D4.2 MIDTERM REPORT ON THE IMPLEMENTED SOLUTIONS FOR ENERGY POSITIVE BLOCKS IN LEIPZIG

30/09/2021

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Dissemination level		
PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	

Deliverable administration

No & name	**D4.2 Midterm report on the implemented demonstrations of solutions for energy positive blocks in Leipzig**				
Status	Released	**Due**	M24	**Date**	2021-September-30
Author(s)	See pt. 1.2				
Description of the related task and the deliverable. Extract from DoA	T4.1 Local coordination in Leipzig (LPZ) M1 – 60 This task ensures the achievement of the SPARCS objectives and efficient co-operation within the Leipzig Lighthouse Prototype Team, parallel work packages, other stakeholders and supporting partners, as well as the Sustainable Espoo development programme. The main activities include, among others: to maintain strict control of the lighthouse implementation process and schedule. This report presents a detailed plan of introduced actions and sub actions in Lighthouse City Leipzig. It includes a detailed Gantt for the prototype phase and responsibilities. It also shows the preparation for the monitoring phase toward Milestones 8 - Completion of the prototype sites, which is due in M30.				
Participants	LEI, LSW, CEN, SEE, ULEI, WSL, FHG IMW, SUITE5, FHG IAO				
Comments					

V	Date	Authors	Description
0.1	05/07/21	ALL	1st draft Leipzig partners
0.2	12/08/21	ALL	2nd draft Leipzig partners
0.3	25/08/21	LSW	Control by translation agency
0.4	31/08/21	LEI, LSW	Deliverable checked by WP leader and released to reviewer (ESP, ULEI)
0.5	09/09/21	ESP, ULEI	Feedback from reviewers (ESP, ULEI)
0.6	30/09/21	LSW	Feedback included, released to coordinator and QM
1	30/09/21	VTT	Coordinator submits the deliverable to the EC

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SPARCS

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 an 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 organisations, 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

VTT · Stadt Leipzig · Câmara Municipal da Maia · Kladno · Δήμος Κηφισιάς · Espoo · KONE · SIEMENS · PLUGIT · CITYCON · ril · ADVEN · Fraunhofer · BABLE · WSL Wohnen & Service Leipzig GmbH · Leipziger Stadtwerke · CENERO · seecon Ingenieure · Universität Leipzig · spi Sociedade Portuguesa de Inovação · NEW · OR Reykjavik Energy · CTU Czech Technical University in Prague · Suite5 We Deliver Intelligence · verd · ЛЬВІВАВТОДОР · CiviESCo · GOPA.com Member of GOPA Consulting Group

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Table of Contents

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Executive Summary

This report updates the detailed plans and progress of all demonstration activities conducted in Leipzig, Germany, as part of the SPARCS project. The report is presented at the midterm of the project (M24). An overall summary of the Lighthouse demonstrations in Leipzig will be presented at the outset, followed by a summary of the details in the demonstration areas. The demonstration activities cover various low-carbon improvements in urban development, including buildings, energy systems and the use of e-mobility measures and citizen engagement initiatives.

The Lighthouse City Leipzig focuses on two physical districts ("Leipzig West") and one virtual district. The virtual district consists of the virtual power plant, where a wide variety of assets are connected to create an optimized energy management system with real-time data. The platform (digital ecosystem) creates added value for Leipzig's energy system. The exchange of energy data with the various partners forms the basis for the development of the Virtual Energy Community.
In addition, various use cases are being tested, such implementation of blockchain technologies, e-mobility concepts and a district heating study etc. The largest solar thermal plant in Germany is being built in the Leipzig West district, which is part of the project. Finally, SPARCS also studies macro level demonstration actions in the city of Leipzig, for transforming the positive energy community. This step will be focused mainly in the replication phase.

This report describes the detailed plans and the summary of the progress at toward the second project year, including planning of the work, targeted outcome, schedule and partners' roles and responsibilities. A detailed Gantt summarises the demonstration phases.

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1. INTRODUCTION

1.1 Purpose and target group

This report gathers detailed plans for the introduced actions and their sub actions. A detailed Gantt shows the schedules for the introduction of solutions phase, which is an efficient tool for all partners in following the overall project situation and reflecting the status of each action. The responsibilities and partners in charge are also summarised in the Gantt. The report is primarily aimed at organisations working in the SPARCS and collaborative Smart City stakeholder groups. It can also be of interest for other lighthouse projects and cities, and stakeholder partners as well as cities starting to plan similar types of smart city development.

1.2 Contributions of partners

The following Table 1 depicts the main contributions from partners contributing to this deliverable.

Table 1: Contributions of partners

Partner	Contributions
LEI	Editor of the deliverable, responsible for content planning and allocation of writing responsibilities. Chapters 5.1 + 6
LSW	Chapter 1 "Introduction", Chapter 2.1 "Introduction of task 4.2", including the description if the actions and coordination with the partners / Chapter 3.1 "Introduction of the task 4.3" / Chapter 3.2 "Virtual Power Plant and Storage Solution", including the description of the actions and coordination with the partners / Chapter 3.3 "Blockchain supported energy services", including the description of the actions / Chapter 4 Introduction "E-Mobility Integration in Leipzig Lighthouse Demonstration" / Chapter 4.2. Description of the actions together with FGH / Chapter 4.3 Description of the action L16-1
CEN	Chapter 2.3 "Optimal energy distribution in industrial Spinnerei Block" Chapter 4.4 "Bi-directional charging for micro-grid stabilisation"
SEE	Chapter 5.2 "Community support for energy transformation in the district" incl. 5.2.1 "Action for community support for energy transformation in the district" and 5.2.2 "Desk support for interested citizens with information regarding cost-efficient installation of renewable energy sources such as PV and participation in the Positive Energy Community and for local businesses and private persons interested in rolling out project solutions".
WSL	Chapter 2.4 "Efficient and human-centric social housing blocks"
ULEI	Chapter 2.2 Carbon-free district heating in "Leipzig West", 3.2 Virtual Power Plant and Storage Solution, 3.4 Integration of Community Energy Storage (CES) and Community Demand Response and 5.2.3 Empirical research

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

FHG IMW + IAO	Chapter 5.2.2 Actions for community support for energy transformation in the district Chapter 4.1 "Introduction to task 4.4" with the partners / Chapter 4.2 "E-Bus charging integration" with the partners / Chapter 4.3 "Load-balanced fleet management" with the partners / Chapter 4.4 "Bi-directional charging for micro grid stabilisation" - Action L1-4 with the partners
SUITE5	Contribution to Chapter 2.4 Efficient and human-centric social housing blocks with application specific information Chapter 3.5 Ambient ICT Applications and User Interfaces for Electricity Consumption Transformation and Improvement

1.3 Relationship to other activities

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

Table 2. Relationship to other activities in the project

Deliverables / Milestone	Contributions
D4.1	This deliverable D4.2 (due in M24) is the continuation of deliverable D4.1 (due in M12), which reports detailed plan of demonstrated actions and sub actions in Lighthouse City Leipzig.
D4.3	Supports D4.3: Implement solutions for energy positive blocks in Leipzig (due in M36).

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

2. ENERGY POSITIVE BLOCKS IN LEIPZIG LIGHTHOUSE DEMONSTRATIONS

2.1 Introduction to task 4.2 (LSW)

The objective of T4.2 is to demonstrate solutions for Energy Positive Blocks in Leipzig. The Lighthouse City of Leipzig is concentrating on two physical districts and one virtual district.

Leipzig focuses on different energy related topics and would like to examine and review a wide spectrum of different topics.

The following is a description of tasks to make the central district heating system more efficient and thus lower in CO_2 emissions while at the same time increasing the share of renewable energies:

- Construction and integration of a solar thermal plant in the central district heating system
- Research to increase the share of renewable energies in the district heating network
- Assessing waste heat potential
- Integration of storage solutions

Different tasks to optimize the energy flow in a local micro network and tasks to improve the options for residents to control their thermal energy consumptions are implemented.

The goal of the Leipzig actions is to demonstrate how many small actions can be used to optimise the flow of energy in a district. In the future, this should save energy, reduce CO_2 emissions, and increase the share of RES. The Lighthouse City Leipzig will show a concept, which could be used as a master for other districts in the city.

This task includes all demonstrated solutions for energy positive blocks in Leipzig, broken down into the following subtasks:

- Subtask 4.2.1 Carbon-free district heating in "Leipzig West"
- Subtask 4.2.2 Optimal energy distribution in industrial Spinnerei Block
- Subtask 4.2.3 Efficient and human-centric social housing blocks

2.2 Carbon-free district heating in "Leipzig West" (LSW, ULEI)

The Subtask 4.2.1 "Carbon-free district heating in "Leipzig West" is designed to increase the share of RES in the central district heating system. The RES integration focuses on the planning, construction, and integration in the central district heating system of a

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

solar thermal plant, which should supply the residents in the district with low CO_2 heating.

The next step leading to CO_2-neutrality is to research how this post-fossil future would look like.

The area "Leipzig West" will be used to create a blueprint for other districts depending on the specifics of each district (e.g., technologies).

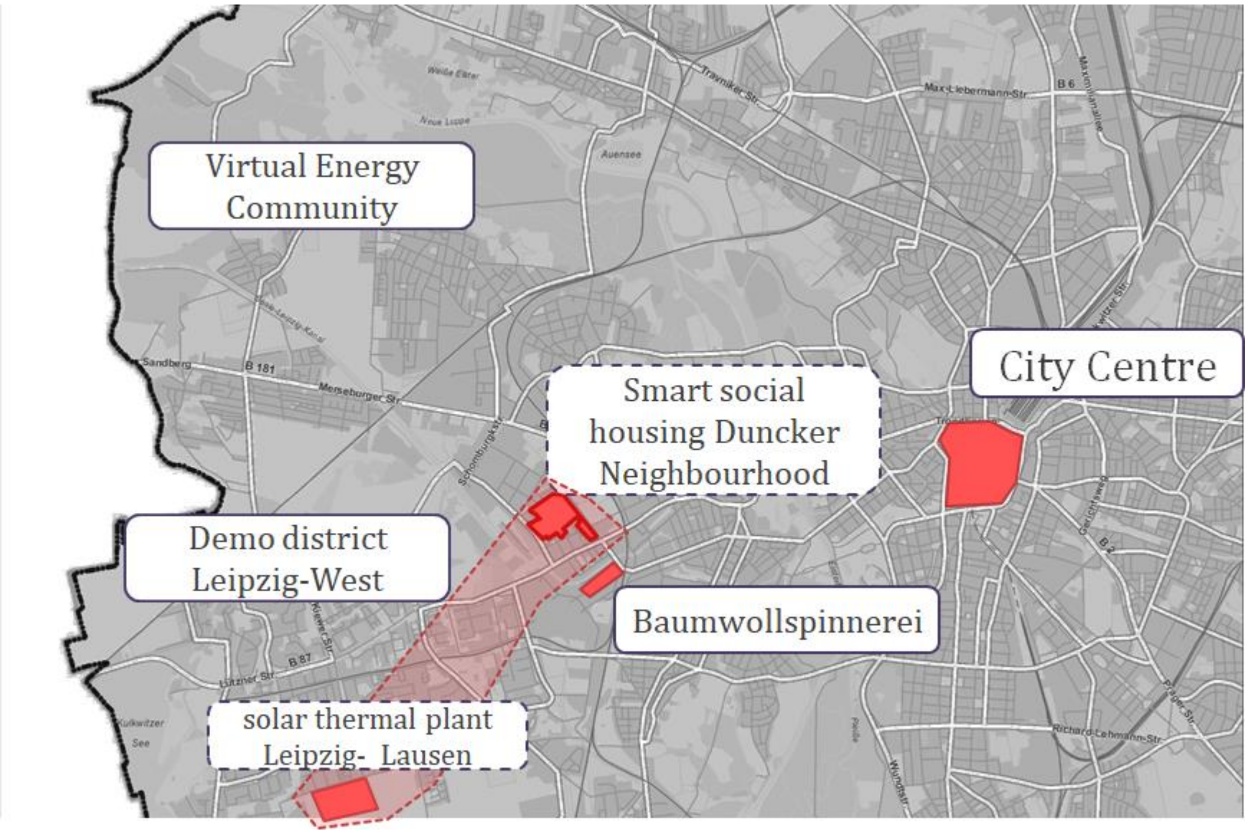

Fig. 1: Location of demo district

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

SPARCS interventions for 2.2 Carbon-free district heating in Leipzig West are:

L6-1 Demonstration of integration of RES in the central district heating network. Based on the integration of Solar Thermal Energy to District Heating - specifically located in "Lausen" in Leipzig West.

L6-2 Estimating potential of the district heating solution in the extended district of Duncker neighbourhood for replication in other urban quarters.

L7-1 Integration of a heat storage in the existing district heating network.

L8-1 Linking of the existing and newly constructed heat storage solutions with the demand side and allow for more efficient controlling of the district heating network.

L6-3 Research to increase the share of renewable energies in the district heating network for a post-fossil future.

L6-4 Assessing waste heat potential within the city boundaries for integration in the central district heating system. Focus will be on most accessible inner-city sources, such as data centres and sewers as well as process heat.

Action L6-1	Demonstration of integration of RES in the central district heating network. Based on the integration of Solar Thermal Energy to District Heating in the area of Lausen (part of Leipzig West) with the potential of using approximately 60,000 m² of space for collectors in total. At the first stage of expansion part of this field will be used to generate approximately 13 GWh/a of solar heat. The total space available makes an extension to 25 GWh/a, possible.
Demonstration plan	As part of the district heating transformation plan LSW is committed to increase the share of renewable heat in its heat generation portfolio. In 2019 a dedicated project team was appointed at LSW and tasked with the planning, building, and commissioning of solar thermal plants in the city of Leipzig to supply renewable heat to the district heating grid. Operation start was targeted for 2022. The first steps of the team and its external partners were to create a feasibility study, find suitable locations and conclude the conceptual design phase. Unfortunately, in the initial planning phases the partners were forced to change the planned location of the solar thermal plant (STP) in Leipzig from "Lindenauer Hafen" to "Leipzig-Lausen", due to environmental protection issues preventing the official permit at the Lindenauer Hafen site. The new location of the solar thermal plant is in the demo district Leipzig West in an agricultural area. The change from fallow (former) industrial area to agricultural area resulted in a new and different approval process to secure the building permit. The new approval process is considerably longer and more complex involving multiple parties in the local/regional and federal administration. The start of operation in 2022 is therefore no longer feasible. The new target date has been set for April 2023.

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	 Fig. 2: Visualisation of one variant (3 in total) of the solar thermal plant in Leipzig West (current approval planning stage).
Roles and responsibilities	**LSW: task leader, coordinator, owner of the generation plant** LPZ: approval process (permit) and support during the search for a location ULEI: Scientific supervisor

Schedule LSW	M1-17	Clarification of the property issue with the City of Leipzig, search for new location & conclusion of contract
	M4-M10	Start of conceptual design phase
	M15	Successful participation in tendering for federal funding, funding is secured
	M28	Tendering process and negotiations for main components are completed, ordering of 1st stage
	M32	Official building permit is obtained
	M36	Start of construction / building
	M42-43	Commissioning of the 1st stage of the solar thermal plant and integration into LSW Digital Platform and energy community
	M43	Operation & monitoring start of the 1st stage
	M55	Operation start of the 2nd stage
Schedule ULEI	M1-M10	Clustering of customer groups, data collection
	M10-M12	Model setup
	M12-M15	Scenario analysis and evaluation
	M43-M60	Monitoring and model refinement

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Milestones/ Tangible outcome	M15	Model results and evaluation (report, contribution to D4.2)
	M43	Commissioning of the solar thermal plant and integration in the central district heating system
	M43-60	First data receipt from asset
Deviations from initial plan (GA)	The Leipzig MS13 goal of completing all demonstration sites by M30 cannot be achieved.	
New deviations into plan (as compared to D4.1)	(See above – deviations from initial plan (GA))	
Progress made until M24	The following key steps have been taken: • Finalisation of conceptual design phase • Awarding of national funding for the project (innovative renewable CHP plants) • Securing of property (contractual) The next steps in the project will involve the tendering process for the main components, continuous work on the approval planning, the detailed engineering phase, construction start of the heat transmission and operation station ("pump house") as well as the 1st stage of the solar thermal plant. The 1st stage is planned to supply approx. 13 GWh/a of heat with a targeted operations start in April 2023. The construction will continue with a final, 2nd stage, which will expand the solar thermal plant to approx. 25 GWh/a. The start of operations for the 2nd stage is targeted for April 2024. The change of location of the STP does not impact WP4 objectives, however, the delayed completion of the STP does compromise monitoring plant operation of 2 years, including realisation of the MS13: Leipzig- Completion of the demonstration sites WP4 - scheduled for M30. The partners regret that they cannot affect the speed of the authorisation processes. However, with respect to monitoring the solar thermal plant, monitoring data from project month M44 - M60, including (incomplete) two summer seasons will be available. ULEI has applied a techno-economic model for the demonstration district. Customer groups were clustered according to the demonstration prototype district borders. Thereafter, data regarding the energy balance had been collected for the demand side. Current heat supply technologies determined the status quo scenario. For the green scenario, different amounts of solar heat were added to the system.	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

In parallel, ULEI has supported the planning process of LSW by applying techno-economic modelling of the STP that must be integrated in the demonstration district. The details of the modelling approach and the results of this case study have been published in a scientific journal. [1]

For this case study, some key performance indicators (KPI) that have been developed for the operationalisation of energy positive neighborhoods (EPN) are applied. This includes KPIs for the so-called Onsite Energy Ratio (OER), Annual Mismatch Ratio (AMR), Maximum Hourly Surplus (MHS), Maximum Hourly Deficit (MHD), and Monthly Ratio of Peak hourly demand to Lowest hourly demand (RPL).

Given the reference case, the AMR is calculated at 0.28. In Fig. 3 the impact of the sensitivity analysis on the AMR is visualised depending on thermal storage size (from left to right: 10–100 MWh) and the model foresight (top-down: 48 h - 8760 h). It shows that lower levels of AMR are achieved with larger storage capacity in combination with enhanced forecast accuracy. However, enlarging the storage capacity alone does not necessarily reduce the AMR since a shorter forecast accuracy impedes the potential for utilising the storage. For example, a storage capacity larger than 20 MWh or 30MW will not yield a further decline of the AMR after limiting the optimisation horizon to 48 h or 336 h.

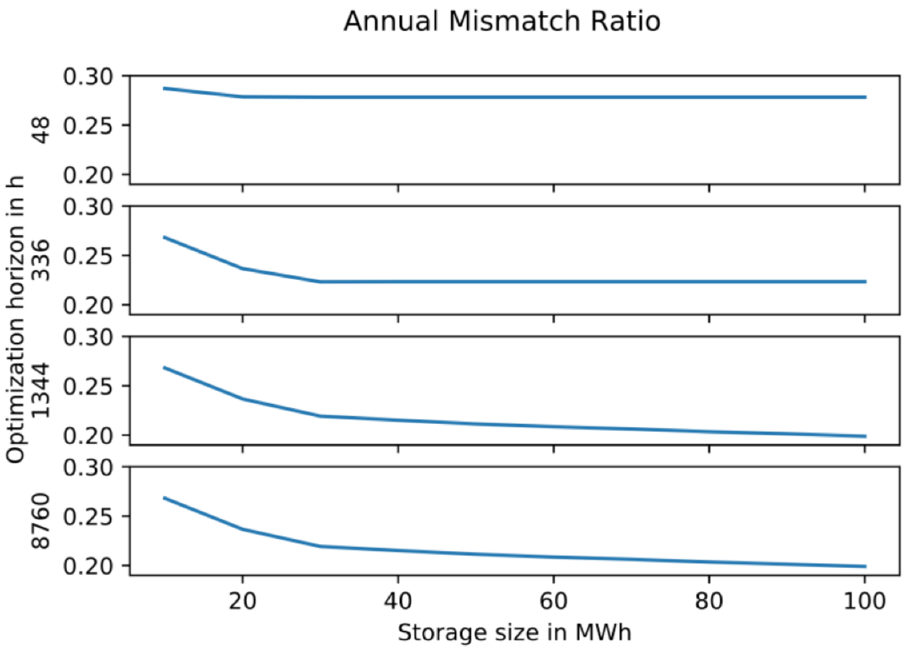

Fig. 3: Annual Mismatch Ratio (AMR) for the demo prototype district depending on the thermal storage capacity and the model foresight.

[1] Uspenskaia D, Specht K, Kondziella H, Bruckner T. Challenges and Barriers for Net-Zero/Positive Energy Buildings and Districts—Empirical Evidence from the Smart City Project SPARCS. Buildings. 2021; 11(2):78. https://doi.org/10.3390/buildings11020078

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Action L6-2	Estimating potential of the district heating solution in the extended district of Duncker Neighborhood for replication in other urban quarters	
Demonstration plan	LSW: Development of an expansion concept for district heating to increase energy efficiency in the "Leipzig West", taking into account the ecological aspect with regard to reduced CO_2 emissions by replacing fossil heat generators. The integration of alternative heating solutions in the district heating system will be examined and evaluated. This also helps to gain important knowledge regarding to the applicability of further district developments. The aim is to increase the district heating supply in "Leipzig West" and the share of renewable energies in the Leipzig district heating system in the future. ULEI: ULEI provides a model-based analysis of alternative district heating solutions. Among others, technology options and potential sites for solar thermal plants are evaluated regarding their technical and economic potential for integration in the district heating network.	
Roles and responsibilities	**<u>LSW: task leader, coordinator</u>** LPZ: Urban Planning Office, strategic planning of STP in urban development ULEI: Potential analysis and review of technical and economic feasibility; Scientific Supervisor	
Schedule	M9-M11	Analysis of the current status
	M12	Workshop to define the modelling scope
	M12-M18	Examination of the heating technologies and comparison of the requirements Data collection and model setup
	M19-M25	Development of the "Leipzig West" energy concept Scenario analysis and evaluation
	M26-M36	Evaluation of the results and verification of a generic transferability to replication areas
Milestone/ Tangible outcome	M36	Report / concept, which includes the following points: • Recording the current status • Comparison of the supply options • Estimating CO_2-reduction potential
Deviations from initial plan (GA)	None	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

New deviations into plan (as compared to D4.1)	Title changes in the amendment process on "Estimating potential of the district heating solution in the expanded Duncker district for replication in other urban areas"

Progress made until M24	In order to carry out the aforementioned model-based analysis of alternative district heating solutions, ULEI has further developed and subsequently applied the techno-economic modelling framework IRPOpt.
	
	The modelling has started with the collection of parameters and boundary conditions, e.g.:
	▪ Wholesale market prices for electricity for the year 2030,
	▪ Commodity prices, e.g., for natural gas, biomass and waste,
	▪ Heat demand profiles and customer types,
	▪ Generation technology costs,
	▪ Decentralised generation technology potential such as solar and waste heat.
	
	The data required for the business scenarios were collected and prepared in structured workshops with participation of the relevant business units of the utility. Based on the data collection, we implemented the generation portfolio for the central district heating system, that consists of
	• Waste-to-energy plant (MVA_25)
	• Biomass CHP (BioHKW_25)
	• Solar thermal plant (TC_35)
	• Gas-CHP
	    • Open cycle gas turbine (GT_AHK 150)
	    • Combined-cycle gas turbine (GUD_1a/b_100)
	• Gas-fuelled combustion engines (iBHKW, BHKW)
	• Thermal storage capacities (TS_35, TS_140)
	• Power-to-heat (P2H_3)
	
	The elements of the district heating system are depicted in the following graphical representation (using the labels given above in brackets):

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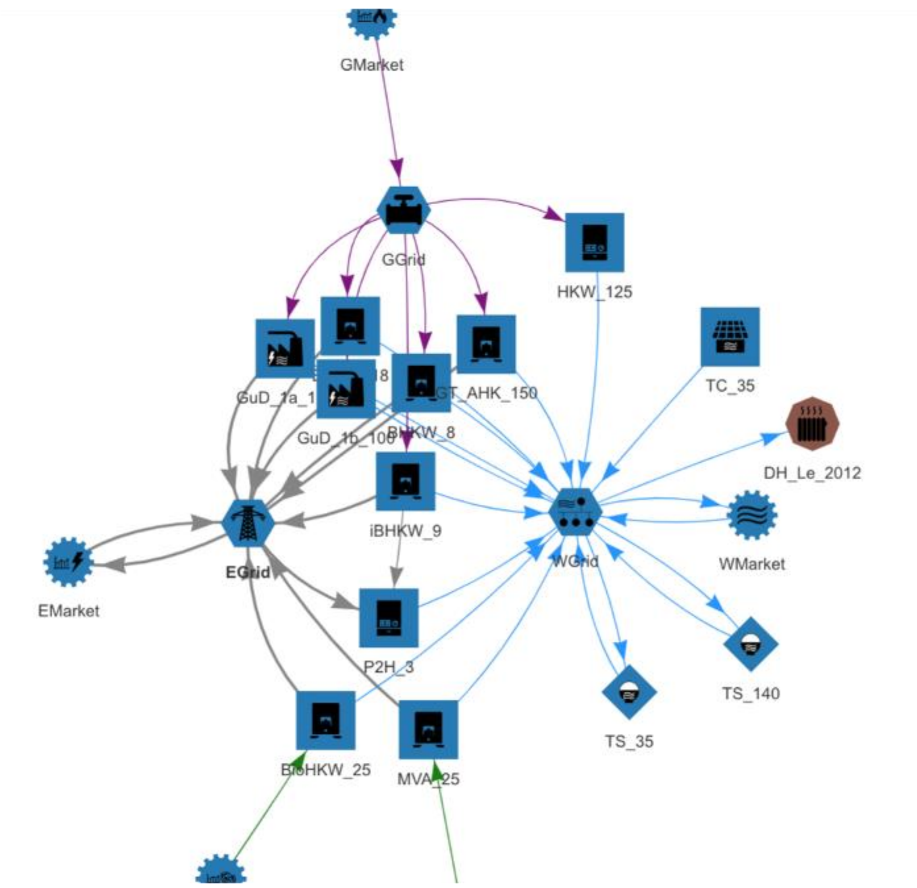
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	 Fig. 4: Reference scenario for Leipzig's district heating system in 2030. As a next step, we have integrated the Duncker district in the model. The results of the scenarios were evaluated with respect to levelized cost of heat supply and CO_2 emissions.

Action L7-1	**Integration of a heat storage in the district heating network to increase the solar coverage rate and equalize the solar heat output integrated into the heating network.**
Demonstration plan	LSW plans to build a heat storage system in parallel to the planning and construction activities of the solar thermal plant. Storage parameters: 2-zone hot water storage tank (not seasonal storage), approx. 1.8 GWh heat capacity, 60m height, max. 120°C storage temperature, 55.000 m^3 stored water volume To facilitate elevated water temperatures and prevent boiling, an insulated layer (membrane) divides the tank in two zones. The cooler upper zone increases the pressure in the lower zone, enabling temperatures above boiling point. The heat storage system will be part of the new cogeneration plant project, planned

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	in the south of the city. The system will be integrated in the district heating system and can therefore be used by all heat generation plants of LSW. The overall plan of LSW is to bring the storage system into operation by 2022. Construction started in M7 and is progressing according to plan. The pillar foundations have been laid as well as the storage system foundation. Work on the superstructure has started.  Fig. 5: Current construction phase Construction is expected to be finished in M29. ULEI expansion of the scope of L6-2. ULEI integrates the above-mentioned technologies in the model and evaluates the effect on cost and emissions.

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Fig. 6: Visualisation of heat storage

Roles and responsibilities	**<u>LSW: task leader, coordinator, owner, and operator of the plants</u>** ULEI: Scientific supervisor:	
Schedule LSW	M7	Construction starts
	M29	Construction finished & filling start
	M31	Commissioning of the heat storage
	M36	Operation start & monitoring start
Schedule ULEI	M13-M15	Workshops to define the modelling scope
	M12-M14	Data collection and model setup
	M15-M18	Scenario analysis and evaluation
	M19-M24	Discussion of results with decision-makers and stakeholders
Milestone/ Tangible outcome	M24	Model results and evaluation (report, contribution to D4.2)
	M36	Operation start of the heat storage system in combination with the district heating grid
Deviations from initial plan (GA)	After detailed technical planning and economic evaluations a change of technology for the planned heat storage system was necessary. No phase-change seasonal heat storage can be implemented since it is not economically feasible due to its size and scale. Moreover, as phase-change materials with suitable properties are either toxic &/or expensive compared to water.	

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	Also, there is no operational experience for a system of this size, which is a reliability issue for the cities energy supply. LSW is now building a large hot water storage tank (two-zone) to the south of the city. The new action will include construction and integration of a 2-zone hot water storage tank (not seasonal storage), 1.8 GWh heat capacity, 60m height, max. 120°C storage temperature, 55.000 m3 stored water volume, construction is ongoing, finalisation is planned for M36.
New deviations into plan (as compared to D4.1)	The power-to-heat (PtH) plant has been removed from this action because: • Current legal regulations in Germany de-facto rule out PtH operation through the public power grid (economically not feasible due to high taxes and levies) • It will not be integrated in the heat storage system • The location of the plant is not in one of the demo districts (except of the virtual energy district) --> direct connection between PV & PtH is not feasible
Progress made until M24	Major part of construction work is completed. The thermal storage is an element of the reference generation portfolio. (See progress L6-2).

Action L8-1	Linking of the existing and newly constructed heat storage solutions with the demand side and allowing for more efficient controlling of the district heating network.
Demonstration plan	Depending on the season, LSW operates the district heating grid at elevated temperatures, which exceed the boiling point of water. Therefore, to increase the degree of utilisation and efficiency of the CHP Combined Heat & Power plants in the grid a pressurised hot water storage system was constructed in 2016. To increase the heat storage capacity, a new 2-zone, hot water storage tank will be constructed together with a new CHP plant (see L7-1). To facilitate elevated water temperatures and prevent boiling, an insulated layer divides the tank in two zones. The cooler upper zone increases the pressure in the lower zone, enabling temperatures above boiling point. The heat storage system will be located to the south of the city, at a different location than the existing heat storage plant. The system will be integrated in the district heating grid and can therefore be used by all heat generation plants of LSW. The overall plan of LSW is to bring the storage system into operation by 2022.

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Roles and responsibilities	**<u>LSW: task leader, coordinator, owner, and operator of the plants</u>** ULEI: scientific supervisor	
Schedule	M7	Construction starts
	M29	Construction finished & filling start
	M31	Commissioning of the heat storage plant
	M36	Start of operation/monitoring
Milestone/ Tangible outcome	M22	Start of construction works
	M31-60	Commissioning of the plant and regular operation
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	Major part of construction work is completed. The thermal storage is an element of the reference generation portfolio. (See progress L6-2).	

Action L6-3	Research to increase the share of renewable energies in the district heating network for a post-fossil future.	
Demonstration plan	Implementation of a potential analysis and evaluation of integral regenerative heat sources in the district heating network for the development of a climate-neutral heat supply system. Based on the mid-term strategy of LSW, ULEI models and evaluates scenarios of the district heating system for the years 2035-2050. The focus is on the development of the supply side technologies. The impact on CO_2-emissions and costs will be evaluated.	
Roles and responsibilities	**<u>LSW: task leader, coordinator</u>** LPZ: Feedback from municipal strategies ULEI: Potential analysis and review of technical and economic feasibility	
Schedule	M13-M15	Workshops to define the modelling scope
	M12-M14	Data collection and model setup
	M15-M18	Scenario analysis and evaluation

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	M24-M36	Discussion of results with decision-makers and stakeholders
	M25-M36	Monitoring, data update and refinement of scenario analysis
Milestone/Tangible outcome	M24	Intermediate Model result and evaluation (report, contribution to D4.2)
	M36	Report, which includes the following points: • Status analysis • Description of technologies / possible technologies • Check compatibility with district heating requirements • Evaluate the impact on CO_2-emissions and costs • Model results and evaluation with Data update (report, contribution to D4.2)
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Extension of the discussion phase with decision-makers and stakeholders to allow for in-person meetings after the lockdown period.	
Progress made until M24	Based on workshops and discussions with LSW, we developed a vision for the long-term transition of the district heating system. Regarding the technology portfolio, we project four basic scenarios that represent the core and primary energy sources of the heat supply: • (Synthetic) Natural gas incl. CCS, • Green Hydrogen, • Biomass, and • Electricity. The scenarios determine the main type of conversion technologies within the district heating system. We assume, that the majority of primary energy in terms of electrons or molecules have to be imported. It will be a matter of the economics to assume a 100% green energy carrier in the modelling exercise. As a prerequisite for modelling, hydrogen-based conversion technologies were integrated in IRPopt (link to L18-1).	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

<table>
<tr><th>Action L6-4</th><th colspan="2">Assessing waste heat potential within the city boundaries for integration in the central district heating system. Focus will be on most accessible inner-city sources, such as data centers and sewers as well as process heat.</th></tr>
<tr><td>Demonstration plan</td><td colspan="2">One objective of our future energy solutions is to couple sectors so that waste heat from industry and commerce can be used for heating applications.
Potential waste heat sources in urban areas are to be localised, analysed and their suitability for heat use, assessed.
Examination of possible waste heat sources suitable for the integration of district heating.</td></tr>
<tr><td>Roles and responsibilities</td><td colspan="2"><u>LSW: task leader</u></td></tr>
<tr><td rowspan="4">Schedule</td><td>M10-M14</td><td>Development of localisation concept of urban waste heat sources</td></tr>
<tr><td>M15-M25</td><td>Application of the localisation methodology and collection of waste heat data</td></tr>
<tr><td>M25-M27</td><td>Analysis and evaluation of waste heat sources</td></tr>
<tr><td>M28-M36</td><td>Further processing of the results in 6-3 concept development</td></tr>
<tr><td>Milestone/ Tangible outcome</td><td>M36</td><td>Report, which includes the following points:
• Localisation concept
• Potential waste heat quantified
• Verification of compatibility with district heating requirements</td></tr>
<tr><td>Deviations from initial plan (GA)</td><td colspan="2">None</td></tr>
<tr><td>New deviations into plan (as compared to D4.1)</td><td colspan="2">Individual data queries from companies take up significantly more time. A generic approach is not possible therefore individual queries are necessary by M25.
Achievement of goals not at risk by M36.</td></tr>
<tr><td>Progress made until M24</td><td colspan="2">To estimate the waste heat potential in Leipzig, an extensive investigation as well as research is necessary in order to carry out a valid evaluation of the usability.
The collection of various waste heat potential represents a particular challenge here. The difficulty so far has been the filtering of relevant companies or potential waste heat sites. In</td></tr>
</table>

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

order to determine waste heat sources from flue gases, contact was made, and data was exchanged with the regional immission control authority regarding systems subject to approval in accordance with the Federal Immission Control Act. Unfortunately, the desired level of data was not obtained. The further inquiry via the municipal office for the environment unfortunately also had poor results.

The route via the Office for Economic Development and the Chamber of Industry and Commerce therefore offered a larger database of listed companies in Leipzig and the surrounding area. Filtering according to company size and industries relevant to waste heat (especially telecommunications / data centres and manufacturing) revealed a large number of possible companies with waste heat (approx. 90).

With regard to the requirement to integrate waste heat in the district heating network, we expect that approx. half of the waste heat potential is in the district heating area of the Leipziger Stadtwerke.

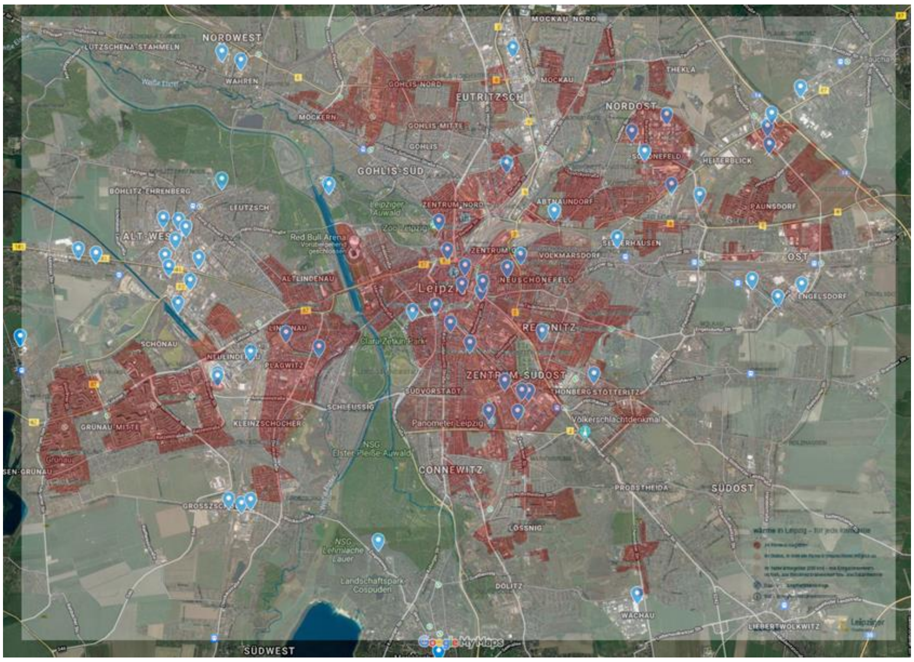

Fig. 7: Current construction phase

With the current development of a guideline for the use of waste heat for companies and the creation of the catalogue of requirements for the suitability of reusing waste heat, the company audit according to a prioritised procedure begins.

Even before SPARCS, the considerations regarding the external use of waste heat from the chemical industry within the

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	metropolitan region arose. With a connecting road, up to 83 MW of industrial waste heat at district heating temperature level would be available all year round. The corresponding amount of heat corresponds to around 38% (over 600 GWh) of the district heating requirement in Leipzig. The planning of the "REFILL" project was initiated this year and is expected to be completed in 2026. More information can be found here: https://zukunft-fernwaerme.de/industrielle-abwaerme-west/

2.3 Optimal energy distribution in industrial Spinnerei block (CEN, LSW)

The buildings and premises of the Spinnerei block (former cotton mill) were originally constructed in 1884 and are protected under the Monument Protection Act. The buildings are mainly built of brick and partially renovated. The buildings prototype area is approximately 17,000m^2. The area is a best practice example for the revitalisation of a former industrial site used for cultural activities and includes a StartUpLab ('from cotton to culture'). StartUps have been based here ever since the Spinnerei block was reopened in its current form. The next step is to develop a smart positive energy district with flexible and intelligent heat and electricity management. Future plans include a new and zero-energy Smart Infrastructure Hub and refurbishment strategy derived from building No. 14 and 18.

The start-up Accelerator SpinLab, which is based at the Spinnerei block along with the business school HHL, will play an active part in developing new business models along the way. Both the SpinLab and the HHL Business School are central stakeholders and involved in SPARCS already. The actions on the Spinnerei block premises include intelligent heating demand control, utilising the old walls of the buildings which function

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

as a heat storage buffer, integration of RES in the local micro electricity grid and bidirectional charging for electrical vehicles, using their storage capacity as a buffer.

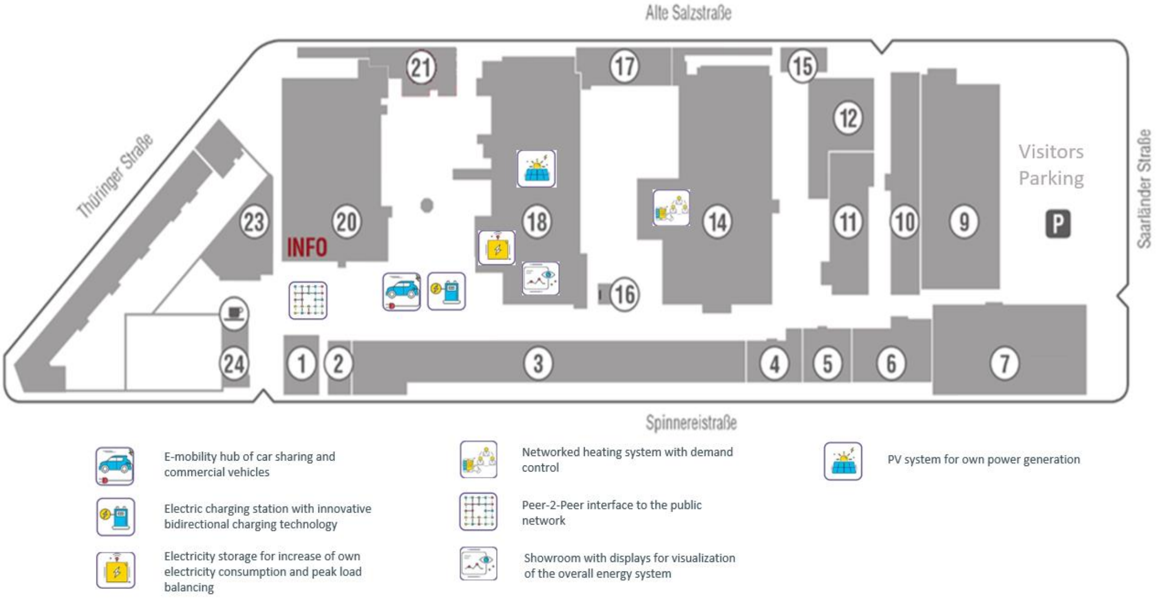

Fig. 8: Map of Spinnerei block*

* The numbers in Fig. 8 refer to the labelling of the different buildings.

Fig. 9: Entrance area of Spinnerei block

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Fig. 10: View of the Spinnerei block

SPARCS measures for optimal energy distribution in industrial Spinnerei block are:

Action L2-1 Installation of equipment to allow for intelligent balancing of PV, CHP, and user demand control

Action L2-2 Balancing the micro grid against the city-wide virtual power plant. This aims at selling energy when demand is exceeded in the micro grid and vice-versa. This action will be closely linked to the business models based on blockchain technology

Action L2-3 Analysing and integrating energy storage solution with bulk batteries to balance production and consumption within the micro-grid.

Action L3-1 Coupling the heating needs with the load profile of the micro grid and taking into account the specifics of the historic building which function as a heat buffer.

Action L3-2 Provide user-interface with air quality info and implicit demand control: through direct feedback and consumption overview as well as recommendation for the tenant's behaviour, the demand is expected to be lowered.

Action L2-1	Installation of equipment to allow for intelligent balancing of PV, CHP, and user demand control.
Demonstration plan	To provide solutions for energy positive blocks and districts that operate as an active part of the city's whole energy system, including RES integration, solutions for integration of RES (for example solar photovoltaic (PV) panels) in an existing district heating network and in a virtual power plant. An array of solar PV panels will be built on the roof of a building in the Spinnerei block

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

and will in combination with an electrical battery be used to increase the percentage of renewable energy in the network. Sensors and monitoring equipment will also be installed to ensure user demand control. As part of this equipment remotely readable smart meters are pictured in Fig. 11 in comparison to an old meter. There is a combined heat and power (CHP) unit already in the network which will also be used in the intelligent balancing of the energy network. Examples of the terminated rooftop evaluation can be found in Fig. 12 and Fig. 13 below. The combination of green roofs and photovoltaics is also included in this evaluation. Based on the different theoretical results, a PV replication strategy for the entire property covering future years was outlined.

Fig. 11: Old electricity meter (left) and new remotely readable meter (right)

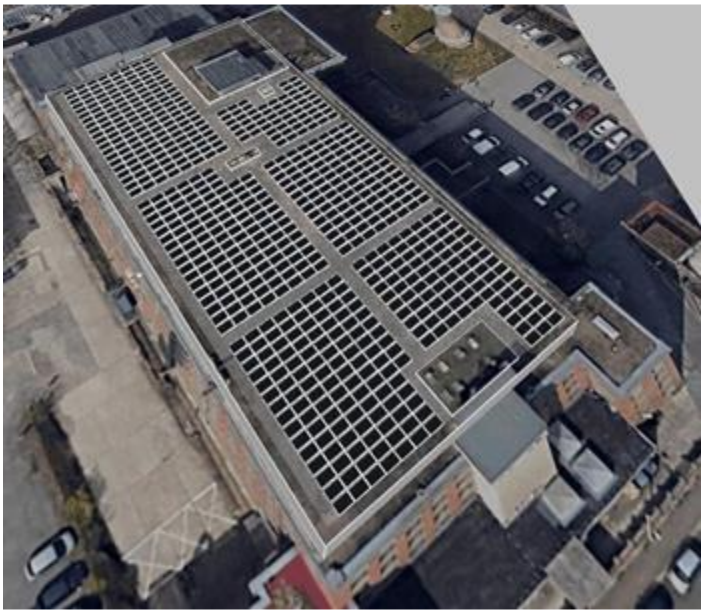

Fig. 12: Simulated PV-Plant geometry for building 18

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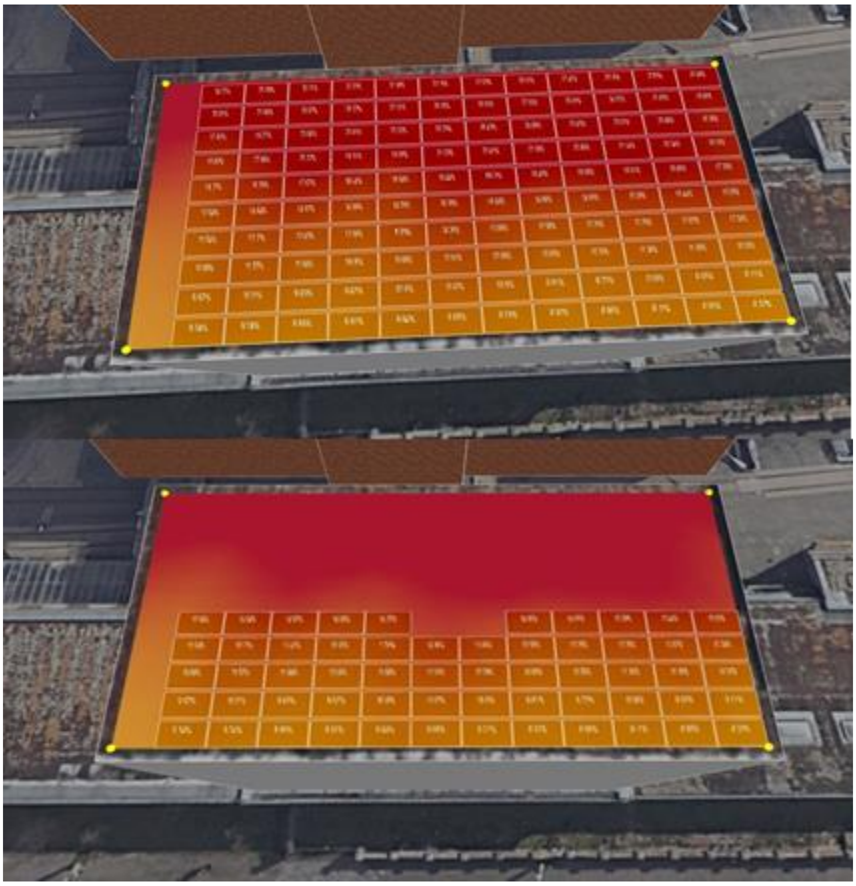
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	 Fig. 13: Yield analysis for simulated plant geometry on building 4	
Roles and responsibilities	**CEN: Task leader**	
Schedule	M1-M6	The concept, design, and planning for the installation of the solar PV panels on the roof of a building.
	M6-M12	This phase will prioritise collaborating with partners to agree on the timeline, design, and concept and preparation of the construction through selection of technology and contractors.
	M12-M30	The purchase and installation of the solar PV panels for the Spinnerei block.
	M18-M30	The purchase and installation of all monitoring equipment i.e., sensors and meters, installed and fine-tuned.
	M24-M36	Parametric configuration of the sensors and monitoring equipment, and the initial data collected from the system.

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	M30-M36	Analysis of the initial database and initial data to ensure configuration and reliability of the system and equipment.
	M36-M60	Introduction of action L2-1 Present a working diagram of the entire energy system for interested affiliated city consortiums. To include the solar PV panels and an explanation of the sensors and equipment used to monitor the energy system's combined heat and power station and of the electrical and heat grid stabilisation.
Milestones/ Tangible outcome	M12	Concept confirmed and aligned with partners
	M30	The installation of the solar PV panels
	M30	The installation of the technical components
	M30	Documentation of fixed parameters for the equipment
	M36	A working database is developed and operational
Deviations from initial plan (GA)	Instead of buildings No. 6, 9, 10, 11 we are now focussing on buildings No. 14 and 18. Because these buildings will fit the most for implementing our tasks and actions.	
New deviations into plan (as compared to D4.1)	Building evaluation for PV-plant location which includes statics, shadowing, and installable capacities No further deviations are foreseen except those due to Covid-19 which include difficulties in tenant contact and the availability of specialised service providers	
Progress made until M24	• Technological concept for the PV-plant is finalised including plan for replication on-site • Procurement phase for central PV-plant components is finalised • Manufacturers for the storage component are being selected • Nearly all Smart meters are installed, first integrations in Energy-Management-Software • Procurement phase for Load Management System is finalised	

Action **L2-2**	**Balancing the micro grid against the citywide virtual power plant. This aims at selling energy when demand is exceeded in the micro grid and vice-versa. This action will be closely linked to the business models based on blockchain technology.**
Demonstration plan	In SPARCS project, LSW is going to develop a citywide virtual power plant. A Virtual Power Plant consists of a group or network of decentralised energy generation technologies such as solar PV

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	panels connected to flexible power consumers and energy storage capacity. One part of this system is an interconnection to the energy microgrid at Spinnerei block to buy and sell energy. CEN will install energy monitoring equipment at the transformation station near the Spinnerei block to measure the energy flow between and the Leipzig citywide energy grid. LSW will establish a continuous exchange of information regarding extra energy supply or demand and prices for this energy and will process and bill these transactions.	
Roles and responsibilities	**CEN: task leader** LSW: responsible to deliver an interface for peer-to-peer energy trading	
Schedule LSW	M26	Integration of electrical substation at Spinnerei block to realise a peer-to-peer trading and collect real time data from it. Data processing and aggregation for further analysis Calculate forecasts of energy demand for this substation Simulation of energy trading between two distinct energy systems (microgrid and virtual power plant) Simulation of grid behaviour and other related points of interests etc.
	M29	Definition of an interface for data exchange between microgrid and city-wide virtual power plant
	M36	Start of peer-to-peer trading Billing of energy transactions is implemented
	M36	Consideration of the micro network in optimising the city-wide virtual power plant Automate energy trading and information exchange, perhaps by using blockchain
Milestones/ Tangible outcome	M18-M24	Letter of Intent to confirm which part of the energy network is included in the balancing of the microgrid and the virtual power plant.
	M32	Successful installation, qualification, and maintenance plan established for the equipment.
	M36	Present a working diagram of the entire energy system for interested affiliated city consortiums. To include the solar PV panels and an explanation of the sensors and equipment used to monitor the energy system's combined heat and power station and of the electrical and heat grid stabilisation.

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Deviations from initial plan (GA)	Instead of buildings No. 6, 9, 10, 11 we are now focussing on buildings No. 14 and 18. Because these buildings will fit the most for implementing our tasks and actions.
New deviations into plan (as compared to D4.1)	• Corona restrictions lead to a delay in P2P Data-Exchange-Interface development
Progress made until M24	• Letter of Intent (LoI) between LSW and CEN to realise peer-to-peer trading is negotiated and provides a bureaucratic base for all further action related tasks. • Energy monitoring for the transformation station is installed

Action L2-3	**Analyzing and integrating Energy storage solution with bulk batteries to balance production and consumption within the micro-grid.**	
Demonstration plan	In order to achieve the effective balancing of the microgrid against the VPP in Leipzig, energy storage solutions are needed. This means installing an electrical battery which can be used as a buffer to store energy, for example from photovoltaics, when overproduced and from CHP, when the price of electricity is low. The batteries will be used to cover the energy demand during high peak demand periods, allowing the CHP to feed electricity to the city network. During days with high solar irradiance PV energy will be fed into the grid when not needed in the microgrid. This ability to act as a buffer is essential to the success of task L2-2.	
Roles and responsibilities	**CEN: task leader**	
Schedule	M1-M6	The concept, design, and planning for the installation of an energy storage system
	M6-M24	This phase will prioritise collaborating with partners to agree on the timeline, design, and concept and preparation of the construction through selection of technology and contractors.
	M18-M30	The purchase and installation of the battery system in the premises of the Spinnerei block
	M18-M30	The purchase and installation of all monitoring equipment i.e., sensors and meters, installed and fine-tuned.
	M24-M36	Parametric configuration of the sensors and monitoring equipment, and the initial data collected from the system.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

SPARCS

	M30-M36	Analysis and evaluation of the initial data base and initial data to ensure configuration and reliability of the system and equipment.
	M36-M60	Introduction of action L2-3 Present a working diagram of the entire energy system for interested affiliated city consortiums. To include the Solar PV and bi-directional charging of an electrical car which demonstrates the impact on the stabilisation of the electrical grid.
Milestones/	M24	Concept confirmed and aligned with partners
	M30	The installation of the battery
	M30	The installation of the technical components for the monitoring system
	M36	Documentation of fixed parameters for the equipment
	M36	The working database is developed and operational
Deviations from initial plan (GA)	Instead of buildings No. 6, 9, 10, 11 we are now focussing on buildings No. 14 and 18. Because these buildings will fit the most for implementing our tasks and actions.	
New deviations into plan (as compared to D4.1)	• Manufacturers for storage solutions and civil engineering companies were difficult to contact which leads to deviations in the conception of the bulk battery and in planning of necessary construction ground analysis and works. • Load management as critical path for component integration sets timeline (load management providers differ in compatible components which leads to restrictions for e.g., the procurement of the bulk battery). This has to be clarified before the storage unit can be selected. • Sensor and meter equipment can only be purchased and installed after the bulk battery is selected. • Timetable is set and deadline is not affected by aforementioned deviations.	
Progress made until M24	• Planning process for physical and digital integration of central system components such as generators, storage and consumers are finalised • Detailed information about the interface between storage and load management software • Advanced procurement process for storage (linked to load management software)	

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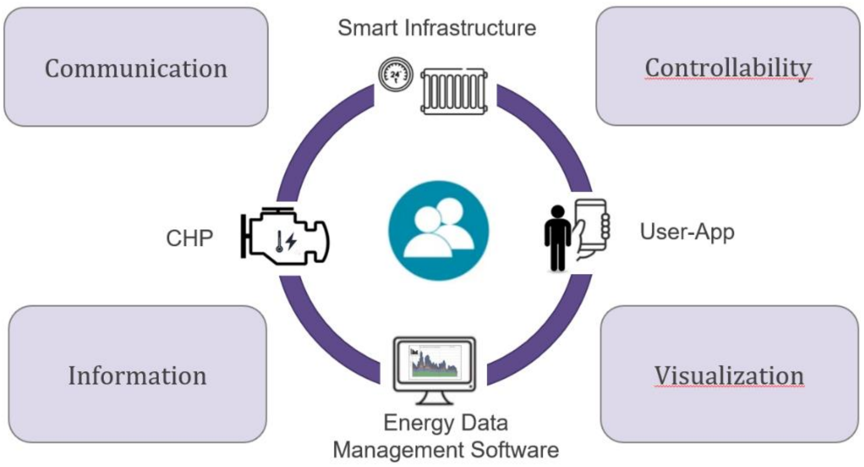
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Action L3-1	Coupling the heating needs with the load profile of the microgrid and taking into account the specifics of the historic building, which function as a heat buffer.
Demonstration plan	The aim of this task is to significantly improve the overall energy performance and energy efficiency of Building No.14 (depending on new space for SpinLab), as well as optimise energy consumption, by installing innovative new technologies in energy management, storage solutions and RES integration. The main task is the installation of smart equipment which will be capable of reacting to the changing heating needs of Building No. 14 and forecast the future needs of the tenants to ensure that energy waste is minimised and that the microgrid can adapt to the changing needs over the seasons proactively with the help of the building itself as a heat buffer. This means that the supply of energy is always matched to the heating needs of the tenant spaces. This helps to save energy in comparison to standard heating systems with standard settings, where for example the supply is orientated to the external temperatures of the heated area. The scheme of the planned core functions of the heating system is shown in Fig. 14 while Fig. 15 shows Building No. 14 from the outside.  Fig. 14: Scheme of the planned heating system

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	 Fig. 15: Building No. 14 from the outside	
Roles and responsibilities	**CEN: task leader**	
Schedule	M1-M6	The concept, design, and planning for the installation of sensors in Building No. 14.
	M6-M24	This phase will prioritise collaborating with partners to agree on the timeline, design, and concept and preparation of the construction through selection of technology and contractors.
	M18-M26	The purchase and installation of the sensors in building No. 14 in the Spinnerei block.
	M24-M30	Parametric configuration of the sensors and monitoring equipment, and the initial data collected from the system.
	M30-M36	Analysis of the initial database and initial data to ensure configuration and reliability of the system and equipment.
	M36-M60	Introduction of action L3-1 A diagram of an application integrated and running for tenant energy needs which also provides feedback as to how and when they change their consumption behaviour. The application would demonstrate how the information of consumption behaviour within a heating grid will help to increase flexibility in heat

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

		supply, as a prerequisite for energy management and transformation strategy. The application will use data from the sensors to visualise the energy use and energy impact on the microgrid.
Milestones/ Tangible outcome	M30	Installation, qualification of the sensors.
	M36	Database qualification complete
Deviations from initial plan (GA)	Instead of buildings No. 6, 9, 10, 11 we are now focussing on buildings No. 14 and 18. Because these buildings will fit the most for implementing our tasks and actions.	
New deviations into plan (as compared to D4.1)	• Building number 14 instead of number 7/11, after an on-site heating system study showed the infrastructure there to be particularly suitable for separately regulating individual tenant areas. This supports the focus on controllability within the planned heating network. • Corona resulted in several delays due to remote meetings and increased logistical effort e.g., for on-site meetings with tenants and service providers.	
Progress made until M24	• Tenant's participation ensured • Procurement process for smart thermostats finalised • Analysis of local heating section completed • Installation of thermostats and associated system components	

Action **L3-2**	**Provide user-interface with air quality info and implicit demand control: through direct feedback and consumption overview as well as recommendation for the tenants behaviour, the demand is expected to be lowered.**
Demonstration plan	In the prototype building 18, there will be monitors and application installed to allow the tenants direct access to the information received by the integrated sensors (Action L3-1). The information will include the current temperature of the building, the amount of energy consumed over various timescales, total share of renewable energy used and air quality. The application will be used for the tenants to respond to the information by providing feedback through the application. A picture of the applications mockup is listed below in Fig. 16. The displayed interface is based on the usage of smart meters largely installed on-site which are transmitting information digitally to the energy management system. A version of an old meter in form of an impeller counter is shown in Fig. 17 in contrast to a new smart meter which supports the required remote readability.

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

In this context, there will be an evaluation for inclusion of the CENERO office space on-site for the presentation of additional information based on the models below.

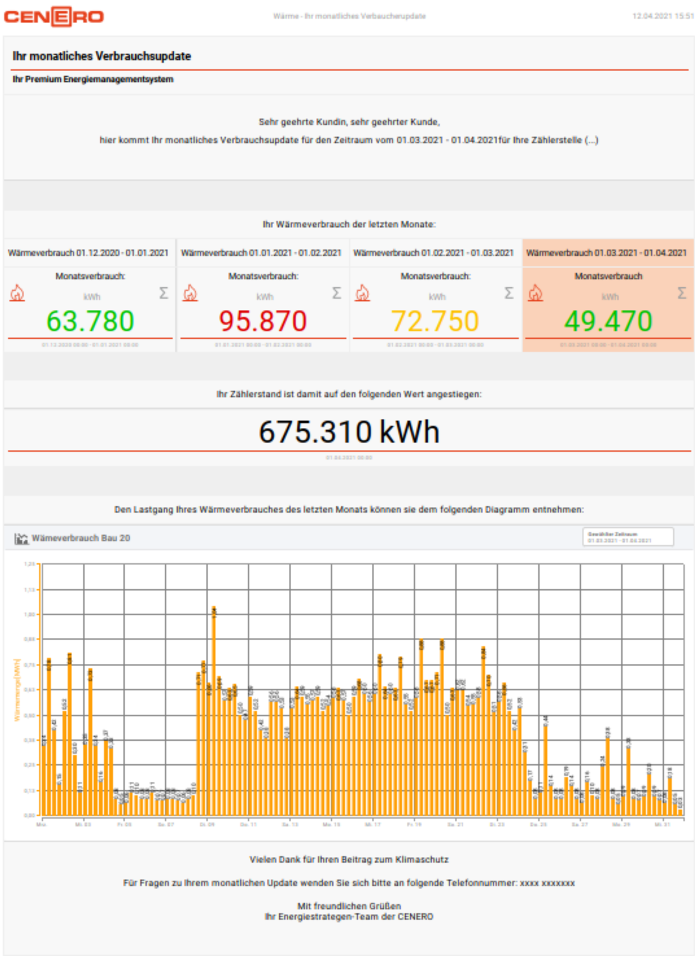

Fig. 16: Mockup of the tenants consumption information interface

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	 Fig. 17: Old impeller counter (left) and new smart meter (right) for heat consumption measurement The action is linked to T21-1 by Seecon.	
Roles and responsibilities	**<u>CEN: task leader</u>**	
Schedule	M1-M6	The concept, design and planning for the use of tablets in building No. 18.
	M6-M12	Collaborate with partner Seecon to agree the timeline for informing tenants through a structured event with open dialogue
	M12-M24	Development of a detailed concept for the implementation and connection of the online application to the heating structure of building No.14.
	M24-M30	Configuration of the sensors and monitoring equipment (L3-1), for monitoring causes and installation of the necessary software to run feedback portals and visualise data.
	M30-M36	Analysis of the application functionality, initial feedback from tenants and tenant information events. Tenant feedback event takes place.
	M36-M60	The application is installed and ready to be used in building No. 14. There will be a prototype showroom in building 18. Demonstration of action L3-2

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

		Present a working diagram of the entire energy system for interested affiliated city consortiums. To include the solar PV panels and an explanation of the sensors and equipment used to monitor the energy system's combined heat and power station and of the electrical and heat grid stabilisation.
Milestones/ Tangible outcome	M18-23	Tenant Information Events
	M30	Installation of screen and monitoring application in Building No. 18
	M33	Tenant Feedback Event
Deviations from initial plan (GA)	Instead of buildings No. 6, 9, 10, 11 we are now focussing on buildings No. 14 and 18. Because these buildings will fit the most for implementing our tasks and actions.	
New deviations into plan (as compared to D4.1)	Building No. 14 instead of No. 7/No.11 due to the better controllability of the house-related heating structure. In Building 14 the heat supply of different tenant areas can be separately shut down due to exclusive usage of those.	
Progress made until M24	• Hardware is procured and broadly installed • Drivers for software connection of hardware are programmed	

2.4 Efficient and human-centric social housing blocks (WSL, SUITE5)

The Duncker district is located in Leipzig West, in proximity to the Spinnerei block. Right next to the Lindenauer Hafen, which is an outstanding urban renewal program, that brings new life to a vestige harbour in Leipzig West. it is a melting-pot district with a stock of historic buildings. The district encompasses 31 buildings with a living space of 65.000 m^2 and includes multiple units, which are priced for social housing needs. With its active and involved tenants, the district is the ideal testing ground for the proposed user-centric control, via a dedicated platform that promotes active involvement of citizens, to optimize the flow of energy.

Within the district, there are seven buildings with 300 apartments owned by LWB, which are supplied by district heating. These buildings will be our prototype area. All apartments will be equipped with net (smart) metering technology for thermal energy. Within the district, a novel solution for optimising thermal energy consumption through the implementation of human-centric thermal demand response programs (implicit demand response) operated by WSL will be demonstrated. Important for social housing is the optimisation of the utilities. For this reason, WSL will implement a dynamic thermal heating controller, which optimizes the heat production based on information regarding the real thermal need of the building (demand-centric).

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Fig. 18: Duncker district

In addition, the heat generation of the solar plant will be examined and compared (LSW) to the heat consumption of the prototype buildings in a sequential manner relative to the potential for different tariffs from a district heating supplier.

The aim of this task is to properly configure and deploy an innovative solution for optimising thermal energy consumption through the implementation of innovative human-centric thermal demand response programmes (implicit demand response) in selected residential building blocks operated by WSL. These housing blocks include social housing flats, which are available to low- or no-income tenants. The optimisation

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

of dynamic consumption as a cost-saving measure is of particular interest in social housing blocks.

The long-term goal is to configure and deploy an innovative solution for optimising thermal energy consumption through innovative human-centric thermal demand response programs.

L4-1: Personalised informative billing: Appealing applications and interfaces will be made available to consumers, allowing them to better understand their consumption patterns, their energy waste, and their flexibility to shift their consumption toward avoiding increased energy charges.

L4-2: Demonstration of dynamic thermal energy tariff schemes, which will be made available to consumers and will engage them in action toward altering their energy consumption patterns and shifting them away from peak periods. Exposure of consumers to real-time energy prices will stand as the first action of engagement in energy saving actions.

L5-2: Human-Centric energy management and control decision support: SPARCS will focus on the definition of detailed and accurate comfort profiles, which will comprise the basis for the subsequent definition of context-aware thermal demand flexibility profiles. Such holistic flexibility profiles will comprise the basis for human-centric optimisation recommendations to be offered to consumers, thus providing targeted guidance on control actions (to be performed manually) for shedding or shifting the operation of thermal loads within buildings, toward significantly reducing energy costs, while safeguarding indoor environment quality (IEQ) and without compromising the building occupants' comfort. Air quality information through user-interface will be provided to Action L5-1, SUITE5, WSL).

L4-3: Appropriate normative comparison mechanisms will be applied to help consumers position themselves against best-performing peers and, thus, better quantify their energy bill savings potential, through utilisation of their energy consumption flexibility

SPARCS measures for efficient and human-centric social housing blocks are:

Action **L4-1**	**Personalised Informative Billing: appealing applications and interfaces will be made available to consumers, allowing them to better understand their consumption patterns, their energy waste and their flexibility to shift their consumption toward avoiding increased energy charges.**
Demonstration plan	• Application is LWB-App "Mein LWB" – existing application of the property owner LWB – NEW will be visualisation of the consumption and annual heating bill • Visualisation of monthly consumption (thermal + hot and cold water) • Application hosted by PROMOS • L4-4 requirement

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	• L4-3 included in application • ULEI is conducting a consumer survey (L21-4) Application developed by Suite5 will include: • Providing an overview of thermal consumption, annual billing information, and environmental impact per apartment • Visualisation of historical energy consumption data, billing and environmental impact • Based on metering equipment to be made available, display a distribution of thermal consumption between rooms • Based on the sensors to be made available, apartment and room specific information, such as temperature, humidity, etc. The schedule of the Suite 5 application aligns with the schedule of actions L5-1 & L5-2	
Roles and responsibilities	**WSL, SUITE5**	
Schedule	M1-M6	Idea and how can it be realised. How can the consumers be integrated (communication-strategy)?
	M6-M20	Evaluation of prototype and first tests (laboratory) integrate into the application and connect the data to the meter-management. Including heating bill calculating software and to the tenant's personal data / application ID clarify communication-strategy and first test buildings (preliminary action L4-4)
	M18-M20	Start of communication with tenants
	M20	Field-test - rollout with first building(s)
	M20-M30	First experience / feedback and optimisation of application and continue rollout in prototype area
	M30-M60	Continue rollout in prototype area and test reproducibility outside prototype area + regular consumer surveys (planned and conducted by ULEI) - L21-4
Milestones/ Tangible outcome	M6	Start evaluation of application
	M20	Tested prototype - application and interface for visualisation of consumption of thermal energy and cold/hot water – ready for field test and rollout Communication with tenants (depending on CoVid19)

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	M36	Complete rollout in demonstration area
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Tested prototype in M24	
Progress made until M24	• New smart heat cost allocators are installed in apartments • "Meine LWB App" design finished and ready for rollout in demonstration area • S5 Application design finished and ready for rollout in the demonstration area • Tenants are informed  Fig. 19: Layout of the "Meine LWB" App	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

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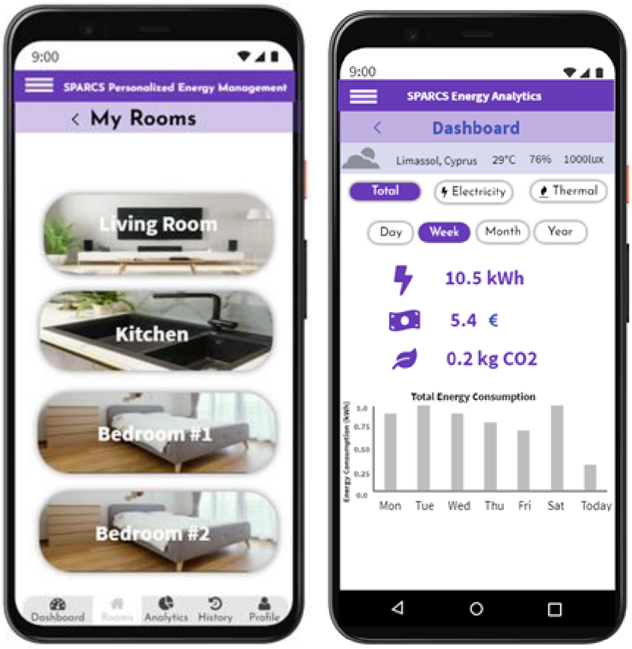
<tr><td></td><td>

Fig. 20: Layout of the “S5” App</td></tr>
</table>

<table>
<tr><th>Action
L4-2</th><th>Demonstration of alternative Thermal Energy Tariff schemes which will be made available to consumers and will allow for understanding their willingness to alter their consumption behaviour under hypothetical scenarios of being exposed to altered tariffs at specific time periods. Exposure of consumers in potential energy prices through the app will be performed in the form of targeted triggers/ surveys and will stand as the first action of engagement in future scenarios for the deployment of dynamic tariffs for energy savings. Alternative tariffs will be created from heating producers, by analysing (offline) demand forecast data, together with production costs (Action L4-2, SUITE5, WSL)</th></tr>
<tr><td>Demonstration plan</td><td>• Generate frequent detailed information of thermal need in apartments for creation of real-time dynamic system and planning and to install new heat cost allocators (sensors) in prototype building which allow the transmission of more frequent data (every 15 min) and information about temperature in the apartments (every 15 min).
• Connect to production information (heating system) to generate a forecast as an initial step and to monitor the system in real time in the second step
• Establish building connectivity for collecting the meter data and the data from the heating system and to bring them together on one platform (raw data) incl. interfaces to transfer data</td></tr>
</table>

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	• Automatic optimisation of central thermal energy production in the basement • Connecting the time resolved consumption data of the building / apartments to the time resolved production data of the solar thermal system Application developed by Suite5 will include: • Forecasting mechanism for the operator/producer of thermal energy in connection to the thermal energy production of the solar thermal system • Push of personalised notifications to local consumers to modify their consumption according to the adapted production plan, facilitating energy cost reduction for both sides involved and minimisation of CO_2 emissions due to the shift of consumption to periods of high CO_2-friendly production. • Producer based on the analysis will build alternative dynamic tariff schemes that could be potentially applied towards their customers. Through the application, consumers will be (at specific time periods) surveyed with regards to their willingness to modify their consumption to indirectly test and validate the applicability and acceptance of such alternative dynamic tariff schemes. • The schedule of the Suite 5 application aligns with the schedule of actions L5-1 and L5-2	
Roles and responsibilities	**WSL, SUITE5**	
Schedule	M1-M6	Concept and how it can be implemented, how can the consumers be integrated (communication-strategy), clarify demonstration building in prototype area (Duncker district)
	M6-M10	Analyse test building and the local heating station, how can it be optimised and what is needed (Preliminary action L4-4)
	M10-M12	Start installation of required devices (sensors, new heat cost allocators in apartments (depends on CoVid 19) and in the building/basement (preliminary action L4-4) in laboratory situation to test communication
	M10-M14	Collect and analyse initial data and integrate these data in laboratory situation
	M14-M22	Rollout of the sensors and system in demonstration building and collect first real time data from demonstration building with new sensors and connect

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

		it to the production data of the solar thermal system (real-time data or simulated data)
	M18-M26	Automate the optimisation and regulation of dynamic heating in laboratory situation and rollout in the demonstration building
	M26-M60	Optimisation and regulation of the dynamic heat station controller and analysis of the real-time consumption data with the production data (solar thermal energy) to create dynamic tariff schemes and input for consumption behaviour
Milestones/ Tangible outcome	M6	Start evaluation of dynamic heating controller
	M12	Sensors tested (in laboratory depending on CoVid19)
	M18	First full collection of data based on heating period
	M22	Finish rollout in prototype buildings and automate optimisation with dynamic information of thermal need in the apartments/building
	M60	Complete data analyses regarding energy savings
Deviations from initial plan (GA)	As per amendment to be changed to: Introduction of virtual alternative thermal energy tariff schemes which will be made available to consumers within the application and will allow them to understand their willingness to alter their consumption behaviour under hypothetical scenarios of being exposes to altered tariffs at specific time periods For example, scenario consumption matched to heat production of solar thermal plant or alternative energy production. The application will ask the consumer to change their behaviour based on hypothetical scenarios - this applies to heat as well as to electricity (L12-1). The application is also connected with L4-1, L4-3, L5-1 and L5-2 Also, a heat forecast will be created by analysing the consumption data to optimize the heat consumption and the heat demand in the building/apartments.	
New deviations into plan (as compared to D4.1)	See amendment	
Progress made until M24	• Building selected – Beckerstr. 52-56 (27 apartments) • Special smart heat cost allocators/sensors are installed in apartments and the building	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	• Building connectivity and data platform is installed • S5 Application design finished and ready for rollout in the demonstration area.
Additional info	L5-1 and L5-2 will be carried out in the same demonstration building.

<table>
<tr><th>Action
L5-1 & L5-2</th><th colspan="2">Human-Centric Energy Management and Control Decision Support: SPARCs will focus on the definition of detailed and accurate comfort profiles, which will comprise the basis for the subsequent definition of context-aware thermal demand flexibility profiles. Such holistic flexibility profiles will comprise the basis for human-centric optimisation recommendations to be offered to consumers, thus providing targeted guidance on control actions (to be performed manually) for shedding or shifting the operation of thermal loads within buildings, towards significantly reducing energy costs, while safeguarding indoor environment quality (IEQ) and without compromising building occupants’ comfort.</th></tr>
<tr><td>Demonstration plan</td><td colspan="2">• Should be done in the same demonstration building as L4-2.
• Based on more frequent information out of apartments, the application (developed by Suite5) returns information to the consumers

Application developed by Suite5 will include:
• Creation of accurate comfort profiles
• Creation of targeted recommendations and guidance on control actions
• Based on the equipment available, provision of personalised information
• Verification and adaptation of comfort profiles and preferences
The schedule of the Suite 5 application aligns with the schedule of actions L4-2, L4-3.</td></tr>
<tr><td>Roles and responsibilities</td><td colspan="2"><u>SUITE5, WSL</u></td></tr>
<tr><td rowspan="2">Schedule</td><td>M1-M6</td><td>Initial set of requirements based on the contract under analysis. Discussions with the local partners about feasibility.</td></tr>
<tr><td>M6-M8:</td><td>Agreement with the local stakeholders on the final setup and installation of equipment which is feasible.
Alignment of the application development action plan with the equipment installation plan</td></tr>
</table>

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

		Definition of the procedure to acquire the consent from the occupants.
	M10-M12	Deliver specs and models Finalise equipment specifications Make data samples available Local stakeholders to provide historical data Co-creation approach to be followed
	M12-M24	Development of application Delivery of ready to test software by M24
	M24-M28	Verification and testing of the application
	M28-M36	Deployment and validation Replication
	M36-M60	Replication to other buildings
Milestones/ Tangible outcome	M12	Concrete application specifications and mockups
	M18	First full collection of data from the heating period
	M22	Automate optimisation with dynamic information of thermal need in the apartments/building
	M24	Tested and ready to be deployed application
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Schedule: M12-M24, Development of application and delivery of ready to test software by M24 M24-M28, Verification and testing of the application M28-M36, Deployment and validation, replication	
Progress made until M24	• Building selected – Beckerstr. 52-56 – 27 apartments	

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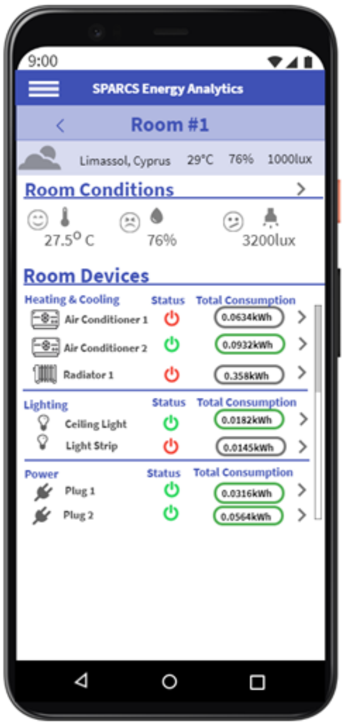
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

- Special smart heat cost allocators/sensors are installed in the apartments

Fig. 21: Special smart heat cost sensors

- Building connectivity and data platform is installed

S5 Application design finished and ready for rollout in the demonstration area



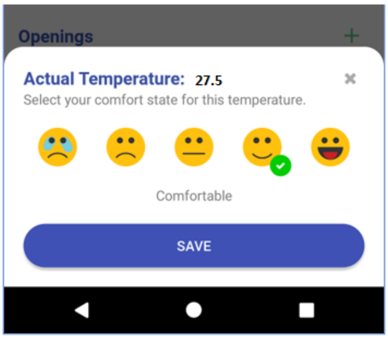


Fig. 22 & Fig. 23: S5 application layout

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	 Fig. 24: S5 application layout
Additional info	L4-2 will be done in the same demonstration building

Action **L4-3**	**Appropriate normative comparison mechanisms will be applied so as to help consumers position themselves against best performing peers and, thus, better quantify their energy bill savings potential, through the utilisation of their energy consumption flexibility.**

Demonstration plan	• Comparison mechanism in the application “Mein LWB” (L4-1)
	• Comparison will be
	    • between consumption of building energy index (kWh/m²) → high or low consumer and
	    • Historical data
	
	Application developed by Suite5 will allow:
	
	• Comparison of consumption with similar peers (neighbours, best/average/worst consumers, etc.) to motivate a change toward lower consumption.
	• Visualisation of the current performance vs similar peers via a ranking.
	• Check of historical performance and rankings achieved
	• The schedule of the Suite 5 application aligns with the schedule of actions in L5-1, L5-2

Roles and responsibilities	**WSL, SUITE5**

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Schedule	M1-M6	Concept and how it can be implemented; how can the consumers be integrated (communication-strategy)
	M6-M20	Evaluation of prototype and initial tests (laboratory), clarification of communication-strategy and first test buildings (preliminary action L4-4)
	M18-M20	Start communication with tenants (field test)
	M20	Field-test - rollout in first building
	M20-M30	Initial experience/feedback and optimisation of application, comparison
	M30-M60	Rollout in demonstration area + regular consumer surveys (planned and conducted by ULEI)
Milestones/ Tangible outcome	M6	Start evaluation of application + integration for mechanism
	M20	Tested prototype - application and interface for visualisation of consumption of thermal energy and cold/hot water + comparison mechanism – ready for field test and rollout Communication with tenants (depending on CoVid19)
	M60	Complete rollout in demonstration area
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	• "Meine LWB App" is ready • S5 Application design completed and ready for rollout in the prototype area – We can add specific screenshots before the M24 Midterm report • S5 application layout:	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

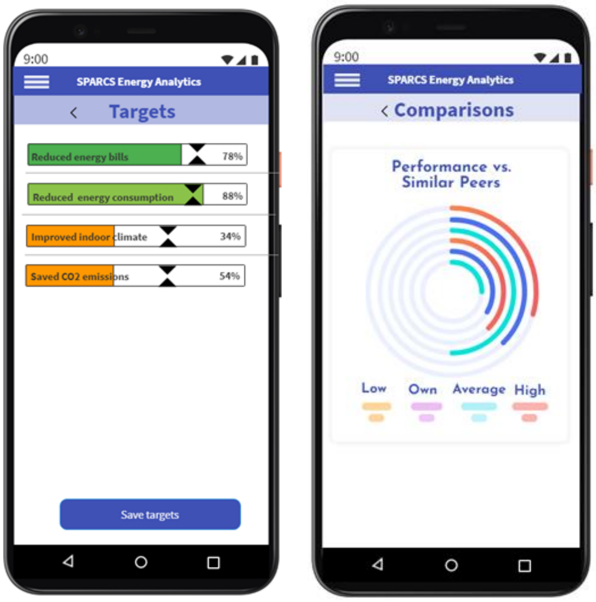
<table>
<tr><td></td><td>

Fig. 25 & Fig. 26: S5 application layout</td></tr>
<tr><td>Additional info</td><td>Integrated in L4-1 and also a part in L5-1 & L5-2</td></tr>
</table>

<table>
<tr><th>Action
L4-4</th><th colspan="2">Improving the connectivity of buildings to allow for integration in the Positive Energy Community and the thermal demand response programmes by means of advanced smart meters</th></tr>
<tr><td>Demonstration plan</td><td colspan="2">Installing internet-spots in basement (WSL “Telemetrie”) to connect energy consumption meter (thermal) (L19-1 – integrate energy and building data in urban data platform of the city) (L9-1 – integration of RES (renewable-energy-systems) in active management or/and the energy producer (heating systems).
Install gateway to collect metering data (heating bill) from the apartments to obtain data for visualisation consumption (L4-1).
Contact Vodafone to establish building connectivity for collecting and merging meter data on one platform (raw data) incl. transfer system</td></tr>
<tr><td>Roles and responsibilities</td><td colspan="2"><u>WSL, SUITE5</u></td></tr>
<tr><td rowspan="2">Schedule</td><td>M1-M6</td><td>Determine demonstration buildings in the demonstration area Duncker district for several actions (L4-1 and L4-3, L4-2 and L5-1 and L5-2) + first gateway tests + gateway strategy and rollout plan</td></tr>
<tr><td>M6-M30</td><td>Rollout of gateways in demonstration area + initial experience and feedbacks</td></tr>
</table>

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Milestones/ Tangible outcome	M30	Complete rollout in demonstration area (for actions L4-1 – L4-3 and L5-1 / L5-2)
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	• All buildings (290 apartments) are ready: • Beckerstr. 2-24 Beckerstr. 26-34 Beckerstr. 36-42 Beckerstr. 44-50 Beckerstr. 52-56 Leidholdstr. 19-25 Morgensternstr. 18-24 • Internet access points are installed in basement • New submetering and sensors are installed in apartments • New wireless data infrastructure and gateways are installed • Potential of LoraWan for demonstration district is assessed together with Stadtwerke Leipzig (L10-1)	
Additional info	Preliminary action for L4-1 – L4-3 & L5-1 / L5-2	

Action L4-5	**Assessment of different tariff schemes, including peer-to-peer tariffs in a collective self-consumption scheme (Mieterstrom model).**	
Demonstration plan	• Assessment of various scenarios/tariff for "Mieterstrom" (PV) from the screen of a housing company (renewable energy) • Economic and feasibility assessment - result used as the basis for L4-6 • Impact on CO_2 reduction	
Roles and responsibilities	<u>**WSL**</u>	
Schedule	M1-M14	Clarify assessment – consider different use cases, calculate different economic cases, talk to different manufactures and innovative start ups
	M14-M24	Finalise the assessment and enter results in study

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Milestones/ Tangible outcome	M24	Study/assessment with recommendation for property owner
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	New legal framework/requirement (renewable energy law = EEG 21) passed in January 2021 and results in changes to "Mieterstrom" and usability of renewable energy for new business models– must be examined by lawyers and changes the economic and feasibility calculation The study will not be completed by M24 – will be completed by M28 This has only an effect on L4-6 (L4-5 is preliminary action) but no effect other actions or goals of the project	
Progress made until M24	• Different models and feasibility options examined • New legal framework (EEG 21) checked • Economic calculation tools are established • Project framework is examined • Risk analyses and recommendation for different models are completed • Expert interviews are completed • Schedule and design of study is completed/customised for compliance with new legal requirements	
Additional info	Preliminary action for L4-6	

Action **L4-6**	**Feasibility study for replication of "Mieterstrom" model and informative billing in all buildings operated by WSL.**	
Demonstration plan	• Replication "Mieterstrom" on the roofs of buildings in LWB and replication of informative billing • Mieterstrom (L4-5): roofs – how much power can be installed – how much CO_2 reduction can be achieved • Informative billing (L4-1): how many apartments – how many gateways are needed = gateway strategy and what is needed for rollout	
Roles and responsibilities	<u>**WSL**</u>	
Schedule	M1-M14	Screening of buildings and collecting data, clustering in different types
	M14-M24	Finalize the study and combine the results L4-5 and calculate the potential electric power and CO_2 reduction

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Milestones/ Tangible outcome	M24	Study with recommendation for property owner
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	L4-5 is preliminary action for L4-6 New legal framework/requirements result in changes to business models and economic calculations Change in L4-5 takes place parallel with L4-6 Study will not be completed by M24 – study will be completed by M28 No effect on other actions or goals of the project	
Progress made until M24	• Summary regarding potential of housing stock of LWB completed • Part I = PV potential/rollout PV ("Mieterstrom") • Detailed analyse of roofs/houses for PV is completed • Tool to calculate the potential, power output and CO2 reduction is completed • Calculation for rollout "Mieterstrom" (L4-5) is completed • Expert interviews are completed • Will be a part of study with L4-5 • Part II = App / rollout • Detailed analyse of buildings / data infrastructure for submetering (heat cost billing) for rollout app is completed	

Action L4-7	**Demonstration of decentralized energy storage within building blocks for optimized self-consumption of locally produced energy (PV)**	
Demonstration plan	Install decentralised energy storage at PV-system with self-consumption (electricity for heating station).	
Roles and responsibilities	**WSL**	
Schedule	M1-M10	Screening of buildings with PV Systems (self-consumption) and collecting data incl. historical data of self-consumption + screening of different calculation of system / dimensioning of storage
	M10-M14	Installation of storage and integration into existing system
	M14-M60	Field test and regular analyses of data for reporting

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Milestones/ Tangible outcome	M10	Calculation of system / storage
	M28	Installation of storage
	M60	Report about storage and self-consumption (incl. economic report)
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Installation of storage capacity within the PV plant will be completed by M28 and not M14. Decision to install a new PV plant in the prototype district and equip it with the storage capacity. No effects on other actions or goals	
Progress made until M24	• Different types of storage capacities and integration models are examined • Different feasibility options for storage capacity within a PV plant examined • Combination with "Mieterstrom" examined and effect of storage capacity is calculated • Roofs in demonstration district checked for compatibility to install PV plant • PV plant calculation is completed • Specific data of PV plant, storage analyses – cost benefit comparison	

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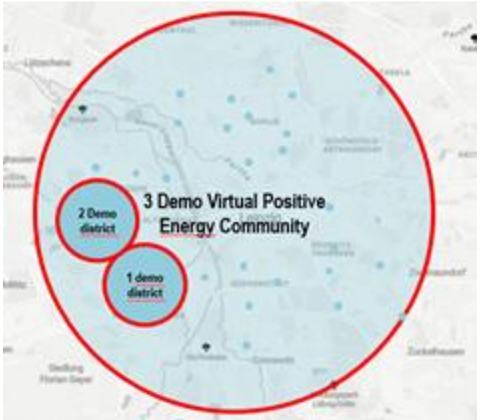
3. ICT AND INTEROPERABILITY IN LEIPZIG LIGHTHOUSE DEMONSTRATIONS

3.1 Introduction to task 4.3 (LSW)

The main goal of T4.3. is to upgrade the interaction between energy producing, storage capacity and the consuming entities from the current level, based on energy network status (district heating and city medium/voltage electrical grid), to a virtually connected community where these entities can exchange energy, based on advanced control functionalities and dedicated communication channels (ICT model, blockchain infrastructure and prediction of the demand).



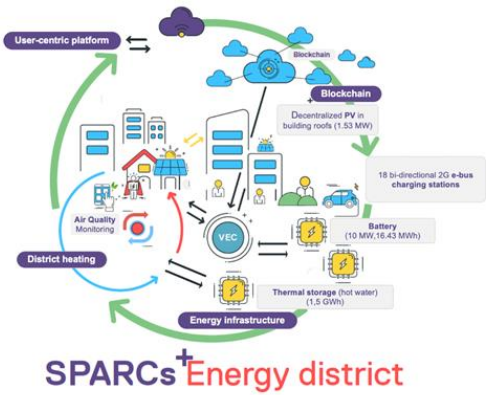


Fig. 27 & Fig. 28: Demo Virtual Positive Energy Community

It is important to note hereby that “Virtual Positive Energy Community” does not refer to the classical understanding of the physical block of densely located building groups in a suburban area but rather to the variety of energy related actions virtually connecting the multiple buildings across the district at various locations. The implemented solutions bundle a multitude of actions that will be partly integrated and implemented in “Leipzig West” as well as among other buildings within and across the city.[2] The annual heat production of the solar thermal plant is approx. 13 GWh/a. The Integration of a solar thermal plant into the district heating system can demonstrate how two former industrial areas (Spinnerei block premises and “Leipzig West”)[3] can benefit from environmentally friendly solar thermal heat produced within the city-built environment. Besides supplying heat to these two districts, the solar thermal plant will supply heat also to the buildings that join the virtually positive energy community and to the city district heating system. Actually, solar thermal plant integration is intrinsically related to virtual positive energy community measures, as the way to optimise control of the various energy systems, which is part of a larger scale vision of the city to connect with consumer energy consumption behaviour.

[2] Notification of PO on necessary change

[3] Notification of PO on necessary change

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

This task includes the introduction of all solutions for a virtual positive energy community in Leipzig, broken down according to the following subtasks:

- Subtask 4.3.2 Virtual power plant and storage capacity solution
- Subtask 4.3.2 Blockchain supported energy services
- Subtask 4.3.3 Integration of Community Energy Storage (CES) and Community Demand Response (CDR)
- Subtask 4.3.4 Ambient ICT Applications and user interfaces for electricity consumption, transformation, and improvement

3.2 Virtual Power Plant and Storage Solution (LSW, LPZ, WSL, CEN, ULEI, SUITE5)

One of the major parts of the subtask 4.3.2 Virtual Power Plant and Storage Solution is: The creation of the future regenerative energy system (RES) from today's point of view will be the orchestration of consumers, producers, prosumers and energy storage capabilities in locally connected, monitored and (self-)steered environments and systems. Besides physical energy related components for generation, distribution and household supply, storage capabilities such as locally installed storage solutions and mobile storage solutions for temporary capacity extensions are necessary components to enhance the district ability of autonomous energy management. To achieve this level of integration and control, an open standard based ICT platform is developed and implemented.

SPARCS measures for solutions for this subtask are:

L9-1 The integration of RES such as controlled or uncontrolled PV with flexible consumers that are interested in an active management of their devices from the outside depending on environmental or economical determinants, flexible prosumers that are interested in an active interaction with CHP, solar plant, geothermal system, their HVAC and grid participants with controllable and actively manageable energy storage systems

L9-2 Study the replication potential of the positive energy community in the replication district Stadtraum "Bayerischer Bahnhof"

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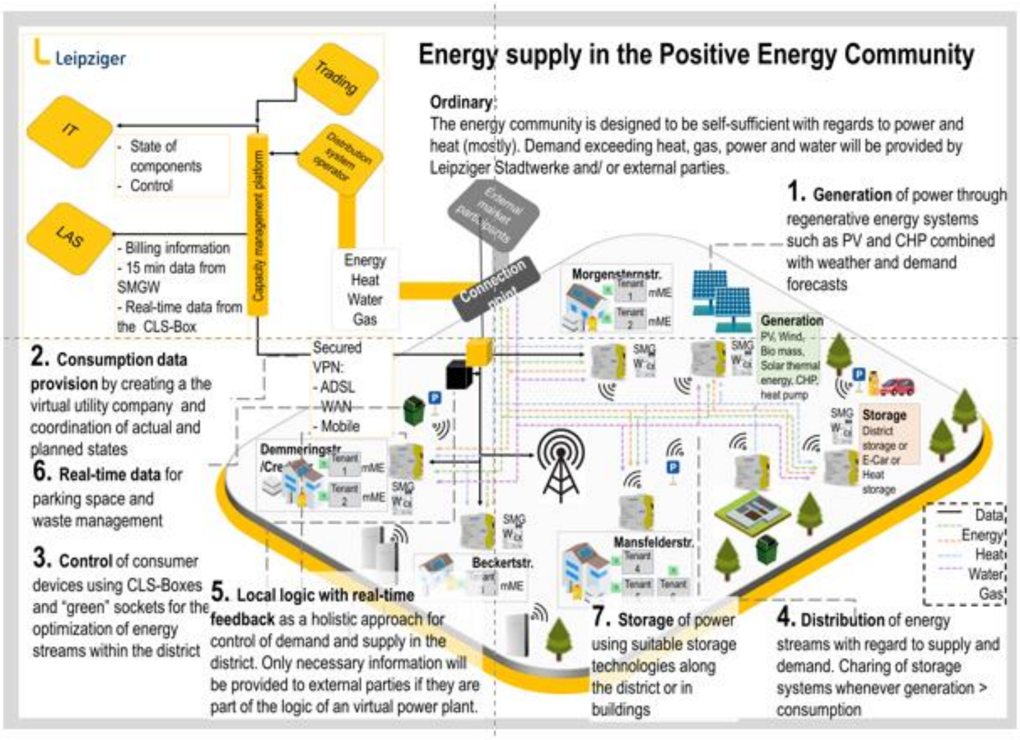

Fig. 29: Energy supply in the Positive Energy Community

L10-1 Integration of standardised sensors and systems within wide area networks (WAN) utilising LoRaWAN. The introduction and usage of LoRaWAN network for connecting sensors and devices through a low energy, low frequency bandwidth will allow for the connection of sensors in cellars and across district with minimum of antennas. This will provide the possibility to integrate a wide area of additional use cases (car parking spot sensors, intelligent waste disposal) throughout the whole demonstration district.

L11-1 Establishment of a distributed cloud-centric ICT System, which enables an intelligent energy management system. In collaboration with WSL, monitored and externally controlled power outlets will be installed in various living units across multiple buildings to prove economies of scale for larger installations on a citywide level. Thereby the power outlets will demonstrate efficient demand side management by monitoring and controlling energy consuming devices.

L11-2 Real-time simulation of the integration of an existing 10 MW battery storage

Action L9-1	**The integration of RES such as controlled or uncontrolled PV with flexible consumers that are interested in an active management of their devices from the outside. depending on environmental or economical determinants, flexible prosumers that are interested in active interaction, CHP, solar plant, the geothermal system, their HVAC and grid participants with controllable and actively manageable energy storage systems.**

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Demonstration plan	This action is the digital foundation of Leipzig's part of SPARCS project. Here LSW delivers all prerequisites for peer-to-peer energy trading, energy communities, a citywide decentralised virtual power plant and the link of heat and power sector. In L9-1 LSW deals with all three demo districts. LSW sets up a link to a microgrid at Spinnerei block (realised by CEN). LSW interacts with the solar thermal power plant for the heat demand and the district in "Leipzig West" and LSW integrates solar power from WSL to the citywide virtual power plant. Fig. 21: Energy supply in the Positive Energy Community gives a short overview over the planned tasks and their impacts. It shows the need to integrate alternative power generation (like solar energy, CHPs etc.) in the virtual power plant of LSW. Together with consumption data, LSW can then balance the energy consumption and generation with respect to ecological and economical restrictions and goals. LSW will work on basis of (almost) real time data and continuously. Therefore, LSW has to implement some real time forecasting and optimisation methods. The integration of an energy storage in this local energy structure will be simulated and LSW aims to demonstrate that the ecological and economic efficiency of the energy supply can be further increased. The citywide virtual power plant is an important part of Stadtwerke Leipzigs Digital Platform ("Digital Platform"). Here LSW stores all data related to asset telemetry and offers micro services for ETL as well as performs analysis of jobs running (and numerous other things). To give a deeper insight into the work, LSW wants to give a short description. For each asset type, LSW needs to realize a prototype to proof its availability to connect with Digital Platform. LSW uses its own hardware, called L.Box, for data sourcing and thus has to find a way to connect the L.Box to this controller of the asset or the meter etc. When this is completed, LSW can rollout the solution to connect all assets of the same kind. The data transmission is standardised; LSW uses MQTT and HTTPS and stores the telemetry data in a time series database. Once LSW has the data, LSW has to clean it up, meaning fill out gaps, cut spikes, and calculate mean values, to have a sound basis for data analysis. Only on this basis, LSW can forecast and optimize the system. LSW assumes that for each kind of data LSW must find a new way to pre-process it (values in watt behave in a different way as in hertz).
Roles and responsibilities	**<u>LSW: task leader, coordinator</u>** WSL: partner for provision of housing units and cooperation

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Schedule	LSW divides the whole action into several work packages. LSW prefers working in an agile software development process, hence LSW describes in the following the goal it wants to achieve at the given time. LSW cannot define all technologies at this point, because some actions are very innovative.	
	M12	Integration of RES part I.1: Define a first interface for data exchange with ULEI, WSL, LWB etc. Calculate first energy generation forecast for each single solar power plant
	M15	Integration of RES part I.2 Data aggregation
	M18	Integration of RES part II.2 Forecasting of heat demand and supply Piloting remote control/ asset steering for demo district “Leipzig West” Simulation I
	M21	Integration of RES part III.1 Forecasting III: electrical power Data aggregation Data Exchange II
	M24	Integration of RES part III.2 Integration of RES part IV: LoRaWAN (see L10-1) Integration of RES part V Expand remote control to electrical devices: Optimisation I
	M27	P2P-Trading I Automation I
	M30	Implementation of an interface and mechanisms for communication between e-bus-charging station and energy community
	M33	Asset network part I Billing II Automation II
	M36	Integration RES V solar thermal power plant Optimisation II
Milestone/ Tangible outcome	M15	(all) PV plants from LWB/WSL are integrated
	M18	Heat supply data from “Leipzig West” is available Frontend/Website for plant monitoring Report for KPIs

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Deviations from initial plan (GA)	None
New deviations into plan (as compared to D4.1)	None
Progress made until M24	The share of renewables at M24 is 85%. The link between the SMA-PV-plants and the LSW data center has been established. Non- SMA-PV plants are being integrated with trough local controllers. Data aggregation and optimisation is being performed based on heating data.

<table>
<tr><th>Action L10-1</th><th colspan="2">Integration of standardised sensors and systems within wide area networks (WAN) utilising LoRaWAN. The demonstration and usage of LoRaWAN Network for connecting sensors and devices through a low energy, low frequency bandwidth will allow for the connection of sensors in cellars and across district with minimum of antennas. This will provide the possibility to integrate a wide area of additional use cases (car parking spot sensors, intelligent waste disposal) throughout the whole demonstration district.</th></tr>
<tr><td>Demonstration plan</td><td colspan="2">In Leipzig West, the project partners plan to realize a smart district. That means collecting data, using the IoT device of Leipziger Stadtwerke (L.Box) for assets of energy consumption and generation. For some other kind of data, this hardware is not useful (e.g., waste disposal, car parking spot sensors, weather data).

Planning to build up a LoRaWAN net in the district of Leipzig West and collect data, which is needed for some municipal use cases (waste disposal, public parking spots or air quality) and energy related use cases (measure weather data, such as air humidity, radiation). On basis of this data, it is possible to design models for forecasting air quality and energy usage or generation or set up other smart services, for example parking spot management for third parties.</td></tr>
<tr><td>Roles and responsibilities</td><td colspan="2"><u>LSW: task leader</u>, responsible for data sourcing hardware, provides a LoRaWAN net in the area of Leipzig West, provides relevant data to third parties (e.g., city of Leipzig, LWB)</td></tr>
<tr><td rowspan="2">Schedule</td><td>M18</td><td>Workshop with project participant to define relevant use cases</td></tr>
<tr><td>M21</td><td>Build and test prototypes</td></tr>
</table>

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	M24	• Roll out several sensors • Roll out LoRaWAN-net in the demo district area in Leipzig West
	M27	Use data and provide data to third parties
Milestone/ Tangible outcome	M24	LoRaWAN-net has been established and first sensor are working
	M27	Use data from LoRaWAN sensor for services and other purposes
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	The LoRaWAN-Gateway was tested successfully. The gateway was installed in the Dunker district. Connectivity to all seven meters is given. Currently the permanent installation is being prepared.	

Action L11-1	**Establishment of a distributed cloud-centric ICT System, which enables an intelligent energy management system. In collaboration with WSL, monitored and externally controlled power outlets will be installed in various living units across multiple buildings to prove economies of scale for larger installations on a citywide level and with that demonstrate efficient demand side management by monitoring and controlling energy consuming devices.**	
Demonstration plan	LSW intends to develop an innovative solution “zero carbon community” (externally controlled power outlet) that enables customers to actively participate in the energy market. It would be necessary to install the solution in the housing units. One goal of the solution is, that the user can increase the share of RES for their energy consumption. During the project time, LSW plans to test and modify the solution according to customer’s needs. WSL/LWB supports LSW in the selection of possible customers in their housing units.	
Roles and responsibilities	**<u>LSW: task leader</u>** WSL: partner for provision of housing units and cooperation	
Schedule	M1-M9	Analysis of the urban ecosystem of the city of Leipzig Development and evaluation of various technical variants

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	M9-M12	Market analysis of the individual business models Preparation of the data and information regarding a practical implementation
	M12-M18	Preparation of the data and information regarding a practical implementation
	M16- M22	Creation of a detailed concept including the design of the gamification
	M18-M25	MVP (minimal viable product) development
	M18-M26	Testing
	M29-M36	Roll Out Green Plugs
Milestone/ Tangible outcome	M12	Analysis, evaluation and preparation of business models
	M14	Market
	M18	Conception
	M30	Implementation
	M34	Product is established in the market
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

<table>
<tr>
<td>Progress made until M24</td>
<td>

- Implementation of the detailed concept of L-ZERO
- Development of the software for the Demand Response
- Implementation of a digital ecosystem for the integration and mapping of the “green plugs”
- Preparation / design of the use cases of the "green plugs"

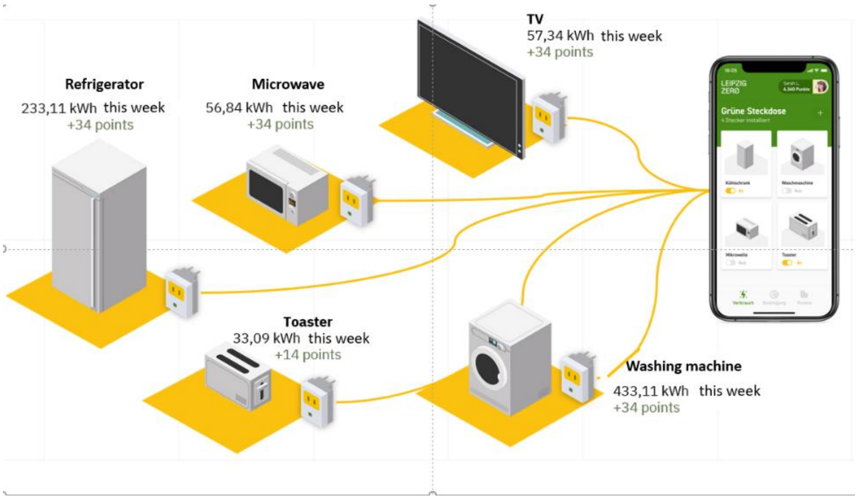

Fig. 30: Mapping of various applications that can be controlled via the ZERO app.

Fig. 31: Mockups Zero App
</td>
</tr>
</table>

Action L11-2	Real-time simulation of the integration of an existing 10 MW battery storage
Demonstration plan	Renewable energy systems mostly comprise a highly volatile energy generation. Wind and solar energy are not always available and LSW has to find solutions to fill these energy supply gaps. Big electrical storages seem to be an answer, but it is not totally clear, how to integrate them in an energy system. LSW will investigate in this action to find out whether it is possible and useful to integrate a battery storage in the citywide virtual power plant by simulating the overall behavior.
Roles and responsibilities	**<u>LSW: task leader</u>**

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	BMW: associated partner, has to deliver relevant information about batteries	
Schedule	M24-M30	Get in touch with BMW to get technical restrictions of the battery Set up a simulation environment Simulate energy production, consumption and possibilities to store energy surplus in a battery (charging) or use extra needed energy from this battery (discharging) Integrate simulation model in real-time energy system as an additional component Evaluate technical, economic and ecological benefits of integrating a 10 MW battery (e.g., for the purpose of grid stabilisation or maximising the usage of renewable energy in a local energy system)
Milestone/ Tangible outcome	M30	Additional software component in city-wide virtual power plant integrated in the real-time stream (could be used for theoretical optimisations or simulations of the energy system) Reporting advantages and disadvantages of using this battery
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	Communication with the BMW head of department is established.	

Action L9-2	**Study the replication potential of the Positive Energy Community in the replication district "Stadtraum Bayerischer Bahnhof"**
Demonstration plan	Study the replication potential of the Positive Energy Community in the replication district "Bayerischer Bahnhof". Action is linked to L19-2 Identify requirements how buildings can be integrated into the positive energy community (LEI, LSW, WSL) and T4.7: Replication and exploitation preparation
Roles and responsibilities	**<u>LSW: task leader</u>** LPZ: link to L19-2 and T4.7 Replication and Exploitation preparation

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Schedule	M24-M33	Analysis of the districts for similarities / differences to the reference project
	M34-M35	Examination of transferability to "Bayerischer Bahnhof"
Milestone/ Tangible outcome	M36	Creation of replication patterns for other quarters
Deviations from initial plan (GA)	Due to change of replication districts in the amendment process the scope of the actions is adapted to "Study the replication potential of the Positive Energy Community in the replication district "Stadtraum Bayerischer Bahnhof".	
New deviations into plan (as compared to D4.1)	Title change in the amendment process to "Study the replication potential of the Positive Energy Community in the replication district "Stadtraum Bayerischer Bahnhof".	
Progress made until M24	Action will start in M24.	

3.3 Blockchain supported energy services (LSW, WSL, CEN)

It will be demonstrated how blockchain technology helps to tackle the core challenge when it comes to energy distribution: the integration of millions of small-scale distributed energy resources in an energy system that is currently not designed for having a large amount of individual market participants. Focus of the demonstration activity will therefore be on the conceptualisation and application of a public blockchain for transactions between energy consumers, producers, service providers and grid system operators in a microgrid. The task includes:

Action L17-1	**Feasibility study on the coordinating role of blockchain in local market dynamics between generating plants and consumers and methods on how meter point operation and meter data management might be done more efficient and cost effective via blockchain.**	
Demonstration plan	Carrying out a feasibility study on this specific topic.	
Roles and responsibilities	**LSW: task leader**	
Schedule	M1-M25	Feasibility study

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Milestone/ Tangible outcome	M25	Feasibility – based on the following points: • Feasibility study on the coordinating role of blockchain in the energy sector • Based on existing scientific articles, adaptability to the project is to be investigated
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	• basic theoretical research blockchain including working principle and classifications • analysis of network architecture • discovery of use cases of the blockchain technology for the energy industry • analysis of use cases for SPARCS • Feasibility study is finished	

Action L17-2	**Developing new potential blockchain-based solutions to enable prosumers to sell their surplus electricity on a Peer-to-Peer marketplace to con- and other prosumers.**	
Demonstration plan	Depending on the results of the study from L17-1 LSW would like to test blockchain-based solutions to enable prosumers to sell their surplus electricity on a Peer-to-Peer marketplace.	
Roles and responsibilities	**LSW: task leader**	
Schedule	M1-M24	The current 3 business models have been absorbed and evaluated
	M24-M36	Development and selection of solutions for blockchain integration for the further course of the project (including economic evaluation)
Milestone/ Tangible outcome	M31	Creation and evaluation of a theoretical concept of a blockchain, which could be applied on the real market.
Deviations from initial plan (GA)	None	
New deviations into plan (as	The schedule is shifting. Evaluation and development of a blockchain solution won't be finished in M20	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

compared to D4.1)	
Progress made until M24	• Economic evaluation of potential business models for a blockchain solution will be finished • Preparing the practical implementation
ldditional info	Implementation follows in Action L17-3.

Action L17-3	**Demonstration of the integration and interactions of IoT devices e.g. distributed power production and storage backed by blockchain.**	
Demonstration plan	One of the main goals of SPARCS project is to realize a renewable, zero-carbon energy community. That includes decentralised energy suppliers (such as local solar power plants) and a system for a continuous balancing of energy supply and demand. Stadtwerke Leipzig decided to build up a Digital Platform (see Action L9-1) based on decentralised IoT devices. These devices provide the LSW with the capability to make any existing asset "smart", that means being able to communicate with the community and know their state at any time. In smart cities, many smart assets- in the energy grid have to be balanced in an optimal way. It means dealing with very big amount of information from all devices simultaneously and finding a way to balance the grid. Blockchain technology can help doing it, because it gives one the opportunity to securely share and store information with all partners (or in this case) asset. Stadtwerke Leipzig has a fully functional prototype for this.	
Roles and responsibilities	**LSW: task leader**	
Schedule	M1-M24	Integration of zero-carbon-community device with LWB-solar-power-plant (digital platform, L9-1) for friendly users (Pilot phase). Customers can buy power from a specific solar panel. These transactions are backed and billed in a blockchain test-networks.
	M24-M36	Further development of the pilot application /system with the goal to deploy it for all zero-carbon-community participants.
Milestone/ Tangible outcome	M36	Roll-out for friendly user Production readiness
Deviations from initial plan (GA)	None	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

New deviations into plan (as compared to D4.1)	New targeted date for production readiness (M36) as the conceptualised product ("Bürgerbeteiligung") first requires the roll-out of the green plugs prior to its production phase.
Progress made until M24	Scalable prototype with functional Ethereum network connectivity is operational. Transactions have been simulated successfully during pilot phase. Product design phase for "Bürgerbeteiligung" is initiated.

3.4 Integration of Community Energy Storage (CES) and Community Demand Response (CDR) (ULEI, LPZ, LSW)

This subtask takes on the task of understanding and predicting the behaviour of energy system participants. The reliable integration of the planned "community energy storage" (CES) and "community demand response" (CDR) represent possible business cases for a successful system transformation at the municipal level. The mathematical optimisation model, as a mixed-integer linear programming, will allow a policy-oriented, technology-based, and actor-related assessment of varying energy system conditions in general, and innovative business models in particular. The integrated multi-modal approach is based on a novel six layer-modelling framework, which builds on existing high-resolution modelling building blocks.

This subtask includes:
L18-1: Further developing and refining the resource planning and optimisation (IRPopt) modelling approach and of the web-based software environment to allow long-term and short-term scenario calculations. This includes the integration of cascading time slices, policy-goals such as renewable energy quota or CO_2-emissions and standard reporting tools.
L18-2: Defining and developing the data acquisition and exchange based on the "Green sockets". (ULEI, LSW).
L18-3: Demonstrating the optimal prediction of user behavior for the virtual energy community and integrating the data model in the energy platform of the municipal utility. Derivation of implications regarding the formulated policy goals
L18-4: Extending the virtual community to Leipzig. Exploration of development paths with respect to varying scenario assumptions.

Action L18-1	Further developing and refining the resource planning and optimisation (IRPopt) modelling approach and of the web-based software environment to allow long-term and short-term scenario calculations. This includes the integration of cascading time slices, policy-goals such as renewable energy quota or CO2-emissions and standard reporting tools.
Demonstration plan	While the basic modelling framework of IRPopt is already in a mature state, the focus of the research in SPARCS requires the

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	ongoing development. This task serves as pre-requisite for actions L6-1, L6-2, L6-3 and L18-3, L18-4.	
Roles and responsibilities	**ULEI: task leader**	
Schedule	M1-M60	Model development and testing regarding: • Supply-side assets • Coordination functions between utility and customers • Seasonal heat storage • Pre-processing of model input • Post-processing of model results
	M12-M24	Preparation and application of the model for supporting the city vision process
Milestone/ Tangible outcome	M24	Documentation of the model status and as part of detailed description of model application in actions L6-1,2,3 and L18-3 (Intermediary report)
	M36	Extension of the documentation as part of the detailed reporting of the actions
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	

Progress made until M24	Model extension regarding:
	• Supply-side assets:
	  ○ Operational P-Q-diagram of Leipzig's CCGT – CHP power plant
	  ○ Electrolysis facility
	  ○ Hydrogen storage
	  ○ Fuel cell
	  ○ Seasonal heat storage
	• Flexible extension of the optimisation period	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

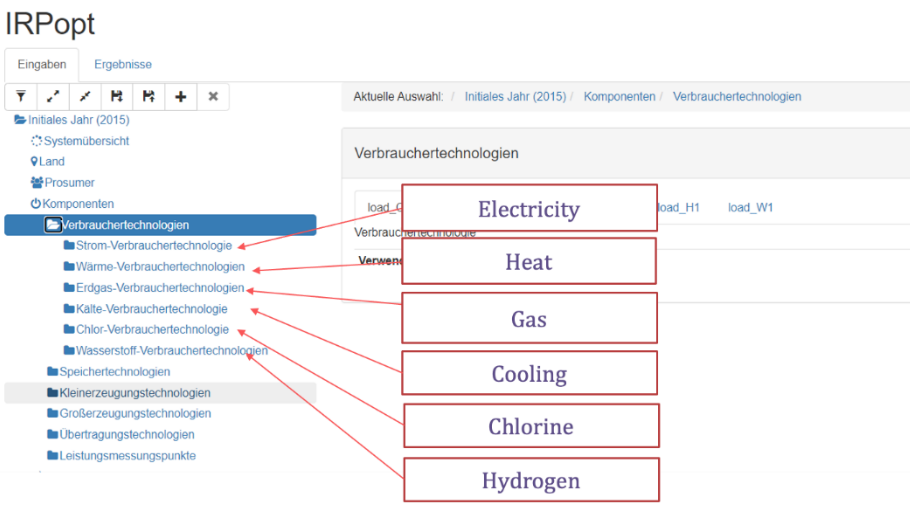

Fig. 32: User interface IRPopt: Exemplary visualisation of the supply-side assets.

Action L18-2	**Defining and developing the data acquisition and exchange based on the distributed “Green sockets”. (ULEI, LSW).**	
Demonstration plan	This task depends on the rollout of sufficient amounts of metering equipment (e.g., L-box) by LSW. LSW will provide access to the data (electricity consumption, district heat demand). The demand-side data will be integrated in our model. This task is linked to L9-1.	
Roles and responsibilities	**ULEI: task leader** LSW: data provision	
Schedule	M1-M12	Definition of data requirements
	M13-M36	Data collection
	M13-M36	Establishment and provision of data transfer
	M18-M36	Data quality check
	M24-M36	Provision of metering data for modeling purposes
Milestone/ Tangible outcome	M36	Data flow established
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Data flow is starting after roll-out of “Green sockets”, depending on progress of L9-1.	

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Progress made until M24	• Communication between IT team and ULEI established • Data requirements clarified • Initial data exchange based on regional heat demand accomplished • Electricity Metering data requires roll-out of "Green sockets" - starting in Q1/23

Action L18-3	**Demonstrating the optimal prediction of user behavior for the virtual energy community and integrating the data model in the energy platform of the municipal utility. Derivation of implications regarding the formulated policy goals.**	
Demonstration plan	The virtual energy community consists of a defined number of households in Leipzig. The electricity demand of these customers is balanced by LSW against a set of real and/or virtual assets. The individual customers are able to change the electricity consumption in respond to external signals. ULEI analyses the consumer behavior. Based on ex-post electricity demand, the optimal scheduling of the community energy storage is determined. The economic performance and optimal size are compared to the actual scheduling. In terms of economics, an established set of indicators is used including the leveled cost of energy storage (LCOES), the leveled value of energy storage (LVOES), payback period (PBP). Additionally, common performance indicators have been the absolute self-consumption (SC) or the SC ratio (SCR). Stadtwerke Leipzig will provide ULEI with all necessary data and will give feedback and hints for the further development of the prediction model.	
Roles and responsibilities	**<u>ULEI: task leader</u>** LSW: provision of data, e.g., electricity demand and seizing of controllable assets	
Schedule	M12	Definition of data exchange interface
	M18	First data transmission
	M21-M30	Preparation and application of IRPopt for the demo district Alternative data collection via SPARCS app
	M28-M30	Evaluation of model results
	M32-M48	Iteration of actions with regularly updates data set (provided by L18-2)
Milestone/ Tangible outcome	M33	Stadtwerke Leipzig and ULEI established an ongoing data exchange to have a common basis for the prediction model of ULEI

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	M36	Report (Scope, Research question, data, modelling results, conclusion)
Deviations from initial plan (GA)	None	
New deviations into plan/New deviations in the plan (as compared to D4.1)	In D4.1 the milestone corresponds to test data. Now the milestone is focused on the transfer of customer data from the "Green sockets", since the implementation planning is concretised by LSW.	
Progress made by M24	• Communication with SUITE5 regarding an extension of the SPARCS app • Tenants will be allowed to give feedback on willingness to shift electricity consumption • Design of a survey that will be integrated in the SPARCS app	

Action L18-4	**Extending the virtual community to Leipzig. Exploration of development paths with respect to varying scenario assumptions.**	
Demonstration plan	Based on the results of 18-3, ULEI explores developments paths for the energy community up to the year 2050. It will be evaluated if the energy community represents a necessary condition to reach the development goals of the city vision. This task also gives input for T4.7 Replication and exploitation preparation.	
Roles and responsibilities	**<u>ULEI: task leader</u>** LPZ: link to T4.7 LSW: Data provider, supervision of scenario assumptions / provide relevant data and give advices to extend the virtual community	
Schedule	M36	Transfer of the qualitative descriptions of the City Vision 2050 T1.2 into reasonable quantitative scenario assumptions with focus on the energy system
	M40	Transfer of the results of L18-3 and extension of the methodology for the virtual community to the city of Leipzig
	M40-M44	Pre-processing of model input data and application of IRPopt

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	M44-M48	Evaluation of model results with respect to the impact on community members and the utility • Costs and benefits • CO_2 emission • Share of RES
Milestone/ Tangible outcome	M50	Report on the economic and environmental impact of an extended virtual community for reaching the goals of the city vision 2050
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	Results of Task L18-3 and the outcome of the City vision workshop are pre-requisites for this Task.	

3.5 Ambient ICT Applications and User Interfaces for Electricity Consumption Transformation and Improvement (SUITE5, WSL, LSW, CEN)

The aim of this task is to develop and deploy universal behavioural change framework focusing on the discovery, quantification and revelation of energy-hungry behaviours of residential electricity consumers, aiming to convey meaningful energy-use feedback to occupants and engage them into a continuous process of learning and improvement. It will follow a stepped approach to reveal energy patterns and reshape sustainable energy efficient behaviours by utilising extrinsic and intrinsic motivation means. Energy will be conserved through the progressive improvement of user behaviours.

This subtask includes:

L12-1: Implementation of a human-centric interface, which allows for monitoring, controlling and normative feedback about the individual energy consumption. Through the application building occupants will be able to trace the impact of their everyday activities and behavior on the building energy performance appropriate interfaces depicting highly granular information about the energy performance at various spatio-temporal levels

L13-1: Demonstration of energy behavioral profiles, revealing the energy related aspects of behavioral profiles and allowing for self-evaluation and normative comparisons of energy behavioral patterns. Such visual metaphors and constructs/ dashboards will enable the energy footprint analysis to identify energy wastes and possible actions that can bring sizeable energy savings.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

L14-1: Maximizing of energy savings at the community level through commissioning on specific energy savings targets, to be widely communicated to engaged consumers. The application allows pledging of individual consumers to achieve specific energy savings over specific timeframes. Additionally, a social engagement loop will be established, comprising a synergetic environment that will effectively engage and sustain the involvement of consumers in energy saving actions

This subtask includes:

Action L12-1	Implementation of a human-centric interface, which allows for monitoring, controlling and normative feedback about the individual energy consumption. Through the application building occupants will be able to trace the impact of their everyday activities and behavior on the building energy performance appropriate interfaces depicting highly granular information about the energy performance at various spatio-temporal levels	
Demonstration plan	Describe the realization plan Application developed by Suite5 will allow: • Providing an overview of consumption, billing, and environmental impact per apartment. • Visualisation of historical energy consumption data, billing and environmental impact. • Based on metering equipment to be made available, display a distribution of consumption between appliances. • Based on the sensors to be made available, apartment and room specific information, such as temperature, humidity, luminance, etc. • Stadtwerke Leipzig can offer data of energy production and consumption and can provide analytical insights into the energy usage of the building (see L9-1).	
Roles and responsibilities	**Suite5: task leader** WSL, LSW: Supporting role. Building management, occupant's interface, equipment and data responsibility. LSW: can provide data, logic, analytics, ideas to Suite5 and WSL, can help with implementation of features.	
Schedule	M30	Provide Suite5 with data
	M6-M8	Agreement with the local stakeholders on the final setup of equipment installations that are feasible. Alignment of the application development action plan with the equipment installation plan. Definition of procedure to acquire the consent from the occupants.

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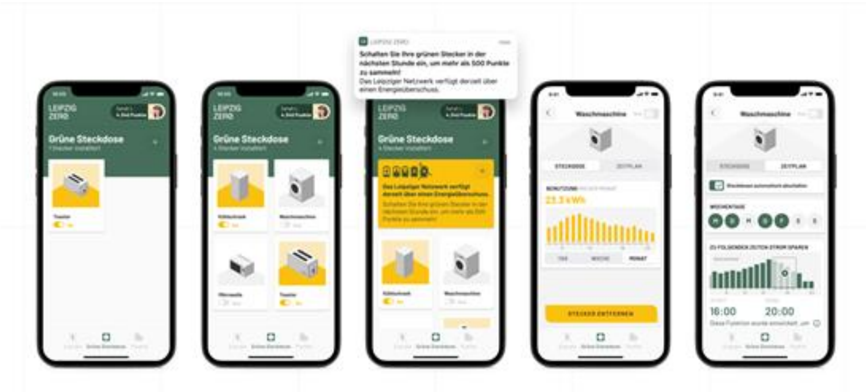
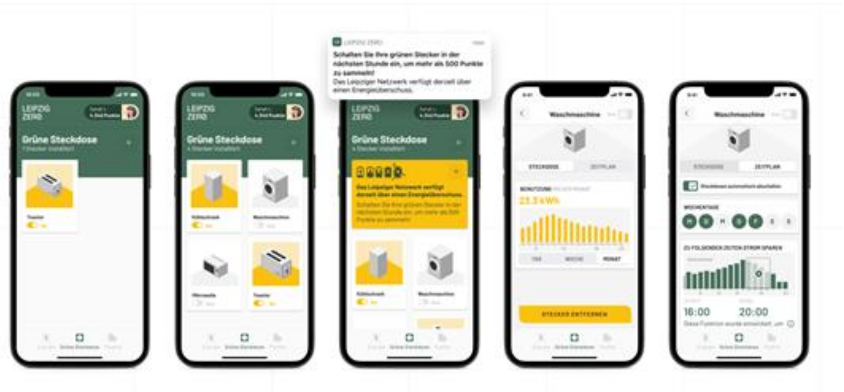
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	M10-M12	Deliver specs and mockups, finalize equipment specifications, and make data samples available, local stakeholders to provide historical data, co-creation approach to be followed.
	M12-M24	Development of application, delivery of ready to test software by M24
	M24-M28	Verification and testing of application
	M28-M36	Deployment and validation, replication
	M36-M60	Replication to other buildings
Milestone/ Tangible outcome	M12	Concrete application, specifications and mockups
	M24	Tested and ready to be deployed application
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Schedule: M12-M24, Development of application Delivery of ready to test software by M24 M24-M28, Verification and testing of the application M28-M36, Deployment and validation Replication	
Progress made until M24	• S5 Application design finished and ready for rollout in the demonstration area – We can add concrete screenshots before the M24 Midterm report LSW: • Implementation of the detailed concept of L-ZERO • Preparation of the interface for network-friendly behavior  Fig. 33: Mockup L-Zero	

	 Fig. 34: Mockup L-Zero • S5 application layout in addition to the screenshots provided above:  Fig.: 35 Mockup SPARCS App

Action L13-1	Demonstration of Energy Behavioural Profiles, revealing the energy related aspects of behavioural profiles and allowing for self-evaluation and normative comparison of energy behavioural patterns. Such visual metaphors and constructs/dashboards will enable the energy footprint analysis to identify energy wastes and possible actions that can bring sizeable energy savings.
Demonstration plan	Application developed by Suite5 will allow: • Comparison of consumption with similar peers (neighbors, best/average/worst consumers, etc.) to motivate a change towards lower consumption.

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	• Visualisation of the current performance vs. similar peers via a ranking. • Check of historical performance and rankings achieved.	
Roles and responsibilities	**Suite5: task leader**	
Schedule	M1-M6	Initial set of requirements based on the contract under analysis. Discussions with the local partners about feasibility.
	M6-M8	Agreement with the local stakeholders on the final setup of equipment installations that are feasible. Alignment of the application development action plan with the equipment installation plan. Definition of the procedure to acquire the consent from the occupants.
	M10-M12	Deliver specs and mockups Finalize equipment specifications Make data samples available Local stakeholders to provide historical data Co-creation approach to be followed
	M12-M24	Development of application Delivery of ready to test software by M24
	M24-M28	Verification and testing of the application
	M28-M36	Deployment and validation Replication
	M36-M60	Replication to other buildings
Milestones/ Tangible outcome	M12	Concrete application specifications and mockups
	M24	Tested and ready to be deployed application
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Schedule: M12-M24, Development of application, Delivery of ready to test software by M24 M24-M28, Verification and testing of the application M28-M36, Deployment and validation Replication	
Progress made until M24	• S5 Application design finished and ready for rollout in the demonstration area	

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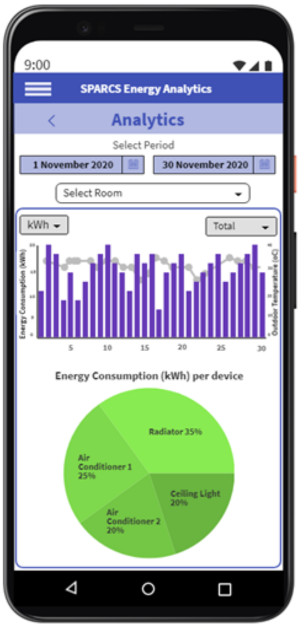
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	• S5 application layout:  Fig.: 36 Mockup SPARCS App

Action L14-1	**Maximising of energy savings at the community level through commissioning on specific energy savings targets, to be widely communicated to engaged consumers. The application allows pledging of individual consumers to achieve specific energy savings over specific timeframes. Additionally, a Social Engagement Loop will be established, comprising a synergetic environment that will effectively engage and sustain the involvement of consumers in energy saving actions.**	
Demonstration plan	Application developed by Suite5 will allow: • Setting common goals and verification of achievements. • Providing feedback about binding cost savings and how it can be offered on social welfare projects. • Visualisation of the current performance vs. targets set and achievements. • Check of historical performance and targets achieved.	
Roles and responsibilities	**<u>Suite5: task leader</u>**	
Schedule	M1-M6	Initial set of requirements based on the contract under analysis. Discussions with the local partners about feasibility.

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	M6-M8	Agreement with the local stakeholders on the final setup of equipment installations that are feasible. Alignment of the application development action plan with the equipment installation plan. Definition of the procedure to acquire the consent from the occupants.
	M10-M12	Deliver specs and mockups Finalize equipment specifications Make data samples available Local stakeholders to provide historical data Co-creation approach to be followed
	M12-M24	Development of application Delivery of ready to test software by M24
	M24-M28	Verification and testing of the application
	M28-M36	Deployment and validation Replication
	M36-M60	Replication to other buildings
Milestones/ Tangible outcome	M12	Concrete application specifications and mockups
	M24	Tested and ready to be deployed application
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Schedule: M12-M24, Development of application Delivery of ready to test software by M24 M24-M28, Verification and testing of the application M28-M36, Deployment and validation Replication	
Progress made until M24	• S5 Application design finished and ready for rollout in the demonstration area • S5 application layout (same as in L4-3):	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

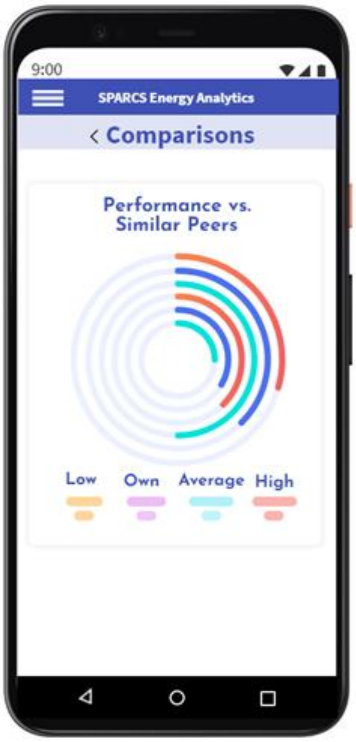

Fig.: 37 Mockup SPARCS App

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

4. E-MOBILITY INTEGRATION IN LEIPZIG LIGHTHOUSE DEMONSTRATIONS

4.1 Introduction to task 4.4 (FHG)

The aim of WP 4.4 is to analyse electric mobility in Leipzig and integrate e-mobility into the explorations. Electric vehicles and electric buses offer the opportunity for high flexibility and through intelligent charge control and charge management power grids are relieved.

Charging stations for passenger cars will be one part of the research. Through the integration of a fleet management system and a charging station management system, mobility needs can be met, and cars can be charged in an intelligent way. Bidirectional charging offers an additional possibility for intelligent charging in the context of SPARCS and is considered as well.

4.2 E-Bus charging integration (LSW, FHG, LPZ)

The Company Leipziger Verkehrsbetriebe (LVB) GmbH is responsible for the public transport in the City of Leipzig. LVB is owner and operator of the network for busses and trams.

During the last few years, the company participated in different research projects on electric mobility. The gained experiences are the base for the implementation of three E-bus lines until 2022. The plan is to transform the bus lines 89/74/76 and 60 from diesel fuel busses to e-busses. Altogether, the company will have 21 e-busses.

Every e-bus line will receive an e-charging station (quick charging station) at the final stop. Furthermore, the LVB will modernize the central bus garage at the location "Lindenauer Bushof", also located in Leipzig West. The location will receive a central charging station with about 10 charging points. The goal is to charge the e-busses during the night. This is one activity for a more climate friendly public transport.

In the course of the SPARCs project, the charging data of the buses will be evaluated, and the impact of the charging stations will be determined. This includes:

Action L15-1: Allocation of electric buses' charging data, integration into the digital energy platform and estimation of the ecological advantages in contrast to buses with combustion engines (LSW, FHG).

Action L15-2: Estimation of the impact of different electrified routes and a different number of electric busses. Definition of the scenarios and determination of the corresponding impacts (LSW, FHG)

Action L15-3: Comparison of the RES production with the demand of electrical energy. Analysis of the given production in combination with the demand to calculate possible shifts to cover the energy needs. Additional analysis for further increase of RES to full fill a 100% demand with RES. (LSW, FHG)1

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Action L15-1	Allocation of electric buses' charging data, integration into the digital energy platform and estimation of the ecological advantages in contrast to buses with combustion engines (LSW, FHG).	
Demonstration plan	- The analysis will reveal the amount of avoided CO_2 emissions of the busses.	
Roles and responsibilities	<u>**LSW and LVB: task leader**</u> • Allocate, integrate, pre-process and provide data FHG: - Analyse data and determine/quantify the advantages	
Schedule	M18-M24	Amendment process
	M25 - M36	Allocate and analyse the data
Milestones/ Tangible outcome	M36	Analysis completed
Deviations from initial plan (GA)	Action has been changed to the following: Allocation of electric buses' charging data, integration into the digital energy platform and estimation of the ecological advantages in contrast to buses with combustion engines.	
New deviations into plan (as compared to D4.1)	Task description updated	
Progress made until M24	Four tracks of the electric buses are operational, additional lines are waiting for regulatory clearance. Data from the charging stations is being extracted. A SCADA interface to the LSW digital platform is in the working.	

Action L15-2	Estimation of the impact of different electrified routes and a different number of electric busses. Definition of the scenarios and determination of the corresponding impacts (LSW, FHG)	
Demonstration plan	The analysis will differentiate between the routes and compare the environmental impacts respectively.	
Roles and responsibilities	<u>**LSW and LVB: task leader**</u> • Allocate, integrate, pre-process and provide data FHG: - Analyse the data in regard to different routes and scenarios	
Schedule	M18 - M24	Amendment process

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

SPARCS

	M25 - M36	Analyse the data and determine the impact
Milestones/ Tangible outcome	M36	Analysis completed
Deviations from initial plan (GA)	Plan has been changed to the following: Estimation of the impact of different electrified routes and a different number of electric busses. Definition of the scenarios and determination of the corresponding impacts.	
New deviations into plan (as compared to D4.1)	Task description updated	
Progress made until M24	Data is undergoing pre-processing (see L15-1).	

Action L15-3	**Comparison of the RES production with the demand of electrical energy. Analysis of the given production in combination with the demand to calculate possible shifts to cover the energy needs. Additional analysis for further increase of RES to fulfill a 100% demand with RES. (LSW, FHG).**	
Demonstration plan	The analysis will investigate the flexibility potential of the charging processes from an ex-post perspective.	
Roles and responsibilities	**LSW and LVB: task leader** • Allocate, integrate, pre-process and provide data FHG: • Analyse data in regard to the flexibility potential	
Schedule	M18 – M 24	Amendment process
	M25-M36	Analyse the data
Milestones/ Tangible outcome	M36	Analysis completed
Deviations from initial plan (GA)	Plan has been changed to the following: Comparison of the RES production with the demand of electrical energy. Analysis of the given production in combination with the demand to calculate	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

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	possible shifts to cover the energy needs. Additional analysis for further increase of RES to full fill a 100% demand with RES.
New deviations into plan (as compared to D4.1)	Task description updated
Progress made until M24	Data is undergoing pre-processing (see L15-1).

4.3 Load-balanced fleet management (FHG, LPZ, WSL, LSW, CEN)

This subtask will demonstrate load-balanced fleet management and charging based upon user specific inputs to the platform defining their flexibility. The system should provide the opportunity to reserve specific charge points in advance based upon suitable predefined and dynamic charging tariffs. This includes:

Action L16-1: Upgrade existing charging stations to allow for intelligent charging, including bi-directional charging, install additional charging stations across the district according to needs (LSW)

Action L16-2: Explore business models and services tailored for residents; allow for reservation of charging spaces, allow for selection of charging tariffs and priority setting (FHG, LSW, WSL)

Action L16-3: Implement and test a mobile user application for reservation and configuration of charging/mobility needs of his privately owned or currently used (shared company fleet) vehicle, integrate the necessary interfaces of participants (LSW, FHG, WSL, LPZ)

Action L16-4: Demonstrate load-balancing with an electric vehicle fleet in accordance to local grid needs (LSW, FHG, WSL, LPZ)

Action L16-1	Upgrade existing charging stations to allow for intelligent charging, including bi-directional charging, install additional charging stations across the district according to needs (LSW).
Demonstration plan	Actual charging station models usually do not provide bidirectional charging. Therefore, in order to achieve the project objectives, either existing charging stations need be upgraded, or new charging infrastructure need to be procured. Description of the realisation plan: The aim is to upgrade the existing network of public charging infrastructure of the LSW with the intelligent or bi-directional

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	charging. The LSW currently operates a network of approx. 200 public charging points at more than 80 locations. For bi-directional charging, the specifications and findings from the pilot setup of the L1-1 project are used and a rollout to the existing charging stations will be designed. In addition, a concept is being developed in cooperation with the charging station manufacturer in order to integrate the bi-directional charging into the calibration conformity, which is required for public charging stations. For the function of intelligent loading, possible use cases are first developed in coordination with the IT department and the information available from the charging infrastructure will be analysed. Possible use cases are a reservation function of charging stations to optimize charging infrastructure utilisation, as well as a network-serving charging in conjunction with new business models for electric mobility.	
Roles and responsibilities	**LSW: task leader** • charging stations need to be defined • charging stations need to be upgraded • charging stations need to be connected to a charging station backend system that provides the relevant protocols	
Schedule	M13-M15	Technical decision for a solution (bi-directional or intelligent charging) by Q4 2020
	M16-M18	Development of a roll-out plan by the first quarter of 2021
	M19-M21	Roll-out to the existing charging infrastructure in second quarter of 2021
	M25	Integration of charging stations to the virtual data platform
Milestones/ Tangible outcome	M25	The charging stations can be controlled by a charging station backend system (including bidirectional charging). 200 charging point with an upgrade for intelligent or bi-directional charging.
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	A total of 250 charging points exists at 80 locations that can be intelligently controlled. The software for smart charging has been updated. The use of charging stations that can charge bidirectionally is being examined.	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Action L16-2	Explore business models and services tailored for residents; allow for reservation of charging spaces, allow for selection of charging tariffs and priority setting (FHG, LSW, WSL).	
Demonstration plan	Different tariff and business models for the reservation of charging stations and charging electric vehicles are conceivable. For example, time-based, energy quantity based or load-based tariffs could be implemented. The combination of the corresponding price components are conceivable. Within the SPARCs project, various business and tariff models will be presented and the corresponding protocols and standards will be taken into account. The corresponding standards and tariff components have already been identified. The definition of the business models and tariffs follow.	
Roles and responsibilities	**FHG: task leader** • Define framework conditions and roles • Identify relevant standards and protocols • Describe business models and selection of charging tariffs based on the standards and protocols LSW: • Define framework conditions • Ensure communication to residents if necessary WSL: • Define framework conditions • Ensure communication to residents if necessary	
Schedule	M3-M8	Identify the relevant protocols and its tariff modules
	M9-M25	Development of the tariff and business models
Milestones/ Tangible outcome	M8	Relevant standards, protocols and existing services are identified
	M25	Business models and services are developed
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Final report till M25 (compared to M19 within D4.1).	
Progress made until M24	A draft of the results is already available. It first describes the roles and actors in the context of e-mobility. Based on this, challenges in the implementation of variable customer tariffs are presented. The separation of the roles *charging station operator* and *e-mobility provider* makes it difficult to pass on variable prices to the	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	customer. Nevertheless, a target to realize the corresponding prices is shown. Finally, different pricing models and their advantages and disadvantages are presented.

Action L16-3	Implement and test a mobile user application for reservation and configuration of charging/mobility needs of his privately owned or currently used (shared company fleet) vehicle, integrate the necessary interfaces of participants (LSW, FHG, WSL, LPZ).	
Demonstration plan	An app for defining mobility needs is to be implemented. First views for a user interface were already set up. These include, for example, the functionality of asking the current and desired state of charge. The views and the app will be finalised after the charging infrastructure and user group are defined.	
Roles and responsibilities	LSW, WSL, LPZ: • Define framework conditions • Define and provide a fleet	
Schedule	M1-M14	Develop mock-ups and different views
	M15-M19	Implement the relevant views
	M20-M25	Implement and test backend functions
Milestones/ Tangible outcome	M14	Views are developed
	M25	App is implemented
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	 Fig. 38: App view according to current status	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	The e-mobility app is in use for customers. With the L.Drive app, customers can flexibly use innovative charging systems as well as charging solutions. With the matching charging tariff L-Strom.drive, users can "fill up" with electricity for their e-car.

Action L16-4	**Demonstrate load-balancing with an electric vehicle fleet in accordance to local grid needs (LSW, FHG, WSL, LPZ).**	
Demonstration plan	The bookings of a fleet management system serve as input for the optimisation algorithm determining the charging schedules. In addition, grid constraints will be taken into account. A fleet and charging stations will be defined to demonstrate the algorithms.	
Roles and responsibilities	LSW, WSL, LPZ: • Define framework conditions • Define and provide a fleet support • Define and provide charging stations support • Provide communication between optimisation algorithm and charging stations	
Schedule	M1-M15	Defining the electric fleet and charging stations
	M16-M17	Clarify contractual framework
	M18-M29	Integrate the electric fleet and charging stations
Milestones/ Tangible outcome	M17	Framework conditions are defined
	M29	Load-balancing with an electric vehicle fleet in accordance to local grid needs can be shown
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	Based on OCCP functionalities demand response is operational with LSW fleet.	

4.4 Bi-directional charging for micro grid stabilisation (FHG, LSW, CEN)

This subtask will demonstrate the bi-directional charging for micro grid stabilisation by integration of the e-mobility platform and its integrated charging optimisation. To

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

facilitate the subtask, the charging optimisation algorithms – based on a mixed integer linear program (MILP) – must be extended and evaluated to enable bi-directional charging of electric vehicle fleets. The objective for this subtask is to show bi-directional charging to stabilise a micro grid, based on load and supply forecasts.

This includes:

Action L1-1: Development of bidirectional e-charging system allowing for parked vehicles to be used as additional storage capacity. (CEN, LSW).

Action L1-2: Eco-friendly and CO_2-reducing corporate e-car sharing in combination with load-oriented fleet management solution. Analysis of the effects of integration in the micro grid (CEN).

Action L1-3: Demonstrate bi-directional charging with micro grid stabilisation (CEN, FHG).

Action L1-4: Extend the charging optimisation algorithms for EVs bi-directional charging (FHG, CEN).

Action L1-1	Development of bidirectional e-charging system allowing for parked vehicles to be used as additional storage capacity.
Demonstration plan	The aim is to test and to demonstrate the bi-directional loading system, as a pilot project. Partners LSW and Cenero on the area of the Spinnerei block are building the test setup. It will include a charging station and an electric vehicle with the function of bidirectional charging, as well as a local battery storage system. As part of a pilot project, bi-directional charging for e-cars will be tested and demonstrated on the site of the Spinnerei block. The test setup will consist of a collaboration between CENERO and Seecon. CENERO will ensure the installation of the necessary charging points as well as the connection of the charging stations to the load management and the electricity storage system. Seecon will lease the associated e-car with the capability for bi-directional charging, which are currently hardly common on the market, BMW will support the project with providing a correspondingly modified i3 together with the associated wallbox and Seecon will provide the usage data. Renewably generated energy will be fed in via the planned PV system on the site and brought in via load management for charging processes. Before the cooperation with BMW, it was planned to include the bidirectional charging station of Walther Werke. But since for this system there is no compatible EV on the market, the station will be installed but will be initially only available for unidirectional charging processes. But in perspective it supports bidirectional charging, as soon as there is an according technical standard implemented on vehicle level.

Roles and responsibilities	**<u>CEN: task leader</u>** LSW: responsible for the construction and operation of the new constructed charging station	
Schedule	M1-M6	Developing the concept, design and planning for the installation of a bidirectional charging station. In the first meetings between LSW and Cenero, the exact location of the loading system will be defined.
	M6-M18	Collaboration with partners to agree on the timeline, design and concept in order to prepare the construction through selection of technology and contractors.
	M21-M30	The installation of the bi-directional charging station in the Spinnerei block.
	M21-M30	Integration of an electrical vehicle provided by partner Seecon with bidirectional loading capability.
	M30-M60	Demonstration of the bidirectional capability of the charging station with fine-tuning and development of an algorithm (action L1-4). A showcase to allow fellow city consortiums to see the bidirectional loading of the electrical car with a visualisation, for example LEDs with a color system to indicate loading and unloading of electrical energy into the car. This showcase will also demonstrate the use of solar PV panels as an electrical energy source used to load the electrical car and to be fed back into the micro grid.
Milestones/ Tangible outcome	M18	Letter of Intent between Seecon and CENERO.
	M21-30	The purchase and integration of an electrical vehicle with bidirectional charging capability.
	M30	After a thorough examination, the idea of converting the carport area into an electric charging station was rejected because the structural conditions (e.g., a coal bunker that would have to be filled and straightened) make the civil engineering work on site more difficult and very costly. However, it is planned to set up a showroom in the immediate vicinity in the energy center in Building 18. Here, the functionality of load management in terms of the interaction

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

		between generation, storage and consumption will be made tangible for the public.
Deviations from initial plan (GA)	Instead of buildings No. 6, 9, 10, 11 we are now focussing on buildings No. 14 and 18. Because these buildings will fit the most for implementing our tasks and actions.	
New deviations into plan (as compared to D4.1)	• Installation of the charging stations nearby the carport • 2 types of Charging Stations installed: The charging station of Walther Werke will initially be used for unidirectional charging, as no suitable production vehicle was available for bidirectional charging. In the future, it is planned to enable bidirectional charging via the charging station. First bidirectional charging station and car will be provided by Seecon in cooperation with Kostal and BMW.	
Progress made until M24	• Installation of the unidirectionally used charging station of Walther Werke • final plan for setting up the bidirectional charging station with Seecon and BMW	

Action **L1-2**	**Eco-friendly and CO_2-reducing corporate e-car sharing in combination with load-oriented fleet management solution. Analysis of the effects of integration in the micro grid.**	
Demonstration plan	In collaboration with the Frauenhofer IAO, CEN will be developing a rudimentary pilot system for eco-friendly and CO_2 reducing corporate car sharing. The solution will be tested in the Spinnerei block as a development opportunity for both the Fraunhofer IAO and CEN to analyse the options and solutions for a fleet management solution. The car sharing company teilAuto have an electrical charging station in the Spinnerei block and so will be approached to discuss the possibility of utilising their cars for the fleet management system. The car provided by Seecon for the bi-directional charging station will also be included as part of the fleet.	
Roles and responsibilities	**CEN: task leader**	
Schedule	M1-M6	Alignment with Seecon as to using their car as part of a fleet management system resulting in a letter of intent.
	M6-M18	Alignment with teilAuto on utilising their backend data for the development of a rudimentary fleet management system.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

		A letter of intent with teilAuto, especially in regard to data sharing and data collection.
	M18-M36	Fraunhofer IAO to support the development of a rudimentary fleet management system to be tested with the teilAuto and Seecon cars.
Milestones/ Tangible outcome	M18	Letter of Intent with Seecon
	M18	Letter of Intent with LSW
	M21-M30	Installation and qualification of the bidirectional charging station.
	M36	An e-mobility hub consisting of a local electrified car sharing concept and commercial vehicles in close proximity to Building 18. In addition, the car will have a parking space there for bidirectional charging and will be marked with the logos of the SPARCS project and the respective cooperation partners.
Deviations from initial plan (GA)	Instead of buildings No. 6, 9, 10, 11 we are now focussing on buildings No. 14 and 18. Because these buildings will fit the most for implementing our tasks and actions.	
New deviations into plan (as compared to D4.1)	• SPARCS partner Seecon acquired as fleet operator. • The car sharing provider teilauto has announced that a backend change in the e-car segment is imminent. Currently, it is not clear how this change will be designed. The integration of teilauto into the e-mobility concept is therefore on hold. Another reason for this is the difficulty of connecting teilauto to the load management system, since the backend is provided by a third-party provider. Close coordination with LSW would only be necessary at this point if teilauto was integrated and is therefore also postponed.	
Progress made until M24	• Approval Seecon for fleet management • Bidirectional vehicle ordered and wallbox ordered • First conceptual coordination see & FHG for the implementation of fleet management • Interface definition load management for analysing effects on micro grid	

Action L1-3	Demonstrate bi-directional charging with micro grid stabilisation.
Demonstration plan	The first bidirectional charging station in Germany will be built and will demonstrate bidirectional charging of electrical cars. The discharging electric vehicles will feed electricity into the

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	grid. In this way, parked vehicles can act to stabilize the micro grid. The electrical car will be used as a battery during times of excess electricity production as it will be fully loaded and during times of low production, the energy can then be fed back into the electricity grid to aid in peak shaving and load management.	
Roles and responsibilities	**CEN: task leaders**, technical support, Define the micro grid and provide relevant information FHG: Extend and adjust constraints regarding bidirectional charging	
Schedule	M1-M6	The concept, design and planning for the installation of a bidirectional charging stations.
	M6-M12	Collaborate with partners to agree the timeline, design, and concept in order to prepare the construction through selection of technology and contractors.
	M12-M21	Coordination of selected technologies and contractors
	M21-M30	The installation of the bi-directional charging station in the Spinnerei block.
	M18-M24	Integration of an electrical vehicle provided by partner Seecon with bidirectional loading capability.
	M24-M60	Demonstration of the bidirectional capability of the charging station with fine-tuning and development of an algorithm.
Milestones/ Tangible outcome	M36	An E-Mobility-Hub consisting of a local electrified car sharing concept and commercial vehicles in close proximity to Building 18. In addition, the car will have a parking space there for bidirectional charging and will be marked with the logos of the SPARCS project and the respective cooperation partners.
Deviations from initial plan (GA)	Instead of buildings No. 6, 9, 10, 11 we are now focussing on buildings No. 14 and 18. Because these buildings will fit the most for implementing our tasks and actions.	
New deviations into plan (as compared to D4.1)	• Placement of E-Mobility-Hub on given parking space near Building 18	
Progress made until M24	• Bidirectional vehicle ordered and wallbox ordered • Concept for presentation of Mobility Hub finalised	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Action L1-4	Extend the charging optimisation algorithms for EVs bi-directional charging.	
Demonstration plan	Version 1 of the charging station optimisation algorithm only provides unidirectional charging. Version 2 will also provide bidirectional charging. The constraints are to be adapted in such a way that discharging electric vehicles and feeding electricity into the grid will also be possible. In this way, parked vehicles can provide energy for the energy community.	
Roles and responsibilities	**FHG: task leader**, Extend and adjust constraints regarding bidirectional charging CEN: technical support	
Schedule	M20-M24	Idea and how can it be realised, how can the consumers be integrated (communication-strategy), clarify demonstration building in demonstration area (Spinnerei block) and develop the extension for the charging optimization algorithms.
	M24-M32	Extend the algorithm
Milestones/ Tangible outcome	M24	Necessary installation is finished, and target is defined
	M32	Extended algorithm exists
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Due to delays in the procurement of the charging infrastructure the algorithm will be developed later.	
Progress made until M24	None (due to delays in the procurement of the charging infrastructure)	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

5. MACRO LEVEL INTERVENTIONS FOR INTEGRATED ENERGY POSITIVE SOLUTIONS

5.1 Planning of Energy Positive Communities in Leipzig (LPZ, FHG)

The planning of energy positive communities builds upon the learnings from already implemented actions. It is set to integrate planning tools of the City of Leipzig (Urban Data Platform) with data and knowledge gathered during the implementation of the positive energy community (L19-1). Furthermore, it determines the requirements to expand and integrate more buildings and stakeholder into the positive energy community (L19-2).

The City of Leipzig (LEI) is currently developing an operational concept for the implementation of the urban data platform of the city which is based on the already existing geospatial data infrastructure. In this project LEI already works together closely with its public utilities, especially Leipziger Stadtwerke (LSW). Action 19-1 will be an excellent use case for the urban data platform to explore the added value of urban data for a municipality and other stakeholders. Additionally, LEI is working on the set up of a digital urban twin for the city. The integration of energy and building data from the SPARCS demos will contribute to the overall goal of creating a profound information and knowledge base for urban development and planning decisions.

The subtask 5.1.1 will therefore demonstrate solutions for innovative planning of future energy positive communities. Actions include:

5.1.1 Energy Positive District Planning (LPZ, WSL, LSW)

Action L19-1	Integrating energy and building data into the Urban Data Platform of the City of Leipzig for advanced and integrated district and building planning.	
Demonstration plan	Monitoring and collection of energy and building data during the implementation phase of the energy positive community. Determine requirements for integration of data into the urban data platform (data formats, API's, etc.). Determine possible use cases and integrate data into the urban data platform.	
Roles and responsibilities	**LPZ: task leader**, coordination	
Schedule	M18	Mapping of available energy and building data within the project (in connection with WP 2 & KPI definition, linked to L18-2).
	M24	Determine requirements for the integration of data into the urban data platform.

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

SPARCS

	M30	Conduct Workshops with stakeholders within the administration on how to integrate energy and building data
	M36	Determine possible use cases for the integration of the data into the urban data platform.
	M36-M60	Integration of energy and building data into the urban data platform.
Milestone/ Tangible outcome	M36	RoadMap for implementing data into urban data platform Leipzig
	M48	1st integration of energy and building data into urban data platform Leipzig
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Further workshops are planned in order to gather additional requirements and pre-existing data regarding energy and building data, therefore delaying the implementation road map to M36.	
Progress made until M24	Two workshops (M18, M20) conducted on requirements for climate and building data as well as direct contact established towards responsible units within the city administration, namely the Office for Housing Subsidies and Urban Renewal and the Office for Geoinformation. With the help of the conducted workshops, one possible use case could be identified: The use case foresees the usage of the data gathered within one SPARCS district (Duncker district) for analysis of the framework conditions and the preparation of a district-related energy and CO_2 balance sheet. With the help of data gathered within SPARCS, energy efficiency and CO_2 reduction potentials including cost and profitability analysis on individual building, block and district level will be determined.	
Additional info	Implementation road map (M36) is basis for T4.7 and L20-1, develop future tools for city planning (GIS-based visualisation of energy positive districts)	

Action L19-2	Identify the requirements how buildings can be integrated into the Positive Energy Community; determine the smart building requirements to support the creation of holistic system intelligence.
Demonstration plan	Identification and description of requirements for buildings and stakeholders to be integrated into the positive energy community.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	Determine the technologic requirements (sensors, smart meters, connectivity etc.) and next steps to integrate energy-related building data into the Urban Data Platform (UDP). Development of a checklist/action guideline for the integration of energy-related building and district data into the UDP based on the experiences from L19-1 on data from the Duncker-Viertel demo district. Actions carried out under T4.2, T4.3 and T4.4 and findings and recommendations derived from their implementation will be carefully reviewed to determine technical requirements for further integration of relevant energy-related building data.	
Roles and responsibilities	**LPZ: task leader**	
Schedule	M1-M36	Monitor requirements for buildings; determine necessary technology
	M36-M60	Workshops with local stakeholders on results and findings on the integration of energy-related building data into the UDP (T4.2 - T4.4)
Milestone/ Tangible outcome	M36	First interim results can be integrated in D4.4 Interoperability of holistic energy systems in Leipzig (interim report)
	M60	Integration of results in D4.7 on the integration of energy-related building and district data into the UDP
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Shift focus from integration in virtual energy community towards integration into Urban Data Platform (UDP) of the City of Leipzig.	
Progress made by M24	First exchange of existing building data on public buildings (M20), additional sensor installations discussed (M22). Existing sensors on all public buildings in Leipzig under review (M22).	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

5.1.2 Standard model for smart cities (LPZ)

This task includes the assessment of a standard model for the Leipzig replication districts in close collaboration with partners, stakeholders and the responsible city departments and the synchronisation with similar aspiration in Espoo; this includes a survey on resulting benefits for citizens, the city and the possibilities to affect the creation of new smart and clean city solutions (LPZ, FHG).

Action L20-1	Assessment of a standard model for the Leipzig replication districts in close collaboration with partners, stakeholders and the responsible city departments and the synchronisation with similar aspiration in Espoo; this includes a survey on resulting benefits for citizens, the city and the possibilities to effect the creation of new smart and clean city solutions.	
Demonstration plan	Discussion will start after M36 in connection of results of WP1, WP3 (Task E22-1), T4.6, T4.7, WP5 (incl. road map for development of standard model, municipal working group, workshop with property developers etc.)	
Roles and responsibilities	**LPZ: task leader** FHG IAO	
Schedule	M36-M42	Discussion on findings, exchange with LC Espoo on findings of E22-1
	M42-M54	Internal working process including municipal working group (gather results from T4.6 on citizen engagement + T4.7 replication)
	M60	Definition of standard model, integration of results in D4.7
Milestone/ Tangible outcome	M54	Internal working group established, local workshops and exchange with Espoo carried out
	M60	Results included in D4.7
Deviations from initial plan (GA)	None	
New deviations in the plan (as compared to D4.1)	Further interdependencies with WP1.	
Progress made by M24	Task starts in M36	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

5.2 Community support for energy transformation in the district

5.2.1 Introduction to task 4.6 (SEE/IMW)

The objective of task 4.6 is to engage and support the citizens in the energy transition through inclusive and participation-oriented measures similar to well-established energy revitalisation management. The main implementation premises focus on introducing and involving the local communities in activities promoting sustainable energy sources, developing the energy saving habits and raising awareness on the critical yet simple climate change prevention measures that can be done on an individual level through non-invasive adjustment in the current lifestyle.

SPARCS positive energy community management (PECM) includes two main tasks:

L21-1, strategical, processual, and participative tasks:

- Identification and activation of key participation groups (tenants, local companies based in the examined areas, long-termly also the Leipzig citizens in general).
- Planning and partially organising (or advising) the participation, communication, and information deliverance formats.
- Resource-and activity-oriented involvement of technical and strategical SPARCS-partners.
- Involvement of the key strategical partners outside of the SPARCS Leipzig consortium.
- Monitoring and evaluation.
- Quality management of SPARCS-products through the interaction with the local communities.

General coordination and on-schedule control (reference: participation concept). L21-2, new approach towards on-site energy advisory (desk support):

- Information and advice on the cost-efficient use of renewable energies.
- Energy advisory for local communities and companies on the implementation of projects (also outside of SPARCS) that effectively contribute to reinforce and further develop energy positive communities.
- Constant improvements and expansion of participation options for diverse milieus in the activities related to energy transition and climate change prevention.

The basis for L21-1 is the participation concept that was submitted shortly after the end of the first project period and published on MS Teams in M15. The document presents the wide range of planned-/undertaken participation and information activities that help to raise awareness on civic contribution in building carbon neutral, energy positive and climate-friendly living space. As the concept is placed in the SPARCS-project, the above-mention measures are focused in the first place on the efforts pursued by the technical partners (LSW, WSL, Cenero, Suite5). The concept does not only aim to establish a firm communication basis that would explain the purposes behind the particular technical products (i.e., application, bidirectional charging stations for electric vehicles, energy storage, sustainable district heating) to the local communities but also creates formats that allow to facultatively take part in the co-creation process of the individual products. This includes i.e., participation on selected product development activities - foremost feedbacks, testing phase, eventually also direct/indirect co-development activities.

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

The initial premise of L21-2 was to support the tenants from the demo-district Duncker neighbourhood and other interested parties with an on-site energy advisory. Due to COVID-19 such activity is not possible anymore and therefore the whole idea of desk support needed to be redesigned.

An important part of Seecons work in general is so called a Dual Participation and Collaboration Approach (DPCA) - all participation, collaboration, characterize the concept and information deliverance activities are planned both with technical partners and strategical partners (City of Leipzig, communication department of LSW, Fraunhofer IMW/IAO, Leipzig University). The reason behind it is that although the integration of the technical measures of the SPARCS-project with efforts of creating and assisting the sustainability-driven communities is one of the key goals of the participation concept, it still needs to align with the local, long-term community support needs, regardless the topic of collaboration. Therefore, the participation and communication undertakings that are conceptualised and examined throughout the project's lifetime should be designed in a way that enables their further use after the SPARCS-completion. The task L21-2 which focuses on desk support for local communities provides a great ground for in-depth exploration and definition of formats that would serve a long-term purpose. Therefore, the success of L21-2 is only possible if the local municipality planning, environmental, digitalisation and energy city units as well as the municipal quartier management offices are involved in the development and execution process from the very beginning.

5.2.2 Actions for community support for energy transformation in the district (SEE)

The action L21-1 concentrates on activities realised within the work spectrum of positive energy community management (PECM). The purpose of its main elements (foremost participation, communication and information deliverance formats as well as monitoring, evaluation and quality management) enables to actively involve the local communities in the energy transformation process. It also aims to raise awareness of the individual's impact on the climate change prevention efforts and to encourage the usually neglected social and cultural groups to take part in the inclusive, participation practices.

Action **L21-1**	**Establishing community management/energy advisor, which supports the residents with the energy transformation of privately owned buildings. This includes the access to the newly established Virtual Power plant and the smart grid in general. (SEE, LPZ, FHG).**	
Demonstration plan	M1-M6	• Activation and involvement of technical and strategical partners into the development of the participation strategy. • Secondary involvement in a product vision for an application. Definition of the main reasons for participation.

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

		• Preselection of interesting participation and communication formats.
	M6-M12	All activities crucial on finalisation of participation concept.
	M12-M18	• Examination of stakeholder-analysis from L21-3. • Involvement of key external partners (foremost planning department, climate preservation control centre, quartier management office Leipzig West, local high schools, VDI-GaraGe). • Deep-dive into digital participation tools and contact-free engagement instruments
	M18-M24	• Development of contact free participation methods incl. posters, postcards and idea-box as well as elderly and family-oriented analogue engagement activities like coffee and chat days. The conception and execution phase were based on in-depth exchange with the key SPARCS-partners. • Concept-development and respective engagement of the key stakeholder development for education offers for school students
	M24-M30	• M24: Evaluation of the participation process. • User workshop in Duncker neighbourhood and further activities • M28: Discussion and, if beneficial/possible/feasible, also establishment of a strategic plan for involving Ceneros planned participation activities in Spinnerei block into the overall participation process. The goal is to merge on the conceptual level both demo districts. • Further workshops still in planning process!) • Adjustments and expansion of the participation options. • Initial development of guidelines as basis for replicability.
	M30-M60	Citizen participation activities with Cenero in Spinnerei block. Active desk support, workshop conduction, expansion of participation option through new, preferably innovative measures

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

SPARCS

		Sidenote: Seecon is actively searching for development and deployment a geospatial-augmented reality table that would visualize SPARCS products and let the citizen understand their impact through an active, real-time interaction.
Roles and responsibilities	**SEE: task leader,** management, and control of the action LPZ: partner; mediator/networker; supervisor and strategical mentoring regarding integrated and inclusive urban development FHG: partner, innovator, mediator/ networker	
Schedule	M1-M12	Conceptual phase, participation concept
	M12-M24	First implementation phase. Only a few technical products are ready for demonstration and evaluation
	M24-M36	Second implementation phase. Most of the technical products are ready to examine, therefore the active involvement of the citizens in the SPARCS activities can begin. The phase will be evaluated in M36.
	M36-M48	Evaluation phase and expansion of participation options.
	M48-M60	Evaluation phase and expansion of participation options. Development of guidelines for replicability of the best practice.
Milestones/ Tangible outcome	M12	Participation concept final
	M36	First evaluation of conducted measures and the necessarily adjustments.
	M48	Report on PECM (Deliverable D4.6). Update of the PECM based on feedback and experience collected through the monitoring and evaluation phase.
	M60	Final report including replication strategies of best practices.
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	Due to COVID-19 all the technical partners had to postpone the development and/or deployment phase of their products. Consequently, most of planned actions needed to be redesigned and/or rescheduled.	
Progress made until M24	First implementation phase. Only a few technical products are ready for demonstration and evaluation at this point, therefore	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	most participation actions are concentrated on information, awareness raising and activation of the citizens that would be interested in testing phases as well as workshops that are not related to the products. The phase will be evaluated in M24. The M12-M24 contained following activities: • Establishing a Workshop-agenda with FHI IMW -> its respective implementation • Involvement of communication department of LSW and LWB-WSL in communicating the selected participation and communication activities. Agreement on agenda and activity type. LSW with possible, big delay • Involvement of Duncker neighbourhood tenants into citizen engagement process: contact-free methods/posters and idea-box, idea-box, coffee and chat days, user-workshop SPARCS-app • Finalisation of the cooperation with VDI-GaraGe/education offer for citizen science workshops with students on SPARCS-topics • Engaging local high schools into the activities • Organisation of workshops on the city level: Ökolöwe/Umwelttage 29.06.2021, workshop on citizen engagement/energy positive districts • Organisation of SPARCS-internal workshops on citizen engagement (exchange, brainstorming, focus: participation in time of COVID-19, engagement of the hard-to-reach groups, etc.)

The action L21-2 is an inseparable part of PECM coordination – the participation-driven energy management efforts are strengthened by the local desk support and consultancy for every party (either private or commercial) that is interested in active contribution of co-creating a positive energy living space. The onsite work is targeted also to those that need even basic information of the energy transition and climate change prevention measures. It needs to maintain an inclusive, neutral character.

Action **L21-2**	**Desk support for interested citizens with information regarding cost-efficient installation of renewable energy sources such as PV and participation in the Positive Energy Community and for local businesses and private persons interested in rolling out project solutions (SEE, LPZ, FHG)**
Demonstration plan	• The first activities related to desk support (apart from implementation premises included in the participation concept) will be pursued not earlier than in M24, after the evaluation of the first implementation phase. Between M24 and

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	M30 a decision on the form and location of the desk support that would align with the DPCA will to be made. After completing the conception phase of the desk support that include the participation formats, the work on active cooperation with the local community will start. As in the case of participation concept at the end of each cycle the efforts will be evaluated and the adjustments for further development set for implementation.	
Roles and responsibilities	**<u>SEE: task leader,</u>** management and control of the action LPZ: partner; mediator / networker; supervisor and strategical mentoring regarding integrated and inclusive urban development FHG: partner; innovator; mediator / networker	
Schedule	M1-M12	Definition of key goals behind the desk support based on SPARCS-measures, implementation premises and allocation in the participation concept (M12).
	M12-M18	Research on broader activity-spectrum on contact-free/digital/additional participation tools due to COVID-19 and considerable product deployment delays.
	M12-M24	The next step is redesign and redefinition of desk support. The new framework set until M24.
	M24-M48	Implementation phase. The phase will be evaluated in M36 and M48.
	M48-M60	Report of desk support. Adjustments made upon the results of last evaluation.
Milestones/ Tangible outcome	M12	Allocation of implementation premises for desk support in the participation concept.
	M24, M36	Work review with Leipzig Consortium.
	M48	Report on desk support.
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	The major factor in forming the desk support and respectively making it replicable on the city scale is to collaborate with the key external partners. After the series of interviews with diverse	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	municipality units conducted in 4th quartal 2020~~,~~ two cooperation partners were included into the cooperation network. Those are: • District management Leipzig West (Stadt Umbau Management), who have a substantial experience in community support but did not expand its actions of Duncker neighbourhood • Office for Housing subsidy and urban revitalisation (Amt für Wohnungsbau und Stadterneuerung)

The aim of Action L21-3 is to involve all relevant stakeholders into the project activities, to increase their awareness for energy efficiency in general as well as their acceptance for the implementation of the specific SPARCS actions. Participation is an important prerequisite for the successful implementation of energy system transformation and can only succeed with the broad support of the citizens. This support can be gained at various levels, from information and transparency to consultation, co-determination or even decision-making by the citizens. Concerning the SPARCS activities, concentrating mainly on the first two levels, as the measures have already been defined, but there is still room for creativity.

The typical case in the project is company-driven implementation of decentral actions, where a specific local target group is to be won as customers for user centric solutions in order to demonstrate the potential contribution of all these actions taken together to the development of energy-positive districts. This means that separate customer groups are addressed for each action using different/adapted participation formats. As part of the action, regular workshops are designed, carried out and evaluated together with the companies concerned. In doing so, both classical and innovative formats are experimented with. The selection is based on an analysis of successful formats in comparable European projects and experiences of the city of Leipzig. During the project, an iterative process will be established to continuously develop the participation concept on the basis of lessons learned.

Concerning the regular workshops, the project started with a first workshop to identify relevant stakeholders for the implementation of SPARCS measures in Leipzig on 7 November 2019, followed by two workshops to discuss the draft of the SPARCS participation concept for Leipzig on 23 April 2020, and to discuss the adaptation to Covid-19-related restrictions on 27 May 2020. The first workshop to establish an exchange of experiences between the SPARCS cities on the topic of citizen engagement took place within the Leipzig City Café at the annual meeting on 7 October 2020. The exchange was continued on 1 June 2021 with a workshop on the adaptation of citizen Engagement to the "New Normal" (Covid restrictions) and on 23 September 2021 with a workshop on case study approaches for specific, hard-to-reach target groups. As part of the Leipzig Environment Days, a workshop was held on 29 June 2021 with Leipzig citizens on the topic of energy-positive neighbourhoods.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

Action **L21-3**	**Creating methodological approach for developing positive energy building blocks user centric solutions in the urban context and facilitating dialogues and discussion with citizens in the format of regularly scheduled workshops (4 per year), building upon Leipzig's long tradition of citizen engagement (FHG, SEE, LPZ)**	
Demonstration plan	• Step 1: Stakeholder analysis • Step 2: Collection of relevant participation formats (desktop research) • Step 3: Evaluation of the experiences of other SCC1 projects regarding their relevance for Leipzig (Task 1.6 questionnaire) • Step 4: Collection of participation experiences in Leipzig (interviews) • Step 5: Compilation of relevant participation formats for Leipzig • Step 6: Development of guidelines for participation in Leipzig • Step 7: Implementation, evaluation and adaptation of participation formats	
Roles and responsibilities	**FHG: task leader**; management and control of the action SEE: partner; innovator; mediator / networker LPZ: partner; mediator / networker	
Schedule	M1-M12	Stakeholder analysis, Desktop research of participation formats
	M6-M10	Interviews with Leipzig actors
	M10-M12	Discussion of possible participation formats for Leipzig
	M13-M60	Implementation of workshops, continuous evaluation of implemented formats and adaptation of the participation concept based on lessons learned
Milestones/ Tangible outcome	M12	Methodological basis for the participation concept (toolbox prepared in Task 1.6)
	M48	Input for the Report on Citizens and stakeholders in Leipzig's energy transition
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	None	
Progress made until M24	Basic collection of participation formats for Leipzig, first steps of implementation	

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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

5.2.3 Empirical research (ULEI)

ULEI will investigate the socio-psychological factors driving citizens to get, and stay, involved in district-based smart and ecologically sustainable energy management. This enables both improving monitoring and steering of specific community actions (district-based positive energy communities) as well as to derive transferrable knowledge about the “human factor” in implementing pro-ecological community innovations. Specifically, on the one hand, ULEI plans to measure person-level factors, such as personal attitudes or perceived personal competences. In addition, ULEI will capture collective-level factors, such as identification with the community, perceived energy-related and project-related community norms, and perceived collective efficacy to improve sustainable energy use as a community. Person- and collective-level factors will be measured at three time points (longitudinal evaluation study design) during SPARCS intervention to assess behavioural change and effectiveness of interventions.

ULEI will also make use of an experimental design by implementing control groups with no SPARC measures to ensure that intrapersonal behavioural change and effects of SPARCS measures are not due to “learning effects” by filling out the survey questionnaire repeatedly. This research program will enable ULEI to investigate causality, from which communication strategies can be derived and communicated to project partners.

Action L21-4	Conducting a comprehensive empirical research program on how personal-level (e.g. personal attitudes) and collective level variables (social identity variables) provide pathways to positive energy districts and communities, identifying the ingredients of successfully communicating collective sustainability transitions that in fact change people’s course of action (ULEI, LPZ)
Demonstration plan	In close collaboration with WSL, ULEI will gather data at different time points in the implementation phase of subtask T4.2.3 Efficient and human-centric social housing blocks. The implementation phase has been rescheduled to begin in Summer 2021. Public information events will be used for Duncker neighbourhood citizens (part of L21-1 and L21-2) to invite citizens to collaborate by filling out questionnaires at different stages of the implementation process, aiming at 3 points of measurement. Each point of measurement consists of three phases: (1) distribution of announcement flyers, (2) distribution of survey questionnaires, (3) collection of survey questionnaires. A week before data collection starts, each household in the sampling area will be informed via flyers about the day and time frame ULEI employees will personally distribute survey questionnaires to households. Surveys will be accessible in a paper-pencil format only, for which participants will have one week to fill out. One week after distribution of the survey questionnaires, ULEI employees will personally collect filled out questionnaires. In case

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No. 864242
Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

	(potential) participants are not at home at phase 2 and/or 3, survey questionnaires or stamped envelopes will be placed in the mailbox. These data collection phases are planned to be repeated at later measurement points (potentially in fall 2021 and spring 2022) to assess effects of SPARCS-measures. In addition to the survey in the Duncker neighbourhood, where SPARCS-measures are being implemented, the survey will also be conducted in two areas in Leipzig where no measures are taking place These act as necessary control groups in order to be able to make more robust statements about the effectiveness of SPARCS-measures. The data will be analysed, and the results presented to both WSL and the Leipzig project consortium, discussing interpretation and implications for improving the implementation process at Duncker neighbourhood and other places (e.g., with regard to properly communication sustainability transformation). Further investigations on the ground of our specific results will be selected and specific data collection opportunities that elucidate in close coordination with the project partners. Results of the 1st survey will also be included in D4.6 Citizens and stakeholders in Leipzig's energy transition (report).	
Roles and responsibilities	**ULEI task leader:** Conducting empirical survey and experimental research on person-	
Schedule	M19-M24	preparations & data collection at Duncker neighbourhood and neighbourhood acting as control group (1st survey)
	M25-M28	Data entry, data analyses and reporting
	Approx. M25-M60	Preparation and conducting 2nd and 3rd survey, and further analyses and reporting
Milestones/ Tangible outcome	M28	Presentation of Results of the Duncker neighbourhood study (1st survey)
	M34	Presentation of the further analyses and findings on effectiveness of SPARCS-measures
Deviations from initial plan (GA)	None	
New deviations into plan (as compared to D4.1)	• The implementation phase was originally scheduled to begin in autumn 2020 but had to be postponed Summering 2021 as the Corona pandemic delayed project onset in the target neighbourhood • Research program has been specified	
Progress made until M24	Data collection of 1st survey will be completed by end of M24	

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Additional info	Due to current circumstances of COVID-19 the starting point for data collection at Duncker neighbourhood might be postponed.

6. Replication and exploitation preparation (LPZ, BABLE, WSL, LSW, CEN, SEE, ULEI, SUITE5, CiviESCo)

All work in the Lighthouse Demonstration City Leipzig aims at developing solutions and services for future energy positive blocks (EPB) and districts to reach the development goals of sustainable Leipzig. Replication and exploitation opportunities is the driver for the actions. SPARCS offers a platform for demonstrating, analysing, evaluating and optimising the solutions as well as collaboration means and community engagement models.

The task will:

- deliver a Post-SCC01 Monitoring Strategy (M48),
- prepare for immediate replication in selected energy districts e.g., dwellings owned by the municipal housing association spread out across the city and Stadtraum Bayerischer Bahnhof,
- develop future tools for city planning,
- evaluate governance models,
- further the creation of local business models.

Replication is additionally supported by collaboration with existing networks, such as NEU e.V. and Metropolregion Mitteldeutschland, which bring together more than 75 actors in the field of renewable energy solutions and SMEs.

Results of the task will be included in D4.7 Replicating the smart city lighthouse learnings in Leipzig (report).

T4.7	Replication and exploitation preparation
Demonstration plan	Preparing for replication is one major aspect of SPARCS. Already during project implementation necessary networks with property developers of different districts and other property owners (e.g. housing associations) will be established and the progress of the SPARCS demonstrations will be illustrated. Based on the development plans of the districts roadmaps for replication will be drafted. Furthermore, the results and findings of D4.3, D4.4, D4.5 and D4.6 will be evaluated and recommendations and guidelines for the further developments of PEDs will be drafted. Actual and future strategic documents of the City of Leipzig regarding climate protection and energy transition will be monitored and the possible contribution of the SPARCS introduced actions toward the achievement of the set goals will be illustrated.

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	The replication preparation will consist of several workshops with relevant stakeholders from city administration, SPARCS implementation partners, property developers and civil society.	
Roles and responsibilities	<u>**LPZ: task leader**</u> WSL, LSW, CEN, SEE, ULEI, SUITE5 – input from local demonstrations (T4.2, T4.3, T4.4, T4.6) BABLE – Input from WP 1 CiviESCo – Input from WP 7	
Schedule	M1-M36	in connection to T4.5 Integrating energy and building data into the Urban Data Platform of the City of Leipzig for advanced and integrated district and building planning (LPZ)
	M4-M36	In connection to T4.1 Apply KPIs (T2.1) and monitor Lighthouse project progress (LPZ)
	M8-M60	Ongoing exchange with regional working groups with involvement of City of Leipzig, Metropolregion Mitteldeutschland, NEU e.V. via participation in meetings, conferences etc. after implementation of T4.2-T4.4 (e.g., on-site visits etc.)
	M12-M36	Built-up contacts with property developers and property owners (presentation of SPARCS and demonstrations, development of road map for replication)
	M36-M60	GIS-based visualisation of Energy Positive Districts (in connection to Action L19-1)
	M36-M60	Prepare for immediate replication in selected energy districts, e.g., housing neighbourhood and Stadtraum Bayerischer Bahnhof (LPZ)
Milestones/ Tangible outcome	M36	Draft of Monitoring Strategy
	M48	Post SCC01 Monitoring Strategy
	M60	Report on Replication (D4.7 Replicating the smart city lighthouse learnings in Leipzig: technical, social and economic solutions with validated business plans)
Deviations from initial plan (GA)	Change of replication district Leipzig 416 to LWB premises The proposed replication district Leipzig 416 has massive delays due to a change of the property developer and related to that revised planning procedures incl. new city council decisions. This leads to a massive delay in the planning and construction phases which won't start before 2023.	

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	As the change of demo blocks in T4.2.3 gives new opportunities for ensuring replication in Leipzig as it is now focusing on existing buildings from 1970ies in the Duncker-Mixed use Neighbourhood,
New deviations into plan (as compared to D4.1)	Besides the change of the replication district there are no effects on the timing and content of T4.7.
Progress made until M24	Progress has been made to align upscaling, replication and exploitation activities between the different WPs. Exchange with WP4 partners and also with the second Lighthouse City Espoo on the alignment of replication activities is taking place and ongoing. Discussions with different city departments is ongoing to secure synergies with other municipal initiatives e.g., energy-oriented refurbishment of different districts.

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7. ACRONYMS AND TERMS (ALL)

API: Application programming interface

AMR: Annual Mismatch Ration

BUS-LI-BE: electric buses sharing station

CDR: Community Demand Response

CES: Community Energy Storage

CHP: Combined Heat power

DPCA: Dual Participation and Collaboration Approach

EEG: Erneuerbare Energien Gesetz (engl. Renewable energy law)

EPB: energy positive blocks

EPN: energy positive neighborhoods

EV: electric vehicle

FIG: Figure

GA: General Assembly

GeoAR: augmented reality with geodata

GHG: Greenhous Gases

GmbH: Gesellschaft mit beschränkter Haftung (German for Ltd. Company)

HTTPS: Hyper Text Transfer Protocol

HVCA: Heating, Ventilation and Air Conditioning

ICT: Information- and Communication techniques

ID: identification

IEQ: indoor environment quality

IoT: Internet of Things

IT: Information Technologies

IRPopt: Integrated Resource Planning and Optimisation (ULEI)

KPI: Key Performance Indicator

LCOES: levelized cost of energy storage

LED: light-emitting diode

LoI: Letter of Intent

LoRaWAN: Long Range Wide Area Network

LVOES: levelized value of energy storage

MHD: Maximum Hourly Deficit

MHS: Maximum Hourly Surplus

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MILP: mixed integer linear program

MQTT: Message Queuing Telemetry Transport

MVP: minimal viable product

No: Number

OER: Onsite Energy Ration

PBP: payback period

PECM: positive energy community management

PED: Positive energy district

PV: photovoltaic panels

PtH: Power-to-Heat

RES: Renewable energy system

RPL: Monthly Ratio of Peak hourly demand to Lowest hourly demand

SC: self-consumption

SCC1: Smart Cities and Communities

SCR: self-consumption ratio

SMA: system measurement and plant engineering

SME: System Management Entity

STP: Spanning Tree Protocol

UDP: Urban Data Platform

VPP: Virtual Power Plant

V2G: Vehicle-to-Grid

WAN: Wide Area Networks

WP: Work package

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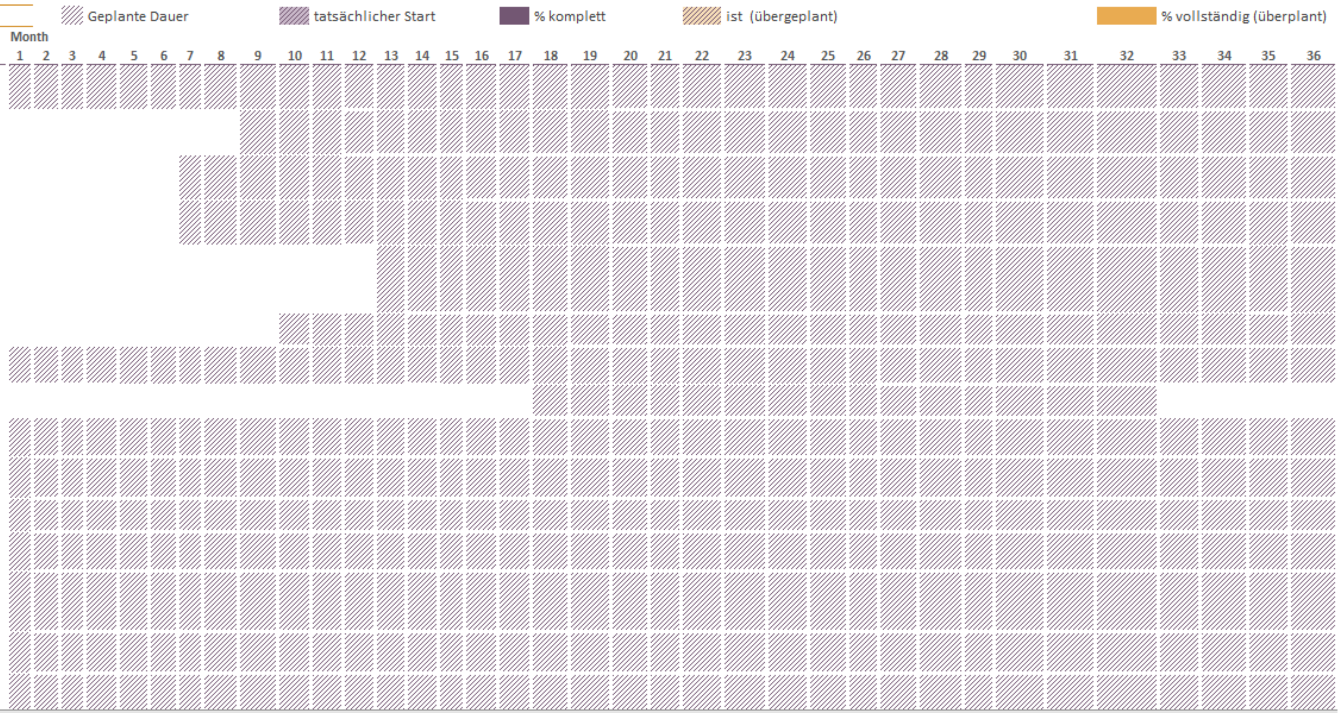
8. GANTT CHART – D4.2 MIDTERM REPORT ON THE IMPLEMENTED SOLUTIONS FOR ENERGY POSITIVE BLOCKS IN LEIPZIG

	Task	Start	Duration	Milestone	1	Ready
L6-1	Demonstration of integration of RES in the central district heating network ()	1	18	12	1	0%
L6-2	Estimating potential for using additional RES in the central district heating network (LSW, LPZ, ULEI)	7	5	0	1	0%
L7-1	Integration of a Power2Heat (LSW, ULEI)	5	10	0	1	0%
L8-1	Linking of the existing and newly constructed heat storage solutions with the demand (LSW, ULEI)	1	18	12	1	0%
L6-3	Research to increase the share of renewable energies in the district heating network (LSW, LPZ, ULEI)	32	27	35	1	0%
L6-4	Assessing waste heat potential (LSW)	1	18	0	1	0%
L2-1	Installation of equipment (CEN)	5	22	14	1	0%
L2-2	Balancing the micro Grid (CEN, LSW)	3	3	0	1	0%
L2-3	Analysing and integrating Energy storage solution (CEN, SEE, FHG)	12	13	0	1	0%
L3-1	Coupling the heating needs (CEN)	12	16	18	1	0%
L3-2	Provide user-interface (CEN)	4	54	32	1	0%
L4-1	Peronalized informative Billing (WSL, Suite5)	12	24	20	1	0%
L4-2	Demonstration of Dynamic Thermal Energy Tariff (WSL, Suite5)	13	11	18	1	0%
L5-1 u.	Human-Centric Energy Management and Control Decision Support (Suite5, WSL)	1	29	14	1	0%
L4-3	Appropriate comparison mechanism	1	60	0	1	0%



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Topic: LC-SC3-SCC-1-2018-2019-2020: Smart Cities and Communities

L4-4	Improving the connectivity of buildings (WSL, Suite5)	13	11	14	1	0%
L4-5	Assessment of different tariff schemes (WSL)	9	21	15	1	0%
L4-6	Feasibility study (WSL)	11	19	19	1	0%
L4-7	Demonstration of decentralised energy storage within building blocks (WSL)	10	16	20	1	0%
L9-1	The integration of RES (LSW, WSL)	6	24	25	1	0%
L10-1	Integration of standardized sensor (LSW)	3	33	12	1	0%
L11-1	Establishment of a distributed cloud-centric ICT System (LSW, WSL)	9	16	0	1	0%
L11-2	Real-time simulation of the integration of an existing 10 MW battery storage (LSW, BMW)	8	25	21	1	0%
L9-2	Study the replication potential of the Positive Energy Community(LSW, LPZ)	1	12	0	1	0%
L17-1	Feasibility study on the coordinating role of blockchain (LSW)	6	12	8	1	0%
L17-2	Developing new potential blockchain-based solutions (LSW, StromDOA)	1	35	0	1	0%
L17-3	Demonstration of the integration and interactions of IoT devices (LSW)	3	27	24	1	0%
L18-1	Model development (ULEI)	1	24	15	1	0%
L18-2	Defining and developing the interface to the municipal data platform (ULEI)	12	12	18	1	0%
L18-3	Demonstrating the optimal prediction of user behavior (ULEI)	15	9	0	1	0%
L18-4	Extending the virtual community to Leipzig (ULEI)	1	35	6	1	0%
L12-1	Implementation of a human-centric interface (Suite5)	30	30	0	1	0%

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SPARCS

L13-1	Demonstration of Energy Behavioural Profiles (Suite5)	1	60	0	1	0%
L14-1	Maximising of energy savings at the community level (Suite5)	12	22	20	1	0%
L15-1	optimizing load-depending electric busses charging stations (LSW, FHG)	7	21	18	1	0%
L15-2	Integration of Bus disposition schedulel (LSW, FHG)	6	30	24	1	0%
L15-3	Implementation of a standardized charging station monitoring (LSW, FHG)					
L16-1	Upgrade existing charging stations(LSW)	4	32	14	1	0%
L16-2	Explore business models and services tailored for residents (FHG, LSW, WSL)	1	36	0	1	0%
L16-3	test a mobile user application (FHG, LSW, WSL, LPZ)	1	36	0	1	0%
L16-4	Demonstrate load-balancing with an electric vehicle flee (FHG, LSW, WSL, LPZ)	1	36	0	1	0%
L1-1	Development of bidirectional e-charging system (CEN)	1	36	0	1	0%
L1-2	Eco-friendly and CO2-reducing corporate e-car sharing (CEN)	3	33	0	1	0%
L1-3	Demonstrate bi-directional charging with micro grid stabilisation (CEN)	3	33	0	1	0%
L1-4	Extend the charging optimization algorithms for EVs bi-directional charging (FHG)	1	36	12	1	0%
L19-1	Integrating energy and building data into the Urban Data Platform (LPZ)	1	60	0	1	0%
L19-2	Identify the requirements how buildings can be integrated into the Positive Energy Community (LPZ)	6	21	9	1	0%
L20-1	Assessment of a standard model (LPZ)	6	21	9	1	0%
L21-1	Establishing community management/energy advisor (SEE, LPZ, FHG)	1	60	0	1	0%
L21-2	Desk support for interested citizens(SEE, LPZ, FHG	1	60	0	1	0%
L21-2	Desk support for interested citizens(SEE, LPZ, FHG	1	60	0	1	0%
L21-3	Creating methodological approach for developing positive energy building blocks (FHG, SEE, LPZ)	1	36	8	1	0%
L-21-4	Conducting a comprehensive empirical research program(ULEI, LPZ)	5	31	9	1	0%

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