D3.1 Detailed plan of the Espoo smart city lighthouse demonstrations

30/09/2020

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Dissemination level

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Deliverable administration

No & name	**D3.1 Detailed plan of the Espoo smart city lighthouse demonstrations**				
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Description of the related task and the deliverable. Extract from DoA	**T3.1 Local coordination in Espoo (ESP) M1 – 60** This task ensures the achievement of SPARCS objectives and efficient co-operation within the Espoo Lighthouse Demonstration Team, parallel work packages, other stakeholders and supporting partners, and the Sustainable Espoo development programme. The main activities include, among others: keep strict control of the lighthouse implementation process and schedule. This report presents a detailed plan of demonstration actions and sub actions in Lighthouse City Espoo. It includes a detailed Gantt for the demonstration phase and responsibilities. It also shows the preparation for the monitoring phase towards Milestones 8 - Completion of the demonstration sites, which is due in M30.				
Participants	ESP, VTT, KONE, SIE, PIT, CIT, RIL, ADV, BABLE, CIVIESCO				
Comments					

V	Date	Authors	Description
0.1	01/2020	All	working document
0.2	08/2020	MH	Ready for internal review
0.3	24/09/2020	WP leader	Deliverable checked by WP leader and released to the Coordinator and the Quality Manager for quality check and subsequent submission to the EC.
1	28/09/2020	VTT	Coordinator submits the deliverable to the EC

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About SPARCS

Sustainable energy Positive & zero cARbon CommunitieS demonstrates and validates technically and socioeconomically viable and replicable, innovative solutions for rolling out smart, integrated positive energy systems for the transition to a citizen centred zero carbon & resource efficient economy. SPARCS facilitates the participation of buildings to the energy market enabling new services and a virtual power plant concept, creating VirtualPositiveEnergy communities as energy democratic playground (positive energy districts can exchange energy with energy entities located outside the district). Seven cities will demonstrate 100+ actions turning buildings, blocks, and districts into energy prosumers. Impacts span economic growth, improved quality of life, and environmental benefits towards the EC policy framework for climate and energy, the SET plan and UN Sustainable Development goals. SPARCS co-creation brings together citizens, companies, research organizations, city planning and decision making entities, transforming cities to carbon-free inclusive communities. Lighthouse cities Espoo (FI) and Leipzig (DE) implement large demonstrations. Fellow cities Reykjavik (IS), Maia (PT), Lviv (UA), Kifissia (EL) and Kladno (CZ) prepare replication with hands-on feasibility studies. SPARCS identifies bankable actions to accelerate market uptake, pioneers innovative, exploitable governance and business models boosting the transformation processes, joint procurement procedures and citizen engaging mechanisms in an overarching city planning instrument toward the bold City Vision 2050. SPARCS engages 30 partners from 8 EU Member States (FI, DE, PT, CY, EL, BE, CZ, IT) and 2 non-EU countries (UA, IS), representing key stakeholders within the value chain of urban challenges and smart, sustainable cities bringing together three distinct but also overlapping knowledge areas: (i) City Energy Systems, (ii) ICT and Interoperability, (iii) Business Innovation and Market Knowledge.

Partners

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EXECUTIVE SUMMARY

This report presents a detailed plan of all the demonstration actions that SPARCS will realise in the city of Espoo, Finland. We start by describing overall summary of the Lighthouse demonstrations in Espoo, and then continue by going into details in the demonstration areas. The demonstration actions cover broadly different low carbon improvements of urban area development, including buildings, energy systems, transportation, urban planning and citizen involvement.

Espoo city structure has five large district centres, and our demonstration areas focus on two of these centres in Leppävaara and Espoonlahti districts. Sello area at the centre of Leppävaara district is an existing urban area, where demonstration actions focus on improving the existing urban infrastructure, although there are currently massive construction sites improving the public transportation connection. Lippulaiva block at the centre of Espoonlahti district is a new block that is currently under construction, hence, offering us a potential to test and demonstrate energy positive block solutions in new buildings. In addition to more practical demonstrations, we have a 3rd demo site concentrating on urban planning in the Kera area, with the high ambition level for sustainable and smart district development. And finally, SPARCS also studies macro level demonstration actions in the city of Espoo.

We will explain in this document the detailed plans for the demonstration phase, including planning of the work, targeted outcome, schedule and partners' roles and responsibilities. The initial KPI's have also been recognised, paving the way for impact assessment in collaboration with work package 2 and supporting the preparation for the monitoring phase. A detailed Gantt summarises the demonstration phases, aiming towards Milestone 8 - Completion of the demonstration sites, which is due in M30.

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1. Introduction

1.1 Purpose and target group

This report provides a throughout overview of the 100+ Smart city lighthouse demonstration actions realised in the City of Espoo, Finland. We have three SPARCS demonstration sites in Espoo. Sello area as the centre of Leppävaara district offers a fruitful place to test innovative energy positive block solutions incorporated in existing urban environment. Lippulaiva block at the centre of Espoonlahti provides a demonstration site for constructing a new energy positive block. Kera development area focuses on the planning phase, aiming to develop and demonstrate solutions for the planning process of an energy positive block. In addition, SPARCS has various macro level interventions focusing on the broader level aspects.

In the demonstration sites, SPARCS is making interventions related to different aspects of energy positive blocks: buildings, energy, transportation, ICT, people involvement and urban planning. These interventions done in the demo sites are formulated from many detailed level demonstration actions.

A detailed Gantt shows the schedules for the demonstration phase, acting as an efficient tool for following the overall project situation and reflecting the status of each action. The detailed plans of demonstration actions include work plan, targeted outcome, partners' roles and responsibilities. The detailed planning includes preparation for the monitoring phase that will follow the demonstration phase in M36.

The demonstration actions presented in this report follow the task structure of WP3:

- A summary of the Espoo lighthouse actions activities in section 2, following the work done in T3.1 Local coordination in Espoo.
- Energy positive blocks demonstrations (task 3.2) in section 3, including:
    - Lippulaiva site in section 3.2,
    - Leppävaara site in 3.3,
    - Kera urban planning actions in section 3.4, and
    - Macro level energy related action in section 3.5.
- ICT and interoperability demonstrations (task 3.3) in section 4.
- E-mobility integration activities (task 3.4) in section 5.
- The planning of energy positive districts (task 3.5) in Espoo in section 6.
- The community engagement activities (task 3.6) in section 7.
- Air quality (task 3.7) in section 8.
- Smart business models (task 3.8) in section 9.
- Macrolevel interventions for energy positive solutions in section 10.
- Replication and exploitation preparation (task 3.9) are discussed in section 11.

This report is primarily targeted for organisations working in the SPARCS and collaborative Smart City stakeholder groups. It can also provide insights to other lighthouse projects and cities, and stakeholder partners; as well as cities starting to plan similar kind of smart city developments.

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1.2 Contributions of partners

The following Table 1 depicts the main contributions from partners in this deliverable and work planned and performed.

Table 1: Contributions of partners

Partner	Contributions
VTT	Editor of the deliverable. Content planning, allocation of writing responsibilities. Section 1, 5.5, 8, 9.3, and 11.
ESP	Lead of sections 2, 3.1, 3.4, 3.5, 4.3, 5.1, 5.4, 6, 7.4, 9.4, and 10.
CIT	Lead of sections 3.2, 5,2,
SIE	Lead of sections 3.3, 4.1, 4.2,
KONE	Lead of sections 4.4, 7.1, 7.2, 7.3, 9.1, 9.2,
PIT	Lead of section 5.3
ADV	Detailed plan of Action E1-6 in section 3.2

1.3 Relations to other activities

The following Table 2 depicts the main relationship of this this deliverable to other activities or deliverables within the SPARCS project.

Table 2. Relation to other activities in the project

Deliverable / Milestone	Contributions
D3.2	This deliverable D3.1 is the starting point for deliverable D3.2, which reports the implemented demonstrations of solutions for energy positive blocks in Midterm (due in M24).
D3.3	Developed further from D3.2, describing the implemented demonstrations of solutions for energy positive blocks in Espoo (due in M36).
M8	Support for completion of the demonstration sites in Espoo in M30.
WP2	KPIs development initiated and supporting the monitoring of the actions.
WP6	Knowledge change between other SCC1 projects and other networks. Contributions to recommendations building in T6.2.
WP7	Links to business models development and exploitation; aiming for wide knowledge exchange

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2. Overview of Lighthouse demonstrations in Espoo

2.1 Introduction to activities in Espoo

Espoo is the second largest city in Finland with some 280 000 residents. The city has had goals in sustainability since 1990's and currently the topic of City strategy 2017-2020 is "The most sustainable city in Europe – now and in the future. One special character of Espoo is its structure: instead of one city centre, Espoo has altogether 5 city centers that are actually like cities in the city, providing all necessary services close to our residents. In this project, we have demonstration areas located in two city centres: Sello demonstration in Leppävaara and Lippulaiva demonstration in Espoonlahti. Both city centres are currently developing rapidly and foreseeing many new residents in the next 10 years. Leppävaara is already now the largest city centre and if it was an independent city, it would be 13^{th} – 15^{th} largest city in Finland by population. The smart city lighthouse demonstration and replication sites in Espoo are showed in Figure 1.

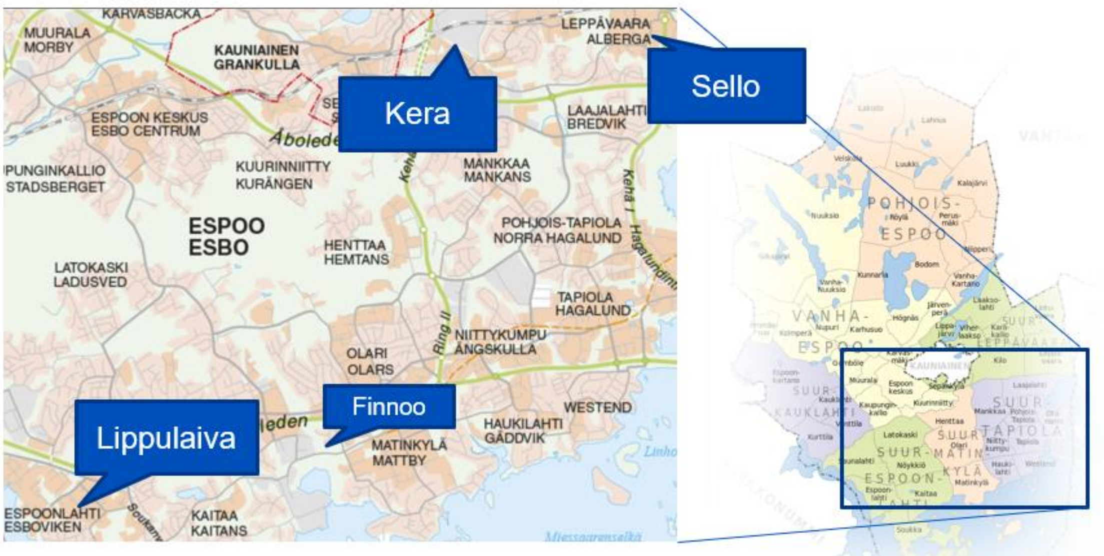

Figure 1. A map shoving the SPARCS demonstration and replication locations in Espoo, Finland.

Demo area in Leppävaara is located around shopping centre Sello and its block, which is mixed-use: there is, in addition to the shopping centre, residential buildings, public services and entertainment. The Sello shopping center opened in 2003 and new energy management solutions by Siemens are demonstrating direct impact on energy efficiency. Solar panels and battery energy storage are well-known solutions, but their optimized integration to the building energy system requires new approaches. Controlling electric loads like lighting, HVAC and elevators support total system balancing and increase the total flexible capacity that can be sold to Fingrid's Frequency Containment Reserves. Electric vehicle and e-Bus charging will also be integrated. District Heating is business-as-usual in Espoo, but demand side management leveraging the thermal mass of building structures will allow Sello to reduce peak load and produce savings both in energy expenses and CO_2 emissions. Geoenergy potential will be assessed during the up-coming planning of a new Sello

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extension. In Sello, continuous work towards better energy-efficiency has been done for years. Sello has been rewarded with EU energy service award and LEED Platinum level certification for the operating time.

The Lippulaiva shopping center is under construction by its owner Citycon, and it will utilize new energy solutions from day one. When finished the shopping center will be the largest geothermal heating and cooling energy plant in Europe for a commercial building, built under Lippulaiva. The regenerative geoenergy system by Adven will cover 100% of the cooling demand and almost the entire heat demand of the shopping center and residential buildings nearby, leaving only a fraction of heat to be sourced from the district heating grid in case of prolonged cold weather. Excess heat recovered from summertime air conditioning and refrigeration systems are injected into the geoenergy field, increasing the capacity and efficiency of the system. This makes the geoenergy system in essence a seasonal thermal energy storage solution. PV panels provide clean on-site renewable electricity and battery storage will be assessed. Lippulaiva is an important mobility hub comprising a metro station, bus terminal and facilities for cycling and e-mobility. Citycon is also engaging citizens and young consumers, in particular, to participate in the co-creation of the new shopping center. Collaboration with local schools has led to the establishment of so-called buddy classes, and pupils will work directly with Citycon on specific sustainability themes. City of Espoo will concentrate on promoting sustainable lifestyle among its citizens.

The Kera area is a deprived industrial area developed in the 1970s and now to be reallocated for mostly residential use. Existing landowners include the retail group S-Ryhmä, currently one of the largest producers of renewable energy in Finland, and Nokia, with headquarters in immediate vicinity and strong support to the 5G based smart infrastructure development in Kera. SPARCS will develop and pilot new models for co-creation, energy communities and stakeholder engagement to bring residents in the new Kera district to the center of energy ecosystem, maximizing local production and encouraging prosumer models to enhance the utilization of distributed generation.

Solutions will be replicated in other sites around Espoo, particularly in Finnoo district and in collaboration with Smart Otaniemi innovation ecosystem. Demand side management will be rolled out throughout the city building stock, including city's rental housing provider Espoon Asunnot.

2.2 GANTT

A detailed Gantt shows the schedules for the demonstration phase from M1 to M36 in

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Table 3, providing an efficient tool for all partners in following the overall project situation and reflecting the status of each action. The milestones defined for each action are highlighted in the table, with columns representing the month number (1-60), but for actions with a more continuous nature only the end date has been specified. The responsibilities and partners in charge are also summarised in the Gantt. The order of entries follows the structure of this report.

Table 3. GANTT for Espoo demonstrations. The codes on the left (e.g. E1-1) refer to detailed numbering of demonstration actions in Espoo. The partners short names working in the demonstration are listed).

2.3 Preparing for the monitoring

A participatory workshop on KPIs was held with the guidance of WP2 in February 27th 2020. Each demonstration action includes a plan for the performance monitoring and prospective KPIs are described in this document. KPIs will be refined in later stages to assess both the measures undertaken and results achieved.

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3. Positive energy blocks in Espoo lighthouse demonstrations

3.1 Introduction to task 3.2

The objective of Task 3.2 is to demonstrate solutions for positive energy blocks and Districts. While positive energy districts (PEDs) are expected to generate annually more energy than they consume and, in theory, could thus operate in isolation of surrounding infrastructure, this is not necessary nor desirable in practice. The key driver for the European Commission to develop PEDs is to empower local stakeholders, engage citizens and gain public support for the low carbon energy transition. Ideally, PEDs are independent and locally administered entities with local renewable energy generation, storage and distribution, and they interact with the wider energy system. The interaction includes among others energy trade, flexibility services and storage.

The Espoo demonstration sites assume a comprehensive approach to energy systems. Electricity, heat, cooling, mobility, clean fuels, flexibility and storage capacity are controlled by smart solutions that minimise emissions and costs while ensuring reliability and local ownership. Sector coupling yields more degrees of optimisation, but requires comprehensive automation, new business models and transaction platforms such as blockchains.

Two of the demo sites, Sello and Lippulaiva, comprise a shopping center, residential buildings, libraries and other public services, and rail and bus terminals with improved e-mobility, cycling and pedestrian options. Citizens have here various roles as customers, passengers or residents, or simply socializing without being confined in any specific category. The third demo site, Kera, is a new residential district, currently in city planning and due to be developed in the next 10-15 years. In all sites, promotion of sustainable lifestyles is as important as adopting new technology.

The three sites are in different stages of development. Leppävaara Center with the Sello shopping centre have been in use for several years. The Lippulaiva shopping center with residential buildings and metro station is under construction and scheduled to start operation in 2022. The development of Kera district is currently in city planning phase and its construction not be completed in the timeframe of the SPARCS project.

3.2 RES integration in Energy Positive Lippulaiva blocks

Subtask 3.2.1 RES integration in Energy Positive Lippulaiva blocks focuses on the energy systems in new Lippulaiva shopping center and the surrounding residential building blocks. Leasable gross area of the shopping center alone is 44,000 m^2, with additional 550 residential apartments and senior house with approximately 120 apartments. Figure 2 and Figure 3 below show an architecture sketch of Lippulaiva shopping center with residential blocks and a picture of the construction site on 12th of August 2020. The opening of Lippulaiva shopping center is planned to be on 1st of April 2022.

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Figure 2. Lippulaiva architecture picture as it will be when ready (above) and picture of construction site from 12th of August 2020 (below).

On-site RES production includes 4 MW regenerative ground source heat pump plant, 50,000 m of bore holes and approx. 200 MWh/a PV system. The new Lippulaiva shopping centre together with surrounding buildings create a district with a multi-mix consumption and the potential to achieve zero-energy level and beyond. Heating and cooling demand of Lippulaiva shopping center as well as residential buildings and senior house is mostly covered with heat pump plant. Figure 4 below shows hourly heat consumption profile in one year of Lippulaiva (simulated data) and the orange color presents the share of heat demand provided by heat pump system.

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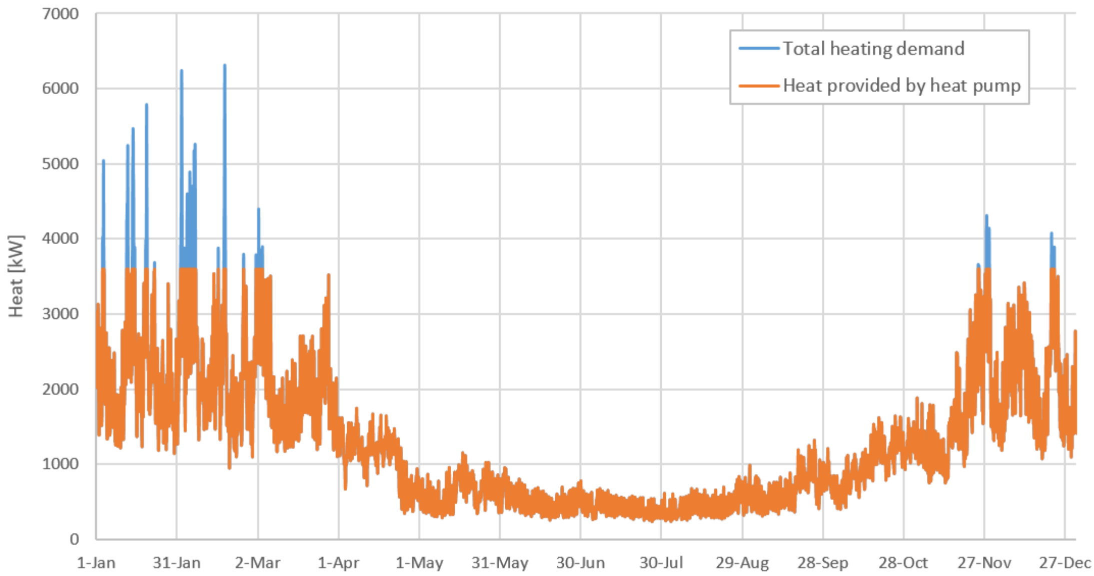

Figure 3. Total heating demand in Lippulaiva and heat provided by heat pump system.

SPARCS interventions (E1) for solutions for Positive Energy Blocks in Lippulaiva are presented in tables following. Actions E1-1 and E1-2 concentrate on on-site energy production. The target is that heating and cooling demand in Lippulaiva shopping center is mainly covered with on-site geothermal heat with heat pump (system by Adven). Beside the heat pump system, Lippulaiva will have district heating connection and electric boiler for back-up heating system and for peak heat demand. The on-site waste heat is utilized when possible. Electricity demand is covered with PV panels (roof) and certified renewable electricity. The capacity of PV panels is assessed in Action E1-2.

The target is that energy consumption and production are smartly controlled. In Action E1-3 the potential to use an electricity battery as an emergency power is assessed. Together with this, the smart control system and participation to Nordpool's reserve markets is assessed. With this type of smart electricity control service, it would be possible to decrease electricity costs with smart control strategies, which follow the electricity market price and control the consumption level as well as utilizes electricity battery. The idea is to follow tomorrow's day-ahead market price for electricity and participate in reserve market with battery storage. Simultaneously, the smart electricity control service would cut peak loads and gain savings in electricity costs.

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Action E1-1	**Optimisation of the NZEB energy system with integrated RES and Virtual power plant (ADV CHP-bio, electricity contracted via Nord Pool) based on big data and predictive building control strategies. The system uses a regenerative geo-energy field also storing thermal energy to the ground. The source provides enough heating and cooling for the Lippulaiva blocks. Momentary excess can be exchanged with renewable DH network.**
Detailed plan	• To determine the energy consumption profiles in Lippulaiva shopping center and residential blocks (simulations) as well as to describe the consumption of heating, cooling and electricity and possible waste heat sources that can be utilized. • To provide the description of the thermal energy system (heating and cooling) including the virtual power plant, on-site heat recovery and control strategies. • To examine the possibilities of heat recovery from metro tunnel.
Targeted outcome	To achieve Lippulaiva as NZEB with integrated RES and purchased certified renewable electricity with utilizing on-site excess heat, smart control strategies and smart thermal energy storage system.
Roles and responsibilities	CITYCON: As owner of Lippulaiva, Citycon acts as Action leader. CIT provides simulated energy consumption data for partners and ensure that Lippulaiva will be as energy efficient as possible. ADVEN: Adven is the energy partner in Lippulaiva providing heating and cooling energy and investing in thermal energy system. Adven provides the thermal energy system description including thermal storage. Description of big data and predictive building control strategies concerning heating and cooling is done together with Citycon. VTT: VTT defines the terminologies and calculates the KPI's defined. VTT provides feasibility studies on heat recovery from metro tunnel and connecting geothermal to local DH network together with CIT.
Schedule	• CIT: provides simulated energy consumption data M6 and consumption description in M12 • ADV: system description and description of control strategies together with Citycon M18 • VTT: feasibility studies on heat recovery from metro tunnel M6 (done)
KPIs	• On-site energy ratio (OER) = "On-site produced renewable energy" / "Total energy used" • Annual mismatch ratio (AMR) • Annual final energy consumption (kWh/m^2/year) • CO_2 emissions
Deviations from initial plan	Electricity demand for Lippulaiva (other than produced with on-site PV panels) is purchased as certified renewable electricity and not with virtual power plant (CHP-bio).

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Action E1-2	**Final dimensioning of the PV plant (capacity depends on the detailed design of the roof structures, and relations between PV and the green roofs)**
Detailed plan	To assess the final dimensioning of the PV plant. The target is to maximize the amount of PV panels in Lippulaiva shopping center and the amount depends on the detailed design of the roof structures.
Targeted outcome	The final dimensioning of the PV plant in the rooftop (size, energy production, effect).
Roles and responsibilities	CIT: Providing input data and dimensioning the PV plant. VTT: Calculating needed KPI's.
Schedule	CIT: Dimensioning of the PV plant by M12.
KPIs	• onsite electricity production compared to electricity consumption in Lippulaiva blocks (kWh/year and % share) • monthly electricity produced with PVs (kW)/ installed PVs (kW)
Additional info	The architecture of Lippulaiva shopping center has changed since the original SPARCS project plan, affecting changes to the original approximation of PV plant size.

Action E1-3	**Assessing the potential to use a battery energy storage system as emergency power while it provides frequency-controlled reserves and local cost minimization. Control strategies are developed together with business models.**
Detailed plan	• To assess the optimal size of battery energy storage • To assess the potential to minimize electricity costs in Lippulaiva by optimizing electricity usage, producing own energy and participating in electricity reserve markets • To assess different control strategies for smart electricity consumption, production and battery usage
Targeted outcome	To assess the potential and describe the benefits of battery energy storage together with smart electricity control strategies and participating in frequency-controlled reserve markets.
Roles and responsibilities	CIT: To assess the potential to use a battery energy storage system and the suitable control strategies as emergency power to minimize costs. VTT: Description of benefits and possible risks for Citycon if participating in reserve markets. To assess different control strategies for smart electricity consumption, production and battery usage. To support Citycon to assess the potential to use a battery energy storage system as emergency power for cost minimizations.
Schedule	Ready by M15
KPIs	• Energy matching indicator (to be specified later) • Pay-back period of battery energy storage and smart electricity control strategies

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Action E1-4	Improving the self-sufficiency of surrounding blocks, emulating the heat export from the ground source heat pump to the surrounding residential building blocks through the local heating network.
Detailed plan	Action E1-4 is closely related to Action E1-1 and the work is partly overlapping. In this action the plan is: • To determine the energy consumption profiles in residential buildings of Lippulaiva • To determine waste heat possibilities from residential buildings and assess their possibilities for heating • To assess the use of Lippulaiva geothermal heat to residential heat • To examine the possibilities of connecting geothermal to district heating network (operated by Fortum)
Targeted outcome	Delivering Geothermal heat and cooling to residential towers and service home to be built in connection to Lippulaiva shopping centre.
Roles and responsibilities	CIT: Providing input data of energy consumption in Lippulaiva shopping center and surrounding residential blocks. Writing the description of consumption. ADV: Providing system description of thermal energy. VTT: Assisting in action when needed. Calculating needed KPI's. Providing feasibility studies on connecting geothermal to district heating network (operated by Fortum) together with Citycon and Adven.
Schedule	• CIT: Writing the description of consumption M12. • Adven: Writing system description of thermal energy M18. • VTT: Providing feasibility study on connecting geothermal to local district heating network (to Fortum) M18
KPIs	• Onsite heat produced compared to heat consumed • Excess heat potential available for export

Action E1-5	Proof for the predictability for the energy costs and the profitability of the nZEB solution, paving way for scaling up.
Detailed plan	• To determine base-case where energy costs are compared to • To calculate the energy costs in Lippulaiva • To calculate the profitability of the nZEB solution in Lippulaiva case Due to timing of Lippulaiva construction (opening in April 2022), the costs are calculated based on simulated consumption figures and the proof for the costs will be calculated in project years 4 and 5 with actual consumption data.
Targeted outcome	Finalized energy costs for Geothermal and PV energy production. Cost comparison to base-scenario.
Roles and responsibilities	CIT: Providing consumption and cost data for base-scenario and Lippulaiva case. Providing data for "base-scenario" for cost comparison. ADV: Providing needed input data VTT: Calculating energy costs of Lippulaiva and needed KPI's

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Schedule	• CIT and ADV: Data provided for cost calculations M35 and M59 • VTT: The costs are calculated based on simulated consumption data M36 • VTT: The proof for the costs will be calculated in project years 4 and 5 with actual consumption data M60
KPIs	• Energy costs for customer (€/MWh) compared to base-scenario (compared to other Citycon Shopping Centres)
Additional info	Due to timing of Lippulaiva construction (opening in April 2022), the costs are calculated based on simulated consumption figures and the proof for the costs will be calculated in project years 4 and 5 with actual consumption data.

Action E1-6	**Automation steering system development. Development work on optimizing the efficiency of the building automation steering of HVAC systems in connection to geothermal energy production, including system control, air conditioning, demand flexibility and the utilization of weather forecasts. Case Lippulaiva act as pilot.**
Detailed plan	Optimising and developing the automation steering system.
Targeted outcome	By connecting building automation to Adven energy production automation we are able to optimize more efficiently energy production and minimize expenses and CO2 emissions.
Roles and responsibilities	ADV: Specifying interface and steering procedure together with building automation service provider CIT: Connecting Adven to Citycon's chosen building automation service provider
Schedule	Ready by M36
KPIs	KPIs will be benchmarked to other Citycon Shopping Centres.

3.3 Smart energy solutions for self-sufficiency in the Leppävaara center

Subtask 3.2.2 Smart energy solutions for self-sufficiency in the Leppävaara center focuses on increasing efficiency and self-sufficiency through digital tools and through local thermal energy production.

Leppävaara is one of the fastest growing areas in Espoo and Sello Center is the local Energy hub of Leppävaara (Figure 4). Sello multipurpose centre has an area of 102 000 m2 including shops, a library, concert hall, and movie theatre. Sello center has 2900 parking lots that includes tens of EV charging station. Sello gets 23 million yearly visitors. A new plan of Sello Center extension is under development (illustrated in Figure 5).

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Figure 4 PV Panels on Sello Center. (Source: Siemens)

Figure 5 Future Sello Extension. (Source: Espoo.fi)

In the Action E5-1 Sello's thermal energy processes are modelled to understand the potential increased energy efficiency, self-sufficiency and thermal flexibility. In the following action, Sello's flexibility potential is realized by providing the thermal flexibility to local district heating company (Fortum). In the last action, increasing the self-sufficiency through deep heat geothermal well is evaluated. Details of SPARCS interventions E5 Solutions for Positive Energy Blocks in Sello are presented in tables following.

Action E5-1	Predictive model for the storing energy to the building structures and battery storage to be created and evaluated.
Detailed plan	• Define solution architecture • Define KPIs • Install needed submeters for energy

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	• Calculate time constant and create prediction algorithms for storing energy (heat and cool) in Sello based on physical structure (if available), historical and real time energy data: energy, indoor environment, weather and (visitors and people flow, if available). • Integrate the time constant and prediction algorithm to Sello energy management system via APIs • Integrate Sello energy management system through APIs to local DH company for DH demand side management Additional, if resources are available: • Creating a BIM model of Sello block (in IfcSpace format) • Integrate the prediction model to Digital Twin model via APIs
Targeted outcome	Predicts 48hrs ahead Sello's heating and cooling flexibility with high accuracy based on the different heating and cooling strategies. Use the prediction model to provide increased flexibility for DH DSM in E5-2 and optimization of energy demand. Continue co-operation beyond SPARCS
Roles and responsibilities	SIE: Define solution architecture, provide data needed and create APIs towards VTT and Fortum, acquire BIM model creation VTT: Define solutions architecture, calculate time constant and prediction algorithm, (integration to digital twin, temperature data linked to 3D BIM-model to e.g. visualize temperature, CO_2 and RH, changes during demand response period)
Schedule	Solution architecture defined M14 Time constant defined M19 Prediction algorithm M21 Integrated to Digital Twin M27
KPIs	• Accuracy of the prediction model • Usability of prediction model • Measuring financial value of the prediction model
Deviations from initial plan	SIE: installation of sub heat meters to Sello. At the moment, Sello's heat is metered on 2 main meters. In order to have a good enough granularity for the predictive model, new submeters will be installed.

Action E5-2	Integration with the local district heating grid operated by Fortum (Bio oil Plant 40 MW) for selling cooling/heat and heat demand side management.
Detailed plan	• Define system architecture • Provide flexibility data via API to Fortum • Execute flexibility based on Fortum's signal via API
Targeted outcome	To lower CO_2 emissions level of local DH. To enable consumers to become active part of the energy sector by providing flexibility.
Roles and responsibilities	SIE: Define system architecture, coordinate the work with Fortum and Sello, responsible for implementation
Schedule	System Architecture Defined M3 APIs integrated M5

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	Execute Flexibility Requests M6
KPIs	Flexibility request received and flexibility delivered compared to request of Fortum. Impact on local DH grid CO_2 level. Deviation of indoor temperature compared baseline. Change in energy consumption compared baseline.

Action E5-3	**Evaluate increase of self-sufficiency through the Sello extension. Evaluate deep heat station in new build.**
Detailed plan	• Define scope of the study and limitations. • Gather input data from Sello and solution providers. • Analysis and conclusions.
Targeted outcome	Increase of self-sufficiency of a Sello Block. Understanding technical barriers and commercial potential compared to DH. Understanding technical barriers and commercial potential of P2P heat trade.
Roles and responsibilities	SIE responsible for defining the scope, gathering the input data and analysis.
Schedule	Define Scope of Work M12 Gather input data M20 Analysis and conclusions M25
KPIs	Increase of self-sufficiency of Sello District. Impact on the energy cost compared to baseline.

3.4 City planning for Positive Energy blocks

This intervention makes Kera a testbed for locally adapted PED solutions. In normal circumstances, commercial utilities would invest in traditional infrastructure like 3rd generation one-directional district heating at temperatures up to 120°C. As waste heat sources are typically available at much lower temperatures, grid feed-in requires expensive heat pumps and makes bi-directionality difficult. A bi-directional low-temperature 4th generation district heating network would operate at temperatures below 70°C, improving overall efficiency, reducing thermal losses and making cheaper pipe materials technically feasible.

In the electric distribution grid, remotely read meters are mandatory but enhanced smart grid solutions require additional functionality for demand side management and prosumer support. Energy communities could be established to collaborate with peers and improve self-consumption. New business models for electricity aggregators facilitate participation in Fingrid's flexibility markets. The SPARCS actions under this intervention demonstrate city planning tools to facilitate an innovative and citizen-centered approach to energy grids.

The city planning function is a combined effort by different city departments. For key development projects like the Kera site, the city assigns one project manager to coordinate city planning, stakeholder engagement and the various city projects active

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in the district. In Kera, this includes SPARCS, Clean and Smart Kera (including energy utilities Fortum and Caruna), Neutral Host 5G (with Nokia), and 6aika-funded projects 'Vähähiilinen liikkuminen liikennehubeissa' for low-carbon transportation in mobility hubs, and 'Kieppi' for circular economy. Architectural sketches of the new plans for the Kera area are in Figure 6 and Figure 7.

Figure 6 Architect picture of Kera, Aerial view

Figure 7 Architecture picture of Kera, Street view

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SPARCS interventions E10 - Solutions for Positive Energy Blocks and related demonstration actions are presented in the tables following.

Action E10-1	City Planning for Positive Energy Blocks. Exploring the possibilities to utilize the continuously updated Espoo 3D City model as a support and tool in the development and planning of the new Kera area.
Detailed plan	• Communicate with city architects and zoning personnel to understand and document the role of the 3D city model in Kera planning. • Map technical, economic and regulatory barriers in piloting innovative PED solutions. • Identify opportunities offered by energy community legislation and new cost-efficient renewable energy generation and distribution technologies • Assess new business models for generation, aggregation, storage and distribution. • Explore the benefits of using 3D city model in pursuing new opportunities and implementing PED solutions • Draft process to mainstream 3D city model support in PED development in Espoo.
Targeted outcome	Mainstreamed process to routinely integrate PED considerations in the early stages of city planning will reduce costs and improve the effectiveness of energy efficiency and distributed energy generation measures in new area development.
Roles and responsibilities	ESP: Main responsibility VTT: Support in identifying technologies relevant to PED development leveraging experiences from similar Lighthouse projects Siemens, Adven, PlugIt, Kone, stakeholders: Propose private sector solutions and new business models for public private partnerships in PEDs
Schedule	M18: 3D model in city architecture and zoning process documented M21: Barriers, opportunities and business models assessed M28: Assessment of 3D model feasibility in PED implementation finalized
KPIs	Qualitative assessment (Likert scale) of city planning tool Prospective On-site Energy Ratio and Annual Mismatch Ratio in Kera Prospective impact on energy expenditure for residents (€/year)
Financial scheme	This action does not require infrastructure investment. The city is actively engaged in projects to support renewable energy, circular economy and low-carbon mobility solutions, with specific budgets allocated to local pilots.

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Action E10-2	Energy infrastructure. Planning and on-site follow up of energy infrastructure solutions for positive energy blocks. Solutions enabling energy transfer (consumers as prosumers), including a bi-directional electricity grid and open district-heating network.
Detailed plan	• Identify emerging and established clean energy solutions relevant to Kera, comprising technology, business models and citizen engagement • Assess technology readiness, cost-efficiency, required stakeholder engagement, policy implications and replicability • Develop prosumer models based on new energy community legislation • Assess financial and climate impact of bidirectional electricity and DH grids • Develop guidelines to enhance the uptake of solutions in collaboration with relevant city departments, communities and technology suppliers, aligning with 3D city model support from E10-1 • Pilot guidelines in development of Kera, Finnoo or other sites • Follow-up on PED infrastructure implementation
Targeted outcome	Adequately planned energy infrastructure improves the availability and feasibility of local energy solutions like waste heat utilisation, peer-to-peer energy markets, aggregation of demand side management and feasibility of distributed energy generation.
Roles and responsibilities	ESP: Main responsibility Stakeholders: Propose additional solutions
Schedule	M18. Key solutions identified and documented (ref. M28 of E10-1: 3D city model assessment for PED completed) M36: Guidelines for PED infrastructure development completed M60: Guidelines applied and follow-up in Kera
KPIs	Number of promising technical and infrastructure solutions for PEDs

Action E10-3	Energy system planning. The energy system planning explores options for energy demand side management of all buildings by using energy demand response and energy efficiency, as well as acting as heat storage, and enabling the use of emission-free eco heating energy products and services, and demand flexibility.
Detailed plan	• Categorisation of public building stock to reveal low hanging fruits like swimming pools and sport facilities with specific heating and cooling requirements. • List most promising sites and assess thermal energy consumption. • Develop solutions to harness thermal capacity for demand response. • Document results and disseminate results. Related Actions: E16-1 on Espoon Asunnot, E15-1 on 1MW power VPP aggregation in Espoo City properties, E6-1 and E6-2 on digital platforms in Leppävaara and Kera
Targeted outcome	Demand side management reduces peak demand for heating and power. As peak generation units are typically most carbon intensive, annual carbon

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	emissions decrease with added demand flexibility. System-level planning supports the integration of RES and development of 100 PEDs in EU.
Roles and responsibilities	ESP: Identify suitable sites Stakeholders: propose solutions for demand response
Schedule	M20: list of most suitable sites for demand response M36: technical solutions for DR assessed and documented
KPIs	Total power (MW) and energy (MWh) under demand response. Annual CO2 savings due to DR

3.5 City scale smart heating and thermal demand response

The city of Espoo has implemented demand side management (DSM) of heating in the social housing company Espoon Asunnot Oy. Leanheat Oy, the service provider of the thermal DMS, reports 10% saving in heat consumption and 24% reduction in peak load. City of Espoo is in the process of extending DSM to other public buildings. DSM will decrease peak heat demand and lead to financial savings and lower CO_2 emissions. This subtask extrapolates existing DSM activities to promising subsets of the city's building stock.

Action E16-1	**Buildings demand side management and demand flexibility. The aim is to implement demand side management to achieve demand flexibility on large scale in both public and private buildings. Solutions based on emission free district heating. Espoo Asunnot Oy (Espoo social housing company) has already connected all its 15,000 apartments to demand response and eco heating. During SPARCS, the solution is further developed and replicated. The development of energy efficiency and energy consumption peak loads are monitored to optimize the city level energy system.**
Detailed plan	• Assess DSM scheme for Espoo Asunnot in terms of heat demand, peak load and emissions reduction. • Assess additional energy efficiency and distributed energy generation potential. • Investigate potential to replicate around Espoo. • Prepare plan and guideline to replication. This task is closely linked to electricity DSM in Action E15-1.
Targeted outcome	Demand side management reduces peak demand for heating and power, presenting an opportunity to reduce capex for distribution infrastructure. As peak generation units are typically most carbon intensive, annual carbon emissions decrease with added demand flexibility.
Roles and responsibilities	ESP: Document buildings and heat demand under DSM VTT/Fortum: Estimate carbon emission reduction potential Siemens: Propose technical approach to optimise DSM
Schedule	M12: Document extent and benefits of current DSM measures M18: Prepare plan and estimate techno-economic benefits of scale-up

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	M24: Document findings, report and communicate with stakeholders
KPIs	Total current and potential heat load under DSM (MW) Current and potential savings in capacity fees (€ per year) Current and potential emission savings (CO_2 per year)

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4. ICT AND INTEROPERABILITY IN ESPOO LIGHTHOUSE DEMONSTRATIONS

4.1 Intoduction to task 3.3

The trend towards greater digitalisation of energy has been enabled by advances in data, analytics and connectivity. Digitalisation can greatly increase the lifetime, efficiency and utilization of energy infrastructure and reduce costs. Connectivity helps to couple different energy sectors, so that consumers and producers in any sector can actively participate across energy system operations, increasing the flexibility with which the system can cope with imbalance of supply and demand, and reduces the cost of integrating new technologies like distributed generation, energy storages and electric vehicles.

The EU is moving from centralized electricity generation in power plants operated by large utilities towards a mix of decentralized and often renewable energy production in small facilities. This change in energy sector combined with electrification of mobility and heat creates a new challenge to power grids. Virtual Power Plants are critical element in this transition and are enabled by digitalization.

The energy sector is expected to benefit from blockchain technology, among others it could provide innovative trading platforms where prosumers and consumers can trade interchangeably their energy surplus or flexible demand on a P2P basis without 3rd party involvement, reducing transaction costs. Blockchains could provide a promising solution to control and manage increasingly decentralized complex energy systems.

Decentralized and complex energy systems require also fast communication with high capacity, bit rate, throughput, latency and energy efficiency and resilience. 5G networks are expected to provide the communication requirements for the new decentralized complex energy systems.

The objective of task 3.3 is to enable sector coupling and increase the interoperability, monitoring and control of various energy systems by ICT between smart buildings, smart grid and district heating and cooling systems, EV charging infrastructure, and the allocation of open data.

Task 3.3 Includes following subtasks:

3.3.1 Virtual Power Plant for optimized RES energy use

3.3.2 Smart energy services

3.3.3 Smart Building Energy Management

4.2 Virtual Power Plant for optimized RES energy use

A virtual power plant is a pool of several small and medium scale installations, either consuming or producing electricity. When small and medium scale installation are integrated into a Virtual Power Plant, the power and flexibility of the aggregated assets can be traded collectively.

In this subtask, Sello's multipurpose center virtual power plant platform is utilized. Sello is buying power from Nordpool and is locally producing energy with PV (750 kWp). Sello's power system includes microgrid functionality with integrated electrical

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equipment, mostly HVAC and stationary energy storage (2 MW and 2.1 MWh). Microgrid functionality enables Sello to participate through Vibeco virtual power plant in electricity reserve markets operated by Fingrid. The system is visualised in Figure 8, and Sello's power usage is shown in Figure 9.

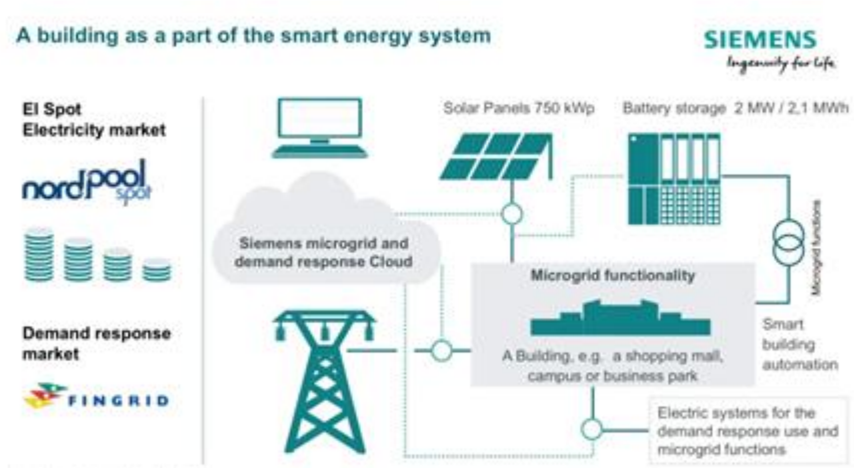

Figure 8. Sello's smart energy system. Source: Siemens

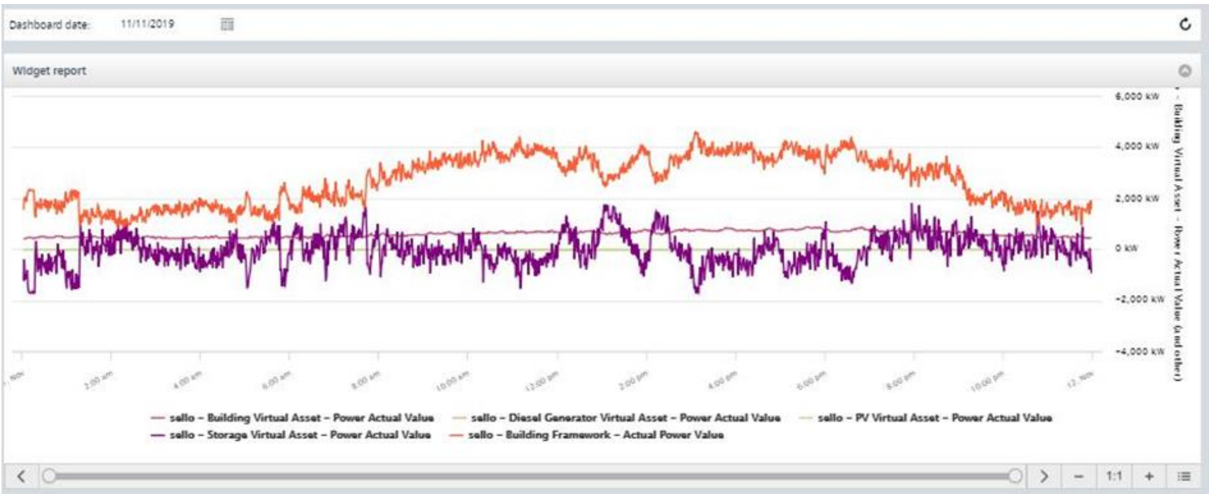

Figure 9. Sello's power usage during a normal weekday. Source: Siemens

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The detailed plans are presented in the following tables.

Action E6-1	Improving the prediction of the energy performance, both heat and electricity, and the predictions for energy market participation for Sello block based on data collected nearly in real time and stored historic data pursuing the Virtual Power plant (VPP) operations. VPP considers Kone's elevators energy control, optimal use of local PV generation, electricity storage, air conditioning, lighting and emergency power systems. Introducing peak-load management, artificial intelligence technologies.
Detailed plan	• Define solution architecture • Integrate real time data from Sello's elevators and escalators, people flow via APIs to Sello's VPP • Integrate Sello's energy data via API to VTT • Create self-learning algorithms of Sello's energy performance • Develop the prediction algorithms until prediction and actual are sufficiently close enough • Provide control strategies via prediction algorithm to increase flexibility towards TSO and improve energy performance Additional, if resources are available: • Integrate prediction algorithm (Digital Twin) to Sello energy management system via APIs • Creating a BIM model (ifcSpace) of a Sello block • Integrate the prediction model to Digital Twin model via APIs to visualize the energy performance • Visualization of energy performance
Targeted outcome	Creating a prediction model based on real time data of Sello blocks energy performance to increase the energy performance of a Sello block and flexibility towards the TSO. Create a co-operation model beyond SPARCS.
Roles and responsibilities	SIE: Provide historical and real time data, provide BIM model, supporting in developing self learning algorithm VTT: Develop self learning algorithm, link data to BIM model and develop KPIs KONE: Provide analyzed data of selected elevators and escalators. Install additional meters if needed.
Schedule	Define system architecture M14 Prediction algorithm first iteration completed M25 Integration of prediction algorithm to Digital Twin completed M29
KPIs	Accuracy of the prediction model Increase of flexible load to average load [%] of different systems Increase of energy performance compared to baseline [%]

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Action E15-1	Feasibility study paving the background for the virtual power plant formed from the loads of the local buildings to balance RES boosted local power network, identifying new business opportunities for aggregators in order to combine small demand response loads and offering them to reserve market (Fingrid). The target is to find and connect enough flexible loads from a local building stock (swimming pools, ice skating halls, sport halls, and office buildings) for 1 MW demand response, to participate in the electricity reserve markets.
Detailed plan	• Gather data on all the Espoo city properties • Analyze reserve flexibility potential of different properties • Connect chosen loads and properties to VPP • Aggerate loads and offer them to reserve markets • Analyze results Similar activity on heat DSM in Action E16-1.
Targeted outcome	Enables city's properties to become active in energy sector by providing flexibility to reserve markets, to play a vital role in energy transformation. Understand flexibility potential of different type of properties.
Roles and responsibilities	SIE: Analyze flexibility potential, connect buildings to VPP and trade flexibility in reserve markets. ESP: Provide data on all Espoo city buildings. Enable work in the properties and in the systems required by VPP. VTT: Assess emission savings by VPP solution
Schedule	Input data gathered M12 Analyze carried out M17 First loads traded in reserve markets M24
KPIs	Impact on local and national CO_2 emissions. Flexibility aggregated.

Action E16-2	Blockchain technology options for supporting demand response and virtual power plant in positive energy districts. Blockchain enabled business cases and control strategies will be studied, while possible policy and regulation related challenges will be identified.
Detailed plan	1. Assessment of pros and cons of blockchain solutions. 2. Identification of most promising applications for blockchain. 3. Assessment of legal framework. Ref Action E12-3 Blockchains for Kera energy transactions.
Targeted outcome	Blockchains may prove a cost-efficient and reliable platform for energy prosumer and demand side management transactions
Roles and responsibilities	ESP: Overall coordination VTT: Technical support on blockchain solutions SIE: Commercialised blockchain services
Schedule	M15: Blockchain pros and cons assessed M30: Applications identified and mapped, legal framework assessed
KPIs	to be defined

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Action E17-1	Virtual twin of a real demo for a positive energy building block, to build a showcase and support replication. Provides both the visual of the building and the operational behavior (same energy load as in the real buildings and the block) for the building energy system.
Detailed plan	Building of a virtual twin for Sello. Virtual twin focuses on predicting electricity demand and on-site electricity production from PV. It can also help to run Virtual Power Plant (VPP) in Sello. Optional (if suitable data received from Sello) to include electricity battery, EV charging and participation to the electricity market (FCR-N). Virtual twin visualises also the measurement values and the results in a building model. Virtual twin also will have heat energy included, in connection to action E5-1: heat performance and storing energy to building structures.
Targeted outcome	Virtual twin predicts online the electricity and heating demand, as well as PV production in Sello for the next 24 hours (with as small difference to monitored data as possible). This can be used also for optimisation purposes. The monitored data and results of virtual twin can be visualised in a building model.
Roles and responsibilities	VTT: Virtual twin planning and building. Stakeholders: Giving data (and BIM if available) from Sello.
Schedule	First version of Virtual twin for predicting electricity demand during 2020 (by M15). PV production added in spring 2021 (M20). Visualisation during 2021 (by M27). Final virtual twin ready by M30.
KPIs	How well the virtual twin reflects the monitored situation (RMSE [%]).

4.3 Smart energy services

Modern energy services can be provided more efficiently, flexibly and reliably, if they are based on an appropriate ICT platform. 5G technology is an established global standard for mobile connectivity, it and enables control of high number of appliances. Blockchain and IoT are evolving quickly, presenting new opportunities for optimised energy performance and innovation. The detailed plans are presented in the following tables.

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Action E6-2	Developing new potential smart energy services based on the digital platform (open cloud based IoT operating system, MindSphere by SIE) from the energy performance view point in the Leppävaara area by finding new value for residential buildings of being flexible part of the greater energy system, including district heating and cooling usage control based on the grid conditions.
Detailed plan	• Assess feasible scope of buildings in Leppävaara district to be included. • Estimate heat and power demand profiles. • Assess flexibility potential. • Propose actions to exploit DSM measures. • Document and communicate to stakeholders.
Targeted outcome	The Sello center is contributing to distributed energy production and grid balancing using smart DSM solutions. Extending this service to adjacent buildings yield economies of scale and demonstrate scale-up potential
Roles and responsibilities	SIE: Assess the flexibility potential, create a technical solution, assess business model ESP: Engage stakeholders including public buildings and Espoon Asunnot in Leppävaara district
Schedule	M15 Mapping the scope of buildings M20 Technical solution and business model M26 A proof of concept is implemented and results analysed
KPIs	Profitability , CO_2 emissions, Leppävaara district self sufficiency

Action E12-1	Smart infrastructure 5G. Investigating opportunities offered by the Kera digital platform and local district 5G network for management of the smart power grid, optimization, bi-directional energy flows, energy demand side management and demand flexibility.
Detailed plan	• Investigate and document current 5G projects in Kera. • Identify opportunities for synergies in energy efficiency, DSM, prosumer. transactions and innovative business models. • Map and engage key stakeholders. • Document findings, report and communicate.
Targeted outcome	Energy performance optimisation requires automation and smart solutions to ensure energy savings, cost effectiveness and reliable operation. 5G infrastructure facilitates smart energy.
Roles and responsibilities	ESP: Main responsibility. Stakeholders
Schedule	M15 Current projects documented M25 Opportunities identified, stakeholders mapped and engaged M30 Findings reported
KPIs	Number of new solutions with 5G utilisation

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Action E12-2	5G as service enabler. Developing new service models for autonomous transport and e-mobility linked to the local 5G network, solutions enabling the use of car batteries as energy reserve and the operation of autonomous transport. (ESP, stakeholders)
Detailed plan	Identify smart infrastructure requirements for autonomous transport and e-mobility. Open discussion with smart city Kera area development, relevant stakeholders and ongoing projects developing autonomous transportation and 5G technologies in Kera (including LuxTurrim5G+ / Neutral Host Pilot -project; Six Cities: Low-carbon transport in mobility hubs -project). Estimate car battery capacity available for energy reserves in different scenarios.
Targeted outcome	Car batteries and smart charging can improve power balance and reduce emissions and costs. 5G technologies can support the use and operation of autonomous transportation and enable e-mobility in local networks.
Roles and responsibilities	ESP: Main responsibility.
Schedule	M3-12 Opening discussion with relevant stakeholders. M12-36 Assessment of car battery solutions. Assessment of local 5G network in the operation of autonomous transportation.
KPIs	Battery storage capacity available. Service models for autonomous transport / e-mobility.

Action E12-3	Blockchain technology as enabler. Enabling energy transfer and tracking in bi-directional power grids (electricity and heat) with the use of blockchain technology.
Detailed plan	Conduct literature study and compile blockchain models globally Create SWAT table for blockchain utilisation Propose blockchain model for electrical and thermal energy transactions and flexibility aggregation Estimate costs and benefits Investigate legal barriers Ref: Action E16-2 blockchains for city-wide DSM.
Targeted outcome	Cost-efficiency and uptake of distributed power and heat generation is enhanced if prosumer model is streamlined and automatic. Blockchains ensure prosumer model transparency and verification functionality.
Roles and responsibilities	ESP: Overall coordination. VTT and Siemens: technical support. Stakeholders
Schedule	M14 literature and models studied M18 SWAT table prepared M22 Blockchain model proposed

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	M25 Costs, benefits and legal barriers investigated
KPIs	To be defined

4.4 Smart Building Energy Management

Subtask 3.3.3 Smart Building Energy Management demonstrates how domain knowledge and real-time monitoring of elevators, escalators and people flow can be employed for smarter decision making and demand response actions by the building energy management system.

Action E6-3	**Solutions in Smart Building Energy Management. The activity demonstrates how elevators, escalators, and people flow intelligence solutions, could be utilized in smart building energy management and demand response via interoperability with energy management system through APIs. Aim to reduce peak demand.**
Detailed plan	1. Define technical architecture 2. Define algorithm and software specification 3. Validate technical performance in development environment 4. Test data communication performance between building management and KONE devices 5. Use communicated data of KONE devices in smart building energy management system, for example, to momentarily supply more power from an on-site battery bank or reduce consumption of other appliances when an elevator is accelerating in order to limit the power demand peak visible to the electricity grid and verify the desired effect.
Targeted outcome	Enabling solutions for elevators, escalators and people flow intelligence solutions to interlink with building energy management systems to provide additional value to the building owner/operator, especially in the form of power demand forecasting.
Roles and responsibilities	KONE: Algorithm and software development in KONE devices, which allow real-time communication with building energy management systems. Installation/updating of required KONE components in the pilot building(s) SIE: Read the transferred KONE data and showcase its applicability in making smarter decisions for building energy management and demand response (Sello): Potential testbed for implementing the on-site communication system with high-end monitoring and control capabilities on existing Siemens VPP
Schedule	Data transfer test and verification M9 Peak power reduction test and analysis M21 Reports and further analysis M33
KPIs	Number and share of KONE equipment participating in smart building energy management and demand response in pilot building(s) Amount and ratio of elevator/escalator peak demand reduced by intelligent power management Effect on the amount of consumed energy by the building

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5. E-MOBILITY INTEGRATION IN ESPOO LIGHTHOUSE DEMONSTRATIONS

5.1 Intoduction to task 3.4

Mobility has a large impact on sustainable urban development from ecological, economic and social perspectives. The objective of task 3.4 is to boost electric mobility in the city of Espoo, focusing especially on mobility hubs, new planned public and private EV charging infrastructures and its integration to the smart grid, and mobility and accessibility through sustainable transportation options. Espoo, as a city, is characterized by multiple smaller urban centres, situated around rail tracks (metro and local trains, also a light rail system from 2024 onwards), which makes it possible to develop dense and mixed-use urban cores that rely on sustainable modes of transportation, including public transportation, walking, bicycling and different 'last mile' solutions that support sustainable mobility options including e-mobility.

The task is divided into four subtasks that focus on the development of e-mobility in Espoonlahti district and Lippulaiva blocks (subtask 3.4.1), Leppävaara district and Sello blocks (3.4.2), Kera area (3.4.3) and on the general urban planning requirements level (3.4.4). In the tasks, the requirements, demands, models and possibilities of electric mobility solutions – such as electric shared cars, buses, refuse trucks and bicycles – are mapped and assessed, and their prospective applications for replication are examined. The overall aim is to support the formation of multimodal e-mobility hubs in Espoo – that combine public transportation with e-mobility solutions – and to produce feasible solutions for replication elsewhere.

5.2 Boosting E-mobility uptake in the Espoonlahti district, Lippulaiva blocks

This subtask 3.4.1 Boosting E-mobility uptake in the Espoonlahti district, Lippulaiva blocks. E-mobility solutions will be developed in Lippulaiva district (shopping center, residential buildings and senior house) by offering EV parking and charging capacity as well as facilities for e-bicycle. SPARCS Interventions E2 for Boosting E-mobility uptake and related demonstration action plans are presented in the following tables.

Action E2-1	Integrating and grid impact assessment of community and residential EV parking in the Lippulaiva blocks: up to 140 charging units, currently grid access dimensioned for maximum 400 EV.
Detailed plan	• Dimensioning and designing EV parking for shopping center customers and residential buildings in Lippulaiva • Designing smart charging infrastructure to EV together with service provider • Assessing possibilities of Vehicle to Grid solutions in Lippulaiva.
Targeted outcome	To have community and residential EV parking in the Lippulaiva blocks and offer EV charging capacity for Espoonlahti area.
Roles and responsibilities	CIT: Dimensioning and designing EV parking with service provider

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	VTT: Estimation of required amount of charging units using ABTM (Activity based transportation model). Literature review on Vehicle to Grid (V2G) solutions and assessing the possibilities of V2G in Lippulaiva, how could V2G support the Positive Energy District idea
Schedule	• Dimensioning and designing EV parking and charging capacity for Lippulaiva, M12. • Estimation required for charging data during mid August 2020; literature review on V2G, M12 (VTT)
KPIs	% of EV equipped parking spaces locally. # of EV equipped parking spaces.
Additional information	Citycon will decide the specific amount of EV parking and charging units which can deviate from the original plan since new design and architecture of Lippulaiva.

Action E2-2	**Opportunities to support and enable e-bicycling with appropriate parking and charging infrastructure (inverters, parking facilities, size demands, secure charging infrastructure) boosting the E-mobility in the whole Espoonlahti district.**
Detailed plan	• Examine existing city-level plans and local and regional bicycling strategies, and existing shared city bike system in relation to SPARCS goals, and facilitating discussion with different city departments. • Assessing e-bicycling possibilities in Espoo (integration to city transportation system, integration to existing and future mobility hubs). • Assessing the possibility to offer warm storage room for e-bikes. • Organizing a public event in Pikkulaiva for locals where e-bikes and sustainable mobility are presented and promoted, possibility to try e-bikes (connections to Task 3.6), together with local e-bike companies and other stakeholders. • Assessing e-charging requirements and facilities.
Targeted outcome	Support and develop e-bicycling in Espoonlahti and Lippulaiva area, and sketch possibilities for the city in general. E-bicycling can, in specific, answer to the first/last mile challenges related to sustainable mobility.
Roles and responsibilities	CIT: Assessing the possibilities to have appropriate parking and charging infrastructure in Lippulaiva, arrange event in Pikkulaiva for promoting e-bikes. ESP: Assessing e-bicycling in Espoo and Espoonlahti area, including already set local and regional bicycling strategies, existing shared city bike system goals, and targets of the city in general for bicycling as a mobility mode. Arrange e-bicycling event in Pikkulaiva/Espoonlahti. Support the analysis of e-charging requirements and facilities. Assessing e-bicycling solutions from elsewhere.
Schedule	M6: Assessing examples from Europe on e-bicycling development, deployment and infrastructure issues. Planning of a e-bike event started. M20: Event in Espoonlahti promoting e-bikes.

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	M36: Connecting insights from SPARCS to City of Espoo's bicycling strategy work. (Note: The overall timeline of Espoonlahti development and Lippulaiva construction is highly relevant for the scheduling here, as is the Corona-virus situation.
KPIs	% of parking facilities for e-bicycling.

Action E2-3	**Boosting the uptake of e-mobility: Sustainability strategy for how to access Metro and Lippulaiva with other sustainable mobility modes, developing Lippulaiva as hub for shared eVs. Development of commercial electric vehicle charging services. Analysis of energy demand for electric buses, taxis, garbage and delivery trucks and other service vehicles and impact on electric grid. Development of smart charging services.**
Detailed plan	Developing a sustainability strategy with a focus on 'last mile' solutions and e-bicycles, assessing similar strategies globally for Metro (or similar public transportation connection) access. Examining potentials for different electric vehicle type charging services (with relevant stakeholders) and EV sharing (services) - and analysis of the impacts on the grid.
Targeted outcome	Insights on e-mobility hubs on accessibility, shared mobility services, energy demand and impact assessments and integration of smart charging services.
Roles and responsibilities	ESP: Assessing Metro accessibility, linking it with other city and regional plans and frameworks on sustainable mobility; assessing other examples of similar cases. Facilitating discussions with HSL and HSY. Examining possible connections with Task 3.6. CIT: Support other partners in the Action. VTT: Simulation of vehicle fleets and their impact on grid. KONE: Support other work in the Action, especially through Task 3.6 and help in traffic analysis within buildings if needed. SIE: Support action leader in analysis of energy demand for electric utility vehicles. PIT: Support other work in the Action, especially charging.
Schedule	Ready by M36
KPIs	Energy and time used for charging (trend). % of vehicle kilometers done with EVs compared to overall car-based mobility (estimate). Sustainability strategy on Metro access and 'last mile' solutions completed (y/n).

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5.3 New E-mobility hub in Leppävaara

This subtask 3.4.2 New E-mobility hub in Leppävaara aims to develop large-scale EV charging systems. The subtask implements a charging system which could be used by multiple EV types in Leppävaara. This E-mobility hub includes Finland's first large-scale public E-bus charging infrastructure. Upcoming EV types such as service vehicles, mobile machinery and electric car sharing are investigated. The subtask analyses different charging strategies and how to optimize large–scale charging systems. Impacts on the grid are also analysed. The subtask investigates commuter parking as a part of the total building power management. The subtask will look into the financing and business models for the charging systems with multiple stakeholders. One aim of this subtask is also to provide sufficient knowledge for replication and improvement of a similar charging solutions in other nodal points in transit system (such as Espoonlahti and Kera). SPARCS interventions E7 for New E-mobility hub include following demonstration actions.

Action E7-1	Developing Leppävaara EV-mobility hub as a whole. Helsinki Region Transport (HSL) and the City of Espoo have high targets for the electrification of transport. The Sello block and area will be developed into a new E-mobility hub connecting local and long-distance trains, city E-buses, and a new fast E-tramline. First mile/last mile services will be enhanced by including charging services for car sharing. Interoperability of charging infrastructure will be ensured to provide access for other user groups, e.g. electric service vehicles and mobile machinery. The requirements and impacts on the electrical grid will be analysed in collaboration with all relevant stakeholders.
Detailed plan	1. Implementing a bus charging system in Leppävaara. 2. Examine the possibilities to further development of the charging system into EV-mobility hub. Analyze the EV-mobility hub charging for some of the following: passenger cars, taxis, shared cars, service vehicles, mobile machinery and electric bikes. Possible implementations if right partners found. 3. Data gathering from the Leppävaara charging system. 4. Analyzing the requirements and impacts on the electrical grid.
Targeted outcome	Future charging systems must be built as EV-mobility hubs due to rapid growth of electric vehicles. For optimizing the hubs, it is important that as many vehicles as possible are connected to the same charging system. This action aims to improve the future EV-mobility hubs based on the charging system in Leppävaara.
Roles and responsibilities	PIT: Implementing the bus charging system. Gathering data to cloud and analysis. EV mobility hub charging analysis. Possible future implementations. VTT: Analysis of commercial vehicles and their charging needs. Simulation of requirements and impacts on the electrical grid. ESP: Facilitating discussions with relevant stakeholders (HSL and HSY). Connecting the demonstration activities in Leppävaara with the district, city, and region development in a broader sense.
Schedule	M3: Bus charging system. Data gathering from the system starts. M16: Analysis of charging needs of vehicles in EV-mobility hub.

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	M24: Possible service vehicle testing with charging system. M24: Simulations of the requirements and impacts on the electrical grid ready. M24: EV-mobility hub analysis ready. M30: Possible implementation of other chargers into the system.
KPIs	1. Greenhouse gas emissions reduction. 2. Charging time / day and charging time / month. 3. Charged power / month and charged power / day. All of the KPIs are measured based on Plugit cloud data from the charging system.

Action E7-2	Development of EV charging for customers of the shopping centre and commuter parking as a part of the total building power management and microgrid solutions. Optimisation of EV car charging and power management. Utilisation of activity based models for load prediction and development of energy demand response services (V2G), control strategies based on business models (Park&Charge concept). Dynamic pricing models for electric vehicle charging and price of electricity depending on the flexibility resource the EV can bring. Test would focus also to gain user experience data out of the EV charging usage for the future energy optimization purposes and to connect EV charging stations to VPP. Integrating data and services. 5G is enabling the data transfer.
Detailed plan	1) Integrate EV charging software system to Sello building automation system to integrate different platforms together in order to perform peak-load management on the whole building level. 2) Extend charging data to partners or to a 3rd party for load prediction and analysis purposes.
Targeted outcome	To enable EVs participation in peak-load management on the whole building level, understand EV load profiles, further research and develop more sophisticated business models for dynamic charging or/and V2G applications.
Roles and responsibilities	SIE: Integrate EV charging for building level peak-load management, extend data for partners and further study dynamic pricing and V2G models. PIT: Providing electric bus charging data for peak load review of the whole Sello area. Support other work. VTT: Estimation of EV peak load and grid impact using combination of VTT simulation methods (VTT Smart eFleet and ABTM)
Schedule	1) Integrate EV and BMS software platforms together at M15 2) Send charging data from summer 2020 period (time-series) to partners at M15 3) Use history data (time-series) to show peak-load management capabilities at M24 4) Draw conclusions at M24

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KPIs	1) Able to verify that EV charger fleet successfully deviates charging power for peak-load purposes (history data); 2) Able to provide charging data to partners, and use partner analytics for further research

Action E7-3	**Optimal charging strategies for commercial vehicle fleet. Utilisation of activity-based models for demand response prediction. Plugit Finland will be responsible for developing the services related to electric commercial vehicle charging.**
Detailed plan	1) Analysing the charging demand of a commercial vehicle fleet 2) Charging strategies and activity-based models 3) Simulations and analysis of different scenarios
Targeted outcome	Future commercial fleets will be electric, and it is crucial to have optimal charging strategies for large fleets. This action aims to find different suitable charging strategies.
Roles and responsibilities	PIT: Analysis of charging needs of a commercial vehicle fleet. Data from Leppävaara charging system. Support VTT in simulations. VTT: Commercial vehicle fleet simulations and analysis of different charging strategies
Schedule	M12: Charging demands of a commercial vehicle fleet M18: Charging strategies and activity-based models M24: Simulation results, analysis of different charging strategies
KPIs	Peak demand reduction using the charging strategy Utilization of chargers in the system after charging strategy. Number of charging strategies simulated.

Action E8-3	**Evaluate feasibility for shopping behaviour in the EV charging concept**
Detailed plan	Research dynamic pricing models and its suitability for charging operations with literature review and end-consumer questionnaire.
Targeted outcome	To understand how to implement EV charging business models to enable EVs to participate in balance management (e.g. V2G)
Roles and responsibilities	SIE: Execute end-consumer questionnaire. Draw conclusions on how to implement dynamic pricing or V2G business case
Schedule	End consumer questionnaire at M15-M24, conclusions at M24
KPIs	Able to draw conclusions from end-consumer questionnaire and literature review

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5.4 E-mobility solutions replication and uptake in Kera

This subtask *3.4.3 E-mobility solutions replication and uptake in Kera* focuses on the development of e-mobility and multi-modal mobility solutions in Kera area. Kera is currently in the first stages of a redevelopment process of being turned during the 2020s and 2030s from a brownfield, logistics and industrial area, into a new city district comprising of mixing housing, workplaces and shared spaces for culture and social life. From a mobility perspective, the area is already connected by a local train line to the rest of the Espoo city and the overall metropolitan region – the new local centre of the Kera area will be developed around the train station, providing genuine possibilities for multi-modal transportation solutions, e-mobility, sustainable 'last mile' -strategies and an urban structure emphasising walking and bicycling, with further rail-based solutions planned for the future as well.

The subtask is divided into two actions that aim to support the development and the implementation of multi-modal transport solutions in Kera, and to replicate the prospective solutions developed in the other actions of the task (mainly Action E7-1 in Leppävaara district) to the urban planning process of Kera, in an aim to support the development of sustainable e-mobility solutions in the area from the planning stages onwards. The project's activities in Kera are actively connected with the overall Kera development process as well as other projects and stakeholders involved in the development of the new city district.

Action E13-1	Multi-modal transport solutions with focus on last- mile including charging of the e-fleet. The aim is for an emission-free, clean multi-use area (living, shopping and services) by minimizing the need for private cars.
Detailed plan	Utilisation of insights from the other task actions in Espoonlahti (E3-1-3) and Leppävaara (E7-1-3) districts. Assessing replication of the appropriate solutions in an urban planning –context in Kera (planning phase). Close follow-up and linkages with different Kera development stakeholders and projects (including the City of Espoo's area development leader and urban planning department; HSL and HSY; other projects developing Kera area [Clean and Smart Kera; The Six Cities Strategy: Low-carbon mobility in transportation hubs; The Six Cities Strategy: KIEPPI – Partnership model for sustainable neighbourhoods; LuxTurrim5g/Neutral Host]). Assessing successful multi-modal districts and mobility hubs globally, and the process of implementation through urban planning processes. Examining PED-model from mobility perspectives in Kera case.
Targeted outcome	Supporting the planning and design of Kera area to enable multi-modal transport solutions and last mile -mobility services by making use of the learnings on e-mobility from Leppävaara and Espoonlahti districts. The co-operation with the multiple and diverse Kera area stakeholders is important, and provide a platform for active dialogue. Insights for future PED areas from mobility perspective (in an urban planning framework).
Roles and responsibilities	ESP: Main responsibility.
Schedule	M1-M36: Follow-up and review of actions E3-1-3 and E7-1-3 and their learnings. M3-M36: Opening and expanding an active and ongoing dialogue

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	between different Kera area stakeholders. M6-M36: Assessing suitable e-mobility solutions on the basis of the learnings from the other task actions. The overall Kera area development timeline and the schedule of the other task actions are highly relevant for the schedule of this action.
KPIs	How are multi-modal and e-mobility transport solutions taken into consideration in the Kera plan and planning process? (Qualitative) Modal split in Kera area during planning phase (estimate, trend).

Action E13-2	**Replication of e-mobility solutions. Further development and implementation of Leppävaara e-mobility solutions. (Action E7-1) Charging stations for company-owned electric vehicles.**
Detailed plan	Close follow-up and review of Action E7-1 (developing Leppävaara EV-mobility hub as a whole) results and insights. Assessing appropriate replicated activities for Kera area (urban planning context) in relation to the Kera area plan and development process. Communication with other relevant Kera area stakeholders and projects (see also Action E13-1).
Targeted outcome	Drawing insights from the Leppävaara solutions and assessing the implementation of prospective solutions for mobility hub development in Kera area and for the development and drafting of charging stations in Kera area planning where available.
Roles and responsibilities	ESP: Main responsibility. Gathering an overview on the possibilities for replication in Kera area (urban planning). VTT: Support action leader with expertise on e-mobility solutions and demand estimation SIE: Support action leader with know-how on infrastructure development (microgrids, VPPs, digital energy community platform). Expert role based on Leppävaara e-mobility solutions. Sello charging system maintenance and development. PIT: Support other work. Possibly implementation of the charging system. System planning and development based on Leppävaara charging system.
Schedule	M1-M60. The schedule is tightly connected with the Action E7-1 timeline, as well as the overall Kera area development process.
KPIs	# of e-mobility solutions from Leppävaara replicated in Kera (plan). # of charging stations for company-owned electric vehicles in Kera (plan).

5.5 E-mobility urban planning requirements

This subtask 3.4.4 *E-mobility urban planning requirements* aims at the optimal integration of charging for all vehicle types, both privately owned and commercial vehicles. The work is aiming for a holistic view of the city of Espoo with a special

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emphasis on the demonstration areas, i.e. Leppävaara, Espoonlahti and Kera. In order to carry out the task, VTT will utilize two in-house simulation methods: VTT Smart eFleet and an activity-based transport model (ABTM).

VTT Smart eFleet has been developed for the simulation of commercial vehicle fleets where the routes are predefined. Hence, the simulation model is very well suited for public transport simulation, but also other commercial vehicles, such as delivery trucks and refuse trucks, can be simulated. Based on the given routes and schedules, detailed information on energy consumption and need for charging at different locations is obtained. Various charging management strategies can easily be implemented and tested within the simulation framework.

The ABTM is focused on urban personal mobility and it can be used to simulate the entire transport network of a city or area. The model is based on statistical data on households and mobility patterns, and the model can be used to obtain the traffic flow for the area under study. The model can easily be scaled up to study the impact of new residential areas or modifications in the public transport network. Hence, the ABTM will be used for forecasting the traffic situation and energy demand beyond 2030.

Action E18-1	Optimal integration of EV charging, taking into account all modes and types of electric vehicles, commercial as well as private, in the E-mobility nodes of Leppävaara (Sello block), Espoonlahti (Lippulaiva blocks) and Kera, managing of peak power demand and related effects from the urban planning. Analysis of future demand and development of smart charging strategies for different scenarios. This takes into account predictions of expected numbers of electric vehicles in each use case segment up to 2030 and beyond, the foreseen demand for power and energy and their impact to the grid.
Detailed plan	1) Generating and simulation of fleet scenarios in VTT Smart eFleet 2) Demand generation from co-created visions. Transport and charging network loading from the demand. Resilience testing through variety in inputs.
Targeted outcome	Charging scenarios through ABTM. Recommendations for spatial development.
Roles and responsibilities	VTT: Demand generation, modelling, simulations. SIE: Support action leader on simulation models. PIT: Support/ Advisor ESP: Supporting the development and analysis of future scenarios for the districts, especially with Kera area development process.
Schedule	M1 – M60: The schedule is connected with E7-3 Action and iteratively builds up on the feedback from the project.
KPIs	Developed recommendations for planning (y/n).

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6. Planning of Positive Energy Districts in Espoo

Energy infrastructure like electricity distribution grids, district heating networks, natural gas and other fuel provision lays the foundation to modern energy services for households, businesses and industries. In new city development areas, solutions must be designed and infrastructure investments made before residents arrive. This requires careful analysis and accurate estimates on future needs. Heating and cooling needs could also be affected by changing weather patterns. New innovation, ambitious climate action, shifts in consumer behaviour and changes in economic performance may over time result in situations, where the built infrastructure is not optimal for the needs of residents. Lock-in effects, like dependence on one specific fuel type or heat supplier can be mitigated by favoring flexible infrastructure designs. In a worst-case scenario, expensive energy infrastructure may turn into stranded assets if consumers choose competing technologies.

3D city models may be offered on open platforms and formats so stakeholders can easily access and utilise the data. Software developers can develop new online services for local consumers. The data also allows detailed simulation analyses and automatic calculation of solar, wind and geoenergy potential to support the selection and sizing of energy infrastructure. Using a common and regularly updated city model facilitates collaboration of different engineering companies and engagement of stakeholders and citizens in the process.

Action E17-2	CityGML as a tool for energy positive block development. Starting 2019, The City of Espoo offers an open, and public, Espoo 3D City model. The model covers all of Espoo and all objects included are described in the CityGML standard, except for bridges and tunnels. The action implements the MODER tool using Apros simulator and City GML integration, for assessing the potential for energy positive blocks in Espoo. The methodology has been developed in the H2020 project MODER, Mobilization of innovative design tools for refurbishing of buildings at district level (Innovation Action, EeB-05-2015).
Detailed plan	This action studies in practice, how CityGML could be integrated in the planning and development of energy positive blocks, local energy production and energy efficiency of buildings. This action includes: • Formulate the selection criteria for choosing a suitable area. The defining factors are e.g. the availability of data and its level of detail. (For the new areas data might be not available.) (ESPOO, VTT) • Identify a suitable mixed-use area, which will act as a reference site with the adequate level of detail in CityGML. Potentially, the district could be Kera or Finnoo. If another site is chosen, opportunities may later be exploited in Kera to support PED development. (ESPOO) • Espoo will provide data related to the identified district in CityGML format. Espoo will check and improve the semantics of the data provided in the CityGML, to include e.g., construction year, building use, heating and cooling type, number of occupants, ventilation heat recovery, etc. In case of seasonal storage - possibly geometric description in CityGML). • Identify a set of technologies to support local PED development, including energy efficiency improvements and distributed energy generation

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	opportunities. The related objectives for the energy solutions will be formulated. (VTT, ESP) • Establish a design scenario portraying positive energy block solutions (VTT, ESP) • Carry out block level 12-month simulation using Apros simulator and City GML integration, using both a cold winter and warm winter scenario. (VTT) • Optional: If seasonal storage is included, estimate time needed for storage patterns to stabilise. (VTT) • Calculate On-site Energy Ratio for all scenarios (VTT) • Optional: assessing CAPEX and OPEX. carbon emissions. • Assess opportunities revealed by the 3D data to fast-track such technologies (ESP) • Visualising the results (VTT, ESP) • Engage with stakeholders to validate processes (ESP) • Document the process described above (ESP, VTT)
Targeted outcome	New development sites differ in geographies, building stock and local energy sources, so there is no one-size-fits-all model for a district energy solution. This work aims to clarify how CityGML could support low carbon urban planning and block/district level energy analysis. This work can also provide a good practical use case for the municipality for collecting and incorporating needed building and energy related semantics into the CityGML. The geographic and building data combined with energy simulation results allows techno-economical assessment of proposed solutions and enables informed decisions based on local specifics.
Roles and responsibilities	ESP: Identify Kera, Finnoo or another suitable district in Espoo, and provide data related to the identified district in cityGML format, check and improve semantics of the data. VTT, ESP: Identify baseline energy solutions and propose new positive energy block solutions. VTT: Carry out required analysis as specified above ESP, VTT: Engage with stakeholders to validate results
Schedule	M14: Site identified M20 Energy solutions identified M28 Simulation completed M34 Results validated and communicated
KPIs	OER, optional: Annual energy expenses for improved system, Savings in cost and emissions compared to baseline solution.
Deviations from initial plan	Visualisation of the results can look a bit different than shown in DoW, due to recent changes related to the MODER tool.

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Action E20-1	FINNOO REPLICATION. Identifying the requirements for buildings to be integrated in the energy infrastructure; smart building requirements. The smart building and open interface requirements can be put into practice through terms for the plot assignment.
Detailed plan	Document Finnoo site specification, building stock and terms for developers Assess the proposed local energy solution, prospectively based on semi-deep boreholes and local low-temperature heating network Assess requirements for building-level heat exchangers and heat distribution system Assess opportunities for bidirectionality, waste heat and heat storage Assess metering requirements to facilitate smart automation and forecasting Estimate OER, financial and carbon savings Adjust terms for the plot assignment to reflect lessons learnt and enhanced replication
Targeted outcome	The Finnoo district will utilize new local energy solutions. Successful implementation provides excellent basis for replication
Roles and responsibilities	ESP: Main responsibility Stakeholders: Propose new solutions
Schedule	M18: Document Finnoo specification and requirements for energy efficiency M25: Identify and assess further development options M28: Report findings
KPIs	Number of new technical and business model solutions developed/implemented OER

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Action E22-1	Co-creation for smart city development. Co-creation models to support land use planning are developed as a collaboration between industry, SMEs, citizens and other stakeholders to support functional solutions of new development areas regarding e.g. energy, mobility, and service solutions based on digital platforms and fast networks.
Detailed plan	Co-creation model is facilitated by 3rd party subcontracting, which is now under preparation (summer 2020). The model will first be made for Kera and only after that, a more general model for whole city of Espoo.
Targeted outcome	For sustainable smart city development, co-creation model / alliance model is needed to support collaboration and best practices.
Roles and responsibilities	ESP: to tender and choose the service provider for creating these models. stakeholders: to participate in the co-creation process
Schedule	M12 Subcontracting documents ready to start the actual subcontracting process. M15 Process finalized, subcontractor chosen M16 Project to create co-creation model starts M24 Model for Kera finalized M30 More general model for City of Espoo finalized M36 Internal work, communication to introduce models to different stakeholders in city organization, as well as outside the city organization.
KPIs	to be defined

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7. COMMUNITY ENGAGEMENT IN ESPOO

7.1 Intoduction to task 3.6

The objective of task 3.6 is to engage citizens in the energy transition in Espoo, through different channels focusing on different citizen groups. Furthermore, the task aims to ensure a continued sustainable lifestyle, with a special emphasis on urban mobility behaviours and citizens' daily journeys. The task is divided into three subtasks that focus on defining and validating solutions for encouraging people to change their daily mobility habits, co-creating for energy positive behaviour, and supporting a sustainable lifestyle by offering teaching and education.

The task follows a design thinking process, utilizing methods from co-design. It starts with expert and lead user interviews for understanding the big picture and trends of current and future (sustainable) urban mobility (in Espoo). Based on the expert and lead user interviews, themes for more detailed research are identified, and these themes will guide the following user studies. The user studies provide an end user point-of-view and insights into the process of defining solutions for encouraging more sustainable mobility behaviours. Based on the findings from the aforementioned studies, design sprints are organized. The design sprints will gather all relevant stakeholders (identified through expert interviews and user studies) into the ideation and validation of innovative solutions for future sustainable mobility in Espoo, more precisely Leppävaara and Espoonlahti. In addition to the aforementioned actions, a Buddy class concept idea is developed further, and educational workshops with young people as well as events for locals to present and test sustainable mobility solutions are arranged. By engaging diverse stakeholders into the design thinking process of task 3.6, a more bottom-up and collaborative approach to creating sustainable change is enabled.

7.2 People flow and daily journey

This subtask 3.6.1 People flow and daily journey aims to define and validate solutions for encouraging people to change their daily mobility habits optimizing people flow from an energy and user experience perspective. This is aimed at through lead user studies and mobile probing with citizens of Leppävaara and Espoonlahti. The lead user studies provide understanding of successful solutions to the identified mobility challenges and mobile probing provides understanding of end user needs, challenges, and desires related to smooth and sustainable daily journeys and urban mobility. Also, workshops and testing are conducted with local citizens for defining and validating the most potential sustainable urban mobility solutions for Leppävaara and Espoonlahti. Finally, the solutions will be reflected on for forming macro level conclusions, and insights will be conveyed to city planning authorities. SPARCS Interventions for Engaging users are presented in the tables following.

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Action E3-2	Define and validate solutions for encouraging people to change their daily mobility habits optimizing people flow from energy and user experience perspectives. Developing and validating the chosen lead user innovations in the Espoonlahti district. Encouraging people to use positive district solutions for their daily lives, optimising urban flow from energy and user experience perspectives.
Detailed plan	• User research about Espoonlahti citizens' mobility habits, experiences, needs, challenges and desires through **mobile probing** and **workshops with diverse stakeholders** following the citizen engagement principles • **Defining relevant focus area** for interventions based on the user research • **Identifying relevant lead user innovations** for sustainable mobility through **snowballing** etc. • Developing and validating (chosen lead user innovation) solutions for encouraging sustainable mobility behaviors from energy and user experience perspectives with Espoonlahti citizens through **workshops** and **testing** • Encouraging people to use positive district solutions for their daily lives through sharing information of LU innovations through **workshops and arranging events for locals to present sustainable mobility possibilities** (e-bicycles, EV's)
Targeted outcome	In order to define and validate solutions for encouraging more sustainable mobility behaviors, we need to first understand which motives and values drive current behaviors and how this knowledge can be utilized in facilitating a sustainable and citizen-driven change towards more sustainable mobility habits.
Roles and responsibilities	KONE is responsible for planning and conducting the user research and workshops. Citycon is responsible for arranging events for locals where sustainable mobility habits are presented.
Schedule	Mobile probing ready by M15. Lead user research, workshops and local events done by M36. Mobile probing activities have been postponed from Spring to Autumn 2020, due to the COVID-19 situation affecting citizens' mobility behaviors. This should not considerably affect other planned activities.
KPIs	to be defined

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Action E8-2	Experiment concepts for encouraging people to use E-mobility solutions for their daily mobility habits optimizing people flow from energy and user experience perspectives. Experimenting lead user innovations in the Leppävaara district. Encouraging people to use existing positive district solutions for their daily lives, optimising urban flow from energy and user experience perspectives.
Detailed plan	• **Experiment** concepts for encouraging people to use E-mobility solutions for their daily mobility habits optimizing people flow from energy and user experience perspectives. • Experimenting lead user innovations in the Leppävaara district through **testing** • Encouraging people to use existing positive district solutions for their daily lives through sharing information of lead user innovations through **workshops.**
Targeted outcome	Experiments and test help us to understand what works and what does not, and why. This information will help us to develop better solutions for citizens' needs.
Roles and responsibilities	KONE
Schedule	Experimentation is based on mobile probing insights and will be done, together with workshops, by M36.
KPIs	to be defined

Action 11-1	Citizen mobility. Conveying insights to city planning authorities of citizens' preferable future multimodal mobility habits, schedules and routes to optimize the people flow from energy and user experience perspectives. Utilize input from actions in Leppävaara and Espoonlahti.
Detailed plan	Citizen's needs and tested solution ideas (best practice insights for enabling more sustainable behaviors) are conveyed to city planning authorities through a **report**, possibly including personas/design drivers /scenarios/storytelling.
Targeted outcome	The aim is to share best practice insights to utilize gained knowledge for Kera development.
Roles and responsibilities	KONE
Schedule	City planning authorities are met in M13 for planning the format of reporting. Reporting is done by M36.
KPIs	to be defined

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Action E19-1	Define and validate solutions for optimizing urban people flow from energy and user experience perspectives. Identifying the benefits and the added value for citizen and other stakeholders in different district lifecycle phases.
Detailed plan	• Identifying the benefits and the added value of developed solutions for citizens and other stakeholders in different district lifecycle phases through **design sprints.** • **Reflecting** on the solutions developed and tested/validated in actions E3-1, E3-2, E8-1, E8-2 and forming macro level **conclusions** of the most potential solutions (balancing and energy positivity aspects) and their possible risks.
Targeted outcome	We aim to provide ideas of most potential solutions (that have a balance between the user experience and energy positivity aspect, cf. four lenses of innovation) for macro level development, to enable replication/scaling and further development and testing of the developed solutions.
Roles and responsibilities	KONE
Schedule	Design Sprints are planned in collaboration with stakeholders in M10-15. First Design Sprints are conducted in M15-17. All Design Sprints are conducted by M36.
KPIs	to be defined

7.3 Co-creation for energy positive behaviour

This subtask 3.6.2 Co-creation for energy positive behaviour aims to engage local citizens of Espoo into co-creation for energy positive behaviour. The plan is to conduct lead user interviews for identifying solutions for engaging and encouraging energy positive behaviours, arrange design sprints and co-creation workshops with diverse user groups and stakeholders, and involve the local communities into planning and building a future energy positive community through a Buddy class initiative. The aforementioned actions take place in Espoonlahti, Sello and Leppävaara, Lippulaiva. These actions will provide user insight input for experimentation and piloting in Leppävaara and and Espoonlahti districts, and for actions in Lippulaiva and Kera.

In Espoonlahti, new shopping center with residential buildings and senior house is under construction. During the construction period as well as after opening of the shopping center in April 2022, citizens are engaged in multiple ways, such as informing local citizens of the progress of construction, engaging them to involve in the design processes of the shopping center and long-term commitment of youngsters with Lippulaiva Buddy class initiative. Users' engagement activities will be done in close co-operation with SPARCS partners and e.g. through a working group including Citycon, HSL, and Länsimetro Oy (metro operator) to actively connect with local citizens.

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Engaging users in Lippulaiva and Espoonlahti area are presented in tables following, SPARCS Interventions E3.

Action E3-1	Piloting ways to engage and encourage citizens' energy positive ways of behaviour, developing new energy positive district solutions and improving the awareness of existing ones during the construction time and the daily use of the Lippulaiva services.
Detailed plan	• Developing new energy positive district solutions based on studied lead user innovations focusing on mobility through **design sprints** and **co-creation workshops.** • Piloting ways to engage and encourage citizens' energy positive ways of behaviour through **user involvement in workshops** and by **testing** developed lead user solutions. • Improving the awareness of existing solutions during the construction time and the daily use of the Lippulaiva services **through co-creation workshops, informing letters for neighbours and visualizing solutions with informative way** (for example videos of energy system).
Targeted outcome	Through citizen involvement we aim to engage and encourage citizens' sustainable mobility behaviors.
Roles and responsibilities	CITYCON is responsible for planning and conducting enagement actions in Lippulaiva and Espoonlahti area KONE is responsible for planning and conducting the user research and design sprints/workshops and for testing the developed lead user solutions VTT provides support in developing the user research method for different citizen target groups. ESPOO is supporting citizen engagement pilots and activities on raising awareness of new and existing solutions.
Schedule	Engagement actions will take place during the project months M1-M36, reporting done in project month M36.
KPIs	Number of users engaged through workshops (responses, feedback received etc.) Number of users engaged through social media (retweets etc.)

Action E3-3	Co-creation of shopping centre in collaboration with young consumers. Co-creation of the design of Lippulaiva with the aim to improve convenience and usability for young people. Focus on catering to the needs of young people for customer experience and their needs to enable and improve their use of environmentally friendly modes of transportation.
Detailed plan	• Arranging Lippulaiva Buddy Class action where a school class is engaged to Lippulaiva project. One 7th grade class (starting in Aug 2020) is choosed as a Buddy class and co-operation will continue until they are 9th graders.

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	• Buddy class action includes meetings with students with informative lessons supporting curriculum. Topics include: planning shopping center together with youngsters, physics with sustainable energy solution, sustainable mobility, social studies with making arrangement rules for shopping center, study guidance with topic of "working in shopping center".
Targeted outcome	To engage youngsters in development of their own neighborhood with long-term time-scale. Simultaneously educate youngsters in sustainability especially in energy systems and mobility.
Roles and responsibilities	CITYCON is responsible with arranging Lippulaiva Buddy Class action and gets help from other partners in SPARCs (ESP, KONE, VTT) ESPOO supports connections between young citizens (local schools) and the project. VTT provides support in developing a youth engagement research plan in Lippulaiva, implementing the plan and analyzing the feedback collected
Schedule	Lippulaiva Buddy Class action planning started in 03/2020 (M6), choosing Buddy class 08/2020 (M11), meetings with Buddy Class 09/2020-09/2022 (M12-M36), reporting in project month M36.
KPIs	Number of responses received per topic Number of users engaged indirectly (families etc.)

Action E8-1	Study lead user citizens' energy positive mobility behaviours, develop new and improve the awareness of existing positive district solutions during the daily use of Sello services. Input for actions in Lippulaiva and Kera. Identifying lead users and studying their behaviour related innovations, which have the most extensive impact on everyday energy consumption. Developing new energy positive district solutions and improving the awareness of existing ones. Input for experimentation and piloting in Leppävaara and Espoonlahti districts.
Detailed plan	• **Identify lead users** and study their behaviour related innovations, which have the most extensive impact on everyday energy consumption through **interviews,** possibly **planet-centric design canvases** and **the four lenses of innovation.** • Study lead user citizens' energy positive mobility behaviours through the **sustainable mobility innovations** they have developed. • Develop new energy positive district solutions through **co-creation workshops with citizens** / diverse stakeholders. • Improve the awareness of existing positive district solutions during the daily use of Sello services through sharing knowledge of lead user innovations through **workshops.** • **User insight** input for experimentation and piloting in Leppävaara and Espoonlahti districts, and for actions in Lippulaiva and Kera.
Targeted outcome	Through lead user involvement and studying their innovative solutions, we aim to come up with and test innovative sustainable mobility solutions for

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	energy positive districts. Workshop serve as a means to communicate and share knowledge of existing solutions with citizens.
Roles and responsibilities	KONE
Schedule	M36
KPIs	to be defined

7.4 Sustainable lifestyle

While positive energy infrastructure and modern technology can contribute significantly to the overall sustainability of urban districts, citizens need to be informed about the impact of their choices as consumers. Sustainability may be included in curricula of schools and kindergartens, as children are more susceptible and can also educate their parents. The enhanced technical options for measurement, monitoring and analysis in SPARCS demo sites provides valuable data that can be utilised in communicating the benefits of sustainable lifestyles. This subtask 3.6.3 is an ongoing activity with continuous interaction with more implementation-oriented actions. It includes close collaboration with a local school and introduction of a buddy class. Here, all three pillars of sustainable development (ecological, economic, social) are taken into account.

Action E19-2	Sustainable lifestyle. Espoo wants to be a responsible pioneer. The city is building a sustainable future through mobility, construction and energy solutions, by offering teaching and education supporting a sustainable lifestyle, by providing culture, sports and social and health care services enhancing wellbeing and by maintaining comfortable nature and green areas nearby. SPARCS actors integrate this support in their daily work including support for low-emission solutions, guidance and energy advisor services.
Detailed plan	• Sustainable lifestyle options are communicated through-out the project, in conjunction with the city's Sustainable Espoo programme and other projects. The city communicates the various possibilities for sustainable lifestyles that the activities in the project develop and improve on different facets of life, through its both internal and external communication channels and platforms. • Buddy class concept introduced to introduce and develop sustainable lifestyle in city of Espoo.
Targeted outcome	To make Espoo citizens more aware of their potential towards more sustainable lifestyle. Engage citizens into active dialogue on sustainable lifestyles.
Roles and responsibilities	ESP: Main responsibility. Engaging different stakeholders into the process.
Schedule	M12: plan for action finalized, buddy class activities begin

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	M24: communications campaign towards selected target groups to build awareness of sustainable lifestyle M36: reporting of the activities in buddy class concept, cross-pollinating of two buddy classes (see Action E 3-3)
KPIs	to be defined

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8. Air Quality in Espoo

The objective of task 3.7 is to ensure the availability of clean air.

Action E21-1	Effects on air quality. Follow up of air quality development in the Espoo Lighthouse demonstration districts during the project duration.
Detailed plan	Obtaining the data for air quality from available public resources such as HSY. Comparing air quality throughout the project. Highlighting possible impacts related to SPARCS development.
Targeted outcome	Overview report of the development of local air quality (demonstration areas)
Roles and responsibilities	VTT - air quality data tracking and possible interpretation related to Sparcs HSY - air quality data provision
Schedule	M1-M60
KPIs	Levels of CO_2, NOx, and PM pollution

9. SMART BUSINESS MODELS IN ESPOO

9.1 Intoduction to task 3.8

The objective of task 3.8 is to identify the city's and other stakeholders' business model concepts supporting the energy transition in cities toward carbon neutral energy supply with the optimal and most cost-efficient ways for arranging the collaboration. The task includes three subtasks connected to five different actions where the objective is to approach smart business models from several perspectives and different scales. In the context of smart cities and energy positive districts, business models are multi layered concepts where various stakeholders are connected forming a larger ecosystem. Through different methods, such as design thinking and business model innovation, the task covers actions where the aim is to recognize and identify the elements of business models that provide new ways of creating value, both economic and social, for Espoo and other stakeholders, including citizens.

In addition, this task focuses heavily on identifying relevant collaboration partners in the possible ecosystem and supports dissemination of SPARCs aiming to generate and foster new future businesses and business models. The task is thematically closely connected to the Work Package 7 (Exploitation and Business Ecosystems) and hence, partners involved are collaborating and aiming to wide knowledge exchange for example by contributing to the project deliverables.

9.2 Engaging (lead) users and co-creating (energy positive) business models

This subtask 3.8.1 Engaging (lead) users and co-creating (energy positive) business models aims to pilot ways to co-create business models together with different stakeholders. (Lead) users involved in the co-creation are planned to be both experts and company or organisation representatives as well citizens. In this subtask, KONE focuses especially on mobility, including both people and material mobility. The subtask has started by conducting expert interviews in order to research and understand the topic at large and the current challenges of energy positive mobility and its business models. Based on the insights from the expert interviews and citizens' daily journeys and mobility habits researched in the subtask 3.6.1., KONE will create and select themes for co-creation workshops and design sprints where stakeholders' value identification and possible new business models will be developed further aiming to also pilot and develop ways to engage users in business model creation. SPARCS Interventions E4: Smart Business models include actions as follows.

Action E4-1	Engaging (lead) users and co-creating (energy positive) business models in Lippulaiva.
Detailed plan	• Researching and piloting ways to engage users (citizens and companies / other organisations) in business model co-creation • Organising co-creation workshops (e.g. Design sprints) around relevant topics found from user research • Expert interviews to support ecosystem mapping

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Targeted outcome	By engaging users (both citizens and company / other organisation representatives) in co-creation of business models in an early phase,we aim to research and develop business models that create real value for all stakeholders.
Roles and responsibilities	KONE is responsible for planning the methods how to engage users and organising the co-creation sessions and conducting expert interviews.
Schedule	Expert interviews conducted 3-6/2020 (M6-M8), interview analysing 6-9/2020 (M9-M12), co-creation planning and workshops 8-12/2020 (M11-M15) and 2021 (before M27).
KPIs	Number of people engaged and what were the learnings. How well four lenses of innovation (desirability, sustainability, feasibility, viability) are considered as part of the business models.

Action E9-1	Engaging lead users and co-creating energy positive business models in Sello
Detailed plan	• Researching and piloting ways to engage users (citizens and companies / other organisations) in business model co-creation • Organising co-creation workshops (eg. Design sprints) around relevant topics found from user research realized in task 3.6. • Expert interviews to support ecosystem mapping
Targeted outcome	By engaging users (both citizens and company / other organisation representatives) in co-creation of business models in an early phase, we aim to research and develop business models that create real value for all stakeholders.
Roles and responsibilities	KONE is responsible for planning the methods how to engage users and organising the co-creation sessions and conducting expert interviews.
Schedule	Expert interviews conducted 3-6/2020, interview analysing 6-9/2020, co-creation planning and workshops 8-12/2020 and 2021
KPIs	How many people are engaged and what were the learnings. How well four lenses of innovation are considered as part of the business models.

9.3 Smart Otaniemi

Smart Otaniemi connects experts, organisations, technologies and pilot projects. It brings the building blocks of a smart future together and works on world changing ideas for smart energy that will be both sustainable and commercially successful [https://smartotaniemi.fi/].

This subtask 3.8.2 Smart Otaniemi focuses on collaboration between SPARCS and Smart Otaniemi innovation ecosystem. Networking activities aim for knowledge exhange and leveraging further testing of innovative smart city solutions beyond

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SPARCS activities. As an example, during the first quarter of 2020, Smart Otaniemi ecosystem arranged several events: open clinic, virtual event, workshops and seminars. Smart Otaniemi showroom presents showcases for both international and national visitors (currently showroom is replaced by virtual events due to COVID19).

Action E23-1	**Smart Otaniemi pilot platform. Smart Otaniemi innovation ecosystem as facilitator of developing bankable smart city solutions for worldwide replication. Focus areas: efficient use of energy, intelligent use of data, and creating solutions for real customers. https://smartotaniemi.fi/**
Detailed plan	SPARCS will collaborate with the Smart Otaniemi network and co-organises common dissemination activities and events locally. SPARCS activities will be presented in Smart Otaniemi events, such as in Otaniemi open doors (seminars or webinars). This action will support leveraging funding for smart city developments beyond SPARCS demonstrations. As an example, this collaboration aims to bring together groups of organisations, which can apply additional funding for collaborative development and demonstration, such as collaborative development of carbon free shopping malls from Business Finland.
Targeted outcome	Increasing the collaboration and knowledge sharing among SPARCS partners and Smart Otaniemi network, to connect SPARCS with other actors in Finland. Increased capabilities of SPARCS partners and stakeholders by increasing their awareness of trending technologies and supporting partners to test more innovations beyond SPARCS demonstrations.
Roles and responsibilities	VTT leading the networking, in collaboration with the City of Espoo and other stakeholders.
Schedule	Continuous collaboration
KPIs	Dissemination KPIs reported as a part of WP8 activities. Number of new innovative projects leveraged beyond SPARCS and the total volume of the additional funding.

9.4 Smart business

Positive energy districts require new kinds of technical solutions and business models. Local ownership is enhanced by the emergence of livelihoods and promising export opportunities. The introduction of energy communities will benefit small and medium size businesses, as large corporations are excluded from decision-making positions. Smart and citizen-based business solutions can leverage local opportunities, such as sector coupling of power, heat and mobility, and employ cutting edge ICT services provided by the 5G infrastructure, 3D city models and blockchain platforms.

This subtask 3.8.3 will assess the opportunities for smart business, investigate new companies with relevant products and coordinate with stakeholders to create an enabling environment for private sector participation.

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Action E23-2	Smart business. The development of new business out of Espoo Lighthouse actions is supported by connecting and linking to local (e.g.YritysEspoo) and national actors.
Detailed plan	Enabling connections and discussions between SPARCS partners and local and national actors in relation to the actions taken in the project. Promoting SPARCS activities as part of the Sustainable Espoo programme. Assessing the city's role in supporting smart business, describing services for supporting new companies, collaboration or research initiatives, and city as a platform approach.
Targeted outcome	Provide possibilities and support for new smart businesses to emerge from the Lighthouse activities.
Roles and responsibilities	ESP is in charge of the Action. Practical outcomes are done in co-operation with the other relevant SPARCS partners.
Schedule	Ongoing
KPIs	to be defined

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10. REPLICATION AND EXPLOITATION PREPARATION IN ESPOO

In the leadership programme for pioneering cities, Espoo is committed to achieving the UN's sustainable development goals by 2025. The voluntary local review (VLR) of Espoo published in May 2020 outlines the statues of each SDG and joint efforts for accelerated action. SPARCS is featured in the report and a key instrument in driving SDGs 7,8,9, 11, and many others.

The objective of task 3.9 is to develop and disseminate smart city solutions for reaching the global Sustainable Development Goals (SDGs) of Agenda 2030. It also provides a model for replication throughout other positive energy districts around Europe and, more importantly, a unique case study for global urban development.

Action E14-1	Co-creation for sustainable city development. Coordinated and collaborative and replication of SPARCS Espoo Lighthouse actions in Kera area solutions for smart and energy efficient future living are co-developed as co-creation between the City of Espoo and the local consortia of stakeholders, including close collaboration with e.g. energy utility companies Fortum and Caruna.
Detailed plan	Coordination with other ongoing sustainability projects in Kera. Participation in stakeholder group to outline an energy positive ecosystem and mobility ecosystem. Close co-operation with Smart and Clean Kera –project. Communication with utilities to understand requirements and opportunities of local energy solutions.
Targeted outcome	The development of the Kera are provides a valuable opportunity to test and implement energy and mobility solutions tailor-made for local needs, including the building phase of the area. Involving a wide range of stakeholders, including incumbent utilities improve the outlook of system optimization, reliability and replicability, as well as sustainable urban mobility.
Roles and responsibilities	ESP, stakeholders
Schedule	Coordination is ongoing M8 Positive energy ecosystem study completed M10 Sustainable mobility ecosystem –work started in co-operation with Smart and Clean Kera and Six Cities: Low-carbon transport in mobility hubs -projects. M36 Opportunities for replication and exploitation identified
KPIs	to be defined

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Action E22-2	Ensure global impact of SPARCS actions through the UN SDG 2030 network. UN SDG 2030. The Lighthouse City of Espoo strategy aims at creating an inclusive, safe, resilient and sustainable community, as per the UN Sustainable Development Goal 11. The City of Espoo is also committed, as a selected pioneering city, to begin the work as SDG City with Sustainable Development Goals 4 (Quality Education) and 9 (Industry, Innovation and Infrastructure), and to reach all 17 goals by 2025. The Espoo Lighthouse consortia and actions form an integral part of the roadmap towards reaching these targets, especially goal 7 Affordable and clean energy, 11 Sustainable Cities and Communities, 13 Climate action and 17 Partnerships for the goals. This action coordinates, assembles and channels SPARCS work towards replication and dissemination on European level, towards the European Smart City community, and towards the global international UN community.
Detailed plan	Leverage the UN Agenda 2030 forerunner city role in communication Engage with UN system and assess the role of Espoo in a global UN context. Participate in other networks, including IEA-EBC Annex 83, the PED City Panel of SET-Plan Action 3.2, Eurocities network and several national initiatives.
Targeted outcome	The effectiveness of innovative concepts is enhanced by active communication and participation in global networks, as good practices can be analysed, refined and replicated
Roles and responsibilities	ESP, VTT, Stakeholders
Schedule	Continuous implementation. M5 Engagement with UNTIL unit in Otaniemi, Espoo to present SPARCS and explore opportunities for collaboration M9 Voluntary Local Review published and Espoo featured at UN High Level Political Forum M36
KPIs	to be defined

10.1 Post-SCC1 Monitoring strategy

Espoo will continue work on UN SDG achievement and forerunner reporting until 2025, and pursue to maintain the title of most sustainable city in Europe. In alignment with the Espoo Story, activities towards sustainability will be monitored and communicated on both local and international level. The Post SCC1 Monitoring strategy will be developed throughout the first two years of the project, while replication and exploitation preparation through the UN SDG 2030 network and Agenda 2030 framework will remain at the center of SPARCS implementation throughout the project.

In Espoo, replication will be supported among others through evaluating and packaging guidelines for city planning with the emphasis on energy and mobility, as well as through

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suggesting concrete action points for enhancing governance model for future replication. Local smart city business models and best practices sharing supports further upscaling.

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11. Conclusions

This report introduces the smart city lighthouse demonstration activities in Espoo, Finland. The report gives an overview of the demonstration blocks of Sello at the centre of Leppävaara district and Lippulaiva block in Espoonlahti district. Kera district provides an additional demonstration site, focusing the low carbon urban planning and developing processes and approaches for positive energy blocks. The Gantt chart offers a quick glimpse of the schedule and partners responsible for each demonstration action. The demonstration phase is running from October 2019 until September 2020, followed by a monitoring phase for the two years.

Demonstration activities embark a range of solutions supporting transition towards low carbon areas and testing of possibilities for positive energy blocks in Espoo. The activities include energy efficiency improvements, smart energy management, e-mobility, ICT, utilizing local RES production, citizen involvement and urban planning. Many of the activities challenge the old ways of working, enhancing the collaboration at the municipality, companies, citizens, research, and collaboration networks (such as Smart Otaniemi).

This report presents the plans for the demonstration, as well as targeted outcomes, responsible partners, schedule and a first version of the KPIs. The defined work and its monitoring and KPIs will be further developed in the demonstrations and in collaboration with other work packages in SPARCS.

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SPARCS

12. ACRONYMS AND TERMS

AMR	annual mismatch ratio
ABT M	activity-based transport model
API	application programming interface
BIM	building information model
CAPEX	Capital expense
CHP-bio	combined heat and power production using bio fuels
DH	district heating
DSM	demand side management
EV	electrical vehicle
HVAC	heating, ventilation and air conditioning
IoT	Internet of Things
KPI	key performance indicator
NZEB	nearly zero energy building
OER	on-site energy ratio
OPEX	operating expense
PED	positive energy district
PV	photovoltaic
P2P	peer-to-peer
RES	renewable energy source
RH	relative humidity
RMSE	The root-mean-square deviation
TSO	transmission system operator
VPP	virtual power plant
V2G	vehicle to grid

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