



RESPONSE

Integrated Solutions for Positive Energy
and Resilient Cities

Integrated Solutions for Positive
Energy and Resilient Cities

D7.7

Feasibility Analysis for Turku Replication Plan and 2050 Bold City Vision - V1



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Glossary

Abbreviation	Full form
BCV	Bold City Vision
EU	European Union
EV	Electric Vehicle
GA	Grant Agreement
FC	Fellow City
HVAC	Heating, ventilation, and air conditioning
ICT	Information and Communication Technologies
IE	Innovative element
IS	Integrated Solution
KPI	Key Performance Indicator
LHC	Lighthouse City
LVDC Microgrid	Low Voltage Direct Current Microgrid
PEB	Positive Energy Block
PED	Positive Energy District
PV	Photovoltaic (solar electricity)
RES	Renewable Energy Sources
TA	Transformation Axis
V2G	Vehicle to grid
WP	Work Package

Executive Summary

This deliverable (D7.7) is part of the Horizon 2020 Smart city project RESPONSE and is an outcome of the T7.6 Turku Smart City Replication Roadmap and Planning. Currently the RESPONSE project in Turku Lighthouse City (LHC) is at the end of the implementation phase deploying Positive Energy District (PED) in the Student Village and the monitoring phase is beginning. The aim of the task at hand is to identify solutions to be replicated in Turku thus promoting the transition to energy positivity in other city regions.

This deliverable focuses on representing stakeholder map and analysis of the stakeholder's opinions about replication, with particular attention paid to the city of Turku leaders holding the power to decide whether replication should be enabled and promoted, and in case of some solutions - also done. Moreover, the report narrows down the RESPONSE demonstrated measures based on the first step of evaluating their replication potential. Lastly, the plan for creating Bold City Vision 2050 is represented.

The results of the feasibility analysis of the chosen innovative elements and finalized Bold City Vision will be represented in the next deliverable 7.13. More in detail information about performance data and financial benefits will be gathered and discussions with mapped stakeholders will continue. Moreover, creating Bold City Vision will entail workshops about various topics and the vision of life in the 2050s will be created. The updating of the Climate Plan of City of Turku will begin in the end of the year 2024 and creating Bold City Vision can be integrated into that process. In addition, the results from T9.5 will be integrated as a part of the document. In total, the version 2. of this deliverable will summarize the overall process and provide a detailed replication plan and the Bold City Vision of 2050.

The methodology used in the reports is based on the D8.1 Fellow Cities (FCs) Replication Activities Planning and Sustainability Roadmap Creation, since following the same approach will make the plans of the LHCs and FCc comparable, consistent, and complimentary. Further, however, the phases of the said method have been concretized and contextualised to the conditions of the Turku Lighthouse City, considering its political climate, development strategies and growth priorities.

1. Introduction

1.1 Objectives of the deliverable

City of Turku is aiming towards climate neutrality by the end of 2029 and the strategy is explained in the City of Turku Climate Plan 2029¹. In addition, Circular Turku Roadmap² supports the way towards sustainable life in the city. The Bold City Vision is planned to show a vision of life on the 2050s combining the climate and circularity plans and filling in the sections that are missing in those documents. As City of Turku has set the goal on ambitious level, the Bold City Vision is more of a vision of what life could look like in climate neutral, circular and nature positive city. As earlier explained in the deliverable 7.6, the Bold City Vision could be utilized for defining concrete steps for increasing climate positivity as currently they aren't clearly defined yet. Stakeholder engagement will play important role in the vision process as well as in the replication planning. The roadmap for creating the Bold City Vision 2050 is discussed more in detail at the end of the document.

Replication-wise, the two-fold objective of this first version of the deliverable is to demonstrate the process of replication preparation that consists of mapping stakeholders that can enable, potentially replicate or are affected by RESPONSE demonstrated solutions in Turku. Moreover, there is initial narrowing down and grouping the measures shortlisted for replication based on the set of applied considerations. As a result, this deliverable presents a stakeholder map and stakeholder visions and a short list of innovative elements deemed suitable for planning further replication together with the stakeholders in other areas of Turku.

1.2 Relation to other Work Packages

To develop the replication plan and Bold City Vision 2050, developments in other work packages (WPs) and associated deliverables were considered as follows:

- *WP2 Smart Cities Performance Monitoring Framework and Governance* enables analysing performance of the deployed solutions in respect to the set objectives and thus is considered in replication and building the Bold City Vision 2050.
- *WP5 Business Models for Smart City Solutions and Governance Capacity* provide IE analysis from a socioeconomic point of view, highly relevant in the construction of a replication strategy for Turku in T7.6.
- *WP3 Integrated and Interconnected City Ecosystem Operational Framework* and *WP4 Mobilizing Collective Intelligence through Citizen and Stakeholder Engagement* provide information regarding deployment of measures related to ICT, eMobility, citizen empowerment and air quality monitoring, while the tasks of *WP7 Turku LH City Demonstration, Monitoring and replication activities* provide necessary data about the implementation of energy solutions in Turku PED, as well as monitoring results, which are instrumental asset for conducting replication plans, their validation and development of the Bold City Vision 2050.
- *WP8 FCs Replication Plans and 2050 Bold City Vision* supplies the methodology described in D8.1 FCs Replication activities planning and Sustainability roadmap creation, used as a basis for the present deliverable. The present deliverable will also benefit from the tools described in D8.2 FCs Ecosystem Replication tools development and capacity building - V1, while updating the toolkit proposed in D8.2. The tasks of WP8 will both benefit from T7.6 achievements and bring useful information for building replication strategies and Bold City Vision in the scope of T7.6. As T7.6 draws its methodology from the WP8 tasks and upcoming deliverables, these tasks will establish a constructive dialogue for LHCs and FCs, along with T6.6.

¹ Turku Climate Plan 2029 revised 2022 https://www.turku.fi/sites/default/files/atoms/files/turku_climate_plan_2029_0.pdf

² Circular Turku Roadmap <https://circulars.iclei.org/resource/circular-turku-a-roadmap-toward-resource-wisdom/>

1.3 Structure of the report

The structure of the deliverable is as follows:

- Chapter 1 introduces the objectives and scope of the deliverable.
- Chapter 2 focuses on stakeholder mapping and preliminary stakeholder vision of replicability, as well as preliminary assessment and narrowing down of the measures selected for replication.
- Chapter 3 describes the preparations for envisioning Turku Bold City Vision 2050.
- Chapter 4 concludes the document, presenting the lessons learned at this stage of the project as well as the upcoming work to be realized.

2. Replication plan creation


2.1 Defining replication and strategy

In the deliverable 7.6 replication was defined as: “Replicability refers to the possibility of transporting or ‘copying’ results from a pilot case to other geographical areas, albeit with potentially different boundary conditions. In other words, if a pilot was proven to work in one community or region, it could be exported to other communities or regions (indigenously or abroad) but taking into account that the boundary conditions could be quite different from those in the piloted community or region. Replication may also encompass the management process that was used in the pilot scheme or the cooperation structure between critical stakeholders.”³

In this deliverable the previous definition is supported and expanded to multitude of aspects and characteristics related to the integrated solutions (IS) and innovative elements (IE) demonstrated in RESPONSE. If a measure should only be replicated as it has been deployed in the original context, then it would leave quite a little possibility for replication. Also, as the aim is to improve energy efficiency in the city level, it is appropriate to use the examples and lessons learned from RESPONSE implementation and contextualize them for future development and/or renovation projects in the city with an appropriate degree of flexibility. The project has shown the decision makers at the city level that ambitious energy efficiency solutions are possible and needed to meet the climate target of being carbon neutral by 2029 as well as upkeeping the climate positivity thereafter.

The overall replication roadmap was explained in the previous deliverable D7.6 and follows the four-phase methodology. The current deliverable covers phase 2a – ‘stakeholders’ ecosystem & workgroups; analysis of the demonstrated measures”. The replication approach is explained in the Table 1. Further, an in-depth study of the -measures deemed suitable for replication will be carried out in the upcoming phases 2b, 3 and 4 where more in detail technical analysis along with economical and performance data will be assessed and presented. At this point of the RESPONSE project implementation, it was possible to begin stakeholder workshops and conduct the first round of filtering out the elements not suitable for replication.

Table 1. The approach for carrying out replication in Turku LHC

Steps	Phases	Deliverable	
0. Turku Smart City Replication Roadmap and Planning	1: Baseline and objectives; first study of stakeholders & measures; Analyzing regulations, barriers, & risks	D7.6	
1. Conducting replicability survey and analysing its results	2a: Stakeholders ecosystem & workgroups; analysis of the measures	D7.7	
2. Initial filtering out of measures not suitable for replication			
3. Grouping the remaining replicable measures into common intervention topics, considering targeted replicators			
4. Consulting implementation coordinators and contacting potential replicators; obtaining performance and financial data	2b: Business models, economic feasibility & Funding research 3: Business model's finalisation	D7.13	
5. Technical feasibility analysis for selected locations and (groups of) measures	4: Planning for implementation		
6. Envisaged implementation of replicated actions, including potential funding sources and risk management			

³ D7.6 Turku Smart City Replication Roadmap and Planning

2.2 Stakeholder analysis, methodology and mapping

A stakeholder in an organisation is any group or individual who can affect or is affected by the achievement of the organisation's objectives.⁴ In the meaning applied for the use of current deliverable, stakeholders have been mapped from replication's perspective as the organisations that either (1) can enable and facilitate replication for other actors or (2) can potentially themselves replicate demonstrated solutions or their parts or are essential for validation and using of the services and benefits provided by the readily replicated solutions.

In this deliverable the stakeholders are gathered and presented in the stakeholder map, while the stakeholder vision of the replication is examined from discussions that have taken place between 2022-2024. The discussions with stakeholders will continue and findings will be summarized in the next deliverable 7.13.

The methodology for mapping stakeholders was to examine the organizations that can enable and promote replication (i.e. have power to affect the decision making) and the ones that can potentially do the replication. The work was conducted in a brainstorming session where the local and regional stakeholders were listed and grouped into internal and external stakeholders. Internal meaning partners in the RESPONSE project that have a good understanding in the project goals, are familiar with the demonstrated solutions and have other similar areas in mind for replication. The external actors being ones not involved in the project and need more familiarising in the topic before committing to replication. During the process it was noticed that there is also a need for a third group of stakeholders; stakeholders that validate and use the solutions or benefit from their end result. After this grouping, the contact persons were identified and analysed which solutions could be proposed for them. As a conclusion the stakeholders are listed in the Table 2.

Table 2. Replication stakeholders map

	Stakeholders that can enable and facilitate replication	Stakeholders that can potentially replicate RESPONSE demonstrated solutions or their parts	Stakeholders that validate and use the solutions or benefit from their end result
INTERNAL	City of Turku Political decision makers (city council) Mayor and vice-mayors Urban Environment Services Management Group for Urban Environment Services Mobility unit Turku region traffic (Föli) Environmental protection unit	City of Turku Property management unit Infrastructure / maintenance Turku city office buildings Schools & daycare and educational centers Museums, theatre and cultural venues Game halls, swimming pools and sport venues Science Park of Turku The Maritime Vision of Western Turku Neighbourhood Vision for Runosmäki Turku Student Village Foundation (TYS) Old areas for retrofitting measures (Halinen, etc.) Newly planned constructions (Kylänkulma building) Tenant committees in other TYS housing areas Turku Energia Turku energia sähköverkot Oy	Mentors group TYS residents of PEB/PED buildings
EXTERNAL	Regional council of Southwestern Finland Big Construction companies (YIT, Skanska, NCC etc.)	City affiliated housing companies (VASO, TVT) Private owners/ housing companies Prefabricated house providers such as Kannustalo, Sievitalo Big Construction companies (YIT, Skanska, NCC, SVR) Turku Technology properties University Properties of Finland Åbo Akademi University Foundation SPA Hotel Caribia Kupittaa Citymarket Port of Turku Turku airport Fortum Varissuon lämpö Runosmäen lämpö	General public Tenants of housing companies Office workers and clients of property owning companies eMobility service users, etc.

⁴ D8.1 RESPONSE FCs Replication activities planning Sustainability roadmap creation. <https://h2020response.eu/wp-content/uploads/2022/05/D8.1-FCs-Replication-activities-planning-and-Sustainability-roadmap-creation.pdf>

		Energy companies (Helen, Oomi, Lumme, Väre)	
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2.2.1 The initial stakeholder work

Even though the discussions with the stakeholders had already begun before identifying all the stakeholders within replication, it was important to map them down into the table presented in the previous chapter (Table 2). By doing that it was possible to identify the stakeholders that should be contacted and engaged before representing the replication possibilities to others. The discussions held in 2022 and 2023 focused naturally on the city officials that are the group of internal stakeholders that should be contacted first. Furthermore, after crystallizing the need to pay attention especially on the decision level makers of the stakeholders, there was a workshop organized for the Management Group for Urban Environment Services in February 2024. Detailed findings about the discussions and the workshop are presented on the next subchapters 2.2.2 and 2.2.3.

In general, both the discussions and the workshop addressed the vital need to involve residents and stakeholders into the replication process. Moreover, it was concluded that before promoting any decision making there needs to be more detailed information about the costs of the demonstrated measures and more precise investigation on how existing housing stock could be transformed into more energy efficient. It was noted that probably the most convenient areas for replication would be new areas under planning but the existing housing areas with old buildings should not be left out when improving energy efficiency at the city level. It was also stated that energy efficient solutions should be integrated early in the planning process and there should be clear management responsibilities to guide the project.

Lastly, it can be said that the decision makers of the city of Turku are eager to improve energy efficiency and promote energy positivity throughout its areas. RESPONSE provides valuable example of how to implement energy solutions to both old and new buildings and how they can be integrated together. As the interest is paid on RESPONSE and its solutions and the decision makers have stated the need to study replication possibilities further, it is important to continue the discussion with the mapped stakeholders and present them with the solutions that have been selected to potentially be applicable in certain areas. Now that these measures have been shortlisted, the next step is to study their feasibility more in detail and also, collect available data of costs and benefits. As a result, there will be more in detail replication plan that will be presented in the next deliverable D7.13.

2.2.2 Discussions held about replication in 2022-2023

Discussions about replicability with various stakeholders took place between 2022-2023. The discussions were organized with stakeholders relevant for the two replication areas assigned during the RESPONSE preparation and further reconfirmed in the process of master planning the detailed implementation of project's actions. The intention was to introduce RESPONSE and preparations for its replication. The outcome was raised interest and discussions regarding where the solutions piloted in the project could be replicated in the areas of Runosmäki, Turku Science Park or elsewhere in Turku. The participants of these discussions were mostly from the city of Turku and their opinions can be broadly summarized as there was an interest in replication, but more information was necessary to proceed with more informed planning and deliberations. Moreover, the importance of participatory methods when promoting replication was mentioned various times.

When considering the thoughts on replication within the city, many officials from the Urban Environment Division were contacted. Starting from the area planning, which guides the area development and construction projects established, it was noted that city planning process could begin to demand more ambitious energy solutions at the property level, which would be beneficial when establishing replication plans. Moreover, as the current aim is to mitigate carbon emissions of buildings, there could be carbon footprint limits for new buildings in the future and promoting energy efficient solutions would possibly help to press down the carbon offset as well. Moving further from the area planning into planning of buildings, it is clear that energy related solutions and especially ambitious ones, need to be integrated into the planning

process at early stage. During the planning process it is also important to keep in mind the usage levels of the buildings. One of the issues and perhaps currently the most dominant one is related to costs. To attract investments, the prices should not be too high or otherwise the investment is not profitable in the long run. Thoughts should be paid on that, and it should be analysed how to present innovative solutions that improve living conditions and mitigate climate change when investing in them is more expensive than in regular solutions.

Along with the stakeholders from the Urban Environment Division, people from the Neighbourhood Vision for Runosmäki and the spearhead project of the Turku Science Park shared their views on replication. When considering replication activities in Runosmäki, the resident association active in there should be engaged into the development process. The community is active in participating residents and for example the community house was planned in collaboration with local residents. Support from residents and using peer mentors is essential in introducing innovative solutions in the area, otherwise lack of knowledge could lead to rejection. Also, the Turku Science Park spearhead project confirmed their interest in replicating RESPONSE solutions. The project was represented to the alliance and there was a wish to obtain advice on how to plan and construct climate positive areas. The Science Park project has very ambitious environmental goals and it is seen as one of the highly potential areas suited for replication activities.

In addition to the discussions held with the internal stakeholders from the city level, there were a few meetings with external stakeholders. There was an attempt to harmonize replication planning steps with ongoing initiatives aimed at securing funding from European Investment Bank, but this would have required more detailed follow-up once measures shortlisted for replication are initially matched with potential replicators' interest. In addition to that, there was a discussion with VASO (Varsinais-Suomen Asumisoikeus Oy) that owns, maintains and produces affordable right-of-occupancy homes. There was an interest in replication and for their older housing stock, retrofitting measures could be possible. As the housing stock reaches time for renovation, energy related innovations could be installed simultaneously. Lastly, there was an introduction for the DeCarbon Home research group. Decarbon-Home provides research excellence in the intertwined and ongoing climate-related and social challenges which necessitate a major transition in the Finnish housing system. DeCarbon Home was eager to learn from the examples done in Turku and offer their research expertise to develop methodologies that could serve in the replication and Bold City Vision process.

The discussions held with the mentioned stakeholders were important in gaining an understanding of the current mindset regarding replication possibilities. As there is interest in replication it is easier to continue the discussions and develop the replication plan further.

2.2.3 Management Group of Urban Environment Services' vision of the replicability

As it has been stated, the most important stakeholders in the beginning of promoting replication are the ones with power over the local decision-making. Therefore, special attention was paid on the Management Group for Urban Environment Services as the RESPONSE project's progress was first presented to them in their weekly meeting in the autumn 2023 and continued in the workshop held in February 2024. There was a common wish to obtain more data about the costs and expected savings, and it was stated that replication would be easier in the areas where new buildings will be constructed compared to areas with old building stock. The group members discussed how the deep and energy-efficient renovation is a good option in addition to building anew, and how climate and nature aspects should both be included into the planning process. They agreed on that the idea of energy positivity should be broadened into climate positive construction.

As more in detail insights about RESPONSE and replication possibilities were needed, a workshop was organized for the group in February 2024 at the project premises in the Student Village. The objectives of the event were to show the project area and the solutions in action and map stakeholder's visions about replication. The workshop was divided into two sections; first dedicated to personal insights regarding replication and the second focusing on three different areas and their potential as replication platforms.

The findings of the workshop are divided into the two sections. In the end are the conclusions derived from the workshop and the discussion sparked by the group work.

In the first section the participants were asked to consider the following questions:

- How can you promote energy efficiency / energy positivity through your own work?
- What is needed to concretely implement replication as part of the strategy?
- For what reasons do you consider replication important?

The main themes that emerged from the responses were as follows:

1. Influencing energy efficiency measures uptake and replication is perceived as most easily achieved through municipal guidance documents and by highlighting successful solutions through communication.
2. The success of replication requires the identification of costs, presentation of benefits, potential funding sources, a common work plan, and a shared project leader.
3. To promote replication, solutions should be replicable.

In the second section of the workshop the participants were divided into three groups and each of them were given a different area: Science Park, the Maritime Vision of Western Turku and old housing areas such as Runosmäki neighbourhood. These areas were selected as they are currently in the spotlight in the city planning process, and they were already considered as possible suitable places for replication in the early phase of the RESPONSE project.⁵ The mix areas representing both newly planned for development and existing old building stock made it possible to explore and elaborate different perspectives regarding replication.

In this section the groups were asked to go through the following questions:

- What concrete ideas do you see could be brought to the area? What solutions? (A list of solutions was provided for support)
- At what stage of planning should the solutions be presented to implement them?
- What additional information is needed? What individuals are needed from the city/owners?

The groups had time to discuss the topics and they were asked to write down answers after each of the questions and finally narrow the answers down to the three most important ones. The answers have been analysed together but there are some things that are important when considering new areas or old areas and they have been pointed out.

The insights were that each area is different, and the solutions should be tailored for each area individually. In the planning process, it is crucial to implement vision and mission in the early stages to reach concrete solutions. Also, it was stated that there should be various solutions to compare in the beginning, both traditional options as well as new and innovative ones. Moreover, as all the areas have existing building stock, their potential should be utilized. It was advised to consider what other suitable solutions are existing and how could they be adapted. One important point noted was that it would make management and maintenance much easier if similar solutions were used in various locations.

At the project management level, it was stated that it would be important to have one nonbiased organization facilitating and managing replication process, to ensure objectivity in the planning and economical aspects. The facilitating could be organized through cross departmental working group within the city with support by external specialists if needed. Responsibilities and goals should be bright and clear for the participants.

From decision making perspective there is need for crystallizing the path of decision making and need for pointing out who are the persons responsible for approving energy solutions in the city level.

In general, the Management Group found replication and supporting energy efficiency important. Still, there are some considerations that should be taken into account. At the time of the workshop, the project being on its testing phase, final performance results being insufficient. The board members would have liked to hear about costs and how the

⁵ RESPONSE D7.6 Turku Smart City Replication Roadmap and Planning

innovations are in relation to more traditional and “business as usual” solutions readily available on the market. Thus, the board agreed on continuing the discussion with the mayor board and seeking their opinion on the topic.

2.3 The process of conducting initial feasibility analysis of the Innovative Elements

The preliminary feasibility analysis of all the RESPONSE demonstrates measures was conducted in a form of a survey in March 2023. The respondents were the coordinators overseeing the interventions’ implementation or technical providers of the solutions deployed. At the same time, the surveying was conducted while not all intended measures have been completed, so its results were treated as a starting point for further evaluation and narrowing down the solutions to be replicated.

When analysing the survey’s answers, it is vital to note that the opinions are objective as the implementers/providers have analysed replicability of their own piloted innovations, and not necessarily in the context of Turku but rather more broadly (some of the respondents are not well familiar with the city, its energy infrastructure and development area landscapes). All in all, the results provided a good background information for the next steps in the IE analysis was done.

The surveying form included questions about the following aspects of the demonstrated measures:

- The purpose of the IE: for example, what improvements it provides / is expected to provide.
- The current status of the IE: for example has the IE been implemented already, when will it be finalized, how is it functioning in relation to expected results.
- The envisioned replicability potential of the IE in the city of Turku: for example, you may describe the benefits/potential of the IE, possible bottlenecks.
- The overall replicability score: 1= not replicable, 5 = replicable.
- Potential replication site in Turku: a site, block, building etc. If the IE cannot be replicated respondents were asked for a brief explanation.
- Potential replicators.
- Stakeholders to be involved in replication and why (in addition to potential replicators).
- Other aspects which are important to consider in replication not yet covered in this questionnaire.

In RESPONSE, Turku Lighthouse city implements all together 37 innovative elements of which the survey responses covered 35 (excluding two TYS own-funded measures), and out of them 20 were considered as replicable (Figure 1).

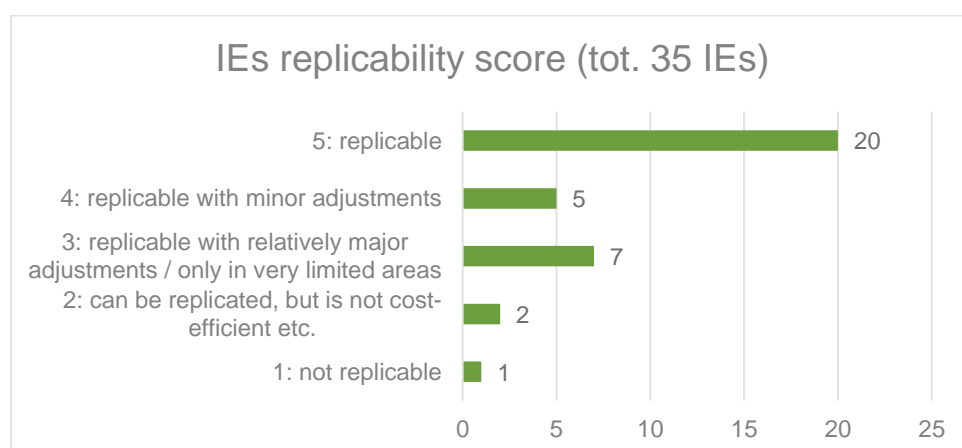


Figure 1. Cumulative results of the replicability survey conducted in March 2023.

The list of IEs and their scores can be seen in the Table 3.

Table 3. The replicability score of Innovative Elements in the survey conducted in March 2023.

Score	IE title
5	IE 1.1.5 DC coupled smart bifacial PV system with optimized racking system for maximum bifacial yield
5	IE 1.2.7 Nano coating 4-glazing windows
5	IE 2.2.8 Smart district heating substation for end user heat demand flexibility
5	IE 3.2.4 Novel PCM Heat Storage for DHW
5	IE 2.1.8 Cloud-based Smart Energy Management System
5	IE 2.1.6 LVDC Microgrid
5	IE 3.1.4 DC-Coupled Battery Storage System (BESS)
5	IE 3.1.2 2nd Life Battery Storage System (BESS)
5	IE 4.2.6 EV sharing scheme
5	IE 5.2.4 LES based meteorological flow modelling system utilizing the 4-meter pre-calculated PALM wind fields
5	IE 4.1.6 Smart City Knowledge Graph platform
5	IE 5.1.1 Local events/meetings
5	IE 5.1.16 Co-creation and Capacity building events
5	IE 5.1.7 Hackathons
5	IE 5.1.11 Cascade funding
5	IE 5.1.17 Training of peer mentors
5	IE 5.1.19 Activities implemented by mentors
5	IE 5.1.20 Training sessions of digital tools
5	IE 5.1.22 Open dialogues with policy level actors
4	IE 2.2.4 Upcycling of the near-by city district cooling energy flows with high COP (>5) heat pumps
4	IE 2.2.7 District heating network control and management with dynamic district heating tariffs
4	IE 3.2.5 District Heating PCM heat storage-as-a-service
4	IE 4.2.5 Light Electric Vehicle charging hub (LEV Hub) for LEV's, e-cargo bikes and e-bikes
4	IE 5.2.5 Sensor network for PM monitoring
3	IE 2.2.5 District heating flexibility optimizing network control and management
3	IE 2.2.6 Optimization settings for two-way consumer/prosumer district heating connection
3	IE 1.2.10 (Self-sufficient) IoT Thermostats
3	IE 1.2.9 Novel Human Thermal Sensation Control
3	IE 4.1.7 Journey Planner application
3	IE 4.1.8 District Heating, Cooling and Flexibility Control Situational Awareness and Anomaly Detection
2	IE 4.1.10 5G Smart City Lighting Poles
2	IE 4.2.4 Fast V2G charging station
1	IE 5.12.21 Avatar creation events

2.3.1 Initial filtering out the non-replicable solutions

The survey results were used for analysing the IEs further and narrowing them down into a selected list of potential solutions to be replicated. The process of narrowing down the RESPONSE Innovative Elements is explained in the Figure 2 below.

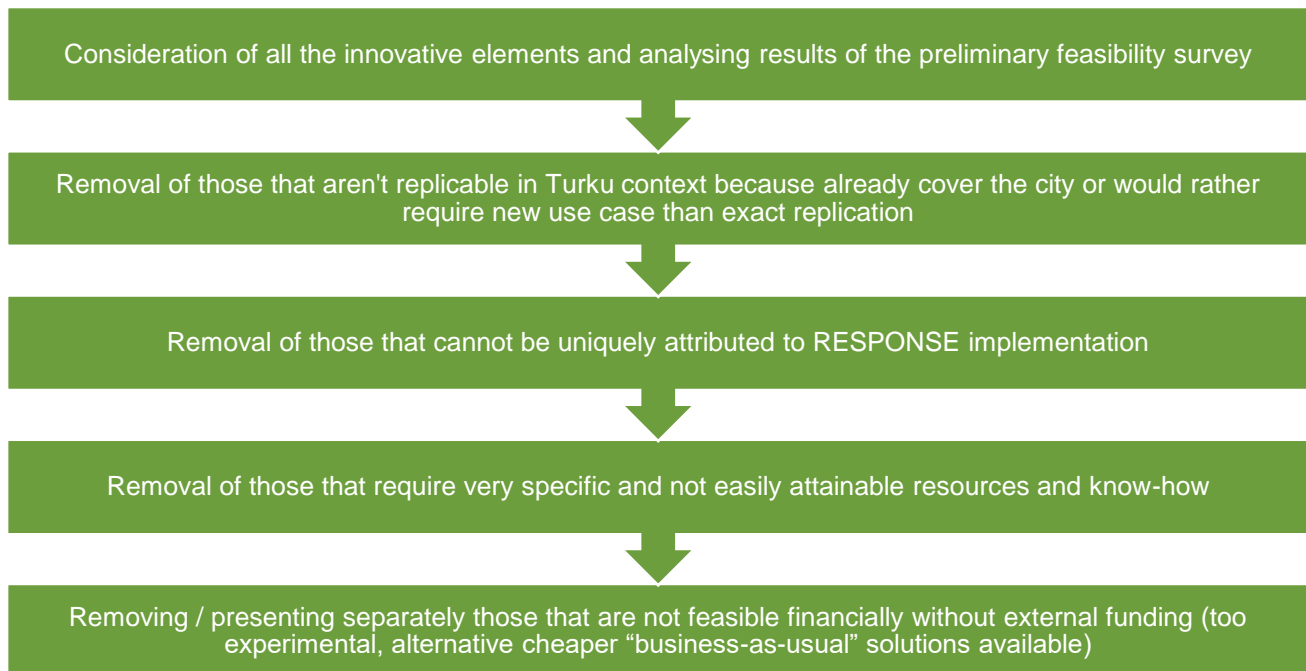


Figure 2. The process of narrowing down the Innovative Elements suitable for replication.

As the outcome of this process, following IEs were deemed to be unsuitable for further replication planning:

- RESPONSE developed meteorological flow modelling with wind fields and one of its direct applications – Air Quality Journey Planner already cover all of Turku.
- Smart City Knowledge Graph AI platform, advanced through the project activities, is rather a tool for piloting other innovations and in the context of its further development would require new use-cases and not a traditional replication in its direct meaning.
- Energy meters, conventional retrofitting (PVs, insulations, changed windows, doors and water taps, etc.) as well as hackathons supported through cascade funding, and other social measures such as local meetings and workshops, co-creation and capacity building events, digital tools training sessions and open dialogues with policy level actors are already broadly enough carried out in Turku in different formats and do not represent innovations specifically introduced by RESPONSE project.
- Developing and piloting district heating network control and management optimizing flexibility and applying dynamic district heating tariffs as well as automated driving and vehicle-to-vehicle communication robot cars via 5G required significant support from research institutions, their resources and know-how which are not easily readily available for majority of replication efforts.
- Lastly, nano coating 4-glazing panels windows, 5G smart city lighting poles and 5G sensor network for PM monitoring all represent innovative measures where alternative, market available solutions deliver comparable results and make more financial sense to explore.

Therefore, of 37 innovative elements demonstrated in Turku, 20 were selected for further replication planning as described in the next sub-chapter.

2.3.2 Selection of IEs to continue the feasibility analysis for replication

The survey results were used for analysing the IEs further and narrowing them down into a selected list of potential solutions to be replicated. The shortlisted measures were grouped into five topics in relation to their function: electricity, mobility, buildings, heat and social (Table 4). Two elements could be attributed to two topics, and these were: IE 4.2.4

Fast V2G charging station that can be placed into both electricity and mobility and IE 2.1.8 Cloud-based Smart Energy Management System that is relevant for both electricity and heat.

The IEs chosen for the groups were seen as ones that have the greatest potential to be replicated. Additionally, as mentioned before, they are innovative and feasible outside the project area. The IEs chosen for the topic *electricity* were seen as ones that can be established together and their implementation doesn't require much additional solutions. The IEs in the topic *emobility* were chosen as they could be replicated in various areas and could be beneficial. The IEs in the topic *buildings* are ones that could be implemented both in new housing areas and older areas where renovations to boost energy efficiency are needed. The IEs in the topic *heat* are ones that could be added to already existing heating and cooling district network. Also, they could be implemented in large buildings that have waste heat sources. The last topic *social* includes IEs such as peer mentoring and avatar creation events that support the replication process and as noted before, are important part of including participatory methods in the process.

Table 4. The selection of potentially replicable IEs grouped into topics.

Topic	Innovative element	Areas suitable for replication	Potential replication area	Potential replicator
Building level measures	IE 1.2.8 Novel high-performance ventilation system with high eff. heat recovery	Areas under development as well as areas designated for retrofitting.	Turku Science Park and Kupittaa-Itäharju, Runosmäki and other suburbs.	TYS and other housing companies City of Turku owned public buildings
	IE 1.2.9 Novel human thermal sensation control			
	IE 1.2.10 Self-sufficient IoT thermostats			
Electricity measures	IE 2.1.6 LVDC microgrid	Areas in active development. Microgrid and its elements are replicable for locations equipped with PV power plants where there's a need to share the produced excess with neighboring buildings, use storage options or EV charging. Smart Energy Management Systems can thus further advance the distribution among clients utilizing electricity price fluctuations and increasing energy saving benefits.	Turku Science Park and Kupittaa-Itäharju Maritime Vision of the Western Turku	Turku Technology Properties
	IE 1.1.5 DC coupled smart bifacial PV system with optimized racking system for maximum bifacial yield			University Properties of Finland (Turku campus)
	IE 3.1.4 DC coupled Battery Storage System			Åbo Akademi University Foundation
	IE 3.1.2 2nd life Battery Storage System			City of Turku newly planned developments
	IE 4.2.4 Fast V2G charging station			TYS and other housing companies
IE 2.1.8 Cloud-based Smart Energy Management System				
eMobility measures	IE 4.2.5 Light Electric Vehicle charging Hubs	Areas that lack of charging stations / or in need of additional ones based on currently available infrastructure.	Turku Science Park and Kupittaa-Itäharju	City of Turku and other property owners
	IE 4.2.6 EV sharing scheme			
	IE 4.2.4 Fast V2G charging station			TYS and other housing companies
Heating measures	IE 2.2.4 Upcycling of the near-by city district cooling energy flows with high COP (>5) heat pumps	Replicable in various areas around the city, considering availability waste heat sources of their own (large supermarkets, malls, hotels, offices with large data, etc.) to ease the integration of the heat pump and related systems application.	Turku Science Park and Kupittaa-Itäharju Maritime Vision of the Western Turku	City owned buildings and large real-estate complexes
	IE 2.2.6 Optimization settings for two-way consumer/ prosumer district heating connection			TYS and other housing companies
	IE 2.2.8 Smart district heating substation for end user heat demand flexibility			Turku Energia and other energy companies as well as large thermal industrial sites
	IE 3.2.4 Novel PCM Heat storage for DHW			
	E 3.2.5 District heating PCM heat storage-as-a-service			

	IE 4.1.8 District heating, cooling and flexibility control situational awareness and anomaly detection			
	IE 2.1.8 Cloud-based Smart Energy Management System			
Social measures	IE 5.1.17 Training of peer mentors	Elderly care and social housing sites, where peer mentoring can be similarly applied.	Runosmäki, Varissuo and other suburbs	City of Turku
	IE 5.1.19 Activities implemented by mentors			TYS and other housing companies with tenant committees or similar
	IE 5.1.21 Avatar creation events	Housing, educational facilities, etc.	Maritime Vision of the Western Turku	

The next steps for finalising the replication feasibility study will be established after this deliverable and the results will be presented in the D7.13. As the solutions have now been narrowed down into potentially replicable ones, more information about them will be gathered, especially concerning performance data and information about financial benefits and costs to support the replication process and planning. The survey done in March 2023 will be repeated with their implementers and providers, meanwhile the discussions with the potential replicators will continue. Lastly, a technical feasibility analysis for planned locations and measures will be conducted and funding sources for replication mapped. As a result, the process will conclude into an envisaged implementation of replicated actions and a risk management plan.

3. Bold City Vision 2050

3.1 Towards 2050 with Bold City Vision

The Bold City Vision 2050 marks a pivotal step towards realizing a sustainable and inclusive future for the city of Turku. This chapter outlines the key steps and considerations to be involved in translating the vision into actionable strategies and guiding documents. As stated earlier in this deliverable, the Bold City Vision will envision life in a climate positive city and describe methods for reaching it. As Turku is aiming to become climate neutral by 2029, the Bold City Vision can dive into topics that have not been addressed that much in the already existing guiding documents such as Turku Climate Plan and Circular Turku Roadmap. The end-result is not envisioned to be a self-standing document but rather a set of recommendations and interventions to be integrated in other strategic papers guiding the development of the city. The methodology is based on workshops carried out with various stakeholders, discussions with other projects (i.e. SPARCS) that have detailed guidelines for formulating the Vision and lastly, there will be recommendations from RESPONSE task T9.5 providing Multicriteria decision support scoring and prioritisation system for energy sustainability and energy trilemma (energy security, energy equity and environmental sustainability) re-estimation. The steps for creating Turku Bold City Vision 2050 are shown in the table 5 below.

Table 5. Steps for creating Turku Bold City Vision 2050

Steps	Phases	Deliverable
0. Turku Smart City Replication Roadmap and Planning.	1: Initial status check and analysis of relevant strategies	D7.6
1. Bold City Vision (BCV) insights from the Stakeholder workshops about replicability.	2a: Replication planning and background work	D7.7
2. Narrowing down IEs for replication and identifying ones that could be replicated in the longer perspective.		
3. Discussions with other EU funded Smart City projects and initiatives.		
4. Future workshops focusing on transportation, circularity, construction and/or citizen engagement. Target groups students and specialists in the field.	2b: Development and multistakeholder validation	D7.13
5. Integrating recommendations from T9.5 and energy trilemma re-estimation into the BCV.	3: Integrating Turku Bold City Vision 2050 with the update process of the Climate Plan 2029	
6. Compiling stakeholder visions and lessons learned from RESPONSE into the BCV and forming it into a set of guiding principles and interventions to the city strategic documents.	4: City board / city council approval and public info campaign	

The timeline and tools for creating the Bold City Vision were shown in the deliverable 7.6. and here is explained the current situation. The stakeholder workshops about replication have started and so far, the focus has been on replication. The idea is to integrate those IEs that cannot be just yet replicated into the Bold City Vision as they could be implemented later in the future. The stakeholder workshops about replication will continue and more in detail information about replication possibilities will be obtained. There has also been a meeting with the SPARCS project team from the lighthouse city of Espoo, and they shared their ideas and advice on creating the Bold City Vision for Turku. SPARCS⁶ project seeks

⁶ SPARCS homepage: <https://www.espoo.fi/en/sustainable-development/sparcs>

new innovative solutions for the development of energy-positive areas as part of a large-scale joint European project and as they are further along in their project it was beneficial to have discussion with them.

The upcoming phases 2b, 3 and 4 will have more in detailed discussions with stakeholders and the Bold City Vision work could be integrated as part of the upcoming updating of the Climate Plan of Turku that will take place in spring 2025. The upcoming workshops about the Bold City Vision will entail topics such as transportation, circularity, construction and citizen engagement. In order to have a wide perspective on the topic the participants in the workshops will be both people who will live their adulthood in the city and specialists who can analyse future through their expertise. The results will also be helpful in envisioning the timeline between 2029 and 2050. In addition, the results from T9.5 will be integrated as a part of the document. As a conclusion, the Bold City Vision will include suggestions about long perspective replication of RESPONSE solutions, give suggestions of needed measures to reach and sustain climate positivity and envision life in the 2050s.

The desired outcome is to have a successful participatory process with proactive contribution of the stakeholders and compile the Bold City Vision with vision statements and guidelines supporting other city documents such as the Climate Plan and Circularity Roadmap.

4. Conclusions

RESPONSE is coming to its final phase where the solutions are implemented, and their potential and benefits can be assessed. As a project, RESPONSE has marked an important step for the city in showing the possibility for having energy positive districts. Since Turku is aiming towards carbon neutrality and supporting sustainable life for its citizens, the examples from RESPONSE are important and showcase methods for improving energy efficiency and even reaching energy positivity. In the city of Turku there are various areas under development and RESPONSE serves them with various potential elements to be replicated.

At this point of the replication planning, the potential measures suitable for replication have been chosen and the discussions with stakeholders have started. As it was stated in the workshop in February 2024, it is crucial to gather information about costs and benefits to be able to support the replication in the decision-making process and the project planning. The decision makers and project developers have a wide interest in the project but before actual replication more in detail information is needed also from the technical perspective. By gathering comprehensive data and engaging stakeholders effectively, the project can advance its replication objectives and contribute to sustainable urban development.

When it comes to the Bold City Vision, it can support the updating process of Climate Plan of Turku and provide valuable insights about the wishes and needs of the citizens. The Bold City Vision will the gaps between 2029 and 2050 and point out issues that haven't been addressed before in the existing guiding documents.

The next phase (April 2024-September 2025) is dedicated to continuing the process of estimating IEs replication possibilities and creating the Bold City Vision. These results will be incorporated into D7.13 Feasibility Analysis for Turku Replication Plan and 2050 Bold City Vision V2.

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D7.6 Turku Smart City Replication Roadmap and Planning (currently under revision)



RESPONSE

Integrated Solutions for Positive Energy
and Resilient Cities



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