RUGGEDISED
Designing smart, resilient cities for all

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Executive summary

The goal of the urban innovation systems analysis was to provide governance recommendations to support upscaling of the solutions in the lighthouse cities (LHCs). In order to do so, enablers and barriers for upscaling were first identified. Then, the effects of these barriers and enablers on the main innovation functions of the urban innovation systems were analysed. The state of each function was assessed and the recommendations for improving them were given. As the final step, potential implications of the recommendations for the existing structural elements of innovation systems were presented.

Our analysis suggests that achieving the desired upscaling levels for Ruggedised innovations will require rethinking of the roles traditionally assumed by the municipalities in all three cities. However, the nature of this new role will be different in each case.

In Rotterdam the major challenge and success factor for upscaling is finding clarity between alternative solutions and arrangements. The RUGGEDISED solutions in Rotterdam are being upscaled in an environment of uncertainty about the future technical, infrastructural, and policy environment, and face meaningful competition from sustainable and less sustainable alternatives. The city government may have an important role to play in providing clarity – not necessarily by picking winners, but by determining which parameters (emissions reduction, growth, resilience, etc.) will be strategically prioritized, and making clear where trade-offs will be needed, and which parts of the transition will see both winners and losers.

For Glasgow the major challenge and success factor for upscaling is the definition and evolution of the City Council's own role in the sustainability transition. In the RUGGEDISED solutions the GCC is taking on roles that either complement or stand in for private market or national government action, and is making use of its own physical, financial, and intangible assets as a market maker, an asset owner, information clearinghouse etc. These roles inherently involve assuming risks that others have opted not to assume. The scenario analysis (D6.2) provides a depiction of how the GCC could succeed in these roles, but it also describes an upscaling process that requires ongoing proactivity from the council, rather than a temporary push and retreat to a more limited role. The recommendations of this deliverable, in part, relate to complementary roles that could be taken via reform of existing institutions, e.g. the Distribution Network Operators (DNOs) or the promotion of alternative institutional forms (e.g. social business).

For Umeå the major challenge and success factor for upscaling will be the city's ability to mobilize its citizenry and business stakeholders behind the city's initiatives. The city is in the enviable position of having a citizenry and stakeholders who are both sustainability-oriented and fully engaged with growth and change processes. Meanwhile, the city council itself has a strong hand through ownership of assets and institutions important to upscaling. Yet many of the solutions (e-mobility hubs, green parking buy-out, 100% renewables) depend to a significant extent on initiatives from citizens and businesses if they are to be scaled up. There is a need to create a political vision and potentially a roadmap that connects the grass-roots energy of the city to the strategies being put forward by the council and its partners, if the solutions are to reach their potential.

Contents

Introduction

The goal of the urban innovation systems analysis is to provide strategy and governance recommendations to support upscaling of the solutions in each lighthouse city.

First, enablers and barriers for upscaling are identified using the Critical Context and Conditions framework. Then, the Technological Innovation Systems framework is used to analyse the effects of these barriers and enablers on the main innovation functions of the urban innovation systems. The functioning of each function is assessed and the recommendations for improving them are given. As the final step, potential implications of the recommendations for the existing structural elements of innovation systems are presented.

The report is structured as follows. First, the method for data collection and data analysis is described. Then, for each city, the barriers and enablers for the innovation system are outlined, followed by an analysis of how these barriers and enablers affect the functioning of the system. The recommendations for national, regional and local governance and strategy are introduced as the next step. The report concludes with a brief reflections and discussion of the results.

Method

The information collection stage was a joint undertaking between the urban innovation systems analysis (task 6.5) and the scenario analysis (task 6.3). Information was gathered through detailed interviews with solution responsibles from all three lighthouse cities; the scenario workshop (for detailed results please refer to D6.2); and additional desk research.

Information collection

The questions for the interviews were designed using the framework *Context and Critical Conditions* to accommodate the needs of both this deliverable and D6.2. The framework was developed for an EU-funded project ECOPOL (2014) but has been adapted to fit the issue of upscaling of the LHC solutions (Figure 1). In particular, the future dimension, originally centred on evaluation and monitoring, was adapted to represent the upscaling scenarios. This dimension is partially covered by Scenario analysis (D6.2) and Energy systems analysis (D6.4).

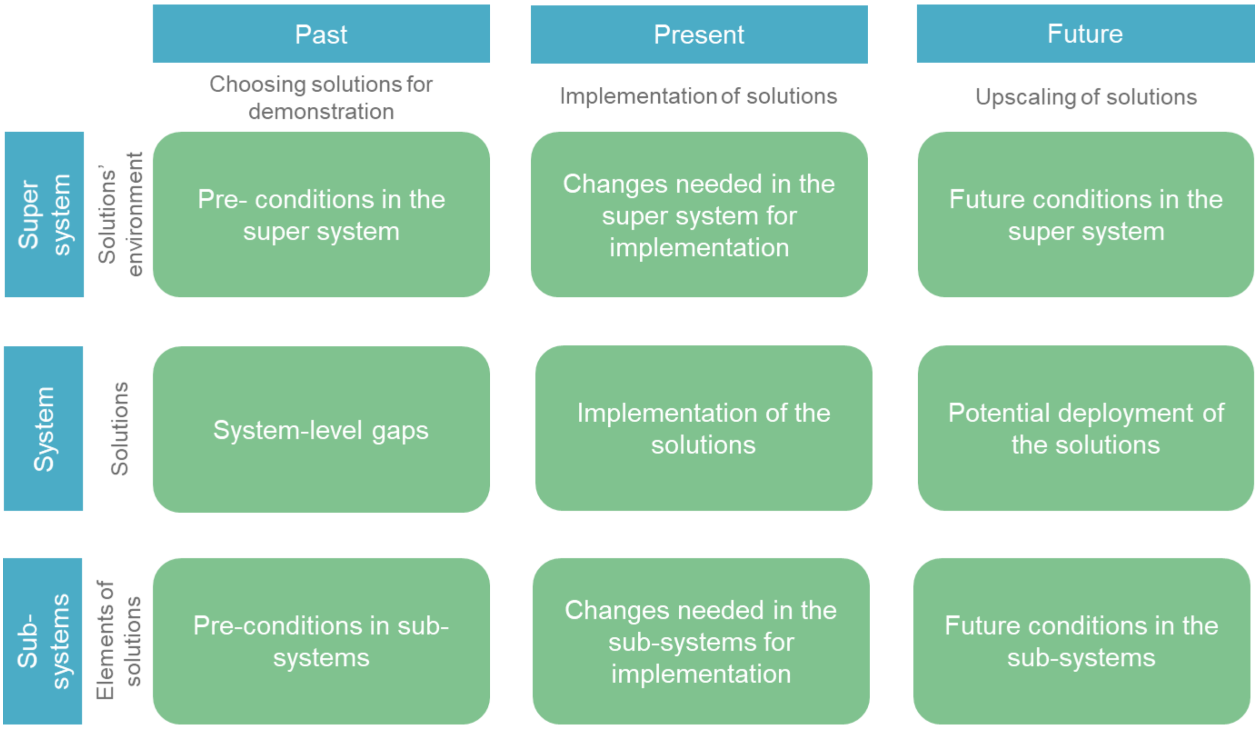

Figure 1 - Information collection framework - Context and Critical Conditions

CCC is a matrix that captures both time (past-present-future) and scale (subsystem – system – super system) dimensions. The system represents an individual solution; the subsystem encompasses components of the solution that need additional attention (e.g. business model, technological components); and the super system the solution's environment (policies, societal attitudes, markets, etc.). Together, they give a picture of solutions' context over time. In the past, the critical conditions were those which led to the choice of solution and demonstration case. In the present the critical conditions are those which determine the success of the demonstration. In the future, the critical conditions are those that are determinant for upscaling potential.

The framework represents a structured way to grasp why certain solutions were chosen over others and what challenges they are facing now at the stage of implementation and in the future during upscaled deployment. It provides information on the main barriers and enablers for upscaling of the solutions.

Information analysis
Concepts from Innovation Systems analysis were then applied to place the barriers and enablers in an urban innovation system context and point towards recommendations for governance and strategies. The main steps of the analysis are presented in Figure 2.

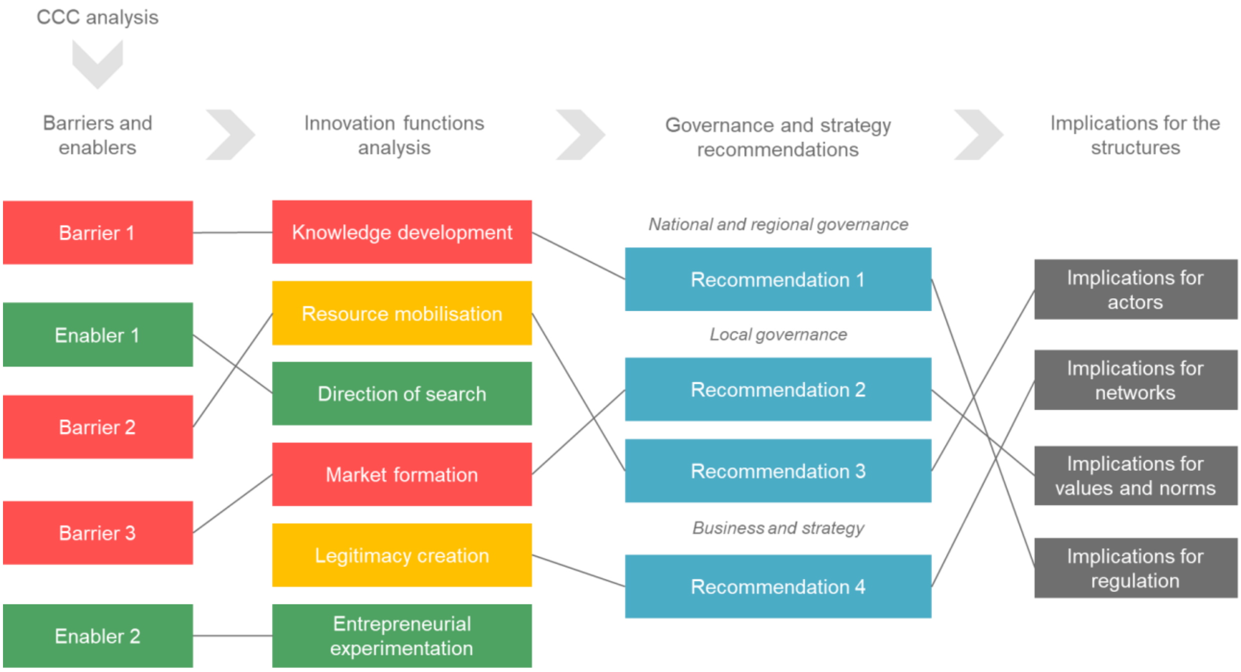

Figure 2 - Main steps in urban innovation system analysis

The framework is based on Technological Innovation Systems analysis (Bergek et al., 2008), adapted in this case for the scope of an *urban* innovation system. The method starts with mapping the structure of the system, including the main technologies, actors, networks and institutions involved. The next step is an evaluation of how well the system performs on six important functions (summarised in Table 1). It is worth noting that no full scale TIS analysis was conducted. Instead, the innovation-system functions were used as a way to translate drivers and barriers into recommendations for innovation system development.

Table 1 - Innovation functions

Process	Explanation
Knowledge development and dissemination	Creation of necessary knowledge about the innovations through R&D and learning, as well as its dissemination across relevant actor groups
Resource mobilization	Attracting the necessary financial, physical and human capital to develop the innovations
Direction of search	Establishment of a shared vision and broad strategies to define the role of the innovations in the society
Market formation	Creation of price-setting and market developing mechanisms, including public procurement, guaranties, subsidies
Legitimacy creation	Creation of broad societal acceptance of the innovations and ensuring their compliance with the existing institutions
Entrepreneurial experimentation	Attempting to find new commercial applications for the innovations through entrepreneurship practices

Source: adapted from Bergek et al., 2008

From there, broad recommendations have been developed to leverage the enablers, address the barriers and improve the general functioning of the system, so that the goals with upscaling are reached. The recommendations primarily address local governance, but national governance and private sector and strategy are also included.

This deliverable is linked to other tasks within WP6. Scenarios developed as part of task 6.3 give a picture of the desired but realistic levels of upscaled deployment, while this deliverable outlines the governance and strategy needs to realise these successful scenarios.

1 Rotterdam

In line with previous work within WP6, the following RUGGEDISED solution clusters were considered for the analysis:

- Smart thermal grid – R1-R4[1]
- Smart electric grid and e-mobility – R5-R7
- Smart services – R8, R11, R13
- Data platforms – R9

As suggested by the stakeholders, solutions R10 *Long-range wireless network* and R12 *High performance servers to heat homes* were excluded from the analysis.

1.1 Enablers and barriers for upscaling

Table 2 presents an overview of all the barriers and enablers to upscaling to emerge from the Critical Context and Conditions analysis. The barriers and enablers are sorted by their relevance to the six innovation system functions. The overall status of the functions, taking these barriers and enablers and their relative importance into account, is analysed in section 1.2.

Table 2 - Overview of the barriers and enablers and their relevance for TIS functions

	Barriers	Enablers
Knowledge development and dissemination	Silo issues (R5-7, R9) Path dependency (R5-7) Skills shortage at the municipal level (R9)	Trend of digitalization (all) Trend of sustainability (all) Demonstrated efficiencies (R1-7) Positive spillover from Ruggedised collaboration (all)
Resource mobilisation	Long term DH expansion plans (R1-4) Prohibitive regulation (R5) Path dependency (R8, 11) Silos within the city (R8, 11) Skills shortage (R9)	Demonstrated efficiencies (R1) Strong networks created within Ruggedised (R1-4)
Direction of the search	Political uncertainty over the future energy system (R1-4, R5-7) Differing interpretations of the existing EU wide energy regulation (R1-7) Regulatory limitations on energy trading between buildings (R1-4) Changes in regulation, e.g. solar subsidies (R5) Weak or mixed signalling from the Climate Law and the Dutch Climate Agreement when it comes to mobility and distributed grids (R5-7) Privacy concerns (R8, R9)	Growing resistance against fossil fuels and natural gas (R1-7) New energy efficiency standards for public buildings, move towards energy neutral buildings (R1-4) Climate Law, Dutch Climate Agreement and the Roadmap Next economy set the general direction (all) Open data standards for data homogeneity being discussed (R9) Data democratization (R8, R9)
Market formation	Lock in to centralised high temperature grid (R1) Potentially dropping prices of electricity (R1) High administrative costs for distributed solutions (R1-4, R5) Existing contracts hard to renegotiate (R1-4, R5) Unclear risk distribution (R1-7) Limited incentives for some parties (R1-7) Supply of affordable tech (R5-7)	Growing demands for energy (R1-4) Declining prices for heat pumps (R1-4) Demonstrated efficiencies (R1-4) Cheaper and more efficient battery tech (R5-7) Mature MaaS providers (R5-7) Cost reduction potential from automatization and smarter algorithms (R8, 11, 13) Variable pricing incentives (R8, 11)

[1] **R1** – Geothermal heat-cold storage and heat pumps, **R2** – Thermal energy from waste streams, **R3** – Surface water heat-cold collection, **R4** – Pavement heat-cold collector, **R5** – DC grid, PV and storage for E-mobility, **R6** – Smart charging parking lots, **R7** – Optimising the E-bus fleet of RET, **R8** – Energy management system, **R9** – 3D city operations model, **R11** – Efficient and intelligent street lighting, **R13** – Smart waste management.

	Barriers	Enablers
	Risk for supplier lock in (R8, 11, 13) Unclear ownership models (R8, 9, 11)	Potential collaboration with the Big 5 for municipal data management (R9)
Legitimacy creation	Range anxiety, new behaviour patterns (R5-6) Weaker guarantees than for AC grid (R5) Aesthetics (R11) Privacy concerns (R9)	Demonstrated efficiencies (R1-7) Emissions reduction (R8, 11, 13) Transparency and open data empowering individuals (R9)
Entrepreneurial experimentation	Power imbalances between actors (R5-R7) Need for well-developed use cases (R9)	Successful intrapreneurship practices (R1-4) Culture of urban experimenting in Rotterdam (all) Existing innovation platforms (all)

1.2 Functional analysis of the urban innovation system

Knowledge development and dissemination

Overall, knowledge development and dissemination processes can be considered a strength. Multiple participants noted that the underlying technologies have been receiving an increasing attention in recent years, powered by the mega trends of digitalisation and sustainability.

On the local level, Ruggedised contributed to creating the essential knowledge about the systems behind the *smart thermal and electricity grids*, particularly their efficiencies, which was then transferred to the non-Ruggedised partners and increased their willingness to engage in similar projects. When it comes to knowledge dissemination, silo issues were repeatedly pointed out during the workshop and the interviews, particularly evident in case of *smart services and data platforms*.

Resource mobilization

Existing political uncertainties and arrangements significantly impede capital flows into scaling up the solutions, and weak management capacity and lack of human capital further weaken the function. For instance, the city-owned district heating system, the plans for expansion of the network and the long-term need for maintenance, limits the infrastructure investments available for the local *smart heat grids*.

Strategic risks associated with prohibitive regulation prevent the expansion and resource mobilization into *smart electric grid* projects. Lack of technology-specific support on the national level and political instability on the local level also slow down investments into *e-mobility* solutions. For *data platforms*, lack of knowledge at the municipal level to strategically manage them was mentioned by multiple actors.

Direction of the search

Direction of the search was perceived to be a weak function. Overall, the national legislation, notably the new Climate Law and the Dutch Climate Agreement, successfully signals a general move towards sustainability, with a clear intended shift away from natural gas and towards distributed solutions. However, the participants noted that for some technical systems, the regulation provides limited guidance, and even mixed signalling. The uncertainties on the international and national level seem to have spilled over to the local level, with many actors worrying that their innovations may end up low on the list of priorities of the new government.

For *smart thermal grid*, the workshop and the interview results showed striking differences in opinions on what the role of the local heat grid should be in relation to the long-term district heating infrastructure. Some actors considered smart thermal grids a way to secure access to energy in areas that district heating does not reach, while others saw it as a way to disrupt and democratize the heat market. The prohibition of heat trading between commercial buildings further complicates the issue.

For *smart electricity grid*, uncertainty over future energy regulation was aggravated by mixed signalling provided by existing regulatory acts. In this regard, the recent changes in solar subsidies regulation were mentioned. Similarly, while creation of local networks is politically encouraged through various policy goals, prohibition for DNOs to own or control storage facilities and requirements to connect to the grid say otherwise. Such mixed signals contributed to creating an uneven playing field and harmed the economic case for distributed solutions. People involved in *smart mobility* mentioned that huge uncertainties remain as per which technologies will be prevalent or receive political support in the long term, making long-term planning and strategic investments difficult.

In turn, for *data platforms*, mixed signals come from competing trends. On the one hand lies democratization of data, with open data-based solutions and upcoming standards, balanced by the countertrend of increasing privacy concerns and related regulation such as GDPR. On the local level, stakeholders seem to have different opinions on the relationship between the two trends. Uncertainties over how these trends will interact in the future led to hesitation when deciding over the ownership structure of the platform – with private, public or hybrid models still on the table.

Market formation

Market formation seems to be a problematic aspect for all the solution groups. While some positive developments were observed, such as falling prices for enabling technologies and the growing potential market, the solutions face significant competition from the existing or emerging alternatives, in addition to competing between each other for limited market share.

Smart thermal grids are being built while the overall demand for energy grows and the prices for heat pumps go down. However, several restrictions define how much of this growing market the solution group can capture. Potentially dropping prices for electricity – not the least due to local electricity grids being built – can lead to re-emergence of electric heating as a competitor. Another problematic aspect for smart thermal is the cost structure – with high investments, and higher administrative costs for district-specific solutions in general. These solutions also give rise to the need to distribute risks between parties and to rewrite existing contracts based that are based on past models and conditions.

Smart electric grid and e-mobility are suffering from many of the same issues as the thermal grid. On the *mobility* side, there are concerns over the fact that the prices for EVs and batteries may not go down fast enough. On the *electric grid* side, current regulatory frameworks such as the requirement to connect to the grid makes it nearly impossible to compete with centrally generated and distributed electricity.

Smart services is a positive exception when it comes to costs. Underlying automation processes demonstrated cost reduction potential, and there seems to be further potential to improve as the algorithms get increasingly sophisticated. However, the risk of a bad choice of suppliers and supplier lock-in was linked to potential price fluctuations in the future.

Data platforms, or the 3D platform, suffers from essentially not having a defined market segment. While the main envisioned user is the private sector, there hasn't been much demonstrated interest from companies to use the platform as of yet. Additional mechanisms impeding market formation include high administrative costs linked to unharmonized data from different sources, an unclear ownership model and a lack of developed use cases.

Legitimacy creation

No significant opposition was observed for any of the solution groups so far, and any potential issues were prevented through careful planning. Legitimacy was further improved for many solutions through demonstrating clear resource savings and emission reductions, both aspects generally valued by the society.

Strong networks created through the Ruggedised project contributed to acceptance of *local heat networks*. There, energy poverty concerns were raised but overall did not act as a significant barrier, in part due to the existing requirement that the heat source has to cost lower than heating with natural gas.

In the case of *smart services*, no significant concerns were voiced at the time of the analysis, partly due to inclusiveness of the implementation process, as in the case of waste management, where all the drivers were assured that their jobs will be secured, while their workload would decrease. In case of smart lighting projects, only minor concerns were raised over the aesthetics of the new lampposts.

The most serious legitimacy issues are expected to be faced by *data platforms* as they gain ground. There, privacy concerns can directly limit the usability and data availability of the platform and limit its business potential. So far though, no significant concerns were raised by the citizens.

Entrepreneurial experimentation

Entrepreneurial experimentation is judged to be a relatively healthy function at this point. Experimentation in the Heart of South has been successful, but as the interviews and the workshop showed, the conditions there are quite specific and may be difficult to recreate in other parts of Rotterdam.

In the case of *smart thermal grids*, experimentation was realised through intrapreneurship, with Eneco developing a solution that could be seen as competing with their main activities. For *electric grids*, entrepreneurial activities were hindered by power imbalances, with grid operators holding a dominant position. Little experimentation has been observed in case of *data platforms,* as the potential benefits of 3D platforms are still being explored.

Overview

The final assessment of the relative strength of each function for each solution group (on a scale from 0 – very weak to 5 – very strong) is presented in Figure 3[2].

[2] Note that this is an indicative assessment based on authors' interpretations of the input received from stakeholders.

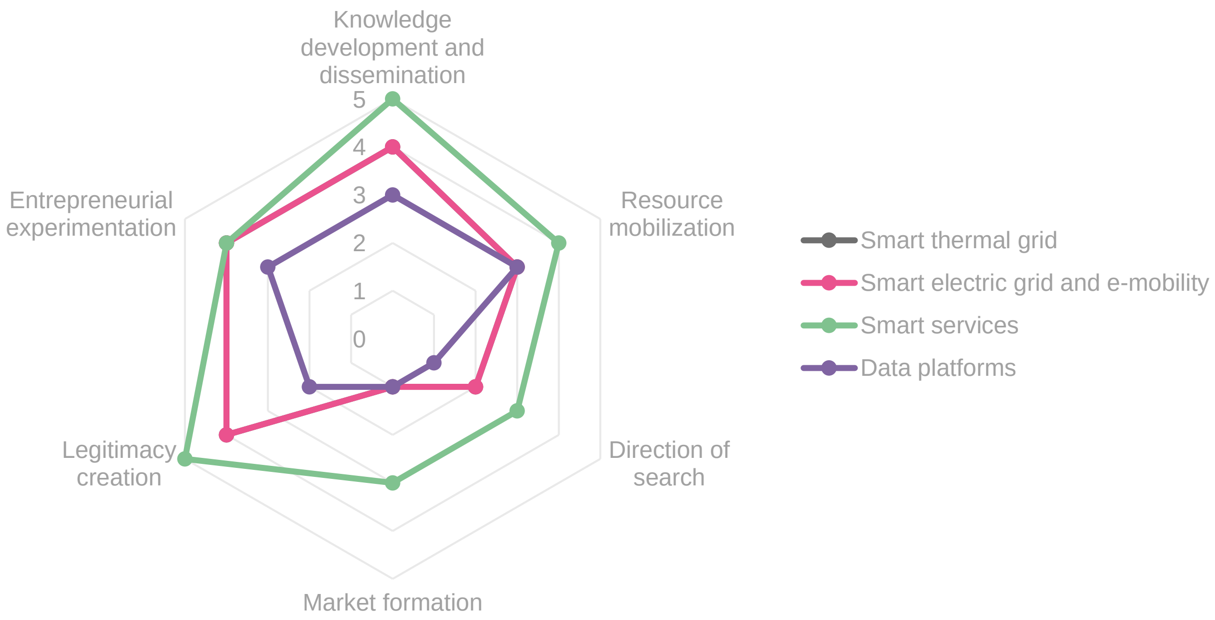

Figure 3 - Assessment of innovation functions per solution group

There are significant differences between the solution groups, but some hotspots are shared by several innovations. Smart services seem to be the least problematic solution group, with easily demonstrated benefits and the relatively incremental nature of the innovation/ease of their incorporations into the existing institutions.

With a strong reputation as a national and international leader in innovation, Rotterdam is home to many urban experiments, explaining the relative strength of the entrepreneurial experimentation and knowledge development functions. However, the potential to create a city-wide market based on the Ruggedised solutions was judged by the participants as rather modest, with unfavourable political, economic and infrastructural conditions. The market formation is slow for various reasons, some having to do with the choice of solutions. Many of them were tailored to the specific conditions in the Heart of South area, and are proving very difficult to replicate in the rest of the city, leading to ideas such as exporting the solutions elsewhere in the Netherlands or Europe. In addition, our analysis showed most of the solutions to be opportunity-driven as opposed to need-driven, with limited consideration to upscaling conditions, weak links between the solutions and the city goals, and unharvested synergies between the solutions themselves. These factors explain the relative weakness of the direction of the search function, where there is no shared understanding of the place of the solutions in the future urban system. Coordinated efforts from the public and the private sector should be aimed at addressing these issues.

1.3 Governance and strategy needs for upscaling

The functional analysis shows that there is significant potential for improvement when it comes to ensuring that the solutions reach the desired upscaling level and find their way to the market. The following sections present a discussion of how public and private actors on a national, regional and local level can contribute to improving the system. As indicated earlier, several functional failures hamper innovation. Structural barriers, such as hampering regulation and norms, lack of capacities or path dependencies locked-in through interactions between incumbent actor groups. Implications of the recommendations for structural elements of the innovation system are also introduced in this chapter. A summary of recommendations and their implications is presented in Figure 4**Error! Reference source not found.**.

1.3.1 National and regional governance

National and regional policy makers can play a central role in improving the direction of search function. In turn, improving this function can enable resource mobilization and foster market formation for the solutions. See Figure 4 for the summary.

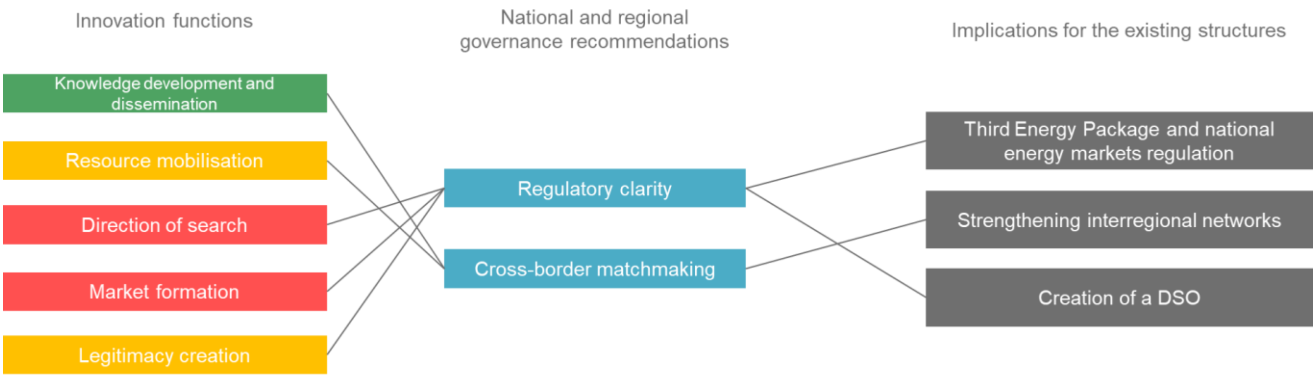

Figure 4 - National and regional governance recommendations

Bringing about regulatory clarity

The central issue on the national and EU level becomes finding the balance between clear signalling and direction setting and maintaining technological neutrality. Participants indicate that the new climate law has provided a strong push for sustainability while also creating an overwhelming uncertainty as per what it entails for each sector. The Third Energy Package of the EU is another source of uncertainty, with different interpretations by the national regulatory authorities across the EU (EDSO, 2006).

Cross-border matchmaking

On the regional level, there is an increasing need for cross-border matchmaking. Exporting the solutions that have proven difficult to implement in Rotterdam but fit the conditions of the other cities, or countries, ensures that the innovations find relevant audiences and their potential is fully harvested. With recent interregional infrastructural developments, the foundation for such a collaboration is already laid.

1.3.2 Local governance

The main role that the municipality could assume is to build a functioning system out of the often-fragmented innovations and ensure that they complement each other and match the needs of the city. In doing so, the following aspects should be considered. See Figure 5 for the summary.

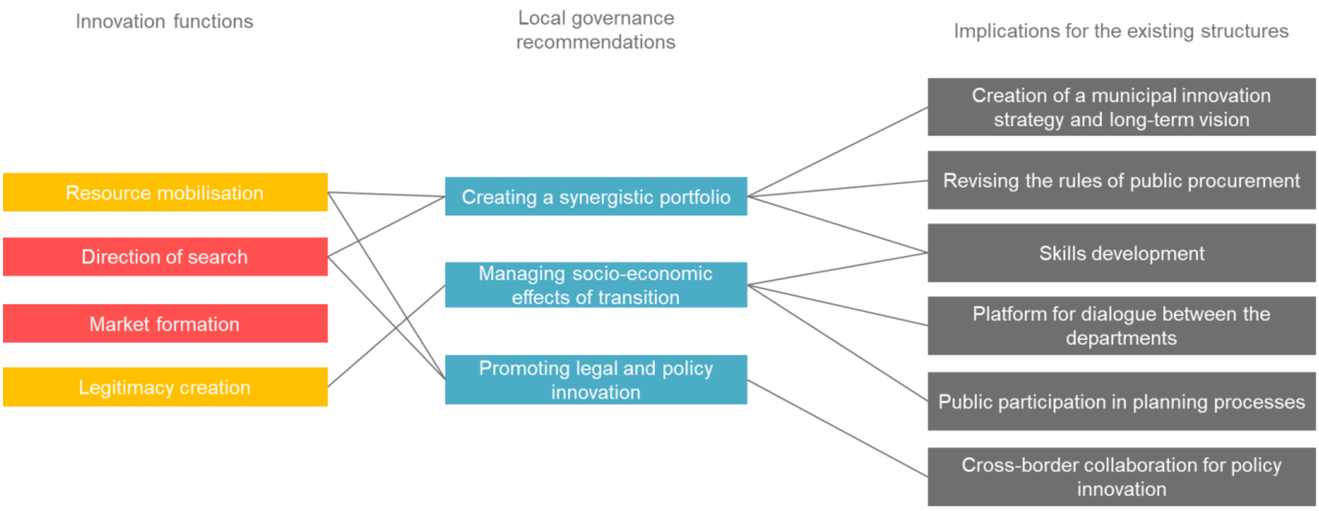

Figure 5 - Local governance recommendations

Creating a synergistic portfolio of innovations

To improve the direction of search function, there is a need for clearly setting the rules of the game when creating the local innovation portfolio. The choice of innovations should be clearly linked to their potential to contribute to the city goals. Linked to these goals should be a set of overarching parameters (e.g. climate impact) that define which of the alternatives will receive long-term political support on the local level.

Structurally, this could be implemented through defining these parameters as part of a city-wide innovation strategy and establishing processes, procedures and routines for municipal innovation management. Revising the rules for public procurement will most likely be required. Creation of an innovation department could be considered for systematising the work, but in any case, skills development should be a key aspect to build the internal capacity for strategically prioritizing innovations. Anchoring the portfolio and the innovation management work in general to the existing city-wide long-term visions could be a key measure to reassure the actors that political uncertainties won't lead to sudden changes in priorities and cuts in support.

Managing socio-economic effects of transitions

Choosing between the alternatives and transitioning away from the existing systems would inevitably lead to emergence of winners and losers. So far, since no difficult choices were made and the solutions are limited to one area, there is little opposition. This will most likely change when upscaling takes place and losers emerge, negatively affecting the legitimacy of the system. Managing socio-economic effects and justice aspects of the transition will become increasingly important for the municipality in the coming years. Rising unemployment, segregation and unequal access to the new opportunities are some of the issues that could emerge. The municipality should assume the responsibility in preventing or addressing these issues.

This would entail a systemic work throughout the planning and implementation. Revising the existing planning processes to emphasize public participation and consultation is one important aspect. Setting aside a budget for managing the negative consequences is another. This could be done through for example matching the reduced need for labour in one area with investment in professional re-education, in collaboration with the private sector involved in innovations. Most likely, several departments will have to be involved, such as those dealing with urban planning, energy and infrastructure, social services, education, creating a need for a platform to facilitate collaboration.

Promoting legal and policy innovation

The upscaling of several solutions is often limited by restrictive or directly prohibitive regulation. While the municipality alone has limited influence over these developments, it can assume a role of mobilising human resources to promote the case of policy and legal innovation.

Structurally this would entail building strong coalitions that include other municipalities around the Netherlands and the EU, research institutes and not the least private sector, to lobby for regulatory change. These could either be built through leveraging the existing networks or through creation of new networks. In addition, skills development to provide legal support for the private sector with interpreting the existing national and international regulation and applying for regulatory exemptions.

1.3.3 Private sector

Much of the success depends on the ability of the private sector to mobilize the necessary resources for upscaling. This, in turn, entails demonstrating and developing business cases with help of the existing accelerating mechanisms, such as Ruggedised. See Figure 6 for the summary.

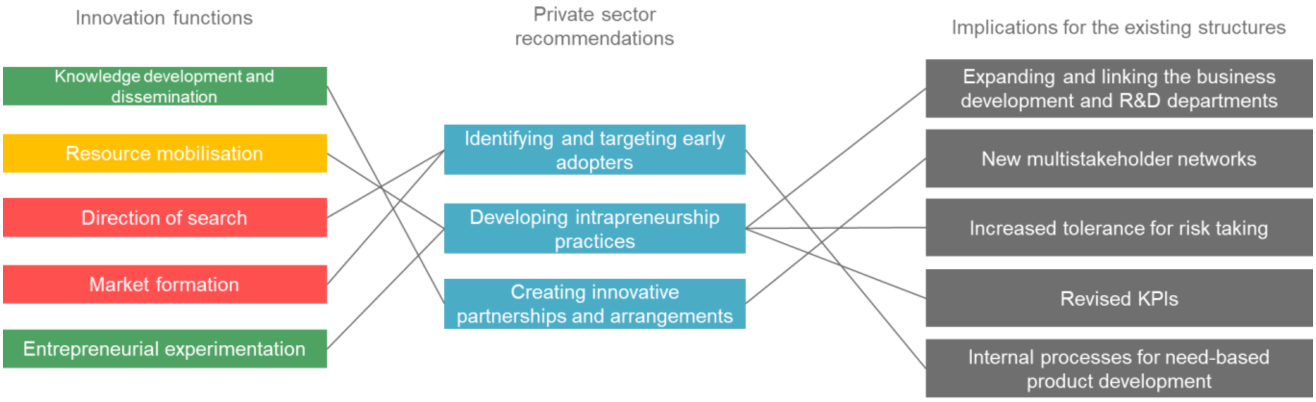

Figure 6 – Private sector recommendations

Identifying and targeting early adopters

None of the solutions implemented in Rotterdam were perceived as technically problematic. Many participants noted that purely technological barriers, if any, were rather easy to fix. Instead, the main obstacles were related to the business models. For Rotterdam in particular, market formation is impeded by not finding the right market segments or trying to target all market segments at once. Identifying potential early adopters - public buildings in case of energy management, digital businesses in case of 3D platform, targeting them and tailoring the solutions to their needs, can bring about the revenues faster while acting as an accelerating mechanism for innovation dissemination. Structurally, it could be realised through business development and marketing functions working together to match the needs of potential market segments with the benefits of the innovation.

Developing intrapreneurship practices

The involvement of the private sector in Rotterdam was different from the other LHCs, as the solutions led by Eneco were directly competing with their main business. From the innovation system standpoint, it is a good practice as it eliminates strong opposition blocks. From the corporate standpoint, such an arrangement can be seen as part of strategic risk/portfolio management, where the investments are being made to secure long-term position in hard-to-predict, changing markets. For instance, while the HoS grid is not likely to provide a significant return on investment as an isolated project, it has potential to reduce future costs of adapting to the changing markets. Through creating knowledge, establishing collaborations, demonstrating the business potential, and anticipating potential issues, intrapreneurship can become a key market creation mechanism.

However, such practice requires creating certain conditions within companies, both structurally and culturally. Increased tolerance for risk through innovative KPIs and balancing the portfolio is one such mechanism. Strengthening, empowering and linking business development and R&D functions is another.

Creating innovative partnerships and arrangements
As our analysis showed, important market structures are missing, blocking the market formation function. Many issues have to be dealt with ad hoc, such as discovering the right ownership models, finding innovative ways to deal with the existing long-term contracts, and coming up with innovative risk arrangements and partnerships. Since many market mechanisms are missing for the innovations at hand, it is likely that these needs will persist going forward.

2 Glasgow

For Glasgow, barriers, enablers, and governance needs for upscaling were considered for five clusters of RUGGEDISED solutions, namely:

- New district heating offerings (G1)
- RES+Battery storage+Grid services (G2, G3)
- EV charging + E-mobility services (G5)
- DSM + Grid services (G8)
- Data-based decision platform (G7)

These clusters were based on an analysis of Glasgow City Council's high-level goals, strategies for achieving these, and measures to deliver on these strategies, as discussed in the Upscaling Scenario workshop and presented in Figure 7.

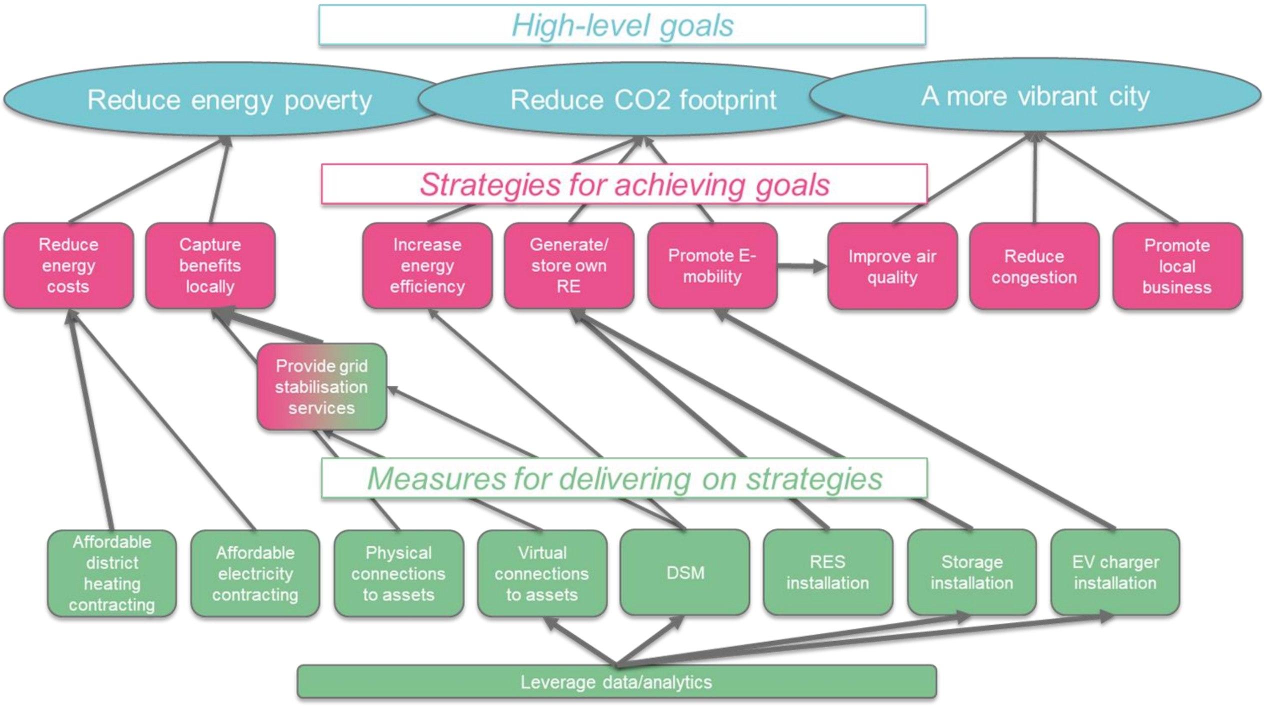

Figure 7 - Goals, strategies and measures related to Glasgow's RUGGEDISED solutions

2.1 Enablers and barriers for upscaling

Table 3 presents an overview of all the barriers and enablers to upscaling to emerge from the Critical Context and Conditions analysis. The barriers and enablers are sorted by their relevance to the six innovation system functions. The overall status of the functions, taking these barriers and enablers into account, is analysed in section 2.2.

Table 3 - Barriers and enablers to upscaling and their relevance to the innovation system functions

	Barriers	Enablers
Knowledge development and dissemination	Complex site arrangement or similar model not yet established in the relevant context (G2, G3, G5)	Falling costs, improving performance for batteries and solar panels (G2, G3)
Resource mobilisation	High installation costs, especially in congested areas (G1) Data sets are disparate and unrelated (G7)	Package solutions are easy to retrofit (G3)
Direction of the search	Planning restrictions (G1) Differing views on future role of DH (G1) Deprioritisation of EVs by new government? (G2/G3/G5)	Anticipated legislation on DH zoning (G1) Inherently slow grid improvements favour batteries (G2, G3, G5) Increasing integration between systems (energy, mobility) (G2, G3, G5) EV stresses on system (G3, G8) Potential transition to from DNO to DSO (G3, G8) Manufacturers shifting to EVs (G5) 2032 EV target (G5) Requirements for charging points in urban planning (G5) Active travel agenda (?) (G5)

	Barriers	Enablers
Market formation	Competition from gas boilers (G1) Reductions to feed-in tariffs for RES (G2, G3, G5) Benefits for end users not clear (G8) Market mechanisms for DSM not fully in place (G8) Gatekeeper/administrator needed for DSM to provide grid services (G8) Lack of charging points/grid constraints create chicken/egg problem (G5) Risks of instability and 'computational stasis' if system is opened up to energy markets (G7)	Financial support for battery storage (G2) Requirements for carbon reduction in new builds (G1, G3) Potential transition to from DNO to DSO (G3, G8) Low Emission Zones in cities (G5)
Legitimacy creation	Wealthier consumers using grid capacity first (G2, G3, G5) Fault risk from batteries creates resistance from grid operator (G2, G3, G5) DSM shifts energy use, doesn't ensure reductions (G8) EV usage potentially fails to deliver behavioural change around short car journeys (G5) EV technology potentially fails to meet hype/expectations (G5)	Lower operational costs for housing managers (G1) EVs fashionable (G5) Air quality benefits of EVs (G5) Low-income neighbours benefit from shoppers/visitors using charging services (G5)
Entrepreneurial experimentation	Low utilization of car park at present (G5) Focus on municipal planning (G7) Regulation on rates limit attractiveness (G1)	First implementations in council housing stock can prove concept (G3) Increasing number of aggregators for DSM (G8) Manufacturers shifting to EVs (G5)

2.2 Functional analysis of the urban innovation system

Knowledge development and dissemination

For the most part stakeholders did not consider the development and spread of knowledge as a critical issue for the upscaling of the RUGGEDISED solutions in Glasgow. Most of the solutions were considered relatively mature technically and relatively well understood by actors in the innovation system. Indeed, in the case of solutions G2, G3, and G5, rapid reductions in technology costs and advancements in performance of batteries and RES were expected to be major drivers of the solutions’ upscaling going forward.

One minor exception concerned the development of business models/contractual arrangements that would allow the leveraging of assets across the car park and the council housing. While market players exist to execute such agreements in theory, the specific arrangements necessary for such a case remain under development and will need to be more widely understood for aggregators to include them in their offerings.

Resource mobilisation

Project stakeholders did not indicate that mobilisation of resources – particularly financial and human capital – was a major issue for the upscaling of the RUGGEDISED solutions in Glasgow. Overall the potential for resource mobilisation, other factors being equal, could be seen as a strength.

A major exception is the promotion of district heat options (G1). Relative to other heating solutions such as gas boilers and heat pumps, district heat requires major capital investments, and the frameworks and economics to justify these investments are seen as weak, and their development uncertain. A particular quandary is that district heat networks benefit economically from population density, which tends to go hand-in-hand with traffic congestion and limitations on the type of major construction project needed to build or extend a network.

A less significant but still material constrain relates to the disparate nature of existing data sets that would ideally be integrated into the data-based decision platform (G7). Legacy systems and formats create a barrier to integration as specific knowledge of old and new systems must be mobilised in concert.

More optimistically, the solutions related to RES and battery storage (G2, G3) were judged to require fewer human and financial resources than competing pathways related to grid modernisation.

Direction of the search

Guidance of the direction of the search is particularly important for innovations where multiple competing pathways are in play, as is the case for Glasgow's RUGGEDISED solutions: the development of new district heating offerings is in competition with both natural-gas and heat pump-based alternatives; distributed RES systems with battery storage represent a kind of alternative pathway to centralised generation and distribution; EV charging systems presume a development of electromobility that competes with fossil-fuelled transportation but also alternative modalities such as cycling and public transport; data-based decision platforms can be developed for municipal planning, facilitation of new business from the private sector, or both; etc. The perceived status of this function – how effectively guidance is being provided on which pathways are prioritized – varied substantially across the solution groups.

The function is weakest for district heating offerings (G1). Views of district heating's role appear to differ both within the public sector (national regulators, municipal planners) and among market players. One way in which this plays out is the area of planning. Current restrictions discourage development independent of economics, but new national legislation on zoning for district heat is anticipated.[3] How this will affect overall expectations about district heating's role is unclear.

The innovation pathway represented by G2 and G3 – distributed electricity generation based on RES and supported by battery storage – is characterized by higher confidence in the prioritized direction. The increasing integration between energy and mobility systems, and the speed and flexibility advantages of decentralized solutions over grid improvements have made stakeholders confident that these systems will be relevant going forward. Likewise, the potential role for demand-side management (G8) seems ever more certain in a grid-constrained world. Even the anticipated transition from designated network operator (DNO) to designated system operator (DSO), important for market formation (see below), is increasingly seen as an expected development.

Stakeholders were most confident in the direction of the search in relation to EVs and charging infrastructure. Both the national government, which established a 2032 target of no new fossil-fuelled passenger vehicles, and vehicle manufacturers, who are increasingly committed to electrification of their fleets and the associated business models, have created a context where municipalities and grid operators can explore charging options with confidence. These have been reinforced by the Scottish Planning Policy's directive to consider charging points in urban planning processes.[4]

Market formation

In several cases (G1, G2/G3) the RUGGEDISED solutions in Glasgow are designed as interventions in weak market formation processes, attempting to stimulate conditions for commercial activity by designing and trialling new commercial arrangements. In terms of external drivers and barriers affecting market formation, the picture was decidedly mixed. For several solutions stakeholders pointed to conflicting forces

[3] https://www.gov.scot/publications/scotlands-energy-efficiency-programme-second-consultation-local-heat-energy-efficiency/pages/4/

[4] https://www.gov.scot/publications/scottish-planning-policy/pages/8/

or a state of flux and uncertainty with regard to key aspects of market formation.

In the context of upscaling going forward, markets for district heat (G1) could benefit from requirements for carbon reductions in new builds, as well as lower operating costs for building managers. Yet stakeholders also pointed to competition from distributed solutions, particularly gas boilers, as discouraging demand.

The same carbon reduction requirements for new buildings could stimulate demand for RES + storage systems (G2/G3). But while financial support for battery storage was a positive force on the supply side, reductions in feed-in tariffs for RES systems had weakened incentives for distributed renewable generation.

Policy was seen as supporting demand for electric mobility (G5), with stakeholders pointing to low-emission zones as a particularly important driver. The supply-side picture was less optimistic, with a lack of charging points and current grid constraints being the main barriers to a robust market growth.

The market for demand side management (G8) was perceived to be in flux. Markets for DSM in commercial properties are already functioning, but the market for grid stability services based on demand management does not yet exist, with no gatekeeper in place on the grid side and an inability to capture benefits on the consumer side. On the other hand, project stakeholders expressed a moderate confidence that the gatekeeper/DSO role would be created.in the coming years and would be able to create the conditions for market formation.

The data-based decision platform (G7), as noted, is seen primarily as a tool for public-sector planning, rather than as a provider of services to the market. Project stakeholders saw potential for private sector usage, but also risks, with usage of the data in energy markets potentially sending mixed or misleading signals to system operators.

Legitimacy creation

The legitimation of the RUGGEDISED solutions among the public was seen as depending on the credibility of the technologies' proposed benefits and the equanimity with which those benefits are distributed.

The legitimacy of the battery storage system (G2) rests largely on the perceived fault risk and the fact that as currently regulated the owner and operator of the battery is a different entity to the operator of the distribution network that bears the risk if there is a fault. The DSO as discussed by stakeholders could own and operate battery storage systems, enabling faster scale-up.

Renewable energy and electric mobility systems are currently seen as fashionable with some parts of the general public, but project participants expect that their legitimacy will depend on a broader distribution of benefits. If wealthier consumers, as early adopters, create congestion in the grid or have disproportionate access to charging infrastructure, the technologies may struggle to scale up. Conversely, benefits (air quality, increased commerce) that accrue neighbourhoods local to the RUGGEDISED solutions are expected to make further upscaling more legitimate.

In the case of demand-side management (G8) and e-mobility (G5), participants also noted the risk of backlash if the solutions do not appear to deliver as expected. In so much that it does not reduce energy use, but simply shifts it, DSM's benefits are not always obvious to laypeople; should EV deployment fall short of the current hype, a public used to traditional fossil-fuelled mobility may become sceptical of e-mobility's potential.

Entrepreneurial experimentation

In the context of the upscaling of Glasgow's RUGGEDISED solutions, entrepreneurial experimentation describes the extent to which the solutions are likely to be tested and developed in a commercial context. Overall the picture here is also mixed, with some solutions showing more positive signs than others.

In certain cases, the RUGGEDISED project and its constituent initiatives themselves provide a positive signal related to this function. In particular, the experimentation around contracting for distributed RES and storage systems (G3) seems likely to generate momentum for similar attempts by other players in the energy market. Likewise, project stakeholders pointed to a relative abundance of existing aggregators and brokers as likely experimenters during the upscaling phase, for both G3 and for DSM solutions (G8).

Less positive were indications related to the EV charging hub, where low pre-existing utilization of the car park being used for the RUGGEDISED implementation creates challenges for the promotion of usage and experimentation around the hub. Arguably, however, this situation was a feature of the choice, and not a bug, as the car park was chosen with the intention of stimulating commerce in the surrounding area.

District heating presents many challenges for entrepreneurs, including rate regulation and access to the distribution network, limitations that can limit interest throughout the value chain. The RUGGEDISED solution (G1) should be seen as a conscious effort to address the inherently discouraging entrepreneurial environment for district heat; yet in an upscaling context the challenges are likely to be persistent.

The data-based decision platform (G7) has potential to stimulate and/or facilitate new business models related to energy and mobility. The implementation in Glasgow, however, focuses on enabling better planning and decision-making by the City Council. Whether private sector engagement is necessary for 'upscaling' is thus a matter of perspective. Nonetheless the approach taken is not designed to maximize commercial experimentation.

Overview

The final assessment of the relative strength of each function for each solution group (on a scale from 1 – very weak to 6 – very strong) is presented in Figure 8.

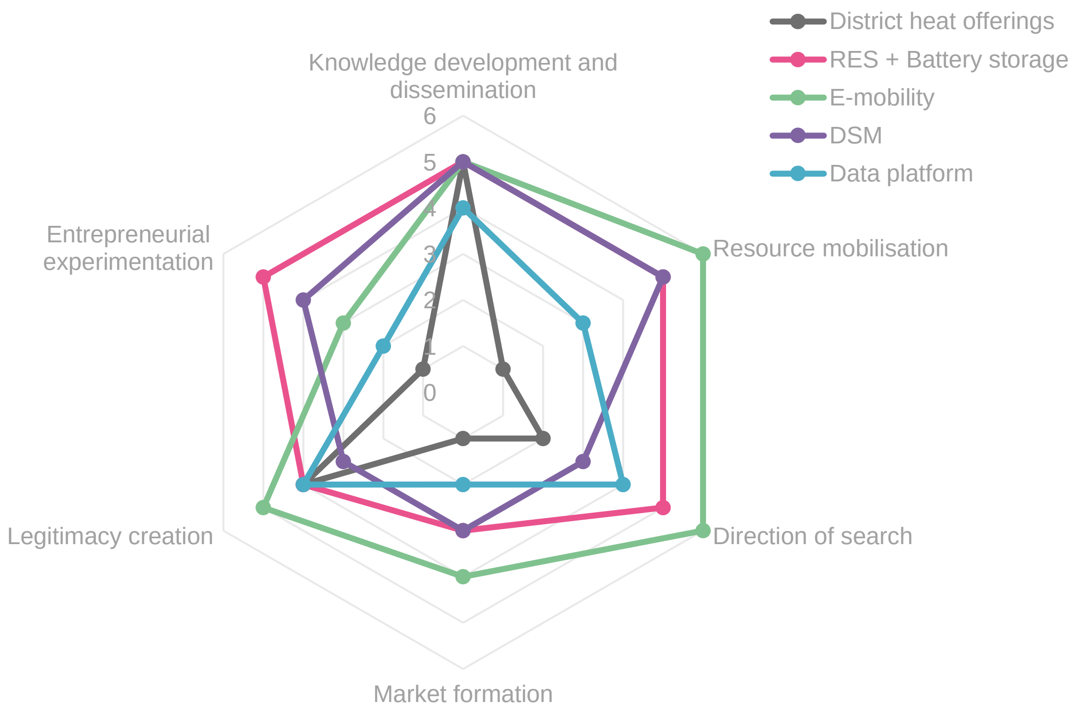

Figure 8 - Assessment of innovation functions per solution group

2.3 Governance and strategy needs for upscaling

What is needed from governance of and strategy within the urban innovation system if upscaling of the solutions is to be encouraged? The performance of the innovation system functions varied across the solutions, but significant needs were evident in market formation, entrepreneurial experimentation, resource mobilization, and in the guidance of the search and the creation/maintenance of the solutions' legitimacy.

A few common strategies appear likely to address multiple weaknesses in the system. Specifically, a way must be found to monetize and market value that consumers/prosumers create for the distribution grid if markets and entrepreneurship around for the RUGGEDISED solutions are going to be robust enough to promote upscaling. In several cases, the most direct and effective solution appears to be the establishment of a system operator authority ('DSO') that can own and manage certain assets as well as contract for grid stability services in ways that the designated network operator today cannot.

A hybrid public/commercial gatekeeping function will also be important in creating a market and allowing for entrepreneurial experimentation via the data-based decision platform.

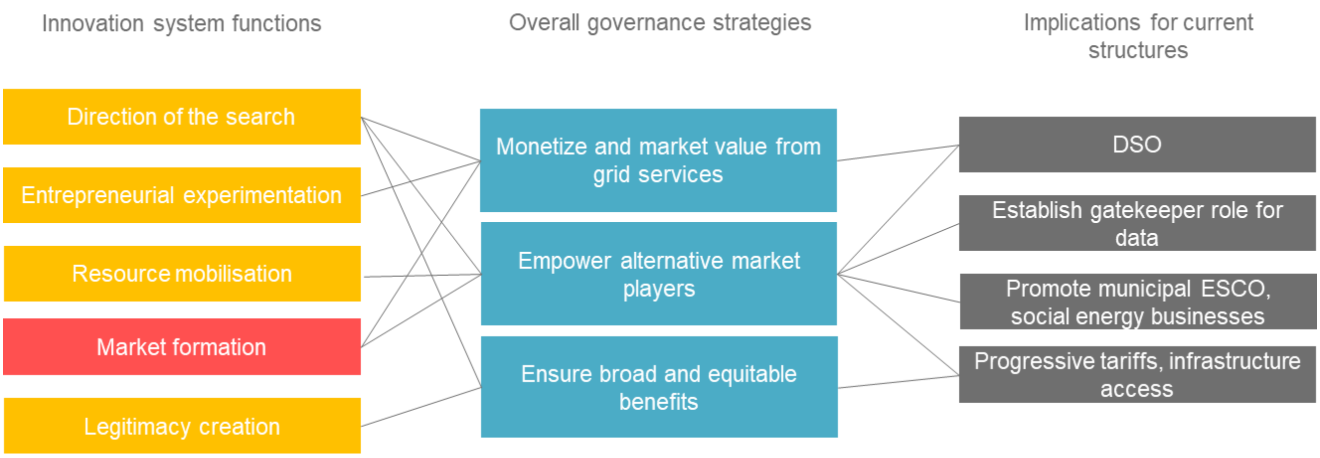

Figure 9 - Governance recommendations

From the supply side, resource mobilization and entrepreneurial experimentation could also be promoted by new actors with different commercial profiles to traditional ESCOs and energy companies. These kinds of actors can help create traction for new arrangements for energy supply and consumption, in particular where risks are perceived by traditional companies to be high. The Glasgow City Council's approach to district heating contracting (D1) and complex site arrangements (G2/G3) are providing some initial models. There may be scope for the public sector (nationally) as well as below-market and social investors to promote the establishment and growth of non-traditional energy businesses for this purpose.

These businesses can have a role in maintaining the legitimacy of the RUGGEDISED solutions by ensuring that otherwise underserved communities benefit from new, smart low-carbon innovations. The national and municipal governments may be able to find other methods to promote this legitimacy. RUGGEDISED provides a project-based example of how to orient solutions to benefit underserved populations and communities. Progressive tariffs and subsidies and prioritized access to low-carbon infrastructure could also be important.

3 Umeå

3.1 Enablers and barriers for upscaling

Table 4 below presents an overview of all the barriers and enablers to upscaling to emerge from the Critical Context and Conditions analysis. For Umeå, energy (U1-U4, U9), mobility (U5-U7) and data (U8) solutions were analysed in clusters. The barriers and enablers are sorted by their relevance to the six innovation system functions. The overall status of the functions, taking these barriers and enablers into account, is analysed in section 3.2.

Table 4 - Barriers and enablers to upscaling and their relevance to the innovation system functions

	Barriers	Enablers
Knowledge development and dissemination	Information overload regarding electricity and mobility choices Complexity of information (all)	Digitalisation of deliveries and online meetings could cut out all need for complex information Increasing awareness about available modes of transport and interlinkage

	Barriers	Enablers
Resource mobilisation	Ticketing systems that are not harmonized (mobility) Lack of open-data guidelines	Tech-industry is growing The bicycle pathway grid is very good Networks created within Ruggedised
Direction of the search	A lack of overall vision for Umeå (all) Political will / courage is lacking (mobility)	Some political decisions in support of a long-term sustainable city (mobility) Cooperation Green-parking pay-off when constructing new housing (mobility)
Market formation	Parking is too cheap Individual choice of using the car is easy Low bus frequency Linear business models (energy)	Emerging patterns of consumption and behaviour Growing demand for energy Restrictions on parking, freight traffic and fossil fuelled vehicles in city centre
Legitimacy creation	Status of bicycling is low in many social circles The ease of driving the car quickly straight to the city centre, no traffic jams Winter climate Large distances from countryside, suburbs to city centre	Many citizens of Umeå are active and engaged in developments Health trends (mobility) Formation of bicycle associations Emerging patterns of consumption and behaviour The proximity in the centre, and willingness of many to walk and bicycle Gamification that encourages new behaviour
Entrepreneurial experimentation	Mismatches between public/policy goals and the most commercially interesting alternatives	Internet of Things (data)

3.2 Functional analysis of the urban innovation system

Knowledge development and dissemination

The active role of public stakeholders that take ownership of results and knowledge from RUGGEDISED means that knowledge development and dissemination is an overall strength in the upscaling context. The integration of the university in public life can also be seen as advantageous, though the resulting high turnover of the city's population may create discontinuities in knowledge development and transfer.

Resource mobilisation

While there was little indication that mobilization of resources in terms of financial capital would be a major issue for the upscaling of the RUGGEDISED solutions, technical infrastructure and human capital may both require development for upscaling to reach its potential. For example, the current lack of harmonisation between transport modes including ticketing systems can create a barrier to investment in new mobility services. It has also been noted that skilled operating personnel will need to be trained, for example, in intelligent building control.

Direction of the search

Several publicly owned companies and public institutions play an active role in the RUGGEDISED project, giving the direction of the search a continuous push forward, particularly important e.g. in exploring viable new business models (energy). However, the overall political goals and ambitions could be higher if upscaling to maximum desirable levels is to be reached.

There is a widespread public sector acceptance that green electricity is the future. However, mobilizing the private sector is recognized as a challenge that remains to be tackled (mobility). For data, national and

European directives are in place and in most cases sufficient, setting a broad foundation for the innovation system. Open data guidelines would be very useful, with both the tech-industry and the number of data-generating entities growing every year.

Market formation

As the old, linear business models for energy can't harness peer-production, creating new business models for energy solutions is very important. It has however proven particularly tricky to put in place market mechanisms for decentralizing the grid, and a key barrier lies in how energy providers can become energy consumers. A growing demand for energy reinforces the importance of progress.

For big data solutions the supply-side challenge largely lies in identifying what data is out there, and gaining access to it, making the potential somewhat hard to gauge. From a demand-side perspective, information overload can be a barrier. The sheer number of choices to make, together with the complexity of information, may negatively affect user uptake of any given solution.

For mobility the great conditions for car-use, such as cheap parking and ease of using the car, with a low bus frequency, hampers the possibility for alternative modes of transport such as bikes, e-bikes, e-scooters and shared cars to grow their modal share.

Legitimacy creation

The partners of the RUGGEDISED project recognize that creating legitimacy for in particular the mobility solutions is a challenge from a behavioural stand-point, pointing to a number of factors that stand in the way of a growing modal share of public and shared transport. Again, the ease of driving the car to the centre is a problem, together with the low status of bicycling in many social circles. Also, the large distances from countryside and suburbs to city centre and the winter climate may make people hesitant to abandon their reliance on the car, at least during the colder months.

On the upside, many citizens of Umeå are active and engaged in environmental issues, and healthy trends are prevalent, which could alleviate some of these problems for the solutions that will be consumer-facing. The compact geography of the city centre, and the visibility of those who walk and cycle could give a boost to new patterns of consumption and behaviour.

In regards to energy solutions, creating legitimacy looks to be less of a problem, as long as consumers of energy can access the energy through functional business models. For data, creating legitimacy is mostly a matter of using the possibilities that do and could exist, such as using gamification to encourage new behaviour while avoiding possible integrity and security risks.

Entrepreneurial experimentation

Neither the need for new actors to experiment entrepreneurially, or the potential, was highlighted by participants; this is likely a reflection of the willingness of publicly-owned institutions to play the role of innovation engine. In an upscaling context, however, delivering the solutions' full potential is likely to require a more diverse community of innovators. Participants saw Internet of Things and personal mobility as areas for more private sector experimentation.

Overview

The final assessment of the relative strength of each function for each solution group (on a scale from 1 – very weak to 6 – very strong) is presented in Figure 10.

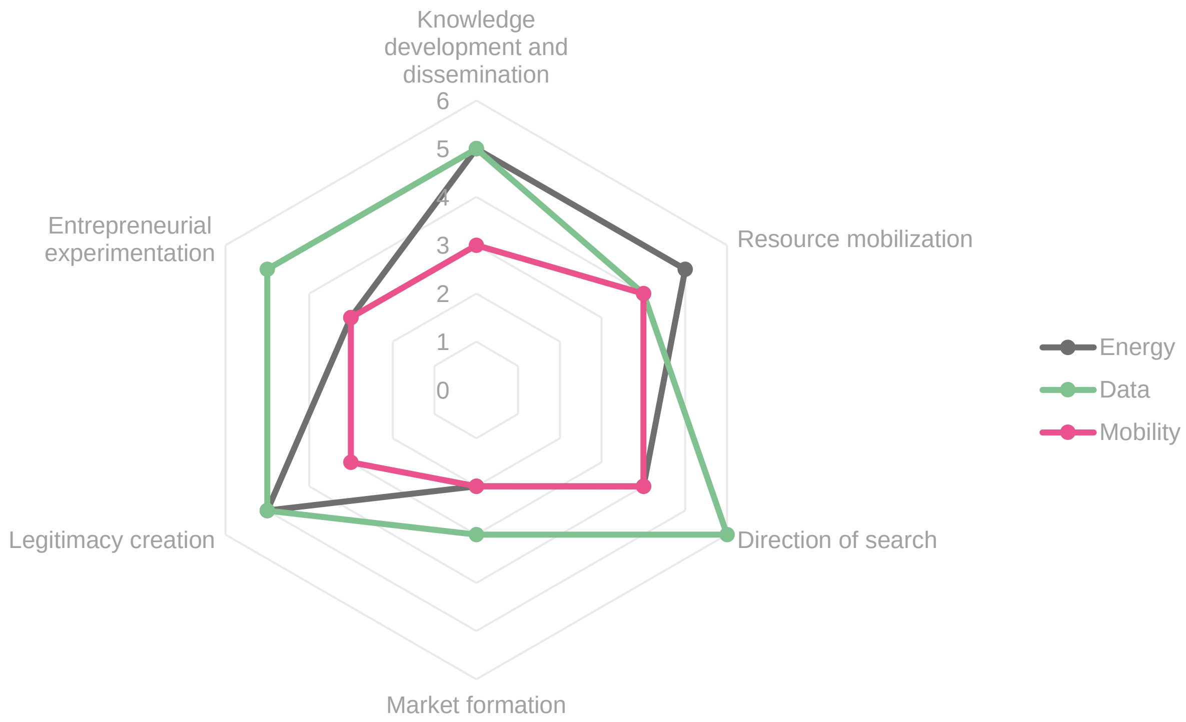

Figure 10 - Assessment of innovation functions per solution group

3.3 Governance and strategy needs for upscaling

The functional analysis shows that for energy and data there is potential for improvement when it comes to ensuring that the solutions reach the desired upscaling level and find their way to the market. For mobility, there is a significant potential for improvement.

Below follows a discussion of governance and strategy needs, for which public and private actors on a national, regional and local level can contribute to improving the system. As indicated earlier, several functions are directly weakened by existing structural barriers, such as regulation, norms, capacities or traditional interactions between actor groups. Implications of the recommendations for structural elements of the innovation system are also introduced in this chapter, summarised in Figure 11.

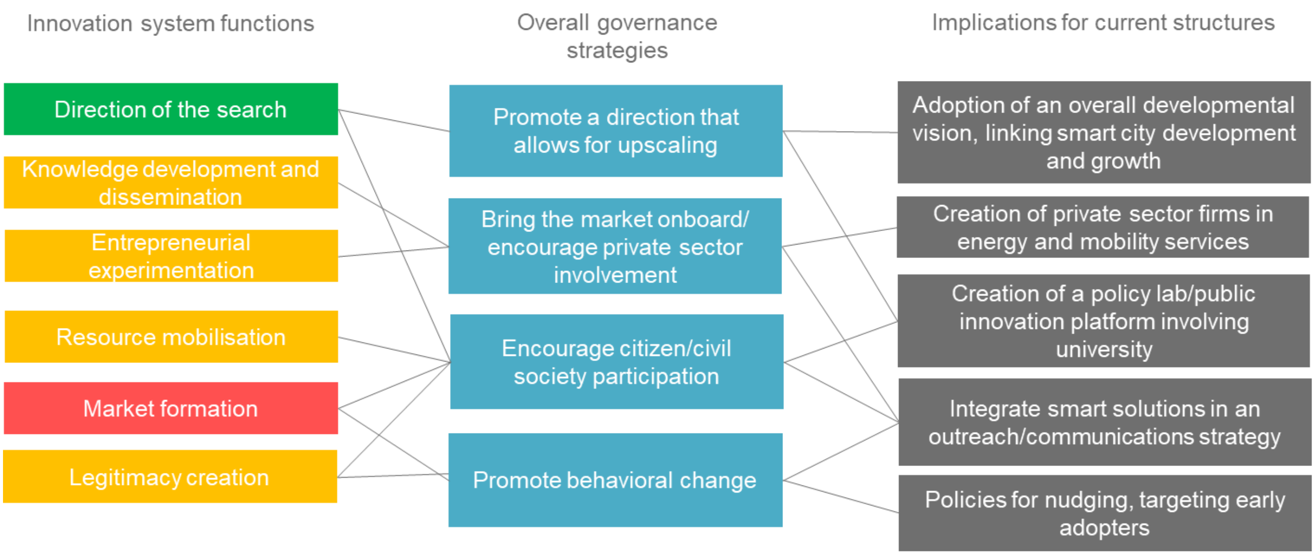

Figure 11 - Governance recommendations

Embed smart solutions in the overall development strategy

A lot can be done at the local level to improve conditions for upscaling for energy and mobility. There is a need to create a political vision and potentially a roadmap that connects innovation and the grass-roots energy of the city to the strategies being put forward by the council and its partners, if the solutions are to reach their potential. This way, the whole city can start to strive in the desired direction, and the groundwork for large behavioural shifts can be laid.

Regulate strategically

Limiting the availability of parking, of freight traffic and fossil fuel vehicle access to the city centre could to a lot to incentivize and encourage a shift to green energy and a modal shift to more sustainable and less space-demanding modes of transport. This does however need to be done with an open and keen ear towards the city stakeholders, in particular users and solution providers, to fit expectations and desires.

Bring the market on board

To spur creativity and encourage experimentation, actions to bring the market on board are recommended, through e.g. inclusion in governance processes and research projects. This could help in tackling problems related to some solutions such as business model development in energy. It could also create growth and innovation opportunities, while taking some of the burden of responsibility away from the public institutions and companies currently carrying a large share.

Encourage citizen and civil society engagement

To enable uptake of solutions, which in particularly for mobility requires behavioural change, an open and continuous interaction with the citizens of Umeå is required. Umeå's transition begins from a strong position, with a young, student-heavy and environmentally aware population. Leveraging citizen interest would maximize the likelihood that the legitimacy of reforms and long-term plans is high and has the desired effects. For data, this could also generate insight into how information overload can be avoided, enabling behavioural change. Synergistic effects in terms of entrepreneurial activity may also arise. Targeted outreach, particularly to university students and researchers, will be of value. Policies that 'nudge' citizens towards solutions to which they are already favourably inclined can bear fruit, as can identification and outreach to early adopters.

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Appendix 1 – Sample CCC Questionnaire

I. Past and Present

A. The system level gap

1. How does the solution link to the issues facing the district? (intro) For example, energy poverty, technical problems with existing heating solutions, plans for retrofits/renovations, availability of excess supply?
2. How common or typical for other districts city-wide are these issues? Is there any plan to evaluate other districts that could be candidates for similar models?

B. Pre-conditions and changes in the super-system

1. Are there any pre-existing policy instruments (strategies, targets, initiatives, subsidies) that supported the choice of this solution for the district? For example, how does district heating fit into broader energy strategies for Glasgow? Any that have hindered the implementation or created the need for adjustments or exemptions?
2. What policy changes are likely be required or desirable for the implementation and maintenance of the solution at the district level?
3. Have there been advocates and supporters who have been important to the selection of this solution for demonstration? Any opponents? Any that were reluctant or needed convincing? These can include direct stakeholders, e.g. council, brewery, residents.
4. Are there any pre-existing structural factors in the economy/society (for example, economics of alternatives, dissatisfaction among residents with the status quo) that supported the choice of this particular solution for the district? Any that hindered it or required adjustments?
5. Will implementing the solution require changes in the nature of the relationship between the actors involved (public-households and between industries), changes in their respective roles and competencies or creation of new actors?
6. How does the solution impact markets for goods or services in the district? (heat market, housing market, other)
7. What are the other, linked, technical systems present in the district and how will they be affected by the solution? (e.g. ventilation, piping, buildings, other)

C. Pre-conditions and changes in the sub-system

1. Please describe any critical advantages of the following types that supported the choice and implementation of the solution for district-level demonstration
   a) The degree to which the technical solution fits district infrastructure, compared to other feasible alternatives.
   b) Openness of stakeholders to the creation of a new business model for heating
   c) Access to essential capacity for delivery (e.g. finance, appropriate technology and maintenance, billing and payment, other?)

II. Future

1. What does Glasgow's demand for energy look like in 2033?
   a) What (if any) grand shifts in energy usage have happened?
   b) Why did it turn out this way?
2. How widespread is the solution in 2033?
   a) How 'big' is 'upscaled'?
   b) What exactly is upscaled? (technology, business model?) Is the business model applied to other technologies or areas?
3. What are the other solutions that meet Glasgow's demand for energy in 2033?
   a) Does the solution complement or compete with these alternatives? In what way?
4. What are the key drivers that allowed the solution to scale up, in terms of:
   a) Enabling technology and infrastructure?
   b) Actors' attitudes, behaviour and relationships?
   c) Policy, society and the economy?
5. What limited scaling up of the solution, in terms of:
   a) Technological and infrastructural barriers?
   b) Actors' attitudes, behaviour and relationships?
   c) Policy, society and the economy?

Appendix 2 – List of stakeholders consulted

	Interviewees	Scenario workshop attendees
Umeå	Christoffer **Ainek**, Umeå municipality Olov **Bergström**, Akademiska hus Jörgen **Carlsson**, Umeå Energi Kristofer **Linder**, Västerbottens läns landsting Jakob **Odeblad**, Västerbottens läns landsting Lisa **Redin**, Umeå university Frida **Sandén**, Umeå municipality Ebba **Sundström**, Umeå municipality	Carina **Aschan**, Umeå municipality Frida **Bergström**, Umeå municipality Olov **Bergström**, Akademiska hus Elisabeth **Lind**, Umeå municipality Kristofer **Linder**, Västerbottens läns landsting Jakob **Odeblad**, Västerbottens läns landsting Lisa **Redin**, Umeå university Frida **Sandén**, Umeå municipality Ebba **Sundström**, Umeå municipality
Glasgow	Ian **Hewlett**, Siemens Ciaran **Higgins**, Derryherk Limited Gavin **Slater**, Glasgow City Council	Bob **Cree**, Glasgow City Council Robert **Davidson**, Glasgow City Council Erica **Eneqvist**, RISE Research Institutes of Sweden Noemi **Giupponi**, Glasgow City Council Blair **Greenock**, Glasgow City Council Ciaran **Higgins**, Derryherk Limited Magnus **Johansson**, RISE Research Institutes of Sweden Nick **Kelly**, University of Strathclyde Laura **McCaig**, Transport Scotland Andrew **Mouat**, Glasgow City Council Michelle **Mundie**, Glasgow City Council Mic **Ralph**, Glasgow City Council Gavin **Slater**, Glasgow City Council Emma **Thomson**, Glasgow City Council
Rotterdam	Roland **van der Heijden**, City of Rotterdam Wouter **Ijzermans**, Eneco Wim **Kars**, City of Rotterdam Rick **Klooster**, Future Insight Peter **Wijnands**, City of Rotterdam	Adriaan **Slob**, TNO Albert **Engels**, City of Rotterdam André **Houtepen**, City of Rotterdam Christian **Veldhuis**, City of Rotterdam Jasper **Feuth**, Eneco Jilian **Benders**, City of Rotterdam Magnus **Johansson**, RISE Research Institutes of Sweden Marcel **van Oosterhout**, Erasmus Universiy Peter **Wijnands**, City of Rotterdam Roald **Suurs**, TNO Rob **Schnepper**, City of Rotterdam Roland **van der Heijden**, City of Rotterdam Roland **van Rooyen**, City of Rotterdam Theo **Konijnendijk**, RET Wim **Kars**, City of Rotterdam Virgil **Grot**, RET Wouter **van Rooijen**, City of Rotterdam

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