property (IP) protection laws and a supportive legal framework for companies wishing to provide their solutions on the Chinese market.

Annex I. SCC Initiatives and relative priority areas

Colours indicate the EIP-SCC "Strategic Implementation Plan" (SIP) priority areas (vertical/horizontal) that the initiative covers:

Main area covered by the initiative (vertical variable)

Second area covered by the initiative (vertical variable)

Other areas covered by the initiative (across both vertical and horizontal variables)

				VERTICAL			HORIZONTAL							
Solution	**City**	**Population**	**Country**	*Sust. Urban Mobility*	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
Barangaroo District Renewal	Sydney	> 500.000	AU											
Waterfront Toronto	Toronto	> 500.000	CA											
Smart Buildings - Pudong New Area	Shanghai	> 500.000	CN											
Octopus System	Hong Kong	> 500.000	HK											
Water Network Monitoring and Management	Jerusalem	> 500.000	IL											
Water Management System	Mumbai	> 500.000	IN											
Smart Melit	Toyota City	100.000 < x < 500.000	JP											

Solution	City	Population	Country	VERTICAL			HORIZONTAL							
				Sust. Urban Mobility	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
Integrated Smart City Grid	Yokohama	> 500.000	JP	■	■	■	■		■		■			
Smart Traffic Management System	Buncheon City	> 500.000	KR	■		■	■	■	■					■
Island Integrated Smart Grid	Jeju Island	> 500.000	KR	■	■	■	■	■	■	■	■	■		
Citizens Connect	Boston	> 500.000	US		■	■	■			■		■		
City Services Smart Platform	Carson City	< 100.000	US	■	■	■			■	■		■		
Envision Charlotte	Charlotte	> 500.000	US	■	■	■	■	■	■		■		■	■
Fiber Optics Smart Grid	Chattanooga	100.000 < x < 500.000	US		■	■	■		■		■			
Windy Grid Chicago	Chicago	> 500.000	US	■	■	■				■		■	■	■
Integrated Smart Grid Initiative	Glendale	100.000 < x < 500.000	US	■	■	■			■	■		■		
Streetline Parker	Los Angeles	> 500.000	US	■		■	■	■	■					■
Big Belly Smart City Waste Management	Philadelphia	> 500.000	US	■	■	■	■		■		■			■
UCSD Microgrid	San Diego	> 500.000	US	■	■	■	■	■	■			■		■
Vienna Citizens' Solar Power Plant	Vienna	> 500.000	AT		■	■	■	■	■	■				■
Blue Gate District	Antwerp	100.000 < x < 500.000	BE	■	■	■	■	■	■	■				
Center of Operations	Rio de Janeiro	> 500.000	BR	■		■	■	■	■	■		■		

Solution	City	Population	Country	VERTICAL			HORIZONTAL							
				Sust. Urban Mobility	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
Hengqin Smart Grid	Hengqin New Area	< 100.000	CN											
MeRegio Smart Grid	Baden Württemberg Region	> 500.000	DE											
Bremen Building Management System	Bremen	> 500.000	DE											
Klimastrasse	Cologne	> 500.000	DE											
Connected Smart Port Logistics	Hamburg	> 500.000	DE											
Smart Power - Intelligent Network of Urban Infrastructures	Hamburg	> 500.000	DE											
E-Energy Mannheim	Mannheim	100.000 < x < 500.000	DE											
Nordhavnen Smart District	Copenhagen	> 500.000	DK											
Waste Water Management System	Copenhagen	> 500.000	DK											
Copenhagen Intelligent Traffic Solution	Copenhagen	> 500.000	DK											
Island EcoGrid	Bornholm	< 100.000	DK											
Tallinn Smart Card	Tallinn	100.000 < x < 500.000	EE											
City Protocol	Barcelona	> 500.000	ES											

Solution	City	Population	Country	VERTICAL			HORIZONTAL							
				Sust. Urban Mobility	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
Smart Street Sant Cugat	Sant Cugat	< 100.000	ES	■	■	■								
Urban Platform	Barcelona	> 500.000	ES		■	■								
Districlima Network	Barcelona	> 500.000	ES		■									
Neighbourhood Urban Observatory	Bilbao	100.000 < x < 500.000	ES	■		■								
Bus Integrated Management System	Donostia-San Sebastian	100.000 < x < 500.000	ES	■		■								
Integrated Security and Emergencies Center	Madrid	> 500.000	ES			■								
Kalasatama Sustainable District	Helsinki	> 500.000	FI	■	■									
ECO2- Tampere	Tampere	100.000 < x < 500.000	FI	■	■	■								
IssyGrid	Issy-les-Moulineaux	< 100.000	FR		■	■								
Lyon Smart Community	Lyon	100.000 < x < 500.000	FR	■	■	■								
Connected Boulevard	Nice	> 500.000	FR	■	■	■								
Intelligent urban mobility management and traffic control system	Thessaloniki	100.000 < x < 500.000	GR	■		■								
Data One Smart Portal	Hong Kong	> 500.000	HK	■		■								
Interoperable Open Platform -	Zadar County	100.000 < x < 500.000	HR		■	■								

Solution	City	Population	Country	VERTICAL			HORIZONTAL							
				Sust. Urban Mobility	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
iScope														
OpenMove	Trento	100.000 < x < 500.000	IT											
Climate Street	Amsterdam	> 500.000	NL											
Power Matching City	Hoogkerk	< 100.000	NL											
Schools Energy Management System	Lisbon	> 500.000	PT											
Smart District Heating - CELSIUS	Gothenburg	> 500.000	SE											
Hyllie Sustainable District	Malmö	100.000 < x < 500.000	SE											
Stockolm Royal Seaport	Stockholm	> 500.000	SE											
Energy Efficient Housing - 3eHouses	Bristol	100.000 < x < 500.000	UK											
Future City Glasgow	Glasgow	> 500.000	UK											
Mass-retrofitting - Hackbridge	London	> 500.000	UK											
Corridor Manchester	Manchester	> 500.000	UK											
MK: Smart	Milton Keynes	100.000 < x < 500.000	UK											
Urban EcoMap	San Francisco	> 500.000	US											
Smart Grid Newcastle	Newcastle	> 500.000	AU											

Solution	City	Population	Country	VERTICAL			HORIZONTAL							
				Sust. Urban Mobility	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
MNPass	Minneapolis	00.000 < x < 500.000	US	■										
HafenCity	Hamburg	> 500.000	DE	■	■									
Energy Matching Infrastructure - eHub	Leuven	< 100.000	BE		■	■								
Demo Norway Smart Grid	Rogaland Region	100.000 < x < 500.000	NO		■	■								
Hudson Yard	New York	> 500.000	US	■	■	■								
Vehicle2Grid	Amsterdam	> 500.000	NL	■	■	■								
Singapore congestion charging	Singapore	> 500.000	SG	■										
Data-driven Pop-up Busses	Boston	> 500.000	US	■										
London Underground Energy Recovery	London	> 500.000	UK	■		■								
Malaga Integrated Smart Grid	Malaga	100.000 < x < 500.000	ES	■		■								
Växjo - Fossil Fuel Free City	Växjo	< 100.000	SE	■	■									
Hammarby Sjöstad	Stockholm	>500.000	SE	■	■	■								
Nice-grid	Carros	< 100.000	FR		■	■								
Tram Smart Enhancement	Melbourne	> 500.000	AU	■		■								
Valencia Smart City Platform	Valencia	> 500.000	ES	■	■	■								
SMILE and Integrated eMobility	Vienna	>500.000	AT	■		■								

				VERTICAL			HORIZONTAL							
Solution	**City**	**Population**	**Country**	*Sust. Urban Mobility*	*Sust. Districts & Built Environment*	*Integrated Infrastructure*	*Citizen focus*	*Policy and regulation*	*Integrated Planning*	*Knowledge sharing*	*Metrics & Indicators*	*Open Data*	*Standards*	*Business Models, Procurement & Funding*
Service for Public Transport														
Smart Santander Urban Platform	Santander	100.000 < x < 500.000	ES											

Annex II. Mapping of the roll-out potential of 10 integrated SCC Solutions

	Technology	*Socio-cultural*	*Political-Institutional*	*Economic/ Business*	**Roll-out potential**
Bigbelly *Philadelphia, U.S.*					

Bigbelly represents a case in which success is ensured by simplicity.

The SCC solution does not require any innovative technology (nor complex netting support) to be implemented. Similarly, it does not require an important change of habits among citizens, unless a need to pay stronger attention to recycling. Also, the population hardly notices the difference, as the solution only slightly involves human interaction.

From an economic perspective, the solution is modular, therefore can be simply scaled and is simple, therefore it can simply be replicated, without requiring to be deeply modified to be adapted to the new environment.

It may be worth however considering that the solution is most likely to be successful in cities where more users can be served (to achieve economies of scale) and where the population density is higher (higher demand for intelligent-waste systems).

Citizen Power Plant *Vienna, Austria*					

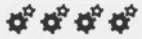
The Power Plant project in Vienna is somewhat complex in some aspects. From a business perspective, it requires a certain involvement of the society, the public administration and the business side. This increases the possibility for issues replicating the project (i.e. it would hardly work where individuals are less concerned with the environment or not aware of the potential of solar power). Legal and normative constraints may be other factors limiting replication as some countries limit the possibility to sell energy.

DataOne *Hong Kong, China*					

Among the key attention factors of the DataOne solution is the cultural dimension and the institutional involvement, which are required to adapt to a collaborative approach for the whole society's benefit. Another aspect is the citizen engagement through social network and other media that in this project was used to increase popularity of the project laying down the basis for its potential scalability.

The project aims to solve simple daily issues of the population facilitating communication; to do it, it uses simple and shared technology.

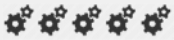
Differently from most SCC solutions, DataOne is expected to best fit in a densely urban context. Indeed, the higher the complexity of the city, the higher the demand for the services it provides.

	Technology	*Socio-cultural*	*Political-Institutional*	*Economic/ Business*	**Roll-out potential**
ITS *Copenhagen, Denmark*					

The solution, although successful, is still subject to a context in which the social-context is very strong and individuals are used to ITC solutions. Technology is available, however requires quite an architecture to be established upon.

Worth to mention is the importance that pilot testing had as a mean to ensure the scalability and later on replicability of the solution as well as the strong cooperation that took place both at national and international level which opened up opportunities for replication.

The ITS solution is expected to be less successful in smaller contexts, where the solutions proposed are less pressing. This however relates to the perception of individuals and, ultimately, on their culture.

Klimastrasse *Cologne, Germany*					

The project puts together a set of different solutions (LED lighting, electric vehicles, residential smart energy management, etc). This increases the complexity, but, on the other side, favours the modularity (i.e. potentially only part of the project can be replicated). The project is based on taking into account the citizens' needs throughout political steps and thanks to: (i) a steering board at City level and (ii) a comprehensive project management carried out by the energy local provider. This was a guarantee of success.

The solution roll-out potential is expected to be different depending on which of its components is assessed. Whilst LED lighting deployment is already being implemented in several cases and appears to be – at least partially – replicable and scalable everywhere and to whatever dimension, this may not be the case for the electric transport system and the smart-home technologies. Both cases refer to not particularly innovative ideas, which therefore can benefit from being tested in several cases and from a higher share of population being somewhat familiar with them. However the commitment required is high and this may be more difficult to be achieved in larger-scale environments.

MK:Smart *Milton Keynes, UK*					

Very wide project, which may be complex to establish as it requires to be developed from a large enough scale from the beginning. It requires an almost full commitment from institutions and a coordinated approach from the different departments, though it could be relatively inexpensive if the city possess the right set of skills. The management of the solution is also very complex.

To ensure its long term sustainability and replicability, project partners committed themselves to design a commercialisation plan since its very early stage of implementation, without postponing the decision to when the research project is close to its end. The project is expected to be best suited for small urban centres being newly created or expanding.

	Technology	*Socio-cultural*	*Political-Institutional*	*Economic/ Business*	**Roll-out potential**
Nice GRID *Carros, France*					

The Nice GRID project requires a strong participation from the local residents, which is expected to limit the scalability in bigger environments. Although technology is there, the number of partners, involved agents, regulatory framework, etc. for the solution to work make it difficult to be replicated without a very strong and shared commitment. However, in those cases where this coordination issue can be can be more easily overrun (e.g. by integrating the solution with other final electricity users), the solution appears to have no significant limitations to roll-out potential (i.e. see sub-section 3.4 on the ecosystem supporting SCC solutions roll-out).

The case of Carros is quite specific in the solutions it tackles. However, it should be considered that it is expected to best serve a small city – or a city area – as its complexity increases exponentially with the urban dimension.

Lyon Smart Community *Lyon, France*					

The Lyon project is a demonstration one, however it does not seem to have specific elements hindering its scalability to a city-level one. The requirement of a significant amount of initial capital can hinder the replicability, however, once the commitment from the institutions is ensured and the investments guaranteed, the project – and its components – are well scalable and replicable. The technology allows a strong degree of automization, which facilitates the roll-out of the solution, in particular to small-scale areas in urban centres, which can then be expanded to include whole cities..

Smart Melit *Toyota City, Japan*					

Apart from a very complex solution at technological level, the Smart Melit project is very tailored to a specific culture and specific needs of a society, which may be difficult to be translated into others. Further, it requires a strong involvement of all parties, being government, households, the Consortium. In other words, the holistic approach adopted is itself challenging its replication.

From a business perspective, it requires strong infrastructure-level investments (sensors, etc.) being installed and maintained. It is expected that the project brings positive results, but rather to inform other solutions than to be replicated as it is. While difficult to roll-out as it is, the solution can still be developed at small scale and is potentially adaptable as it is scaled-up.

Urban Platform *Barcelona, Spain*					

The solution is characterised by a strong involvement of the institutions, but is designed to limit the interaction with the citizens to providing new and more efficient services. This solution represents a very replicable concept, where services provided can be adapted to the demand, but the underlying

	Technology	*Socio-cultural*	*Political-Institutional*	*Economic/ Business*	**Roll-out potential**

network is substantially replicable and scalable. Key component of the solution is its transparency, which allowed city government to explain why they developed new smart applications or publicly sensitive solutions.

The Urban Platform solution is expected to be best replicable in large cities. Indeed, the services it provides would most likely be demanded in complex environments. Further, the larger the audience, the higher the potential for economies of scale, as a relevant portion of the costs would be fixed or semi-variable.

Legend
(min to max)

Technology:
Min: Max:

Socio-cultural:

Political-Institutional:

Economic/ Business:

Roll-out potential:
Min: Max:

Annex III. Toolkit to assess replicability in specific geographical contexts

The toolkit designed to support the roll-out assessment of a given SCC solution recalls the dimensions outlined in the main body of this report. However, these are presented differently below and in another order. They follow the logical steps that are suggested should be covered when addressing the roll-out.

Table 7: Potential roll-out at specific geographical level

Dimension	Roll-out potential evaluation criteria	Sample of KPIs
Political-Institutional	▪ Is there strong enough political commitment at State level? Municipal level? ▪ How difficult would it be to involve the institutions? ▪ Which degree of involvement of the public administration is required? Is it willing to? ▪ Which is in the specific country/ city, etc. the level of trustiness of the population towards the political entourage?	▪ Expenditure in R&D; ▪ Capacity for institutions to lead development (i.e. power distance[40]/ trust in leadership[41]); ▪ Regulatory barriers
Economic/ Business	▪ Is the project able to achieve economies of scale if its size were increased? ▪ Can the project benefit economically from international implementation (e.g. standardization of technology/ equipment/ solutions, etc.)? ▪ Is the business model adaptable to the resources/ stakeholders/ etc. that present in the business environment where the solution would be rolled-out?	▪ Business model-related KPIs ▪ Trialability; ▪ Break-even sales; ▪ Contribution margin; ▪ Conditions of the financial market; ▪ Risk propensity; ▪ Familiarity with similar products; ▪ Instruments offered by financial institutions; ▪ Size and type of potential investors.

[40] *Power distance* hereby refers to the indicator created by Hofstede analysing societies.

[41] *Trust in leadership* can be differently calculated. Hereby reference is made to the Edelman Trust Barometer: http://www.edelman.com/insights/intellectual-property/2016-edelman-trust-barometer/global-results/

Dimension	Roll-out potential evaluation criteria	Sample of KPIs
Socio-cultural	▪ How relevant is the involvement of the specific part of the population that will use and interact with the solution? ▪ Is the solution responding to a pressing need of the very population that will be using it? ▪ Which level of change in the users' habit would the solution entail?	▪ Market demand[42]; ▪ Advantage for end-users/ stakeholders[43]; ▪ Degree of users' interaction. ▪ Propensity to technological innovation; ▪ Degree of cultural collectivism.
Technology	▪ Is the technology advancement coherent with the level of technology it interacts with where the solution is implemented? ▪ Is the technology used able to integrate with the IT systems present where the solution is implemented? ▪ How big and complex is the netting support required to sustain the project from a technological perspective? Is this available? Can it be available in the next future?	▪ On-site verification of eventual technology gaps.

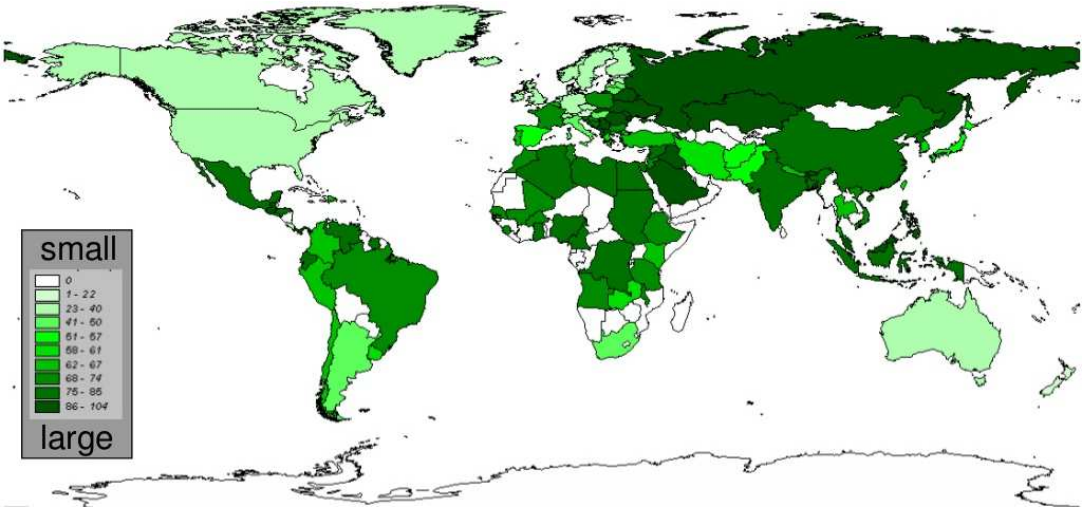
- The first level of analysis concerns the political and institutional environment. The broad indicators listed below are designed to support the understanding of how the political environment would support the roll-out of a specific SCC solution. In particular, it is suggested to analyse:
    - Whether the administration is keen to implement innovative solutions. A synthetic indicator could be represented by the share of GDP in R&D, etc.
    - It is also relevant to consider how keen the society is to follow the political leadership. Such dimension provides the degree at which – in a given environment – the political-institutional dimension can influence the socio-cultural one. A proxy for such assessment can be the analysis of the level of power distance of the society[44].

[42] The indicator – possibly the most relevant one in business replication – is differently addressed, but present in all studies and researches on the subject. Hereby reference is made to the indicators *market demand* and *advantage for end users / stakeholders* in the "replication & scalability" analysis in the CITYkeys study (*Bosch* et al. *2016);*

[43] *Ibid.*

[44] "People in societies exhibiting a large degree of Power Distance accept a hierarchical order in which everybody has a place and which needs no further justification. In societies with low Power Distance, people strive to equalise the distribution of power and demand justification for inequalities of power." Geert Hofstede, Gert Jan Hofstede, Michael Minkov, Cultures and Organizations: Software of the Mind. Revised and Expanded 3rd Edition. New York: McGraw-Hill USA, 2010

Figure 18: Power distance in world societies



Source: Elaboration of Hofstede 2010[45]

Trustees in leaders' choices help to shape the behaviour of the population interacting with the SCC solution (see socio-cultural dimension below). The public support to SCC solutions in countries where the government is highly regarded may help the population perceiving the *innovation* as more positive.

Table 8: Trust in institutions index

Source: Elaboration of Edelman 2016[46]

- Whether there are sensible differences in the regulatory frameworks impacting on solutions from the environment where the project was first implemented

45 Geert Hofstede, Gert Jan Hofstede, Michael Minkov, Cultures and Organizations: Software of the Mind. Revised and Expanded 3rd Edition. New York: McGraw-Hill USA, 2010

46 Edelman 2016 Trust Barometer. http://www.edelman.com/insights/intellectual-property/2016-edelman-trust-barometer/

and where it should be replicated (or, in case of scalability, whether the increase in size would entail a different regulatory framework being applied).

From a business perspective, analysing the possibility and capacity of the business dimension to be applied in a different environment – or scale – translates into the analysis of the flexibility and replicability of the business models. These have been extensively assessed in the previous sections of this document. A brief outline of the main elements required to enable and/or facilitate the roll-out is provided below.

Business models as replicating factors in the roll-out of integrated SCC solutions

For the sake of simplicity, all the elements characterising projects analysed in the previous paragraphs of section 3 have been considered as non-mutating factors. The roll-out potential of projects have been considered on the basis of what SCC solutions were and not what they could have been adapted to be. Whilst this simplification is generally accepted for the exogenous factors , endogenous factors may – under certain limits – be adapted to the different conditions of the environment the projects are to be replicated – and/or scaled – into. This is particularly true when business models are considered in the analysis.

Projects can become more or less "adaptable" to environments depending on how well they configure their business model to match with the local needs, institutional environment, financial market, etc.

The definition of what a business model is vast in the literature. For the purpose of this chapter, the term business model is simplified and entails the strategic approach that considers how to organise the resources to adapt to the context and achieve the objective the project aims to.

Business models are – by definition – adaptable . Hence they represent elements that facilitate the replicability of projects in contexts that present a certain degree of differences from the mother project (i.e. the original project that has been replicated). Specifically, the adaptability of business models focuses on how the resources are gathered and exploited (i.e. financial instruments may be developed to adapt the financial needs of projects to the supply of instruments and resources, etc.).

Business models are therefore keen to innovate – as Casadesus-Masanell and Zhu (2013) said, "At root, business model innovation refers to the search for new logics of the firm and new ways to create and capture value for its stakeholders; it focuses primarily on finding new ways to generate revenues and define value propositions for customers, suppliers, and partners" . Different starting points of business models being adapted to different SCC solutions' context have been analysed in sub-section 2.3.2.

The analysis of how business models adaptability may facilitate the replication of successful integrated SCC solutions is however too complex to be further detailed in this chapter. Indeed it requires that a certain number of solutions are categorised into homogeneous sets – in terms of demand for e.g. resources, risk adversity of shareholders, etc. – and then that common business model solutions to be adapted to them depending on the opportunities that each environment where solutions would be replicated can offer are identified.

It is however suggested that further research is carried out on such aspect of integrated SCC solutions, as the consideration of business model solutions as facilitators for rolling-out may greatly support the spread of innovative, economically sustainable solutions.

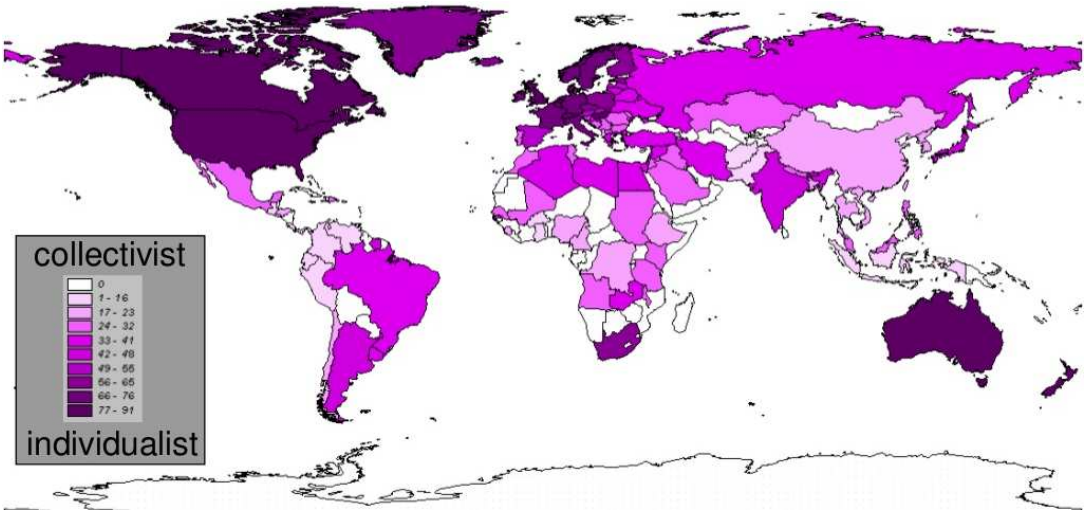
From a social perspective indicators that are relevant being assessed may include:

- Whether the solution **responds to a pressing need** for the society. This element is solution-specific and therefore does not related to a culture, but rather to the single society in which the SCC project is to be implemented. Several indicators can be used depending on the purpose of the SCC solution; e.g. in case of urban mobility the average driving time per households can be considered; for improved ICT systems the average time spent per person in

public administration offices; for safety the number of deaths and injuries due to road accidents, etc.

- Whether the solution requires **the citizenry to interact.** In such case, it is worth considering that the users' behaviour may represent a limiting element for the roll-out of solutions or, rather, a neutral one. As a result, the degree at which a solutions' replicability (and scalability) is limited depends on the propensity of the population to collaborate. SCC solutions are generally related to social and environmental related goals; thus the problem can be simplified in the propensity of the population to act in the society's own good.

Figure 19: Individualism vs. Collectivism in world societies

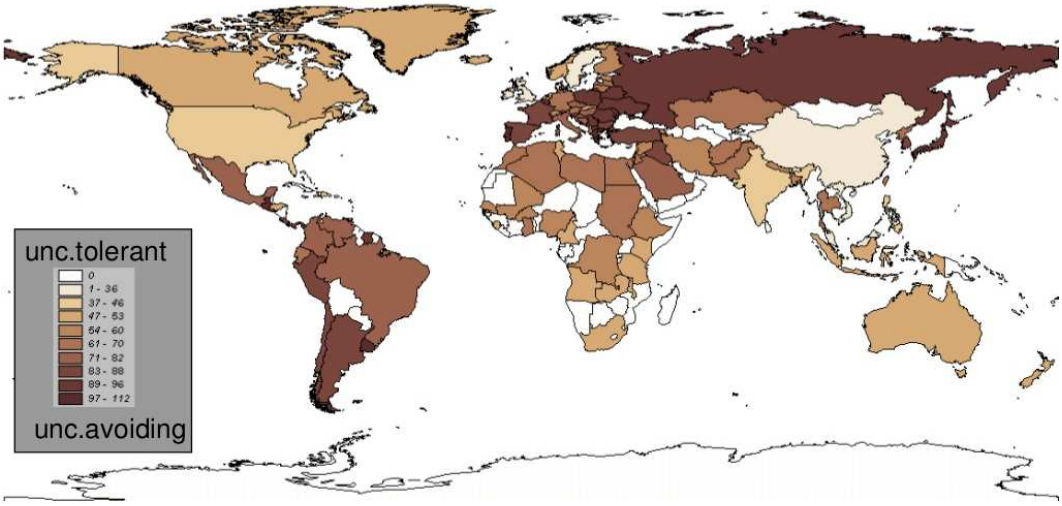


Source: Elaboration of Hofstede 2010[47]

- Whether **society is willing to accept behavioural change** (to the extent required – see citizens' involvement indicator). Depending on the culture users belong to, they may be more or less keen to accept changes in their behaviour and in their daily routine for the progress' sake. A proxy for such assessment can be the analysis of the level of cultural orientation towards conservativism or innovation.

[47] Geert Hofstede, Gert Jan Hofstede, Michael Minkov, Cultures and Organizations: Software of the Mind. Revised and Expanded 3rd Edition. New York: McGraw-Hill USA, 2010

Figure 20: Uncertainty avoidance in world societies



Source: Elaboration of Hofstede 2010[48]

Whilst the analysis has identified a set of indicators for three dimensions, it is worth considering that for the fourth (i.e. technology) the analysis is different. The technological dimension of the analysis is hardly the one limiting the roll-out and – in particular, the replicability of solutions (by definition, technology is the dimension through which globalisation proceeds). However, to scale up or replicate technology-driven solutions it is mainly required that the technology-related network system is able to sustain the infrastructure that is developed. This is ensured through an analysis of the technology required and that present on-site.

Summarising, the successful deployment of SCC solutions in a specific environment strongly depends on how these interface and interact with the environment. It was previously defined that the environment is essentially composed by behavioural attitudes – either at individual or aggregate level. The opportunity to direct such attitudes towards the creation of a SCC-friendly environment would therefore facilitate smart projects' deployment.

The following sub-section briefly presents how the ecosystem – i.e. the sum of stakeholders involved in SCC solutions and relative businesses – can support shaping the environment to support SCC projects' deployment.

[48] Geert Hofstede, Gert Jan Hofstede, Michael Minkov, Cultures and Organizations: Software of the Mind. Revised and Expanded 3rd Edition. New York: McGraw-Hill USA, 2010

Annex IV. In-depth case studies

The complete description and analysis of the ten in-depth case studies of SCC solution best practices, with a specific focus on each of the business models, will be available on the "*Market Place of the European Innovation Partnership on Smart Cities and Communities*" (https://eu-smartcities.eu). In particular the cases analysed in-depth are:

- BigBelly, Philadelphia (US)
- Citizen Power Plant, Vienna (AT)
- Data.One, Hong Kong (CN)
- Intelligent Traffic Solutions, Copenhagen (DK)
- Klimastrasse, Cologne (DE)
- MK:Smart, Milton Keynes (UK)
- Nice GRID, Carros (FR)
- Lyon Smart Community, Lyon (FR)
- Smart Melit, Toyota City (JP)
- Urban Platform, Barcelona (ES)