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Executive summary

Demonstration, pilot, and field lab projects – such as RUGGEDISED and other (inter)national innovation projects – provide a valuable opportunity for European cities to increase their innovation capacity. With their general aims to mitigate climate change and accelerate decarbonisation strategies, cities implement and experiment with cutting-edge technological, smart solutions. Being highly innovative, these smart solutions challenge existing urban infrastructures, settled partnerships, contracts, regulations and ways of working. Such implementation hurdles complicate the demonstration projects and thus are often perceived as risks. However, exactly these hurdles indicate where changes in the implementation context are required for innovations to be successful.

The biggest learning of RUGGEDISED is that, cities, in order to capture the enormous potential of demonstration projects, should perceive the implementation of smart solutions as part of a wider **innovation program** instead of walking the traditional process paths of urban development projects. Such an urban innovation view allows innovation partners to discuss, change and learn from the implementation hurdles that they come across. It turns away from a risk management approach, in which all kinds of institutional changes turn on the red lights. Innovation programs allow cities to increase their long-term innovation capacity, which is a prerequisite for innovations to scale up after the formal end of a project or subsidy.

The current “Guide on RUGGEDISED implementation and innovation of smart solutions” presents a step-by-step approach for European cities to embed their urban innovations (demonstration, pilot and field lab projects) into the wider perspective of an urban innovation program. By doing so, it aims to help European cities to design their urban innovation activities in such a way as to be able to capture the lessons that these innovation opportunities provide.

Three years of innovation and implementation in the RUGGEDISED Lighthouse Cities of Rotterdam, Umeå and Glasgow have provided multiple perspectives on the main themes that need to be taken into account when adopting an innovation program perspective:

- Cooperation in innovation partnerships;
- The changing role of government in society;
- The structure and organisation of public administration;
- Spanning judicial boundaries;
- Sustainable financing, collaborative business models and procurement;
- The role of knowledge in urban policy making.

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1 Smart City projects as an opportunity for Urban Innovation

Demonstration, pilot, and field lab projects – such as RUGGEDISED and other (inter)national innovation projects – provide a valuable opportunity for European cities to increase their innovation capacity. With their general aims to mitigate climate change and accelerate decarbonisation strategies, cities implement and experiment with cutting-edge technological, smart solutions. Being highly innovative, these smart solutions challenge existing urban infrastructures, settled partnerships, contracts, regulations and ways of working. Such implementation hurdles complicate the demonstration projects and thus are often perceived as risks. However, exactly these hurdles indicate where changes in the implementation context are required for innovations to be successful.

The biggest learning of RUGGEDISED is that, cities, in order to capture the enormous potential of demonstration projects, should perceive the implementation of smart solutions as part of a wider **innovation program** instead of walking the traditional process paths of urban development projects. Such an urban innovation view allows innovation partners to discuss, change and learn from the implementation hurdles that they come across. It turns away from a risk management approach, in which all kinds of institutional changes turn on the red lights. Innovation programs allow cities to increase their long-term innovation capacity, which is a prerequisite for innovations to scale up after the formal end of a project or subsidy.

The current “Guide on RUGGEDISED implementation and innovation of smart solutions” presents a step-by-step approach for European cities to embed their urban innovations (demonstration, pilot and field lab projects) into the wider perspective of an urban innovation program. By doing so, it aims to help European cities to design their urban innovation activities in such a way as to be able to capture the lessons that these innovation opportunities provide¹. Three years of innovation and implementation in the RUGGEDISED Lighthouse Cities of Rotterdam, Umeå and Glasgow have provided multiple perspectives on the main themes (see Figure 1) that need to be taken into account when adopting an innovation program perspective²:

- Cooperation in innovation partnerships;
- The changing role of government in society;
- The structure and organisation of public administration;
- Spanning judicial boundaries;
- Sustainable financing, collaborative business models and procurement;
- The role of knowledge in urban policy making.

1.1 Reading Guide

This guide elaborates the aforementioned six themes in the following chapters. Each chapter is built up as follows: a step-by-step guidance is accompanied by illustrations from the Lighthouse Cities and substantiated by state-of-the-art scientific notions.

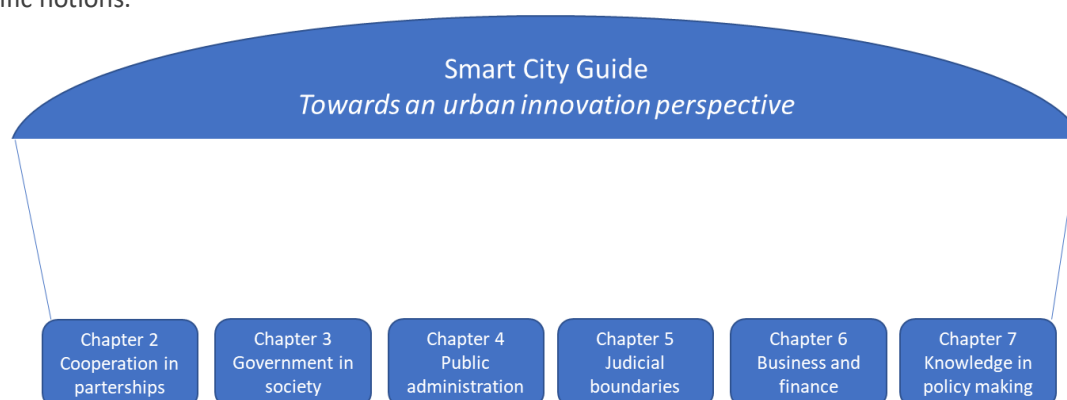


Figure 1: Reading Guide

¹ The city experiences presented in this guide are based on the latest RUGGEDISED reports: the City Implementation Reports (D2.6, D3.4 and D4.4) that the Lighthouse Cities published in 2020, and the lessons learned reports (D1.3 and D1.7) that the Lighthouse Cities collaboratively produced in 2019 and 2020, based on their collaborative learning processes in the Liaison Groups. Download the reports [here](#).

² Please see Appendix A for an overview of the cross-city learning process that the Lighthouse Cities undertook in the past three years. In Liaison Groups the regularly met to discuss pressing topics and reflect on each other's approaches.

2 Cooperation in innovation partnerships

By implementing smart solutions, cities are intervening in existing urban (physical) infrastructures and services: interventions at systemic level, be it urban heat, electricity, mobility or data infrastructures. Key to have impact at this systemic level, is to understand the interconnections and interdependencies of the various parts that the system comprises. However, in-depth knowledge on these interconnections is inherently scattered among urban (public and private) partners. **Are all crucial partners involved in the innovation program?** Partners that have a stake in the current situation, and partners that can contribute to potential solutions?

2.1 Step-by-step guidance

- Create a shared vision at the start of the urban innovation program, based on the values that each partner would like to pursue and the goals that each partner would like to achieve. Search for collective values and goals, but also appreciate differences, and openly discuss conflicting interests. To update and discuss the shared vision is a continuous task.
 - Continuously engage in boundary spanning activities to strengthen the cooperation and improve mutual understanding.
- Based on a thorough stakeholder analysis, performed by the city government and its innovation partners, openly discuss within the innovation partnership whether all relevant stakeholders (related to the problem at hand, or related to innovative solution finding) are at the table. It is necessary to involve partners that may raise implementation hurdles along the course of the program. To perform such an analysis is a continuous task.
- It is equally important to have a complete overview of running contracts and the status (and capacity) of existing (energy) infrastructure(s) at the start of an innovation program.
 - Be keen, in particular, on how smart innovations can be embedded in the existing urban configuration.
- Collaboratively map and discuss the information requirements and knowledge gaps. Note that knowledge on particular areas and urban systems is scattered among partners who do not necessarily agree on each other's knowledge base. Articulate contradictions and information asymmetries. Collaboratively discuss with (external) partners can develop and provide trusted information to the innovation partnership.
- Try to build a self-sustaining Innovation Partnership. Cooperating partners can collaboratively define services and products that they can offer to upscale and replicate successful smart solutions in the region.

2.2 Illustrative example(s) and lessons learned from the RUGGEDISED Lighthouse Cities

The development of a strong partnership is crucial. Specific technologies and innovations are complex, therefore, it is really challenging to connect all elements of smart infrastructures with each other. That means that smart city development is based on understanding the interests that are at stake. A successful implementation relies on co-creation and optimising the whole, instead of aiming for partial gains. Everybody can see the merits of this; however, in real life real co-creation is a complicated challenge.

Experience from Rotterdam

A good and clear collaboration makes the implementation of smart solutions easier. After the consortium was formed, all partners started with lots of energy to work on their solutions, instead of figuring out what the right type of collaboration would be. A strong partnership between the parties can lead to a smoother implementation of the smart solutions, because roles, expectations and deliverables will be clearer. For an overall strategic vision to become a smart city it is necessary to have the strategic levels in the organisation on board. A good horizontal and vertical coordination in the organisation should improve the speed of the implementation phase. But this is a challenging point to accomplish.

Moreover, to have a full overview of information requirements also significantly helps the process to speed up. For instance, such an overview is also a prerequisite for successful procurement of electric busses (R7: "Optimising the

E-bus fleet”). The main lesson learned here is that it is important to have an overview of which elements play a role in the operation of electric buses at the beginning of the process and to adjust the functionality of the software to this. Examples of important factors that influence the use of energy are driving style, cooling and heat, and the use of energy when the bus is not driving.

Experience from Umeå

The purpose of the U1 “Smart City connection to 100% renewable energy” and U3 “Geothermal heating/cooling storage” solutions is to develop a new business model to make it possible to share excess renewable energy between stakeholders in a value chain and ensure better usage of geothermal storage. The overarching goal is to help the stakeholders reduce their climate impact and lower the costs of energy. Three different business models were tested and applied to nine ways of optimising energy use in the Innovation Area. The consortium evaluated these models to show how value creation might occur in the different scenarios. An area-oriented business model, based on sharing economy ideas, really is a novelty and differs significantly from how partners (in Umeå, and elsewhere) used to think. Collaboratively partners analyse the entire energy value chain and try to understand each other’s interests. It is a holistic approach towards the value chain with the aim to see if it is possible to recover and reuse energy along the value chain. Partners understood that focus should be on understanding the interests at stake and exploring different scenarios of cooperation. The process learned that exploring the cooperation models (without a focus on and stress of concrete implementation) helped the process of mutual understanding.

Another example from Umeå relates to the E-charging facilities that were essential to ensure the rollout of E-Vehicles in the area. A charging hub for E-vehicles was tested, with charging facilities for E-bikes, E-cars and car-share. It took the partners quite a long time to develop a shared idea of the aim and added value of this smart solutions. The local combination and optimisation of EV charging, solar panels and battery storage can have several configurations. It is very interesting to optimise this value chain, taking into account that summer and winter time differ significantly in Umeå.

- For the city of Umeå, it is important to experiment with different configurations of EV charging and to be keen on lesson learning. In order to upscale EV charging it is wise to pick the best configuration. The city is the initiator of mobility hubs in new areas. EV is an important part of the overall mobility strategy. There should also be charging stations at the service hubs where people could change from their own cars to shared vehicles.
- For Umeå Energy decreasing peak loads is an important factor as well. Batteries can significantly improve the quality of power.
- However, a huge battery and rapid charging station are more expensive. Then the question appears: who is going to benefit? That is an actual search. There are lots of taxis outside the hospital waiting for a customer. For them to change from fuel to electric cars would be a real opportunity.

Experience from Glasgow

One of the lessons learned is that smart solutions significantly impact the existing (energy) infrastructure. Very often the details on the exploitation, contracts and performance of existing infrastructure are not fully analysed during developing strategic smart city goals and smart solutions. After having had a detailed look at the existing electricity grid it turned out that the fault level was already too high to have additional feed in from the CHP. Scottish Power is working on improving the grid; however, these additional investments cannot be done in the timeframe of RUGGEDISED.

2.3 Supporting theoretical notions

2.3.1 On innovation partnerships that grow beyond the life span of particular projects

Innovation programs and partnerships show great similarities with Living Labs. Their activities fit within the five key characteristics of a Living Lab (Voytenko et al., 2016): geographical embeddedness, experimentation and learning, participation and user involvement, leadership and ownership, and evaluation and refinement. However, the sustainability of the results of Living Labs is a known challenge (Gasco, 2017).

A joint vision is a first step towards the sustainability of Living Labs. However, it is interesting to think one step further. Innovation partnerships may also be aimed at becoming a self-sustaining (organisation and financing) institute beyond the lifetime of the project. This fits to the recommendations of a recent European report on Living Labs (Santonen et al., 2017). Living labs can search for organizational forms and business models that are inspired by the organisation and financing models of Open R&I Innovation PPPs.

Such Innovation Partnerships:

- foster an integrated approach for tailoring, implementing, assessing and reviewing smart urban solutions in the cities which is supported by state-of-the-art knowledge from both academia and practice;
- accelerate market uptake and fosters the forming of and cooperation in smart urban areas and innovation ecosystems;
- develop the learning capacity for the innovation ecosystem and capture lessons learned that support the upscaling of successful smart solutions locally, and support replication to other EU cities;
- sustain implementation of smart urban areas beyond the lifetime of the project within the city because of the self-sustaining model;
- are replicable to other EU cities for developing and implementing smart solutions city-wide.

The self-sustaining model of innovation partnerships can be based on the lessons from about 100 “innovation labs”, field labs, and such like in Europe in which factors for successful Open Innovation Public Private Partnerships (PPPs) have been identified, with a focus on financing the PPP (EU-Great, 2016). Public Private Partnerships for Open Research and Innovation refer to the collaboration between governments ((supra)national / regional / local), knowledge institutes, and private actors (firms) with the aim to address scientific, technological or innovation objectives, to contribute to “the public interest” and “societal challenges”. A Research & Innovation PPP requires formal institutionalisation of the collaboration, involvement of the government as an actor, shared goals and a clearly defined public interest, active involvement and dedicated investments. The last point, “dedicated investments”, is a particularly important factor that impacts the sustainability of the Innovation Partnerships. The partnership may search for a detailed business and investment plan for the different phases of operation and will require careful consideration of joint activities that will generate funds. In the Table 1 below (see De Heide, 2017), examples of services that could be provided to the outside world and to the participating members are given.

Table 1: Examples of services a Research and Innovation PPS can provide

	Service	Activities
Ecosystem	Community building	Scouting, brokerage, awareness creation, dissemination, ecosystem building
	Strategy development	Market intelligence, market assessments, roadmapping, technology watch
	Ecosystem learning	Workshops, seminars to share knowledge and experience
	Representation, promotion	Representing interests during meetings & conferences, organizing (country) visits, roadshows
Technology	Strategic RDI	Joint, pre-competitive R&D, secondment from companies
	Contract research	Specific R&D, technology concept development, proof of concept
	Technical support on scale-up	Concept validation, prototyping, small series production
	Provision of technology infrastructure	Renting equipment, low rate production, platform technology infrastructure, Lab facilities
	Testing and validation	Certification, product demonstration, product qualification
Business	Incubator/accelerator support	VoiceOfCustomer, market assessment, business development, legal. IPR, location, sales strategy
	Access to finance	Financial engineering, connection to funding sources, investment plans
	Skills and education	Courses, bilateral mentoring, workshops, technological infrastructure for education, secondment
	Project development	Identification of opportunities, creating consortia, development of proposals
	Offering housing	Office space and space for experimentation and pilot manufacturing

2.3.2 On information asymmetries and boundary spanning activities

As information and knowledge bases are often scattered and contested, urban innovation programs – the development of a joint vision and consequent implementation of smart solutions – can be seen as an endeavour to span to cross knowledge boundaries. Boundary-spanning processes are among the few promising solutions to cross knowledge boundaries, enhancing knowledge integration (Zaucha et al., 2016). Knowledge integration is geared at members of different fields work together over extended periods to develop novel conceptual and methodologic frameworks (Zaucha et al., 2016). According to Slob and Duijn (2014), knowledge boundaries can be spanned or crossed through the collaborative generation, integration, and application of so-called boundary objects. Boundary

objects are tangible artefacts or object-like forms of communication that inhabit several intersecting social worlds and satisfy the information requirements of each of them.

In RUGGEDISED the Liaison Groups can be perceived as boundary spanning processes. Boundary-spanning processes help to cross the boundaries, facilitate the collaborative production of knowledge, and generate meaningful results for the researchers involved. Additionally, they often enhance trust and performance in collaborative research and policy processes. Boundary objects not only contain knowledge but also lead to action “in ways other than sharing understanding.” Such an object must be capable of provoking collaborative practice. Other examples of boundary objects used in regional management are models, maps, action plans, policy, or research notes. Boundary objects thus are a sort of arrangement that allows different groups to work together without necessarily achieving consensus.

Table 2: The most important concepts of boundary spanning theory (Slob & Duijn, 2014).

Concept	Description
Premise	Communities are separated through boundaries that hamper communication and joint action
Boundaries	Perceived boundaries between communities can be of a different nature (organisational, cultural, geographical, etc.).
Boundary spanning	Activities are undertaken to cross boundaries such as communication or joint activities.
Boundary objects	Tangible products of joint activities that satisfy the communities involved, like maps, action plans, policy notes, among others. They contain knowledge and provoke action.
Boundary spanners	People who cross the boundaries and intermediate between communities. They are accepted in this role by the communities involved, for instance, because they are “part” of the different communities.
Boundary-spanning processes	These processes are needed to produce the boundary-spanning objects with the communities involved.

2.3.3 On the impact of innovation programs on existing urban infrastructures

Urban innovation programs, and the implementation of smart solutions, to some extent resemble what is called ‘mega-projects’. Mega-projects are characterised by the fact that their success and impact are caused by the intensive connections between smaller/individual parts of the project. Moreover, these projects should be seen as ‘acupuncture’ projects that should be well embedded in the existing urban context. Salet, Bartolini & Giezen (2013, p.2) state that even: “the most subtle interventions – relatively small in themselves but with a huge impact - are often the ‘acupuncture’ type projects that aim to interconnect or to upgrade broken or incomplete networks of infrastructure”. This is ultimately the case for the smart solutions in RUGGEDISED; surely, they do not necessarily have to be large in terms of scale to face increasing complexity and therefore require (and/or instigate) a new and innovative mindset and project approach.

3 The changing role of government in society

The role of government in society – and with that the scope and mandate of policy instruments – fundamentally differs between counties. Decarbonisation challenges demand cities to reconsider whether they are up to the tasks they face. Moreover, the RUGGEDISED project shows that (technological) innovations change the – what are already fuzzy – boundaries between public and private interests. Cultures and government roles are often implicit and hard to change. Moreover, urban innovation requires city governments to carefully reflect on the prerequisites that should be fulfilled in order for them to explicitly take position.

3.1 Step-by-step guidance

- Successful urban innovation asks for a strong orchestrating role of local government. Together with the ecosystem partners, reflect on the (implicit) role-taking of the local government. How do other partners see the role of local government? What do they need from the local government? What role do they envisage for the local government, and also for themselves?
- Determine the ‘public interest’ of urban innovation in general, and of each part (smart solutions) of the urban innovation program in specific. A clear message on the public interest of smart and innovative urban infrastructures and services emphasises legitimate public action, and also ensures political back-up.
 - Per smart solution, the public interest may differ. Moreover, it may even differ per aspect of a smart solution. For instance, hosting an urban data platform may be in the public interest, whereas developing apps based on the urban data platform may be more in the private interest. Another example would be the ownership of the urban energy infrastructure that may be in the public interest, whereas transport of energy may be more in the private domain.
 - Novel technologies, new roles and newly minted partnerships need a supportive legal framework, including standardised permits and contracts. Developing contracts that support these new roles and partnerships is highly valuable (see also chapter 5)
- Continuously reflect on how connections and interdependencies between smart solutions may require active public intervention and role-taking, also in those cases that individual smart solutions may be in the private domain.
 - Interdependencies between urban infrastructures may lead to the demand for collective ownership structures. If individual parts of the infrastructures are individually owned, nobody is responsible for ‘connecting’ the dots.
- Continuously reflect on the impact of technical innovations on the division between public and private interests. Innovations may cause a shift in the demarcation of the public interest and require a shift of public role-taking accordingly.

3.2 Illustrative example(s) and lessons learned from the RUGGEDISED Lighthouse Cities

The RUGGEDISED Lighthouse Cities deal with three completely different cultures³. Umeå is to a significant extent community-centred. The local government is very strong. Many challenges and issues are perceived to be in the public interest. Moreover, the regional innovation partners, although some more economically driven than the others, are publicly owned. This adds up to the frame of innovation and a sustainable city to be in the public interest. It seems to be a crucial success factor in building trust and aligning partners. Glasgow, on the other hand is strongly market based. The example from the multi-storey car park is illustrative in that sense. Within RUGGEDISED, Glasgow aims to show the opportunity to use a multi-storey car park as urban battery. The upscaling of such a solution requires a very specific approach, since most car parks in Glasgow are privately owned. To show the upscaling potential of the urban battery solutions, a rather simple and positive business case becomes important. Private car park owners only adopt solutions that are technically proven and economically viable. Government has the role of

³ See also RUGGEDISED, 2020, p.26.

front-runner. Rotterdam is somewhere in between the spectrum of public and private incentives. With its connection to the Heart-of-South PPP redevelopment, the local government has both an economic, as well as an innovation incentive in RUGGEDISED. This is also true for the partners. Eneco and RET are private partners, though partly publicly owned or funded. Only KPN and Ballast Nedam are private partners. Experience shows that a mix of public and private partners (and also a mix of incentives within the municipality itself) requires more time to strategically discuss common goals. If particular interests become clear during the process of implementation, cooperation may be complicated.

Experience from Rotterdam

Rotterdam aims to install a sewage heat recovery system and a pavement heat-cold collector. These innovations are highly novel as they are entwined with municipal property (sewages and pavement). They warrant new roles and the minting of partnerships by previously separated actors. These pavement or sewage pipes physically incorporate and fulfil multiple services (sewage function/pavement and heat exchanger) with divergent aims and beneficiaries (Eneco with the thermal grid users in addition to the users of sewage/pavement).

One of the obstacles in these projects is that two different companies use the same object to provide different services/products. The municipality is responsible for the pavement and Eneco for the heat collectors in the pavement. The same counts for the surface water heat collector, for which the sewage company is responsible for the sewage and Eneco for the collection of heat from this surface water. Each of these parties have different responsibilities and offer a different service or product.

As the picture shows, the two parts, the heat system and the asphalt, are fully interwoven. The product of Eneco, heat, depends on systems that are owned by other parties. In order to be able to make a good product, it is important for Eneco to have access to the heat collectors. The municipality and sewage management are hesitant to hand over such access and responsibility.



Experience from Umeå

Energy-efficient land use through flexible green parking pay off. The city of Umeå focusses on implementing a new business model in the campus/university city area, enabling a reduction of car parking spaces and directing developer investments from parking towards sustainable mobility solutions (E-car sharing, E-buses, E-cycling etc), thus reducing the climate impact and overall energy use. The business model will be an extended version of the Green Parking Pay-Off model that has been developed for commercial buildings in Umeå, and will now be applied to residential buildings as well. Building partners will not be obliged to participate in these new business models. They will be offered several deals (small, medium, large) in terms of green/parking payoff. If they invest in large projects to stimulate smart and sustainable mobility (or put money in the city's mobility fund), they get to build higher density.

Experience from Glasgow

Demand-side management is, in the end, a political topic. Especially the command protocols, control regimes, and hierarchy of decisions within use cases reveal that interests of different policy domains and actors should be carefully weighed against each other. Moreover, to exploit the full potential of demand-side management (in terms of behavioural change based on full information and the development of data-driven services) requires careful consideration. At the moment, demand-side management is often only applied to lower costs for grid operators and energy providers. However, it still is a challenge to get a full overview of the benefits (especially for households and companies) of far-reaching, and radical, demand-side management.

One of the key lessons here is that local RES optimisation and netting off solutions hold the risk for the city government of becoming an energy company in itself. GCC is not very keen on taking up this role. Apart from the fundamental question of whether the government should play an active role on the energy market and generate own revenues, it will create lots of bureaucracy and administration efforts.

3.3 Supporting theoretical notions

3.3.1 On the role of government in society

The conclusions related to the differences between the RUGGEDISED countries is in line with the observation that ‘models of society’ and related ‘welfare models’ significantly differ between countries across Europe (Nadin & Stead, 2008). While this might seem obvious, differences between countries have their repercussions on how urban innovation programs challenge the role of government in society, especially in cross-national project in which lessons learned in one city have to be contextualised and transferred into replication strategies for other cities.

In order to get a grip on the rather abstract notion of ‘the role of government in society’, a helpful distinction is made by the OECD (Frankowski et al., 2018, p.12), see Figure 2. In general, four perspectives can be distinguished along two axes: “(1) result-oriented versus value-oriented; and (2) inside-out versus outside-in. The vertical axis describes the nature of efforts, in which two approaches are distinguished: either policy results are emphasised strongly and preconditions are altered in order to achieve those results, or setting preconditions has the main focus, while there is little or less attention for outcome or implementation. The horizontal axis focuses on the role of government versus the role of society, including organisations that achieve societal goals. The distinction emphasised here comes down to whether government policies are responsive and include stakeholders’ perspectives (outside-in) or whether policy making is restricted to government alone (inside-out).” (Ibid, p.11).

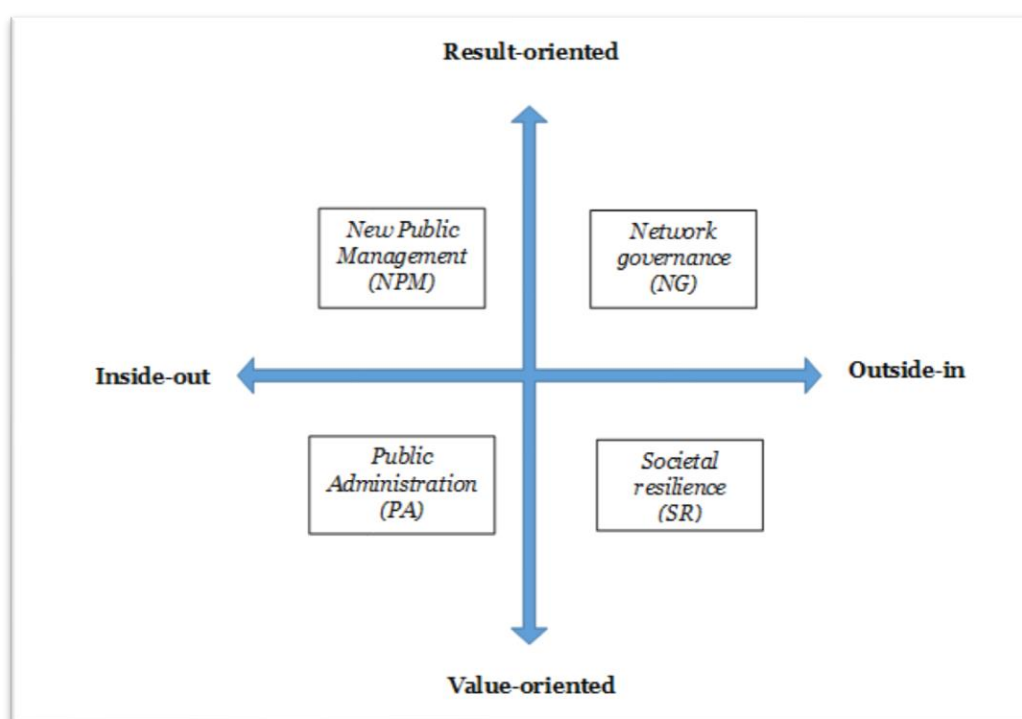


Figure 2: Four governance perspectives (Frankowski et al., 2018)

A distinction between four perspectives on the role of government in society does not mean that a particular government bodies can only be positioned in one quadrant. Instead, governmental practices more than often select, combine and layer ingredients from every perspective. However, in almost every national and urban government one or two perspectives gain dominance over the others.

Why are these perspectives on the role of government in society helpful in stimulating the success of urban innovation programs? The governance perspectives differ in the way urban governments incentivise themselves and their innovation ecosystem partners. If they prefer efficient and effective project results (upper half of Figure 2) they might use a strong hierarchical and accountability perspective (New Public Management) or rely on their strong alliances with partners (Network Governance). If they put emphasis on the process characteristics, rather than project results (lower half of Figure 2) they count on clearly-set institutional ‘rules of the game’ (Public Administration) or be responsive to societal energy and bottom-up, private initiatives (Societal Resilience). Table 3 summarises the main characteristics of the four perspectives.

Table 3: Possible governmental roles and styles (as based on Boonstra et al., 2016).

Quadrant	Brief description of the role	Qualities and characteristics	Participation-form
Public Administration	Legitimate government stands for legitimacy and legality. This form of governance works well when clear procedures to formulate political goals result into official acts.	Government sets the agenda and informs all involved. Mostly via formal procedures.	<i>Informing</i>
New Public Management	New Public Management is about a performing government that achieves measurable goals. Measurable also means that responsible actors can be held accountable.	Government sets the agenda. It does listen to the input of involved parties and sometimes actively seeks advise. Input does not automatically lead to changes or adaptations.	<i>Consulting</i>
Network Governance	A collaborating government aims to achieve goals with efforts by third parties, such as governmental organisations, and companies.	Both the government and other parties set the goals. All parties use their expertise to set responsibilities. All parties are equal and every party determines their own input.	<i>Interplay (or teamwork)</i>
Societal resilience	Responsive governance is based on the initiatives and energies emerging in society.	Governance is focused on collaborating in initiatives by others, thereby advising and supporting these parties.	<i>Collaborating</i>

3.3.2 On how technological innovations challenge public/private boundaries

Urban innovation projects challenge the way in which government is positioned in society. This is mainly due to two reasons:

- As also showed in RUGGEDISED, the complexity of the urban dynamics significantly grows with smart city interventions. Smart urban solutions, whether it be sensors, smart energy grids, new mobility concepts or urban data platforms, show a great cross-domain interconnectedness and require a system, rather than project perspective. Moreover, as it often concerns innovative infrastructures, the embeddedness of – and alignment with – these infrastructures within the existing urban configuration, remains challenging.
- Both the urgency of societal challenges and the characteristics of urban innovations (should) stimulate a continuous debate on what is perceived as the dichotomy between the public and private realm. Intertwined systems/solutions such as urban sewage waste stream and heat-cold pavement collectors raise questions, not only about access, but also about ownership and responsibility; which party owns which aspect of the system and who is responsible to repair damages, who is responsible for periodic maintenance and how will risks (and unexpected costs) be distributed among parties? Today there is still little experience with such agreements.

Various smart solutions in RUGGEDISED (urban data platforms, low temperature heat grids, sewage heat systems) stimulated the discussion among RUGGEDISED partners on the question whether (parts of) these infrastructures should be publicly or privately owned and operated. This is not surprising, since innovative solutions present alternative challenges to questions like: who should have access to the infrastructure (or urban space) and how can overconsumption of a particular service or infrastructure be avoided?

Figure 3 gives an insight to get the reflection on public interest started. Figure 3 distinguishes four different types of goods: private goods, club goods, common goods and public goods. Goods differ, the use of some goods results in scarcity (rivalrous) and whether people can be excluded from consumption/use. Some examples are given in the Figure 3 to demonstrate the differences.

	Excludable	Non-Excludable
Rivalrous	Private Goods food, clothing, cars, personal electronics	Common Goods fish stocks, timber, coal
Non-Rivalrous	Club Goods cinemas, private parks, satellite tv	Public Goods air, national defense

Figure 3: Different types of goods

Overall, can be stated that common pool goods will face depletion because ownership rights about the use are hard to define and maintain. Club goods are usually ill-measured in terms of quality guarantees and cost transparency. Both common pool goods and club goods need an active role by the government. This Figure 3 and distinction is relevant because it illustrates that when goods change in their nature (common, pool etc.), the involved challenges change and with that the focus/approach for governments and municipalities.

Some examples:

- Private rooftops are typically considered as private goods; however, a novel and contrasting view might be necessary as it appears that private urban rooftops are not fully utilized as surface for PV-panels – perhaps the government should regulate this to stimulate the share of renewable energy. Now a private good shifts into the public domain. A rooftop could also function as ‘climate roof’ (for example, vegetation as a carbon sink).
- A high-temperature heat grid usually has only one heat supplier (e.g., industry or incineration plant) and multiple sources (houses/buildings etc.). It is a typical example of a club good. There is little to no rivalry, transparency about the costs is a serious issue which hampers the development of low-temperature heat business cases (as innovative alternative). However, low-temperature heat grids have the characteristics of common pool resources. Fluctuating supply and demand causes challenges surrounding balance and urges to question as to what partners should be included or excluded from the system.
- The use of urban waste heat recovery requires models of shared ownership. Who can be excluded, or should be included? In addition to legal hurdles, such as the absence of contracts regulating shared ownership, although said to be economically feasible (Østergaard & Svendsen, 2019), the business case for waste heat is still weak, meaning small margins and high upfront costs and long payback periods (Lygnerud, Wheatcroft & Wynn, 2019). According to them, there are still many technical, financial and legal barriers that prevent the use of urban heat waste. There are two main legal challenges: the first being the absence of a sufficient legal framework. Urban waste heat recovery is a very young technique and countries do not have a legal framework to support urban waste heat recovery or standardized permits procedures. The second barrier being the absence of standardized contracts, therefore contracts must be drawn up from scratch, thereby increasing costs and extending negotiations. According to the researchers the development of such contracts would be very valuable.

4 Structure and organisation of public administration

The strategic positioning of the team working on the urban innovation program, within the city government is crucial. It determines whether the team is allowed to shift the perspective from mere project implementation towards a wider learning and innovation program management. Strategic positioning of the innovation teams also stimulates to improve the capacity to connect the various levels (strategic, tactical and operational) and the different domains (energy, mobility, housing, urban planning) within the organizations. As knowledge on the urban system level is inherently scattered among urban (public and private) partners, increasing the **agility to connect** is an important factor for successful urban innovation.

4.1 Step-by-step guidance

- The team working on the innovation program should be strategically positioned within the municipal organization.
 - Position should allow the team to easily connect to domain-specific policy departments and relevant initiatives
 - Positioning within strategic policy departments requires extra effort to connect to technical, operational implementation departments
 - Positioning within operational departments holds the risk of overemphasizing a project management perspective and requires extra effort to connect to strategic long-term innovation program management.
- The innovation program should rely on sufficient political and administrative back-up. The program should stimulate multi-level networking between partners: on the operational level, administrative level and political level.
- The innovation program team should include members from operational, tactical and strategic levels, as to align different knowledge bases and create a system perspective on the areas that are subject to the urban innovation program. The early involvement of contractual (legal) and procurement expertise is a crucial prerequisite for successful urban innovation.
- The innovation program team should include (or closely align with) members from relevant domains (energy, mobility, housing, digitalization, etc), as to make sure the area perspective from the urban innovation program resonates with domain-specific policy/investment initiatives.
 - The team should carefully discuss the level of required/desired policy integration.
- The city government should carefully reconsider which level of integrated, cross-siloed planning is appropriate to tackle the innovation challenges that they face.
 - Should they develop new joint and integrated visions, or will intensive coordination be up to the task?

4.2 Illustrative example(s) and lessons learned from the RUGGEDISED Lighthouse Cities

The positioning of the innovation program team within the municipal organisation, and the positioning of the partners within their specific organisation, is of crucial importance. In the RUGGEDISED consortium, this positioning differs across the three Lighthouse Cities. In Rotterdam, the project team is positioned in the ‘engineering department’ of the city administration, in Umeå the team is positioned in the ‘strategic urban development department’ and in Glasgow the team is part of the ‘sustainability department’. The position within the municipal organisation not only affects the ease with which the team can align with other departments, but it also influences the access to the decision-making - and political levels in order to secure political back-up. Moreover, our experience is that the positioning within the organisation also impacts whether people are ‘allowed’ to shift focus from a project management approach towards an innovation program approach. This has to do with the mandate they have to address malfunctioning regulatory frameworks and the time they have for reflection, learning and making mistakes.

Another aspect regarding the strategic positioning of the project is its ‘function’ in ongoing projects. In RUGGEDISED we can see many different approaches on this issue. A helpful illustration is the development of the 3D city model in Rotterdam (R6). The aim of Rotterdam is to bring the Urban Data Platform development one proof of concept further within the timeframe of RUGGEDISED, and use other smart solutions within the project as necessary use cases to do so. Also, after RUGGEDISED another proof of concept will follow. Glasgow is also building on experiences from earlier projects and explicitly dealing with the lessons learned from projects that have been started earlier. The aim of RUGGEDISED is to push these projects further. The risk of starting from scratch and aiming to fully finish in the timeframe of just one project (RUGGEDISED = 5 years) is that cities rush through the required phases of an innovation program: vision, trust, learning, embedding, upscaling etc. We have seen that it works better if the opportunity of having a project such as RUGGEDISED is used to proceed dedicated steps in an innovation journey. The example from Umeå in collaboratively having the time to develop an area-wide business model for sustainable energy, is exemplary in that sense. Dedicated use of a project such as RUGGEDISED also has its drawbacks. In Rotterdam we have seen that the framing as add-on to an existing urban development PPP in the Hearth-of-South Area also complicated the project. The timeframes and contracts of the PPP proofed much more inflexible than originally perceived and did not very easily allow for an ‘add-on’ (see also chapter 5 of this guide).

Experience from Umeå

Successful implementation relies on smooth connections between different levels of the city administration. Becoming a smart city is a strategic decision and should be coordinated from a strategic department (this also counts for other partners). However, most smart solutions will be implemented by operational departments and teams. Continuous dialogue and mutual understanding are desired. Ideally, the people implementing the smart solutions should have also been involved in the proposal phase. However, due to time constraints this was not possible everywhere. The advantage of involving people at an early stage is that implementation could be faster. However, a potential risk is that the bid would be less innovative.

Umeå is working on governance and business models to connect areas to 100% renewable energy sources. This exercise has delivered a complete set of theoretical options of how an optimised neighbourhood energy grid looks like in terms of economic and climate performance. These options are paralleled with organisational and business models that are founded on the idea of sharing costs and benefits. The actual investment does not fit in the RUGGEDISED time frame. The partners emphasise that it is a lot of work to implement the innovative business model in the different companies. The business model is not a traditional way of contracting. The partners are thinking of introducing smart contracts, perhaps using blockchain. Moreover, once implemented, every user within the organisations (including maintenance etc.) should be educated to use such flexible business models. Everybody involved has their own way of controlling the system. It can be a challenge for them to give this up and embrace the new system. As there is leadership that points the direction of a flexible and holistic value case, everybody must follow.

Experience from Rotterdam

The implementation of smart solutions relies partly on the right connection between different levels and departments within the municipality. For the implementation of every smart solution the cooperation of operational departments is necessary. An overall strategic vision to become a smart city requires involvement of the strategic levels in the organisation. A good horizontal and vertical coordination in the organisation could improve the speed of the implementation phase. But this is a challenging point to accomplish.

The success of an urban innovation pilot also lies in uptake of behavioural change at the operational level. The example of waste bin sensors is illustrative in that sense. Involvement and engagement of employees are crucial. Engaging and communicating with truck drivers whose work was affected by the new approach turned out to be one of the key enablers of the success of this pilot. The new approach required more flexibility from the truck drivers and the ability to learn new routines. The pilot, therefore, started with some volunteers that were used in a later stage as ambassadors for the approach.

Experience from Glasgow

One of the lessons learned is that smart solutions significantly impact the existing (energy) infrastructure. Very often the details on the exploitation, contracts and performance of existing infrastructure are not fully analysed during developing strategic smart city goals and smart solutions. After having had a detailed look at the existing electricity grid it turned out that the fault level was already too high to have additional feed in from the CHP. Scottish Power is

working on improving the grid, however, these additional investments cannot be done in the timeframe of RUGGEDISED (see also chapter 2).

4.3 Supporting theoretical notions

4.3.1 On the positioning of the urban innovation team within the organization

If we look at the complexity of smart city projects, they mirror what is often called a ‘mega-project’. Mega projects “build forward on existing realities, as they are not dropped in an empty world” (Salet et al., p. 2). Mega infrastructure and urban development projects, such as RUGGEDISED, are often “not conceived as a single and indivisible package, but as a more or less coherent accumulation of single elements [...] Usually, it is not the volume of mega projects as such that generates complexity of substance, rather it is the relatively loose, very dynamic and multi interpretable character of their substance matter. Projects may end up in highly complex (and usually controversial) attempts of multi-disciplinary integration” (Ibid).

In order to avoid innovation programs to end up in a patchwork of individual projects, it is key to steer clear of traditional project management. Kapsali (2011) examined evidence from twelve publicly funded innovation projects, she revealed that overemphasis on operational control and a lack of flexibility to manage boundary relations and operational change are critical factors for project management of complexity and uncertainty. She advocates to move away from conventional project management. First, because it treats the project as ‘an island’, with closed boundaries. Second, problematic change management is a consequence of tight operational control. An emphasis on closed boundaries and operational control hampers innovation projects; wrong assumptions regarding rationality and linearity create a paradox in project management, namely, that temporary organisations serve long-term organisational goals, and the irony that projects are managed with planning tools that are only applicable to predictable operational activities (such as batch production). Furthermore, the uncertainty, complexity and uniqueness of project activities make control difficult and deviations from plans probable, therefore, managers need flexibility to deal with non-linear innovation processes.

4.3.2 On cross-domain organisation

RUGGEDISED is focused on municipalities in the Lighthouse and Fellow Cities realising smart solutions (with the aim of reducing carbon emissions and improving smart-city capabilities). The smart solutions are exactly the radical/transformational acupuncture-type projects needed for true urban innovation. Governance is such an important instigator of urban innovation that it will be discussed here in detail. Schramm et al. (2018) even state that “governance is the major transformation effort”. As discussed, more intensive cooperation often leads to governance integration. Surely, integration is not a goal in itself, but it is crucial to reach the desired level of integration to reach the proposed goals. Stead & Meijer state that: “policy integration should not be seen as an end in itself but as a way of achieving practical outcomes that simultaneously fulfil the goals of more than one sector or tier of government” (Stead & Meijers, 2009, p. 330).

RUGGEDISED emphasised that governance integration is necessary to make sure that opportunities for a plurality-approach are not missed/neglected, in both the problem analysis as possible solution directions. Municipalities and governments should have a leading role in both horizontally and vertically integrating their project/program approach. Policy integration is an important mechanism to promote sustainable development. Different levels of integration are possible (see Figure 4):

- The first level of governance integration is **cooperation**, which is the degree to which collaboration exists in terms of programmes, resources, information and so on. Here, there tends to be more emphasis on vertical relations between administrative tiers. The concept of “cooperation” can be described as a form of working in association with other organisations for some form of mutual benefit (Huxham, 1996). The focus in this approach is strongly on the output of the collaboration process, often termed the “collaborative advantage”, a kind of synergy that legitimises the association.
- The second level of governance integration, **policy coordination**, aims to adjust sectoral policies in order to make them mutually enforcing and consistent. (Stead & Meijers, 2009). Coordination leads to adjusted policies or goals that remain sectorally separate and distinct.

- The highest level, **policy integration**, results in one joint policy for the sectors involved (Stead & Meijers, 2009). This difference in output is often coupled with differences in objectives as well. Common cross-cutting objectives, not sectoral objectives, are central to policy integration. Examples of cross-cutting objectives in spatial planning include sustainable development, competitiveness and quality of life. Stead & Meijers (2009) state that numerous examples of “integrated area development” initiatives can be found, which may involve coordinating various aspects of physical development, such as infrastructure, land development and construction, or incorporating social and economic development with physical development. Policy integration requires more interaction, accessibility and compatibility, leads to more interdependence, needs more formal institutional arrangements, involves more resources, requires stakeholders to give up more autonomy and is more comprehensive in terms of time, space and actors. Policy integration leads to joint decisions and/or actions and results in joint outcomes.

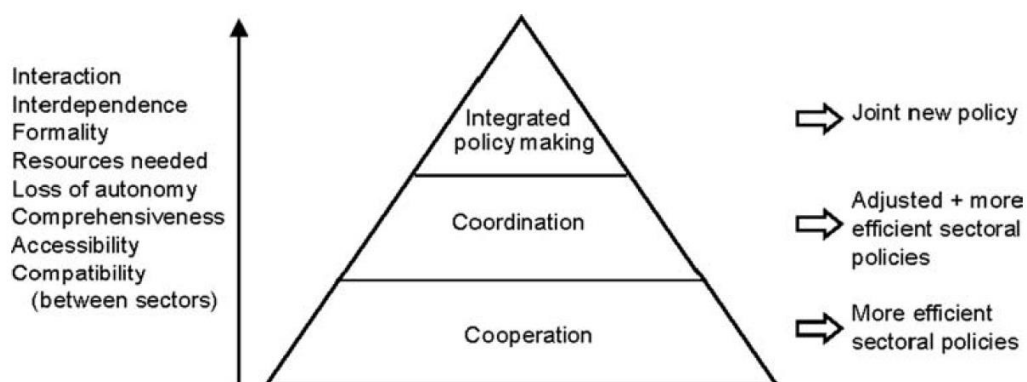


Figure 4: Integrated policy making, policy coordination and cooperation (Stead & Meijers, 2009)

5 Spanning judicial boundaries⁴

By implementing smart solutions, cities face legal challenges. Existing contracts, ownership structures, operating responsibilities and divisions of risk are put under pressure. This is a good thing, as the transitions that need to take place nudge nested systems to change. However, legal issues at the tactical and operation levels often turn out to be significant implementation hurdles. The early involvement of – and intensive cooperation with – the legal team allows to innovate together and to prevent complex negotiations and delays at an early stage.

5.1 Step-by-step guidance

- Explore, well in advance, what stakeholders are active in the innovation area, what their interests are and what agreements may exist (and what needs to be renegotiated) between them.
 - The development of new smart systems in an existing area, where many parties are active and operate under existing contracts, has proven to be one of the biggest challenges. Not all of these existing agreements are flexible and easy to change.
- Novel technologies, new roles and newly minted partnerships need a supportive legal framework, including standardised permits and contracts.
 - Developing contracts that support these new roles and partnerships is highly valuable to speed up the process. Research underlines the need for a more supportive legal framework.
- Gain experience with new roles and shared risks through intensive piloting and learning. Building up experience through pilots will allow parties to better understand the risks and benefits of urban innovation.
 - Municipalities can contribute by making their systems available for experimentation, by providing legal (and of course technical and financial) expertise. Another way to support such innovative systems is by carefully assessing the involved risks. Certain risks might need to be carried by the municipality in order to develop a successful pilot project.
- Rethink the regulatory framework for energy markets. Current rules on energy taxes and network tariffs, do not provide a sufficiently attractive business case to use local produced renewable electricity optimally.
 - Double taxes on storage should be eliminated. Today both green and grey electricity is taxed equally. Research is needed into how energy taxation and network tariffs can contribute to making the energy system more sustainable.
- Perform a data protection impact assessment (DPIA) to get a clear overview of what data can be gathered, used and disclosed. This DPIA is mandatory if processing of data can likely result in high risk to the right and freedoms of natural persons. In case it is not mandatory, a DPIA can still help to build compliance.
 - Designing a 3D city model is challenging because the public authority on the one hand has the responsibility to in a transparent and non-discriminatory way make public sector information available and on the other hand consider protection of public interest. This also includes that they protect personal data, including information that does not on its own present an individual risk, but could entail such a risk when that information is combined with other available information. In case the municipality is not sure whether the processing of data leads to identifiable information, anonymisation can be used to avoid the applicability of the GDPR, given that anonymous information does not fall under the scope.
 - Besides the GDPR there are other regulations and directives that determine what data can be shared on a City platform, like the ePrivacy Directive that requires providers of electronic communications to take measures to make sure that their services are secure.

⁴ The lessons learned presented in this section rely on in-dept interviews with the innovation partners in Rotterdam⁴. The results were then shared and discussed with the two other Lighthouse Cities; Glasgow and Umeå.

5.2 Illustrative example(s) and lessons learned from the RUGGEDISED Lighthouse Cities

Experience from Rotterdam

Experiences regarding contractual agreements

The development of new smart systems in an existing area, where many parties are active and operate under existing contracts, has proven to be one of the biggest challenges in Rotterdam. Due to the RUGGEDISED project, existing agreements were challenged and re-negotiated. This was in particular true for the Smart Thermal Grid. The Smart Thermal Grid, one of Rotterdam's smart solutions in the RUGGEDISED-project, it is developed in the Heart of South-area. Before the start of the RUGGEDISED project all (re)developments were tendered by the municipality, including the Smart Thermal Grid. Ballast Nedam/Heijmans won this tender and this resulted in an extensive public private partnership (PPP) agreement between the municipality and Ballast Nedam/Heijmans on the developments in the area. The agreement includes a strict time schedule and high penalty clauses for the builder, as a result the builder is wary not to jeopardize the agreement as it could result in large fines.

The Smart Thermal Grid is also one of the smart solutions in the RUGGEDISED-project, which is executed on top of the (re)development of the Heart of South-area. It turned out to be challenging to allow both contracts, the existing PPP development-agreement and the RUGGEDISED-agreement, to coexist.

In addition to the adjustments of all these existing contracts the nature of the two projects - the PPP agreement between the municipality and the developer on the Heart of South-area and the RUGGEDISED-agreement-, caused issues. The contracts are completely different as RUGGEDISED has all aspects meticulously documented and budgeted, while the PPP was functionally tendered, meaning that in this particular case only the results and outcome are agreed upon, and the involved parties are free to determine the most cost-efficient path to those goals. The difference in the nature of the contracts, the functionally tendered PPP versus a detailed contractual agreement (RUGGEDISED) causes challenges for the involved actors. A number of smart solutions, the Geothermal seasonal heat and cold storage R1, Thermal energy from waste streams R2, Surface water heat/cold collector R3 and Pavement heat collector R4, are part of both the Heart of South agreement between the municipality and Ballast Nedam/Heijmans and the RUGGEDISED agreement.

Ballast Nedam/Heijmans, the developer of the Heart of South-project, was initially chosen as RUGGEDISED partner and agreed to build a Smart Thermal Grid in the area, connecting several existing and yet to be constructed buildings in the area. However, in 2018, Ballast Nedam/Heijmans decided to hand over their responsibilities (to build this thermal grid) arguing that it was not part of their core business to develop a Smart Thermal Grid and accompanying solutions. Eneco, the energy company and already partner in the project with experience in district heating, and heat supplier of Ahoy -one of the major customers to connect to this new grid-, was willing to take over these responsibilities. A large number of actors was involved in the development of the Smart Thermal Grid and accompanying solutions (Ahoy, Eneco, the municipality, subcontractors, Vattenfall -heat supplier in the area-, as well as potential new buildings such as the nearby cinema and the hotel). All these existing contractual agreements, in combination with funds and responsibilities that were agreed upon in the Description of Work in RUGGEDISED, needed to be revised as a result of this switch. This resulted in a long negotiation process, delaying the project.

Experiences regarding data collection and sharing in the city

The municipality of Rotterdam is currently developing a 3D city model. The aim of the city is to create a digital twin that will allow to get more insight into the real-live statuses, streams and movements of traffic, infrastructure, energy demand and usage of public functions (such as lamp posts and garbage bins), and above all to share data freely with the citizens and businesses. The model includes amongst other things energy consumption data of different buildings, real time parking lot data, data on traffic mobility and data on waste removal. The aim of the municipality's project is to learn how to build such a platform and understand what data they want to make available and to whom. Other important questions concern the governance of the platform; who will develop and own the platform and which parties will own the data? At this stage of the project there are also still questions regarding the added value of such a platform; what services can be developed with the data?

The 3D city platform does not only contain datasets from environmental sources, it also generates log-data. In Rotterdam there is a discussion about to what extent the log-data that will be produced by the users of the platform, can be part of the business case, and under which conditions. The municipality also examines what conditions they

must impose on the contract and the contracting party.

Many cities are experimenting with developing city dashboards, platforms or models (Barns, 2018). Using data from infrastructure, smart (sensor) networks, social media etc (Finch & Tene, 2018). So far, the municipality of Rotterdam has focused on collecting non-personal environmental data. To further explore what data can be gathered, used and disclosed in the 3D City model, the municipality intends to what they call 'intentionally enter a grey area' and experiment with what is allowed under the GDPR. Rotterdam would like to gather more data in their 3D city model without a specified purpose. Instead of determining the purpose in advance, the municipality will do a data protection impact assessment, when an appropriate application for the data is found. This will be in the form of an ethical committee, which will assess the use of data for each particular application (Finch & Tene, 2018).

5.3 Supporting theoretical notions

Three main directions of legal challenges were encountered, and will all be discussed in this subchapter: existing contractual agreements and the interaction between PPP's and RUGGEDISED, the necessity for new partnerships and roles, the legal challenges surrounding Urban Data Platforms and the legal challenges of the production, storage and consumption of electricity.

5.3.1 On the contractual agreements and the combination of Public Private Partnerships (PPP) in tandem with RUGGEDISED

Different types of contracts and projects

Innovation programs and subsidies often interfere with existing contracts and Public Private Partnership (PPP) agreement. The detailed elements that are required to get subsidies from National Governments or the EU are often difficult to match with the specifics of PPP agreements.

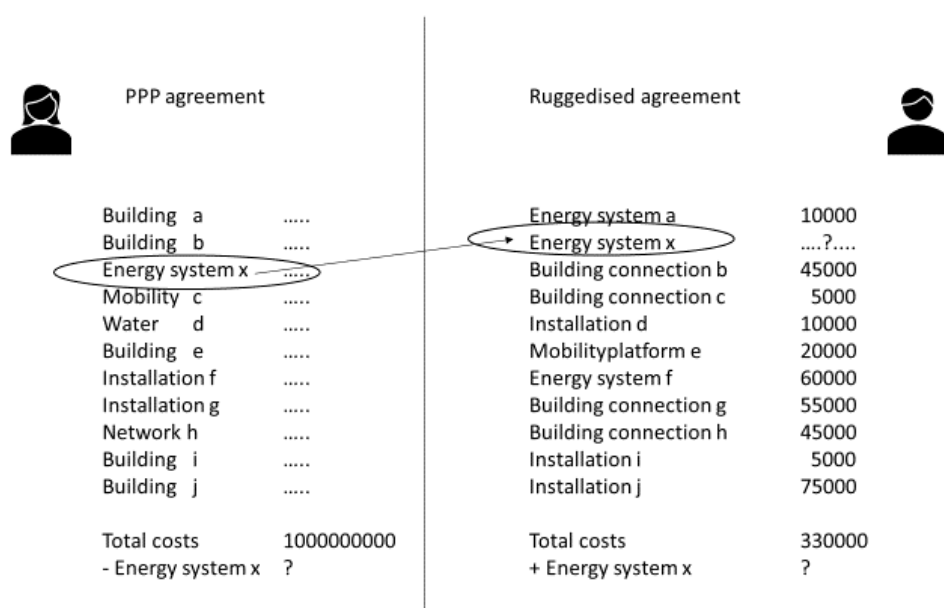


Figure 5: difficulties to match innovation programs with PPP contracts

PPP's often involve long-term commitments and collaborations. In the course of such a long-term agreement the wishes and needs of, for example, the client or contractor may change. In this case the grid was no longer developed by the contractor. Due to the absence of a clear budget, it was difficult to deal with the contractual changes. Studies show that PPP agreements often face major challenges due to changing circumstances. According to these studies this is i.e. caused by a lack of understanding of the complex environment in which PPP's contracts are realized (Demirel et al., 2017).

In large construction and infrastructure projects, partners are often entering into long-term agreements. The context in which these actors operate is highly complex, with many stakeholders involved. There is often a high level of

uncertainty involved and the agreements will most likely be affected by change. According to Demirel et al. (2017) more pro-active anticipation of possible changes in the pre-contractual phase could improve the contract and prepare business partners for possible changes. In this particular case using functional specification in the tender procedure helped to develop an ambitious plan for the area, but more specific details on the budget in the final contract would have helped the final agreement to become more adaptable for change at a later stage.

5.3.2 On data collection and sharing in the smart city

Combining different data sets, from both commercial companies, but also different municipality departments, can lead to new and unexpected applications. This is a common heard experience; *“the purpose of the processing shows itself after the processing is done”* (van Oirsouw & de Lama, 2019). The municipality intends to collect and store all sorts of data streams, even if they do not know (at this time) how these data eventually be used. Developing an Urban Data Platform is challenging because the legal landscape on data is large (see Figure 6). There is legislation protecting the processing of personal data, and at the same time there is legislation that supports free flow of data.

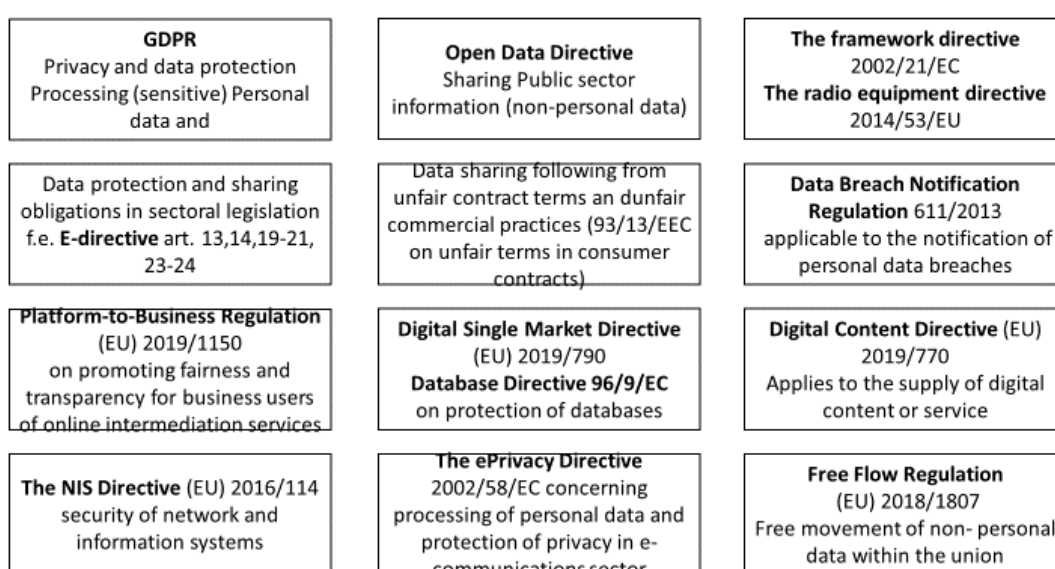


Figure 6: The legal data landscape

A (not comprehensive) overview of the EU legal landscape on data, based on the LeMO report Data-related legal, ethical and social issues (2019).

The use of personal data is regulated under the new General Data Protection Regulation (GDPR), that protects the privacy of people living in the EU. Processing of personal data is protected by the core principles: lawfulness fairness and transparency, purpose limitation, data minimisation, accuracy, storage limitation, integrity & confidentiality and accountability.⁵ Personal data can be a valuable resource, not only for commercial companies, but also for public parties, like local governments, that would like to get more insight in how to improve city infrastructure, reduce CO₂-emissions and more. Some data is in the possession of the municipality and other information is held by commercial companies, public undertakings and citizens.

As reference to the illustrative example: to avoid legal issues the city of Rotterdam has until now focused on environmental, non-personal data, regarding traffic mobility and waste collection. However environmental, non-personal, data often carries a human factor and reveal some information about human activity in the city (Finch & Tene, 2018). The city is aware that by combining physical data, eventually data may become personal data (van Oirsouw & De Lama, 2018). Today the discussion not only focuses on protection of personal data, but also increasingly discusses so-called public sector information (PSI) (Drexler, 2019). This data is mainly held by the public sector, like municipalities. Public sector information can be used to develop new (digital) services or improve policy making. Rotterdam expressed that the platform can be used to facilitate access to this data.

These ambitions are supported by the *Open Data Directive*. The directive supports that data in an ‘open format can

⁵ For more information read LeMO report on Legal issues (2018), p. 19-27

be freely used, re-used and shared by anyone for any purpose'. The Directive wants to ensure that this happens in a non-discriminatory manner. The directive does not apply to personal data,⁶ meaning that public sector information that encloses personal information may not be disclosed.

The regulatory framework on data shows that there is a wish to protect personal data and at the same time the EU is promoting a data driven economy that stimulates the use of open data to develop new innovative services.⁷ Even though the Open data directive is straightforward about personal data not to be disclosed, there is no simple answer to what data can be openly shared and contribute to develop new services and what data should be protected. Reason that this is challenging stems from the broad definition of personal data, meaning *all information that relates to an identified or identifiable natural person*.⁸ As mentioned above by combining different datasets, also non-personal data will become identifiable. The protection of personal data challenges sharing of public sector information. For a complete overview and analysis of European data regulations read LeMO report on Legal issues (2018).⁹

Partnerships

The tension between on the one hand the possibilities that a 3D model of the city and open data can offer, and on the other hand the protection of privacy interests of citizens, also plays an important role in how the ownership of the platform will be organised and what role the municipality should play in this. Several commercial companies have shown their interest, they even offered to build the digital twin and database for free. The municipality is now leaning towards a public-private-partnership. The partner will be selected in a tendering procedure. According to Finch and Tene (2018) cities are increasingly co-operating data intensive projects with commercial companies (Finch & Tene, 2018). Cities are often relying on commercial companies for the deployment, maintaining the network and publishing the data. These parties, naturally, have different -commercial- incentives. However, municipalities have significant purchasing powers and can make high demands (Finch & Tene, 2018).

Access to data

Up till now it has been challenging for the municipality to access data from different municipal departments and public and commercial companies, due to several reasons. One of the main issues is that the data is what they call *immature*, meaning the data is not available in a readable format or the quality is not up to standard. In addition to that, the exchange of data between departments is hampered because the regulatory landscape on data is experienced as complex. The municipality struggles with the question to what extent they can gather, use and disclose data (Vojkovic, 2018). A public authority as the municipality has in general the obligation to *appropriately manage risks*. In order to be able to appropriately manage risks, Rotterdam will have to map the data that is collected; determine how sensitive the data is, if it can be related to persons¹⁰, how data can be combined, and what the results are of combining datasets etc (Finch & Tene, 2018). As a result of these responsibilities, departments are less willing to share all sorts of data. Since the GDPR's entry into force, the municipality experiences that employees are hesitant to share data between departments.

Access to data is especially challenging if it comes to commercially held data. Private companies that generate data are reluctant to share it. There are several legal ways to, in certain cases, demand commercial companies to share data. According to the LeMO report (2018) more and more data sharing obligations are imposed through public tendering. An example of this is described in the last paragraph of this chapter. According to the LeMO report (2019), commercial companies mainly exchange data on contractual basis, by so-called Data-sharing agreements (DSA). The current legal framework does not include many rules that regulate data sharing between commercial companies.¹¹ Coming to an agreement with a private company can be a long process and hamper access to data.

⁶ Article 1 of directive (EU) 2019/1024

⁷ LeMO D2.2 – Report on Legal Issues (2018). Available via: <https://lemo-h2020.eu/deliverables>

⁸ Article 4 (1) GDPR (EU) 2016/679

⁹ LEMO

¹⁰ Bird & Bird, Data-related legal, ethical and social issues, Anonymisation/ pseudonymization, August 2019, p. 17

¹¹ Bird & Bird, Data-related legal, ethical and social issues, august 2019, p.77

6 Sustainable financing and collaborative business models

The systemic and connective nature of smart solutions and urban innovation diverge from the unidimensional and clearly demarcated characteristics of business models and financing incentives. Sustainable financing incentives stimulate to redefine ‘added value’ in a future-proof way. Moreover, in a smart city, smart urban infrastructures, more often than not, allow public and private partners to provide a range of services to various consumers. In order to exploit this diversified capacity of urban infrastructures and optimise the design of these infrastructure at area – or city – level, collaborative business models provide suitable opportunities to overcome split-incentives.

6.1 Step-by-step guidance

- Take time, together with the innovation partners, to invent and discuss new financial methods and vehicles. Novel complex smart solutions demand new financial methods and vehicles. Funding and committed capital is crucial for the realisation of smart solutions.
 - There are three specific aspects of low-carbon technologies, renewable energy solutions and energy efficiency projects that restrict their access to capital: High(er) upfront costs, risk and perceived risk and different business models from traditional energy systems.
- The public procurement procedure plays an important role in many of the smart solutions. It is often experienced as a complex procedure, but at the same time has proven to be a valuable tool for local authorities to define what they want to develop/ buy.
 - There are several ways competitive tendering procedures that can be used for innovative projects. For example, the municipality of Rotterdam suggests that they will tender for an Innovative Partnership the next time they would like to develop a new product or service.
- A market consultation and tendering pilot helps to define the final contract. In order to make use of the creativity of the market and to stimulate innovative solution, the contracting authority could functional tender, meaning that only the goals are specified.
 - Functional tendering can be a way to stimulate innovation. The final contract between the contracting parties, however, should be sufficiently clear, to facilitate that single parts of the agreement can be, if necessary, renegotiated at a later stage
 - Dividing a tender into different steps can be a great way to add flexibility and reach the still uncertain satisfactory end-goal.
- Cities and municipalities can issue Green Municipal Bonds to cover the costs of the projects, and can form public-private partnerships (PPPs). Private-public partnerships can allow for different business models such as concession, shadow pricing and other combinations.

6.2 Illustrative example(s) and lessons learned from the RUGGEDISED Lighthouse Cities

The development of a very strong partnership is crucial. Specific technologies and innovations are complex however, it is really challenging to connect all elements with each other. That means that smart city development is based on understanding the interests that are at stake. A successful implementation relies on co-creation and optimising the whole, instead of aiming for partial gains. Everybody can see that this is true; however, in real life real co-creation is a complicated challenge.

Experience from Rotterdam

In Rotterdam the municipality rolled out a smart waste collection system. Each of the waste containers is fitted with a sensor that measures how full the container is. This data is used to calculate the most efficient route for each garbage truck. Given that this is a new system, the municipality decided to first organize a pilot project. In this pilot project the services/concession were tendered through a public procurement procedure.

After the service was tendered and running, the municipality requested the data from the garbage bins. The aim was to use the data in their 3D city model that the municipality develops. The garbage company, however, refused to disclose the data, arguing that this was not part of the agreement.

A second pilot was organised, and the municipality of Rotterdam included the condition that the smart waste data should be shared with the municipality. Unfortunately, the municipality did not include any conditions on how the data should be shared; in which format and that the data should be shared pro-actively with the municipality. Once again, the municipality was confronted with the importance to accurately describe the service. This time the waste company argued that the data could be collected at their office and the data that was shared was difficult to read for the municipality.

In the final tender for the larger area conditions concerning collection and sharing of data are accurately described. The municipality now receives the data in an agreed-upon format. The data is also uploaded to the City platform discussed in the second paragraph of this chapter.

One of the major challenges in competitive tendering for the ordering party, in this case the municipality, is to clearly define what they want to purchase; what type of services, goods or works does the municipality want. The call for tenders for waste collection services by the Rotterdam Municipality, smart solution R13 “Smart Waste Management”, illustrates this. This example illustrates that the more experience a contracting authority has, the more accurate they can formulate the content/conditions of the agreement. Purchasing new innovative, often complex, services is therefore specifically challenging. It often proves to be impossible to accurately describe the acquisition. The Rotterdam municipality resolved this by setting up small pilot projects and gathering experience before tendering the final contract for the entire area. The example also illustrates how the municipality gained access to data by including it in their tender.

Experience from Umeå

Umeå emphasized that it is hard to get a good picture what ‘functions’ are needed beforehand, at the beginning of a project. Sometimes such complications turn out positive. During the procurement for the new bus stop in Umeå, they used a new procurement-procedure with an important criterium: work together.

The procurement-procedure was subdivided in small procurement steps during the process (step-by-step). Umeå stated that this worked really well. The main reason being that so much can happen during the process. Half-way through one might come to the conclusion that the planned end-result is undesirable.

As discussed earlier in this guide; flexibility is truly important. Umeå stated that dividing the procurement process into different phases is a great way to add flexibility. After all, so much happens with complex projects in the meantime. Surely, with these decarbonizing smart solutions in a way it means procuring the future. Procurement is so uncertain; so there has to be flexibility (and process with different phases). A potential legal risk is present with this strategy; a company that lost procurement is going to file legal injunctions (for example because they want to stay with the start of next phase). This can cause a legal procedure that is capital- and time intensive.

In Umeå the energy company aims to find costumers to join their new business model. They tried to work out ways to work together with businesses and property owners. The new business model is about EPC (energy performance contract). The company that is providing the solution gets a percentage of that reduced energy bill. The process goes as follows: gather data from the house as-is (establish baseline measurement); difference; energy is cut. Clients are anxious to agree on such an EPC-contract. They obviously state why would our energy company work with us to cut our energy bill? They should want to sell more energy? But a lower energy bill is very beneficial for the energy company, because they are able to cut overall capacity as the peak load is lower. Peak loads are the most expensive.

Experience from Glasgow

Glasgow’s smart solution G1 (business models for heat-cold exchange) was completed in August 2018. The development of two business models and the creation of a contractual model for implementation, which is agreed by all stakeholders to be an accomplished piece of work, will enable more informed contract negotiations between generators and consumers of heat and facilitate easier establishment of heat connections in the future. The contractual model is readily available for both public and private sector actors to utilize as the basis of any negotiations. The contractual model also includes a guidance note that provides highly valuable information on procurement regulations and how they affect potential consumers, thus giving confidence to any potential heat consumer that they are acting within the regulations.

6.3 Supporting theoretical notions

6.3.1 On public procurement

In many of the smart solutions competitive tendering, through public procurement procedures, plays an important

role. The public procurement procedure and the resulting agreement is in some cases experienced as a barrier, due to conflicting interests between the earlier agreement(s) and the new plans for the area. In other projects the public procurement procedure is used to fine-tune specific terms and conditions that have been supportive to the project. There are different types of public procurement procedures that can be followed, like the standard open procedure and the restricted procedure. If there is a need for goods, services and products that still needs to be developed, the procedure of an innovation partnership or competitive dialogue can also be used. Especially when a municipality want to develop new innovative solutions that are not available on the market yet, this can be an attractive option. Other procedures to by-pass a lack of knowledge are also available. There are competitive tender procedures possible that allow room for negotiation, like the competitive dialogue. This procedure is reserved for the situation that the contracting authority cannot properly describe the acquisition in full (Haugbølle & Gottlieb, 2015).

Preliminary market consultations can also help contracting authorities in preparing the procurement. The consultation will provide the authorities with knowledge about different options and offers available in the market¹². A market consultation does not replace a competitive tendering procedure, but can be used to prepare the procurement. Another possibility is to tender for an innovation partnership. These procedures are used when the scope, content and price of the contract are difficult to determine¹³.

Competitive tendering procedures	
Open procedure	Market consultations: provide authorities with overview of available innovations, help to finetune final selection and award criteria Anyone may submit tenders. All tenders are considered without prior selection
Restricted procedure	Two-stage process: Anyone may ask to participate, but only pre-selected may submit tenders. Selection is often based on a pre-qualification questionnaire
Competitive negotiated procedure	Anyone may ask to participate, but only pre-selected can submit an initial tender and negotiate. Procedure can only be used if negotiations are necessary. Minimum of three candidates, candidates can be selected through a restricted procedure
Competitive dialogue	Aims to create more flexibility. Procedure used innovative projects, that have not been done before. If it is impossible to define the technical, financial or legal means, this procedure can be used.
Innovative partnership	Innovative partnership allow for the procurement of research and development. Can be used for innovative products and services. There are 3 phases: a competitive phase, research and development phase, commercial phase

Source: ec.europa.eu: Public procurement guidance for practitioners

Figure 7: Public Procurement Guidance

6.3.2 On Sustainable finance

No project would be realised without proper funding. The EU's High-Level Expert Group on sustainable finance (HLEG, 2018) state that Europe's wide-ranging sustainability challenges need sufficient, stable and committed capital and financing. HLEG (2018) emphasises that it is essential to invest in innovation, using vital public R&D funding to stimulate private financing and deliver transformational changes in technologies, business models and services. The complex projects covered in this guide often require new ways of thinking and learning as well as novel forms of collaboration. There are three specific aspects of low-carbon technologies, renewable energy solutions and energy efficiency projects that restrict their access to capital: High(er) upfront costs, risk and perceived risk, different business models from traditional energy systems.

Sustainable finance will play a crucial role in the energy transition and future EU decarbonization and smart-city endeavors.

The novel smart solutions proposed during RUGGEDISED often demand a radical change in mindset, as well as

¹² Directive 2014/24/EU

¹³ Directive 2014/24/EU

business approach. Sustainability transitions involves the substitution of resource use and pollution with technology and know-how, this means more upfront capital in long-lasting assets – (such as efficient lighting, clean energy infrastructure) instead of the continuous throughput of energy and materials. This puts prime importance on the cost of capital, its time horizon and its quality — notably in terms of the sustainability factors being considered (HLEG, 2018).

Nunez Ferrer et al. (2017a) state the following options that are present to overcome aforementioned financial barriers: public grants and subsidized loans, public subsidies based on monetizing positive spillovers, fiscal incentives and public private partnerships (PPP). Nunez Ferrer et al. (2017b) further specify these options in sustainable finance on different levels. The EU has the following financial tools available as public financial support:

- European Structural and Investment Funds;
- EU project development assistance;
- Other EU financial instruments and programmes.

National governments can also intervene with the following financial vehicles:

- Grants and subsidies: financial aid granted by Member State governments can partially overcome the upfront costs of energy-efficiency investments. This avenue is however limited due to the EU state aid rules.
- Tax exemptions, VAT reduction: indirect measures are less costly for the public authorities than direct subsidies.

As RUGGEDISED focuses on Lighthouse and Fellow Cities in the EU the following options can be very helpful:

- Cities and municipalities can issue Green Municipal Bonds to cover the costs of the projects, and can form public-private partnerships (PPPs). The EIB and national promotional banks also play an important role in investments in sustainable smart city technologies.
- Private-public partnerships can allow for different business models such as concession, shadow pricing and other combinations. Raising investment capital by project agglomeration or crowdfunding is also gaining track.

7 Towards better decision making

Due to the complex and systemic nature of smart urban infrastructures, in urban innovation programs actors from different backgrounds and different expertise come together. As no single actor has the capacity to fully understand the entire system with all its complexity, problems and challenges that stem from this complexity and intertwinement are usually not well defined. Each actor builds on its own knowledge base (and its own understanding and demarcation of the system), which complicates the identification of collective knowledge gaps. Consequently, bringing suitable knowledge into policy-making and decision-making processes, requires an enormous effort. Boundaries have to be spanned, which is an intensive, yet crucial, trajectory.

7.1 Step-by-step guidance

- On a structural basis, together with the innovation partners, take the time to reflect on how everyday practices include beliefs and routines that perhaps do not contribute to the overall aim of learning in innovation programs.
 - Try to link these fundamental reflections to nudge everyday practices into the right direction.
- Collaboratively map and discuss the information requirements and knowledge gaps. Note that knowledge on particular areas and urban systems is scattered among partners, and partners do not necessarily agree on each other's knowledge base. Articulate contradictions and information asymmetries. Collaboratively discuss with (external) partners can develop and provide trusted information to the innovation partnership.
 - External partners can help to articulate knowledge questions, as it often proves difficult to know what you do not know.
- On a regular basis, shift mindsets through role-playing games in order to create awareness of how valuable your information is to other cooperation partners.
- Create a shared vision at the start of the urban innovation program, based on the values that each partner would like pursue and the goals that each partner would like to achieve. Search for collective values and goals, but also appreciate differences, and openly discuss conflicting interests. To update and discuss the shared vision is a continuous task.

7.2 Illustrative example(s) and lessons learned from the RUGGEDISED Lighthouse Cities

The RUGGEDISED Lighthouse Cities exchanged knowledge in Liaison Group meetings. Within these meetings the consortium provided the prerequisites to collaboratively build knowledge and reflect on the complexities of urban innovation. Within the Liaison Groups all participants have their own 'individual mental models', shaped by politics, culture, organizational contexts and personal experiences. The idea behind the cross-city learning was to 'gently nudge' these mental models into shared mental models, via group processes and the use of knowledge brokerage strategies. Although such group processes are crucial to build a group-feeling, two general comments should be made on the aim to collaboratively build knowledge and deal with complexity. Amongst other reflections, deliverable 1.7 "Lessons learned on the implementation of smart solutions in the Lighthouses, final report 3/3" concluded that (1) fundamental shifts in mind-set are difficult to combine with the everyday practice of smart city project development, and that (2) articulating knowledge questions is no easy and obvious task.

Complexity of connecting fundamental reflections to everyday practice

A key issue to address in cross-city learning is the relevance of fundamental reflections for everyday practice. The Lighthouse Cities are involved in complicated projects that require a lot of time, effort and concentration. The Liaison Group participants wanted to be fostered during the meetings. They needed inspiration and solutions to the challenges they were readily dealing with. Their expectations sometimes conflicted with the fundamental reflections we tried to provide in the Liaison Group meeting. Shifting focus from: "are we doing things right?" towards "are we doing the right things?". Fundamental reflections enrich the implementation process, however not right away. It was a challenge to connect fundamental reflections to everyday practice, challenging for both the facilitators as well as the participants. Fundamental reflections aim to get past 'political sensitivities' and discuss fundamental content. This point refers to the earlier reflections on the difference between the perception of a smart city project as an

urban development project or an innovation program. Innovation programs inherently deal with political sensitivities, because you are challenging things you have always done a particular way. (RUGGEDISED, 2020a, p.32)

Difficulties to articulate knowledge gaps/questions

One of the aims of the Liaison Group meetings in RUGGEDISED was to collaboratively build knowledge and define knowledge gaps. This point once and again proved very difficult. To know what you do not know is a challenging task. The Liaison Groups and the knowledge partners provided the Lighthouse Cities with a lot of information, in particular on EV charging choices to be made (Glasgow), heat grid governance and business cases (Rotterdam and Umea) and innovation labs (Rotterdam). TNO observed that it really helped here to put a lot of time in preparing the sessions and articulating the knowledge questions, together with the Lighthouse Cities. Moreover, ‘matchmaker’ sessions during the Liaison Group meetings also provided the participants with direct contacts and an overview of the expertise available in the consortium. However, we must conclude that the ambition to be a clearing house and knowledge broker is harder to meet than expected before. This is partly due to the point mentioned on connecting fundamental reflections to everyday practice and the variety of specific and local contexts. The University of Strathclyde did a lot of work for Glasgow, Rise for Umeå and TNO for Rotterdam. However, we did not have the time to translate this specific knowledge to a generic level and make it open for the other cities. One of the reasons is that the demand-driven agenda setting prioritised other issues over this specific knowledge development. However, we tried to bring in as much expertise as possible from the knowledge institutes (University of Strathclyde, Erasmus University, RISE, AIT and TNO). Our experience is that, in this regard, it helps best to carefully discuss the issues that Lighthouse Cities want to bring into the sessions well in advance. Knowledge institutes can help to articulate knowledge questions and coordinate that the necessary expertise is at the table, the moment issues are being discussed among Lighthouse Cities. This way the Liaison Groups can apply a matchmaking strategy and put both external participants as well as the Lighthouse Cities themselves in the position to inform and advice policy makers in a targeted way. (RUGGEDISED, 2020a, p.32)

The added value of serious gaming

The Liaison Group participants were invited to play a serious game focused on a local energy transition process in a fictional urban district; the GO2zero simulation game. The game was developed by TU Delft in the context of the H2020 project CityZen. The game simulates a (small part of a) low-density suburban neighbourhood, with terraced houses, semi-detached houses and low-rise apartment buildings simulating a very frequently occurring neighbourhood in a European city (Bekebrede, van Bueren & Wenzler, 2018). The goal of the GO2zero game is to reduce CO₂ emissions in the district to zero and to reduce the neighbourhood’s energy consumption by 50% with the additional requirement that all the energy is produced locally. The game was included in the Liaison Group meeting because it encourages a re-evaluation of the system as we know it: the roles of the different stakeholders and how carbon reduction goals can be achieved. The RUGGEDISED partners collaboratively defined the importance of:

- Large disruptive investments. During the game, participants invested in disruptive technologies at a very late stage. Early in the game, small investments and bottom-up initiatives related to the dwellings’ energy efficiency dominated the transition. A lack of strategy and financial resources withheld the utility company from big investments in the beginning.
- Continuous information sharing. The network operator emphasized the importance of information in order to timely develop the grid and to facilitate the initiatives pertaining the local green energy generation. Without this information the network operator was always lacking behind in planning. It was forced to be reactive, which led to a rushed planning and sub-optimal situations. The municipality also clearly lacked information on the investing capacity and preferences of the citizens and housing corporations. This led to subsidy measures which were not always effective (shared subsidy in sun and e.g. heat pumps would tackle both electricity and heat challenge) or efficient (too much subsidies leading to overinvestment in solar PVs).
- Public leadership. There were many discussions on the way to go and possible solutions by the players. However, during those discussions there was always a critical and strong (public?) party missing. This led to many ideas never materializing. The importance of having the right players at the table at the right moment was emphasized by this observation.

7.3 Supporting theoretical notions

7.3.1 On complexity and knowledge

In earlier deliverables (D1.1 “Lessons learned on the implementation of smart solutions in the Lighthouses, interim report 1/3” and D1.2 “Overarching innovation and implementation framework”) TNO extensively discussed the epistemological consequences of dealing with complex systems. In other words: **what role does knowledge have decision-making on urban innovation projects?**

In chapter 2 of this deliverable, we have argued that urban innovation increases interdependencies and requires a system view. Following the complexity view¹⁴, policy developers and decision makers are confronted with so called complex (environmental) problems, sometimes even characterized as “wicked” (Head & Alford, 2015) or “super wicked” (Levin et al., 2012) problems. “Wicked problems are generally associated with social pluralism (multiple interests and values of stakeholders), institutional complexity (the context of interorganizational cooperation and multilevel governance), and scientific uncertainty (fragmentation and gaps in reliable knowledge)” (Head & Alford, 2015)¹. In addition, Funtowicz and Ravetz (adapted from Van der Sluijs, 2012) provide a very helpful typology of complex (environmental) problems by distinguishing 6 typical issues that decision makers have to face in complex policy making situations:

- Decisions should be made in an early stage, before enough scientific evidence is in place
- The error costs of decisions are high
- Many different values, and values are in dispute
- Large uncertainties within the knowledge base
- Assessment dominated by assumptions, scenarios and models
- Many hidden value loadings in problem frames, assumptions and chosen indicators.

The importance of knowledge increases, to tackle these challenges. However, what kind of knowledge are we talking about?¹⁵ In general knowledge may be divided along two axes. The first axis distinguishes between different types of ‘what is known, the subject of knowledge’. On the one hand knowledge may refer to events and fact-based information (knowing that), and on the other hand it may refer to relational, procedural, and implementation related information (knowing how). The second axis refers to the ‘transparency’ and awareness/readiness of knowledge. Transparency both from the side of the owner of the knowledge (is he/she aware of the fact that he/she has this

	Knowing <i>that</i>	Knowing <i>how</i>
Explicit Knowledge	Facts, events	Procedures, relationships
Implicit Knowledge / Tacit Knowledge	Mental models, causal relations, experiences,	Heuristics: the way in which mental models and convictions shape your actions: for instance drive decision making and define boundaries of the ‘search for options’

knowledge and that it drives its behaviour?) as well as from the side of the receiving partner. On this axis a distinction is made between explicit and implicit knowledge.

Table 4: Types of knowledge

7.3.2 RUGGEDISED Smart City Guides

Prior to this deliverable, TNO, RISE, the University of Strathclyde and the Lighthouse Cities wrote three other smart city guidance documents in which RUGGEDISED lessons learned have been translated into easy-to-use steps to deal with challenges in becoming a smart city.

¹⁴ This section is based on Woestenburger, Carter and Schingenschloegl (2017), RESIN coping with complexity, handling uncertainty.

¹⁵ This section is based on RUGGEDISED D1.1 “Lessons learned on the implementation of smart solutions in the Lighthouses, interim report 1/3”

- D1.4 – Guide on setting up Innovation Platforms (RUGGEDISED, 2019b)
- D1.5 – Prototype Smart Energy District planner – this deliverable establishes the basis for a prototype smart energy district planner (SEDP) that comprises the generic process, and specific tools, tasks, information and stakeholders required to develop and evaluate a smart solution for a sustainable city district. (RUGGEDISED, 2020b)
- D1.6 – Guidance on Smart City Design and Decision Platform - this guide on Urban Data Platforms synthesises the lessons learned from the implementation phase of the RUGGEDISED project. (RUGGEDISED, 2020c)

These three guides all provide tools – in their own way – to deal with the issues of unravelling the urban system’s complexity and applying collaboratively developed knowledge into decision-making processes. To give some illustrative examples:

- Table 5 is an excerpt from D1.4 and shows how different knowledge brokerage strategies relate to various forms or innovation platforms.
- Figure 8 shows the conceptual model from D1.5, that relate to the smart energy district planning process. This process includes four collaboratively designed appraisal phases that shape the route from initial goals towards the technical design of smart energy infrastructure. The appraisal phases are meant to collect and appraise knowledge from a variety of stakeholders and angles.
- Figure 9 presents a process to develop an urban data platform, D1.6. According to the lessons learned in RUGGEDISED, significant emphasis is put on the importance of a joint and binding vision at the start of the development process.

The smart city guides can be downloaded [here](#)

Furthermore, the Ruggedised fellow cities had been intensively working on a guide on replication assessment. This report (D7.3 Intermediate replication assessment) provides a (qualitative) evaluation framework for replication assessment and supports capacity building and effectiveness of replication activities regarding smart solutions. It can be downloaded [here](#)

Table 5: Types of Innovation Platforms (RUGGEDISED D1.4 Guide on setting up Innovation Platforms)

Type	Goal	Addressed knowledge brokerage principles	Addressed actors	Activities
Network of platforms	Knowledge exchange between cities with the innovation ecosystem in the focus; connecting local initiatives to the global level	Matchmake Build capacity	Cross-sectoral Both actors from local initiatives and the global level	• Network meetings, study visits • Exchange of ideas and knowledge
Local networking platform	Build local capacity among practitioners and establish local networks, creating new ideas	• Inform • (Consult) • Matchmake • Build capacity	Local stakeholders across sectors and institutions	Knowledge exchange formats around various thematic clusters, initiating and supporting projects
Supportive/financing platform	Use or distribute financial resources/incentives to support projects	• (Inform) • Consult • Collaborate	Start-ups, SMEs	Support with different forms of funding, such as venture capital, for upscaling and diffusion
Collaborative & strategic platform	Bringing together stakeholders to implement and/or to work on urban innovation/development strategies; strong governance focus following the strategic goals of the city	• Engage • Collaborate	Different actors/stakeholders (cross-sectoral, cross-administrative, and quadruple-helix)	Meetings, working groups, establishment of strategic alliances
Co-creation platform	Provision of a specific location (e.g., 'space' and 'lab') to support a creative, experimental milieu, focused on specific local needs and urgent issues of a neighbourhood	• Consult • (Matchmake) • Engage • Collaborate • Build capacity	Bottom-up initiatives	Workshops, Living Labs, etc.

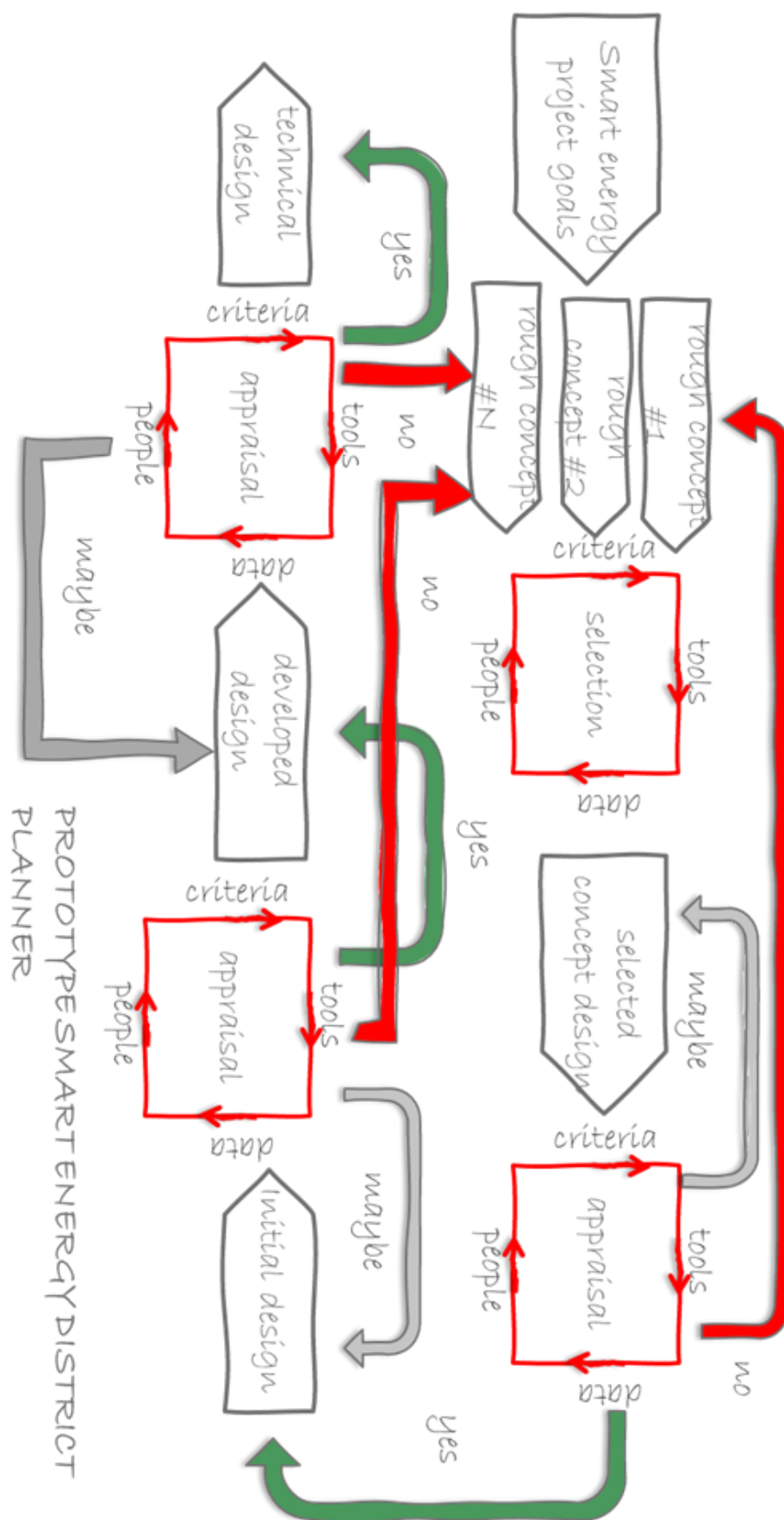


Figure 8: Prototype Smart Energy District Planner (RUGGEDISED D1.5 Prototype Smart Energy District planner)

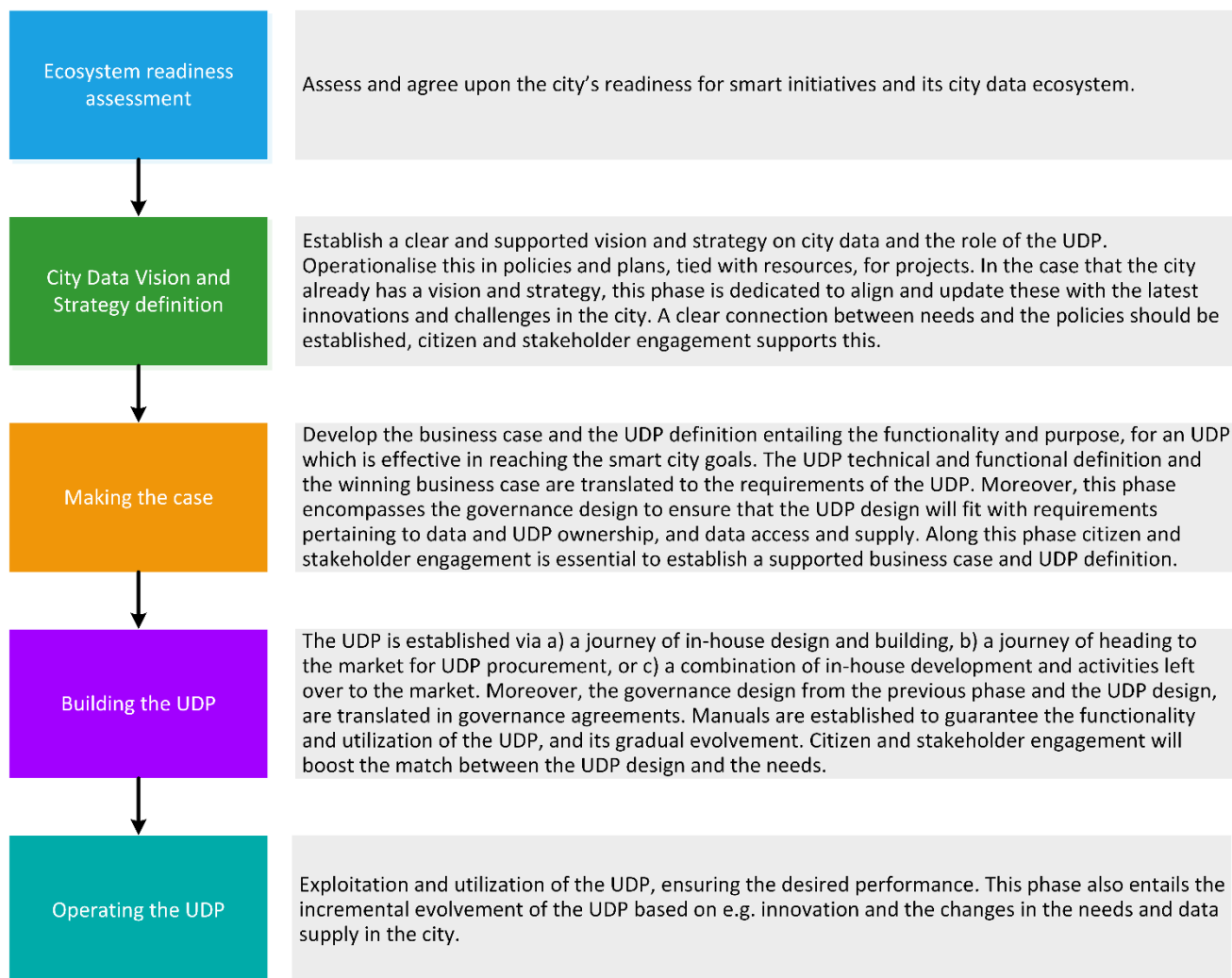


Figure 9: Guidance on Urban Data Platforms (RUGGEDISED D1.6 Guidance on Smart City Design and Decision Platform)

8 Literature

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APPENDIX A – Background information

This guide is the final RUGGEDISED guide of WP1 that focuses on cross-city learning and implementation. In WP1 of the RUGGEDISED project, the main task is to “prepare the ground for innovation and implementation of measures in the Lighthouse Cities”. The overall objective is to guide, coordinate and facilitate the implementation of smart solutions in the three Lighthouse Cities, to support the Lighthouse Cities with knowledge and processes to streamline and guide these smart solutions. This guide is based on the lessons that have been learned and discussed by the Lighthouse Cities in the RUGGEDISED Liaison Group meetings during the past three years.

Prior to this deliverable, TNO, RISE, the University of Strathclyde and the Lighthouse Cities wrote three other smart city guidance documents in which RUGGEDISED lessons learned have been translated into easy-to-use steps to deal with challenges in becoming a smart city.

- D1.4 – Innovation Platforms – Why, how and by whom? (RUGGEDISED, 2019b)
- D1.5 – Prototype Smart Energy District planner – this deliverable establishes the basis for a prototype smart energy district planner (SEDP) that comprises the generic process, and specific tools, tasks, information and stakeholders required to develop and evaluate a smart solution for a sustainable city district. (RUGGEDISED, 2020b)
- D1.6 – Guidance on Smart City Design and Decision Platform - this guide on Urban Data Platforms synthesises the lessons learned from the implementation phase of the RUGGEDISED project. (RUGGEDISED, 2020c)

This RUGGEDISED guide synthesises the learned lessons regarding implementation and innovation of smart solutions in the Lighthouse Cities, with state-of-the-art scientific literature and in-depth interviews, thereby aiming to provide other cities with concrete, tangible strategies, approaches, tools and techniques addressing smart solution implementation. This deliverable as overarching guide will reflect on previous guide when possible. The RUGGEDISED Fellow Cities will test the collaborative smart city guides. Eventual changes will be taken up in the final versions of the guides at the end of the running period of the RUGGEDISED project (Autumn 2021).

Liaison Group meeting as knowledge brokerage instruments

The Liaison Groups aim to secure the coherency of the implementation of smart solutions and to maximise their impacts. In the past three years, the Liaison Groups met at least twice a year and provided the Lighthouse Cities with a knowledge brokerage service. This peer to peer learning enriched the design of smart solutions and improved their implementation processes. The function of the Liaison Groups was not only on a practical level but also on a more fundamental level of capacity building to deal with complexity and urban innovation processes. Furthermore, the lessons taken from the cross-city learning facilitate replication and upscaling of the solutions in the Fellow Cities (Brno, Gdańsk and Parma) and other EU-cities in the future. The sub-objectives of the Liaison Groups are to:

- Develop an overarching innovation and implementation framework to guide and coordinate the implementation of the smart solutions on Energy and E-mobility, ICT, and Innovation and new business models in the Lighthouse Cities;
- Sustain coordination and enhance coherency of implementation (of smart solutions) among the Lighthouse Cities by ensuring that relevant knowledge and experiences are shared in a facilitated fashion, which allows for extracting relevant lessons learned;
- Develop tools and guidance for decision support and implementation of smart solutions in Fellow Cities, and other EU-cities, based on lessons learned.

During the Liaison Group meetings, the Lighthouse Cities and Fellow Cities, together with knowledge institutes, companies and other stakeholders discussed the progress, challenges and learned lessons regarding the implementation of smart solutions. Innovation was a recurring theme as the novel solutions that incorporate both smart and decarbonising capabilities are often not easy to implement and surely do not involve standardised procedures.

Innovation starts with collaborative learning, thereby setting up pilots and experimenting. The success leans on the ability of the different involved actors to come together, work on a joint vision and balance and stimulate the

interaction between and across strategic and operational levels. Urban innovation as the implementation of smart solutions is a truly holistic endeavour which also requires legal challenges to be overcome and new, innovative forms of business cases and financial cooperation to be put in place. Successful urban innovation policies are based on trust and the best scientific insights and knowledge.

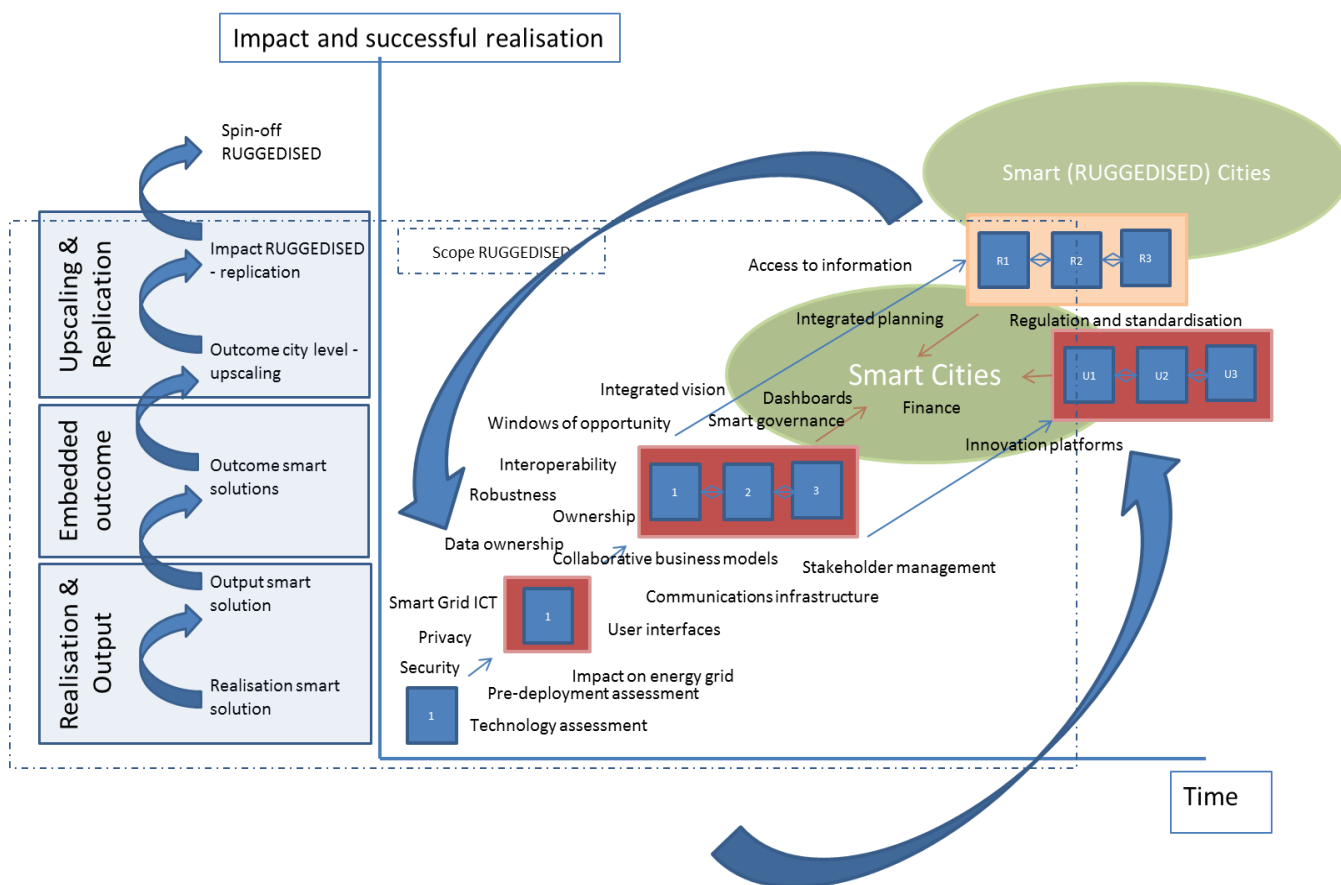


Figure 10: Overarching Innovation and Implementation Framework

Deliverable D1.2 “Overarching innovation and implementation framework” stated the following: “The framework distinguishes between six steps of realisation that are relevant for the impact of smart city solutions on different levels. These steps of realisation start with a ‘simple’ and isolated realisation of a smart solution in a city. The next step is that a smart solution will produce real output if it is well-embedded in the existing urban context. Multiple smart solutions may then successfully produce outcome if they are well connected and collaboratively work in an efficient manner. Outcome at the city level will be reached if smart solutions go beyond being ‘pilot’ projects and are successfully up scaled within the same city. Together they constitute a smart urban structure. Real impact of the RUGGEDISED project, in terms of the replication of smart solutions, is reached if smart solutions are successfully replicated in the RUGGEDISED Fellow Cities. The spin-off of RUGGEDISED is realised when other EU-cities take up the lessons learned and smart solutions.” (RUGGEDISED, 2017).

The aim of the implementation framework demands a holistic view, therefore, the guide on innovation and RUGGEDISED implementation of smart solutions contains guidance on how cities should go about urban innovation, how (collaborative) learning and experimentation takes place, how to translate this into leadership and the coordination of innovative actions, how to distil legal challenges and recommendations on how to overcome those, and novel methods and techniques for sustainable financing and multi-actor cooperation, thereby aiming to secure and foster implementation of smart solutions in EU-cities.