D4.1 Detailed plan of the Leipzig smart city lighthouse demonstrations

30/09/2020

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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	**D4.1 Detailed plan of the Leipzig smart city lighthouse demonstrations**				
Status	Released	**Due**	M12	**Date**	2020-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 SPARCS objectives and efficient co-operation within the Leipzig Lighthouse Demonstration Team, parallel work packages, other stakeholders and supporting partners, as well as the Sustainable Espoo development programme. The main activities include, among others: keep strict control of the lighthouse implementation process and schedule. This report presents a detailed plan of demonstration actions and sub actions in Lighthouse City Leipzig. It includes a detailed Gantt for the demonstration phase and responsibilities. It also shows the preparation for the monitoring phase towards Milestones 8 - Completion of the demonstration sites, which is due in M30.				
Participants	LEI, LSW, CEN, SEE, ULEI, WSL, FHG IMW, SUITE5, FHG IAO				
Comments					

V	Date	Authors	Description
0.1	01/2020	MH	1st draft, content planning and writing responsibilities
0.2	06/2020	ALL	1st draft Leipzig partners
0.3	31/07/20	LPZ	2nd draft Leipzig partners
0.4	01/09/20	LEI	Deliverable checked by WP leader and released to reviewer (LPZ + ESP)
0.5	17/09/50	VTT, LEI	Feedback from reviewers (VTT, LEI)
0.6	21/09/20	LEI	Feedback included, released to coordinator and QM
1	day/month /year	VTT	Coordinator submits the deliverable to the EC

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About SPARCS

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

Partners

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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SPARCS

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EXECUTIVE SUMMARY

This report presents a detailed plan of demonstration actions and sub actions in Lighthouse City Leipzig. It includes a detailed Gantt for the demonstration phase and responsibilities. All WP 4 partners have contributed to this deliverable.

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1. INTRODUCTION

1.1 Purpose and target group

This report gathers together detailed plans for the demonstration actions and their sub actions. A detailed Gantt shows the schedules for the demonstration 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 kinds of smart city developments.

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. Content planning, allocation of writing responsibilities. Chapters 1 + 5.1 + 6
LSW	Chapter 2.1 “Introduction to task 4.2”, including the description if the actions and coordinating with the partners / Chapter 3.1 “Introduction to the task 4.3” / Chapter 3.2 Description of the subtask “Virtual Power Plant and Storage Solution”, including the description of the actions and coordinating with the partners / Chapter 3.3 Description of the subtask “Blockchain supported energy services”, including the description of the actions / Chapter 4 Introduction “E-Mobility Integration in Leipzig Lighthouse Demonstrations” / 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 stabilization”
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”

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ULEI	Chapter 2.2, 3.2, 3.4 and 5.2.3
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 Relations to other activities

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

Table 2. Relation to other activities in the project

Deliverable / Milestone	Contributions
D4.2	This deliverable D4.1 is the starting point for deliverable D4.2, which reports the implemented demonstrations of solutions for energy positive blocks in Midterm (due in M24).
D4.3	Supports D4.3: Implemented demonstrations of solutions for energy positive blocks in Leipzig (due in M36).
M8	Support for completion of the demonstration sites in Leipzig in M36.
WP2	The KPIs defined for the different WP 4 are part of the WP 2 Monitoring and Impact Assessment.

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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 demonstrate a wide spectrum of different topics.

Mix 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 possibilities 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 optimize the energy flows 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 use as a master for other existing districts in the city.

This task includes all demonstrations of solutions for energy positive blocks in Leipzig, distributed 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

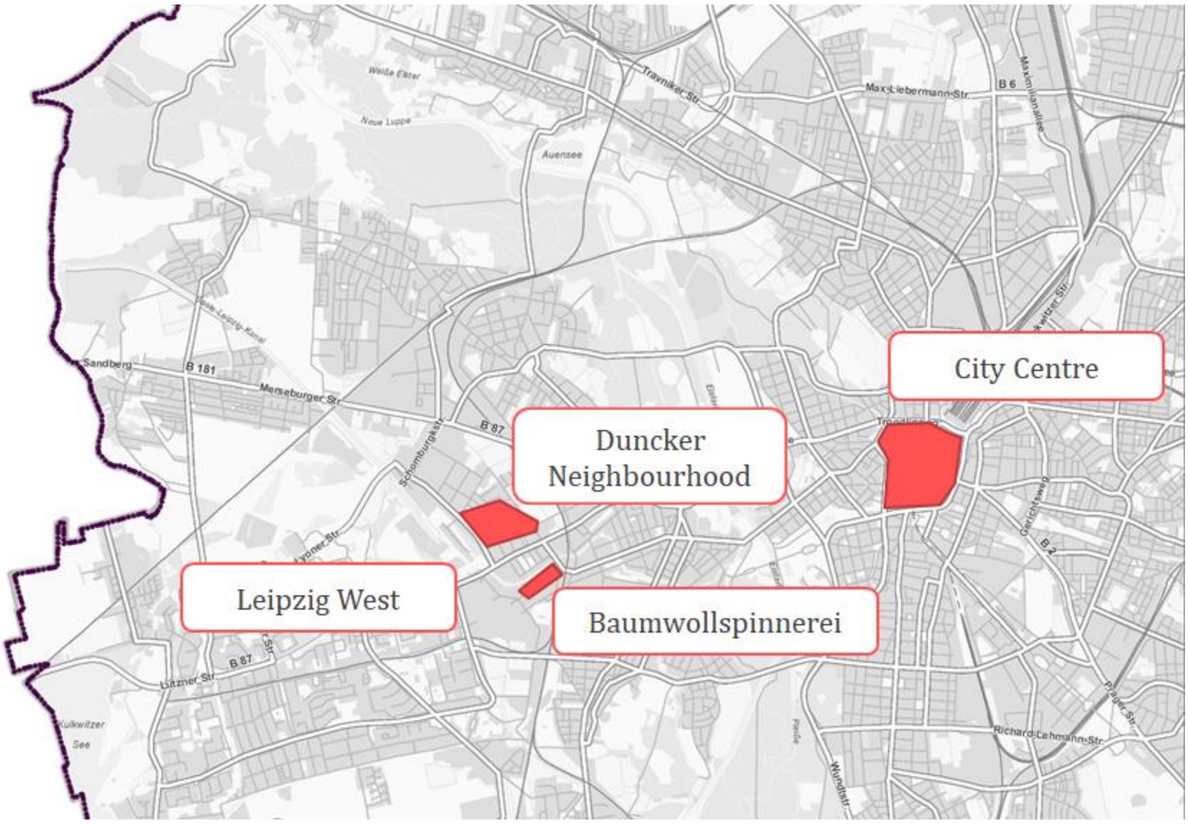
2.2 Carbon-free district heating in "Leipzig West" (LSW, ULEI)

The Subtask 4.2.1 "Carbon-free district heating in "Leipzig West" aims 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 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 a way for this post-fossil future would look like.

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

Fig. 1: Location of demo districts



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

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"Lausen" in Leipzig West. We will analyze how two fallow former industrial areas of energy use can be used to generate environmentally friendly solar thermal heat.

L6-2 Estimating potential for using additional RES in the central district heating network.

L7-1 Integration of a P2H and 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 centers and sewers as well as process heat.

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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 - specifically at "Leipzig West". We will analyze how two fallow former industrial areas of energy use can be used to generate environmentally friendly solar thermal heat.	
Demonstration plan	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 by 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. Following the finalization of the conceptual design phase in the coming weeks, a key milestone will be at the beginning of December 2020. This concerns a project specific tender to secure funding from the federal government (subsidy to support renewable and innovative heat generation for district heating). After successful participation, the project will go into the next phase, which includes the tendering by LSW for solar thermal plant suppliers, continuing the detailed engineering phase and the achievement of official approval by the city (LPZ). In the final phase, the solar thermal plant and its auxiliary facilities will be build and commissioned and the integration into the district heating grid will commence. Upon successfully completing the monitoring phase, the new solar thermal plant will be handed over to the operation and service team. ULEI applies a techno-economic model for the demonstration district. Customer groups are clustered according to the demonstration district borders. Then data regarding the energy balance has to be collected for the demand side. Current heat supply technologies will be added for the status quo scenario. For the green scenario, different amounts of solar heat are added to the system.	
Roles and responsibilities	**LSW: task leader, coordinator, owner of the generation plant** LPZ: Support with the location process ULEI: Scientific supervisor	
Schedule LSW	M1-15	Clarification of the property issue with the City of Leipzig
	M4-M10	Start of conceptual design phase (est. 6 months)
	M15	Successful participation in federal tendering, funding is secured
	M28	Start of the construction / build start

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	M36	Commissioning of the system and integration of solar thermal power plant into LSW Digital Platform and energy community
Schedule ULEI	M1-M10	Clustering of customer groups, data collection
	M10-M12	Model setup
	M12-M15	Scenario analysis and evaluation
	M19-M36	Monitoring and model refinement
Milestones/ Tangible outcome	M15	Model results and evaluation (report, contribution to D4.2)
	M36	Commissioning of the solar thermal plant and integration in the central district heating system
	M36-60	First data receipt from asset
Monitored KPIs	• Supply of renewable heat to the grid in MWh/a (overall) • Supply of renewable heat to the 2 project specific districts in MWh/a • Amount of saved CO_2 emissions in t/a	

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Action L6-2	Estimating potential for using additional RES in the central district heating network	
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 serves to gain important knowledge with regard 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 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 the integration in the district heating network.	
Roles and responsibilities	**LSW: task leader, coordinator** 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 modeling 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
Monitored KPIs	none	

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Action L7-1	**Integration of a Power-to-Heat and a heat storage in the existing district heating network.**	
Demonstration plan	LSW plans to build a Power2Heat plant as well as a heat storage system in parallel to the planning and construction of the solar thermal plant. The Power2Heat plant will be realized by the same project team tasked with the construction of the solar thermal plant. Therefore, the realization plan and schedule are almost identical. The heat storage system will be part of the new cogeneration plant project, planned 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 in 2022. ULEI Extension of the scope of L6-2. ULEI integrates the above-mentioned technologies in the model and evaluate the effect on cost and emissions. Fig. 2: Visualisation of heat storage 	
Roles and responsibilities	**<u>LSW: task leader, coordinator, owner and operator of the plants</u>** ULEI: Scientific supervisor:	
Schedule LSW	M4-M10	Start of conceptual design phase (est.6 months)
	M15	Successful participation in federal tendering, funding is secured
	M28	Start of the construction
	M36	Commissioning of the system
Schedule ULEI	M13-M15	Workshops to define the modeling scope

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	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	Commissioning of the solar power-to-heat plant and integration in the energy system.
Monitored KPIs	• Number of operating hours per anno	

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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	LSW operates the district heating grid at elevated temperatures, depending on the season, above the boiling point of water. Therefore, to increase the degree of utilization and efficiency of the CHP Combined Heat & Power plants in the grid a pressurized hot water storage system was constructed in the recent past. To increase the heat storage capacity, a new hot water storage tank will be constructed together with a new CHP plant. To facilitate elevated water temperatures without boiling, an insulated layer in two zones divides the tank. The cooler top zone increases the pressure in the bottom zone, enabling temperatures above boiling point. The heat storage system will be located in the south of the city, at a different location than the existing heat storage. 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 in 2022.	
Roles and responsibilities	**LSW: task leader, coordinator, owner and operator of the plants** ULEI: scientific supervisor	
Schedule	M3	Finish of conceptual design phase
	M7-M11	Tendering of supplier contract
	M12-M18	Detailed engineering
	M22	Start of the construction
	M28-M34	Commissioning of the system
	M35	Hand-over and start of regular operations
Milestone/ Tangible outcome	M22	Start of construction works
	M45-60	Commissioning of the system and regular operation
Monitored KPIs	• Stored heat in MWh per anno • Supplied heat to heating grid per anno	

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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	**LSW: task leader, coordinator** LPZ: Feedback from municipal strategies ULEI: Potential analysis and Review of technical and economic feasibility	
Schedule	M13-M15	Workshops to define the modeling scope
	M12-M14	Data collection and Model setup
	M15-M18	Scenario analysis and evaluation
	M19-M24	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: • Current 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)
Monitored KPIs	none	

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Action 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 centers and sewers as well as process heat.**	
Demonstration plan	One goal of future energy solutions is to operate sector coupling so that waste heat from industry and commerce can be used for heating applications. Potential waste heat sources in urban areas are to be localized, analyzed and their suitability for heat use is assessed. Examination of possible waste heat sources suitable for the integration of district heating.	
Roles and responsibilities	**LSW: task leader**	
Schedule	M10-M14	Development of localization concept of urban waste heat sources
	M15-M20	Application of the localization methodology and collection of waste heat data
	M21-M25	Analysis and evaluation of waste heat sources
	M26-M36	Further processing of the results in 6-3 Concept development
Milestone/ Tangible outcome	M36	Report, which includes the following points: • Localization concept • Potential waste heating in numbers • Check compatibility with district heating requirements
Monitored KPIs	none	

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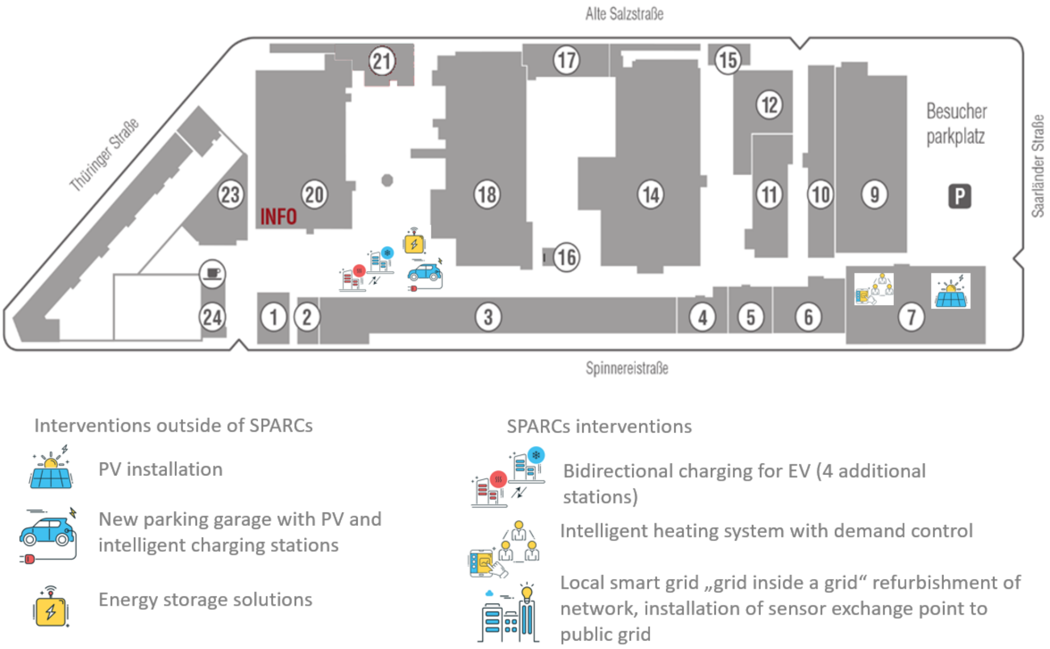
2.3 Optimal energy distribution in industrial Spinnerei block (CEN, LSW)

The premises of the Baumwollspinnerei (former cotton mill) are protected as heritage buildings and were originally constructed in 1884. The buildings are mainly built of brick and partially renovated. The buildings demo area is approximately 30,000m^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 Baumwollspinnerei 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 of building No. 7.

The start-up Accelerator SpinLab, which is based at the Baumwollspinnerei 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 Baumwollspinnerei premises include intelligent heating demand control, utilising the old walls of the buildings functioning as 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. 3: Map of Baumwollspinnerei area*



* The numbers in Fig. 3 refer to the labelling of the different buildings.

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Fig. 4: Entrace area of Baumwollspinnerei

Fig. 5: Impressions of Baumwollspinnerei

SPARCS interventions 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

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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 tenants 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 demonstrate 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 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 building No. 7 or No. 11 in the Baumwollspinnerei and will in combination with an electrical battery be used to increase the percentage of renewable energy in the network. There will also be sensors and controlling equipment installed, to ensure user demand control. There is a combined heat and power (CHP) unit already in the network and it will also be used in the intelligent balancing of the energy network. The roofs of buildings No. 7 and No. 11 are shown in the figure below. Fig. 6: Building No. 7 + 11 at Baumwollspinnerei 

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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 building No. 7 or No. 11.
	M6-M12	This phase will prioritise collaborating with partners to agree the timeline, design, and concept in order to prepare the construction through selection of technology and contractors.
	M12-M24	The purchase and installation of the solar PV panels on building No. 7 or No. 11 in the Baumwollspinnerei.
	M18-M24	The purchase and installation of all controlling equipment i.e. sensors and meters, installed and fine-tuned.
	M24-M36	Parametric configuration of the sensors and controlling equipment, and the initial data collected from the system.
	M30-M36	Analysis of the initial data bank and initial data to ensure configuration and reliability of the system and equipment.
	M36-M60	Demonstration of action L2-1 Present a working showcase of the whole energy system for interested fellow city consortiums. To include the solar PV panels and an explanation of the sensors and equipment used to control the energy system combined heat and power station and stabilisation of the electrical and heat grids.
Milestones/ Tangible outcome	M12	Concept confirmed and aligned with Partners
	M18	The installation of the solar PV panels
	M24	The installation of the technical components
	M30	Documentation of fixed parameters for the equipment
	M36	A working database is developed and operational
Monitored KPIs	• Flexible loads: number of smart meters • Share of integrated systems (smart control/ VPP/ storage) • Share of energy import or energy production self sufficiency	
Additional info	The solar PV panels will be installed on the roof of building No. 7 or No. 11 (depending on new Space for SpinLab)	

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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 decentralized energy generation technologies such as solar PV panels connected to flexible power consumers and energy storage. One part of this system is an interconnection to the energy microgrid at Baumwollspinnerei to buy and sell energy. CEN will install an energy monitoring at the transformation station near Baumwollspinnerei to measure how the energy flow between Baumwollspinnerei and the Leipzig citywide energy grid is. 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	**<u>CEN: task leader</u>** LSW: responsible to deliver an interface for peer-to-peer energy trading	
Schedule LSW	M21	Integration of electrical substation at Baumwollspinnerei to realize 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.
	M24	Definition of an interface for data exchange between microgrid and city-wide virtual power plant
	M30	Start of peer-to-peer trading Billing of energy transactions is implemented
	M32	Consideration of the micro network in optimizing the city-wide virtual power plant Automate energy trading and information exchange, maybe with using blockchain
Milestones/ Tangible outcome	M18-M24	Letter of Intent with a confirmation of which part of the energy network are included in the balancing of the microgrid and the virtual power plant.
	M32	Successful installation, qualification and maintenance plan in place for the Equipment.

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	M36	Present a working showcase of the whole energy system for interested fellow city consortiums. To include the Solar PV Panels and an explanation of the sensors and equipment used to control the energy system combined heat and power station and stabilisation of the electrical and heat grids.
Monitored KPIs	• Flexible Loads: Number of smart meters • Share of integrated systems (smart control/ VPP/ storage) • Total energy generation • Energy Market: participation in market type	

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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-M18	This phase will prioritise collaborating with contractors to agree the timeline, design, and concept in order to prepare the construction through selection of technology.
	M18-M24	The purchase and installation of the battery system in the premises of the Baumwollspinnerei
	M18-M24	The purchase and installation of all controlling equipment i.e. sensors and meters, installed and fine-tuned.
	M24-M36	Parametric configuration of the sensors and controlling equipment, and the initial data collected from the system.
	M30-M36	Analysis and evaluation of the initial data bank and initial data to ensure configuration and reliability of the system and equipment.
	M36-M60	Demonstration of action L2-3 Present a working showcase of the whole energy system for interested fellow 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.
	M18	Concept confirmed and aligned with Partners

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Milestones/ Tangible outcome	M24	The installation of the battery
	M24	The installation of the technical components for controlling system
	M36	Documentation of fixed parameters for the equipment
	M36	The working database is developed and operational
Monitored KPIs	• Flexible Loads: Number of smart meters • Share of integrated systems (smart control/ VPP/ storage) • Energy Storage • Total energy generation	

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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. 7 or No. 11 (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. 7 or No. 11 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.	
Roles and responsibilities	**CEN: task leader**	
Schedule	M1-M6	The concept, design and planning for the installation of sensors in building No. 7.
	M6-M18	This phase will prioritise collaborating with partners to agree the timeline, design, and concept in order to prepare the construction through selection of technology and contractors.
	M18-M24	The purchase and installation of the sensors in building No7 in the Baumwollspinnerei.
	M24-M30	Parametric configuration of the sensors and controlling equipment, and the initial data collected from the system.
	M30-M36	Analysis of the initial data bank and initial data to ensure configuration and reliability of the system and equipment.
	M36-M60	Demonstration of action L3-1 A showcase of an application integrated and running with capability for tenants to use for their energy needs and give feedback as to how and when they change in consumption behaviour. The application would demonstrate how the information of consumption behaviour within a

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		heating grid is going to help to increase flexibility in heat 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	M24	Installation, qualification of the sensors.
	M36	Data bank qualification complete
Monitored KPIs	• Flexible Loads: Number of smart meters • Share of integrated systems (smart control/ VPP/ storage) • Total energy generation • Share of integrated systems (smart control/ VPP/ storage)	

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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 behavior, the demand is expected to be lowered.**	
Demonstration plan	In the demonstration building, 7, there will be screens and tablets installed to allow the tenants direct access to the information received by the sensors installed (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 tablets will be used for the tenants to react to the information by giving feedback through the tablet. The action is linked to T21-1 by seecon.	
Roles and responsibilities	**CEN: task leader**	
Schedule	M1-M6	The concept, design and planning for the use of tablets in building No. 7.
	M6-M12	Collaborate with partner seecon to agree the timeline for informing tenants through a structured event with open dialogue
	M12-M18	The purchase and installation of the tablets in building No. 7 or No. 11 in the Baumwollspinnerei. Tenant information event takes place.
	M18-M24	Configuration of the sensors and controlling equipment (L3-1), with the Tablets and installation of the necessary software to run feedback portals and visualise data.
	M24-M36	Analysis of the tablet functionality, initial feedback from tenants and tenant information events. Tenant feedback event takes place.
	M36-M60	The guided user interface is complete and ready to be installed and used in the building No. 7. The tablet is installed and ready to be used in building No. 7. Demonstration of action L3-2 Present a working showcase of the whole energy system for interested fellow city consortiums. To include the Solar PV Panels and an explanation of the sensors and equipment used to control the

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		energy system combined heat and power station and stabilisation of the electrical and heat grids.
Milestones/ Tangible outcome	M12	Tenant Information Event
	M24	Installation of screen and tablet in Building No. 7
	M30	Tenant Feedback Event
Monitored KPIs	• Flexible Loads: Number of smart meters • Share of integrated systems (smart control/ VPP/ storage) • Total energy generation	

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

The Duncker neighborhood is located in Leipzig West, in proximity to the Baumwollspinnerei. Right next to the Lindenauer Hafen, which is an outstanding urban renewal program, which brings new life to a relict harbor in Leipzig West, it is a mixed district with an historic building stock. The district encompasses 31 buildings and 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 neighborhood is the ideal testing ground for the proposed user centric control, by means of a dedicated platform for an active involvement of citizens, in order to optimize energy flows.

Within the neighborhood, there are seven buildings with 300 apartments owned by LWB, which are supplied by district heating. These buildings will be our demonstration area. All apartments will be equipped with net (smart) metering technology for thermal energy. Within the district, a novel solution for optimizing 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 optimization of the utilities and therefore WSL will implement a dynamic thermal heating controller, which optimizes the heat production with the information of the real thermal need of the building (demand-centric).

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Fig. 7: Duncker neighborhood

In addition, the heat generation of the solar plant will be examined and compared (LSW) to the heat consumption of the demonstration buildings in a time-resolved manner with regard to the possibility of different tariffs from a district heating supplier.

The aim of this task is to properly configure and deploy a novel solution for optimizing thermal energy consumption through the implementation of novel 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. To apply dynamic tariff schemes as a cost-saving measure is of particular interest in social housing blocks.

An overall aim is to configure and deploy a novel solution for optimizing thermal energy consumption through novel human-centric thermal demand response programs.

L4-1: Personalized informative billing: Appealing applications and interfaces will be made available to consumers, allowing them to better understand their consumption patterns, their energy wastes and their flexibility to shift their consumption towards 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 towards altering their energy consumption patterns and shifting them away from peak periods. Exposure of consumers in 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 optimization 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

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occupants' comfort. Air quality info 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 the utilization of their energy consumption flexibility

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

<table>
<tr><th>Action
L4-1</th><th colspan="2">Personalized Informative Billing: Appealing applications and interfaces will be made available to consumers, allowing them to better understand their consumption patterns, their energy wastes and their flexibility to shift their consumption towards avoiding increased energy charges.</th></tr>
<tr><td>Demonstration plan</td><td colspan="2">• Application is LWB-App "Mein LWB" – existing application of the property owner LWB – NEW will be visualization of consumption and annual heating bill
• Visualization consumption monthly (thermal + hot and cold water)
• Application hosted by PROMOS
• L4-4 requirement
• Uni Leipzig is planning a consumer survey (L21-4)

Application developed by Suite5 will allow:
• Providing an overview of thermal consumption, annual billing information, and environmental impact per apartment
• Visualization 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 will follow the schedule of actions L5-1 & L5-2</td></tr>
<tr><td>Roles and responsibilities</td><td colspan="2"><u>SUITE5,</u> WSL</td></tr>
<tr><td>Schedule</td><td>M1-M6</td><td>Idea and how can it be realized. How can the consumers be integrated (communication-strategy)?</td></tr>
<tr><td></td><td>M6-M20:</td><td>Evaluation of prototype and first tests (laboratory) integrate into the application and connect the data to the meter-management. Including heating bill calculating</td></tr>
</table>

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		software and to the tenant's personal data / application ID clarify communication-strategy and first test buildings (preliminary action L4-4)
	M18-M20	Start communication with tenants
	M20	Field-test - Rollout to first building(s)
	M20-M30	First experience / feedback and optimization of application and continue rollout in demonstration area
	M30-M60	Continue rollout in demonstration area and test reproducibility outside demonstration 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 visualization consumption of thermal energy and cold / hot water – ready for field test and rollout Communication with tenants (depending on CoVid19)
	M60	Complete Rollout in demonstration area
Monitored KPIs	• User survey conducted by ULEI – results ULEI – 5.2.3 • Measurement of thermal energy consumption of the building and of each apartment	

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Action L4-2	Demonstration of Dynamic Thermal Energy Tariff schemes which will be made available to consumers and will engage them in action towards altering their energy consumption patterns and shifting them away from peak periods. Exposure of consumers in real-time energy prices will stand as the first action of engagement in energy saving actions.
Demonstration plan	• Generate frequent detailed information of thermal need in apartments to create real dynamic system and planning to install new heat cost allocators (sensors) in demonstration building that allows getting more frequent data (every 15 min) and information about temperature of the apartments (every 15 min). • Connect to information of production (heating system) to generate a forecast in first step and to control the system in real time in the second step • Build up a 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 • Automatic optimization of central thermal energy production in 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 provide: • Forecasting mechanism for the operator/producer of thermal energy in connection to the thermal energy production of the solar thermal system • Push of personalized notifications to local consumers to modify their consumption according to the adapted production plan, facilitating energy cost reduction for both sides involved and minimization 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) questioned 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 will follow the schedule of actions L5-1 and L5-2

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Roles and responsibilities	**WSL, SUITE5**	
Schedule	M1-M6	Idea and how can it be realized, how can the consumers be integrated (communication-strategy), clarify demonstration building in demonstration area (Duncker neighborhood)
	M6-M10:	Analyze test building and the local heating station, how can it be optimized and what is needed (preliminary action L4-4)
	M10-M12	Start necessary installations (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 analyze first data and integrate these data in laboratory situation
	M14-M22	Rollout the sensors and system into demonstration building and collect first real time data from demonstration building with new sensors and connect it to the production data of the solar thermal system (real data or simulated data)
	M18-M26	Automate the optimization and regulator for dynamic heating in laboratory situation and rollout to the demonstration building
	M26-M60	Optimization and controlling the dynamic heat station controller and analyze the real time consumption data with the production data (solar thermal energy) to create dynamic tariff schemes and input for consumption behaviors
Milestones/ Tangible outcome	M6	Start evaluation of dynamic heating controller
	M12	Sensors tested (in laboratory depending on CoVid19)
	M18	First full collection of data due to heating period
	M22	Finish rollout into demonstration buildings and Automate optimization with dynamic information of thermal need in the apartments / building
	M60	Finish data analyses about energy saving
Monitored KPIs	Reduce thermal energy consumption and CO_2generation of the building. Measure heating meter for thermal energy	
Additional info	L5-1 and L5-2 will be carried out in the same demonstration building	

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<table>
<tr><td>Action

L5-1 & L5-2</td><td 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 optimization 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.</td></tr>
<tr><td>Demonstration plan</td><td colspan="2">• Should be done in the same demonstration building as L4-2.
• Due to more frequent information out of apartments, the application (developed by Suite5) brings information back to the consumers

Application developed by Suite5 will allow:

• Creation of accurate comfort profiles
• Creation of targeted recommendations and guidance on control actions
• Based on the equipment available, provision of personalized information
• Verification and adaptation of comfort profiles and preferences
The schedule of the Suite 5 application will follow the schedule of actions L13.1, L14.1 and L15.1</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 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.</td></tr>
</table>

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	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-M20	Development of application Delivery of ready to test software by M20
	M20-M24	Verification and testing of the application
	M24-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 optimization with dynamic information of thermal need in the apartments / building
	M24	Tested and ready to be deployed application
Monitored KPIs	Reduce thermal energy consumption and CO_2 generation of the building. Measure heating meter for thermal energy.	
Additional info	L5-1 and L5-2 will be done in the same demonstration building	

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SPARCS

<table>
<tr><th>Action
L4-3</th><th colspan="2">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 utilization of their energy consumption flexibility.</th></tr>
<tr><td>Demonstration plan</td><td colspan="2">• Comparison mechanism in Application "Mein LWB" (L4-1)
• Comparison could be
    ○ in consumption of building energy index (kWh / m²)
    ○ → high or low consumer
    ○ between different buildings

Application developed by Suite5 will allow:

• Comparison of consumption with similar peers (neighbours, best/average/worst consumers, etc.) to motivate a change towards lower consumption.
• Visualization of the current performance vs similar peers via a ranking.
• Check of historical performance and rankings achieved
• Providing super user capabilities to the building manager, for agregated building information and overview related to ranking achieved per peer group.
The schedule of the Suite 5 application will follow the schedule of actions in L5-1.</td></tr>
<tr><td>Roles and responsibilities</td><td colspan="2"><u>WSL, SUITE5</u></td></tr>
<tr><td rowspan="6">Schedule</td><td>M1-M6</td><td>Idea and how can it be realized, how can the consumers be integrated (communication-strategy)</td></tr>
<tr><td>M6-M20:</td><td>evaluation of prototype and first tests (laboratory), clarify communication-strategy and first test buildings (preliminary action L4-4)</td></tr>
<tr><td>M18-M20</td><td>Start communication with tenants (field test)</td></tr>
<tr><td>M20</td><td>Field-test - Rollout to first building</td></tr>
<tr><td>M20-M30</td><td>First experience / feedback and optimization of application</td></tr>
<tr><td>M30-M60</td><td>Rollout in demonstration area + regular consumer surveys (planned and conducted by ULEI)</td></tr>
<tr><td></td><td>M6</td><td>Start evaluation of application + integration for comparison mechanism</td></tr>
</table>

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Milestones/ Tangible outcome	M20	Tested prototype - application and Interface for visualization 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
Monitored KPIs	User survey conducted by ULEI – results ULEI – 4.2.3 WSL can measure the thermal energy consumption of the building and of each apartment - if it is known who is using the application, WSL could use the information of consumption of the apartment (data protection law). The heat bill calculation and the data measured will be used (heat-cost-allocator, heating meter ...)	
Additional info	Integrated in L4-1 and also a part in L5-1 & L5-2	

Action L4-4	**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**	
Demonstration plan	• Installing internet-spots in basement (WSL "Telemetrie") to connect energy consumption meter (thermal) (L19-1 – integrate energy and building data into 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 get data for visualization consumption (L4-1). • Contact Vodafone to build up a building connectivity for collecting meter data and bring them together on one platform (raw data) incl. transfer system	
Roles and responsibilities	**<u>WSL, SUITE5</u>**	
Schedule	M1-M6	Clarify demonstration buildings in the demonstration area Duncker neighborhood for several actions (L4-1 and L4-3, L4-2 and L5-1 and L5-2) + first gateway tests + gateway strategy and rollout plan
	M6-M30:	Rollout Gateways in demonstration area + first experience and feedbacks
Milestones/ Tangible outcome	M30	Finishing rollout in demonstration area (for actions L4-1 – L4-3 and L5-1 / L5-2)
Monitored KPIs	preliminary action for integration of building consumption data into urban energy platform	

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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 as the basis for L4-6 • Impact on CO_2 reducing	
Roles and responsibilities	**WSL: Task leader**	
Schedule	M1-M14	Clarify assessment – consider different use cases, calculate different economic cases, talk to different manufactures and innovative start ups
	M14-M24	Finalize the assessment and bring it into a study
Milestones/ Tangible outcome	M24	Study / Assessment with recommendation for property owner
Monitored KPIs	Report / Study	
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 roofs of buildings in LWB and replication of informative billing • Mieterstrom (L4-5): roofs – how much power can be installed – how much CO_2 reducing can be achieved • Informative billing (L4-1): how much apartments – how much gateways are needed = gateway strategy and what is needed for roll out	
Roles and responsibilities	**WSL: task leader**	
Schedule	M1-M14	Screening of buildings and collecting data, clustering in different types

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	M14-M24	Finalize the study and combine the results L4-5 and calculate possible electric power and CO_2 reducing
Milestones/ Tangible outcome	M24	Study with recommendation for property owner
Monitored KPIs	• Electric power outcome and CO_2 reducing • Report / study	

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: task leader**	
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 analyzes of data for reporting
Milestones/ Tangible outcome	M10	calculation of system / storage
	M14	installation of storage
	M60	Report about storage and self consumption (incl. economic report)
Monitored KPIs	• Electric power outcome and CO_2 reduction by increasing amount of self-consumption in building. • Measure amount of Consumption through local produced electricity via meter	

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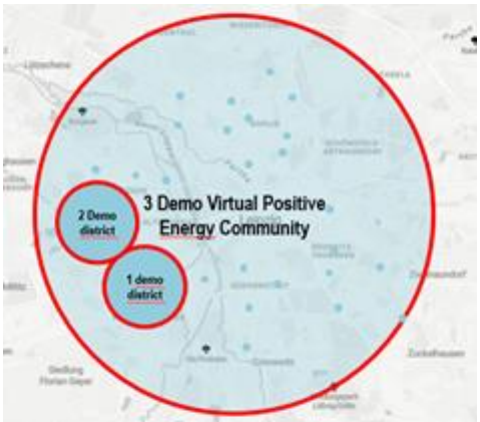
3. ICT AND INTEROPERABILITY IN LEIPZIG LIGHTHOUSE DEMONSTRATIONS

3.1 Intoduction to task 4.3 (LSW)

The main aim of T4.3. is to upgrade the interaction between energy producing, storing and consuming entities. From the current level based on energy network status (district heating and city medium/voltage electrical grid) to a virtual 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. 8: 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 group of buildings in a sub-urban area but rather to the variety of energy related actions virtually connecting the multiple buildings across the district on various locations. The implemented solutions bundle up a multitude of actions that will be partly integrated and implemented in "Leipzig West" as well as across other buildings within and across the city.[1] The annual heat production of the solar thermal plant is about 13 GWh/a. The Integration of the solar thermal plant into the district heating system wants to demonstrate how two former industrial areas (Baumwollspinnerei premises and "Leipzig West")[2] 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, both demonstration activities (Solar Thermal Plant and P2H storage integration) are intrinsically connected with the virtual positive energy community interventions, as the optimal control of the various energy systems is part of a bigger scale vision that the city has connected primarily to consumer behaviours.

[1] Notification of PO on necessary change

[2] Notification of PO on necessary change

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This task includes all demonstrations of solutions for the virtually positive energy community in Leipzig, distributed to the following subtasks:

- Subtask 4.3.2 Virtual Power Plant and Storage 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 Consumptions 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 interventions 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

L10-1 Integration of standardized sensors and systems within wide area networks (WAN) utilizing 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.

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

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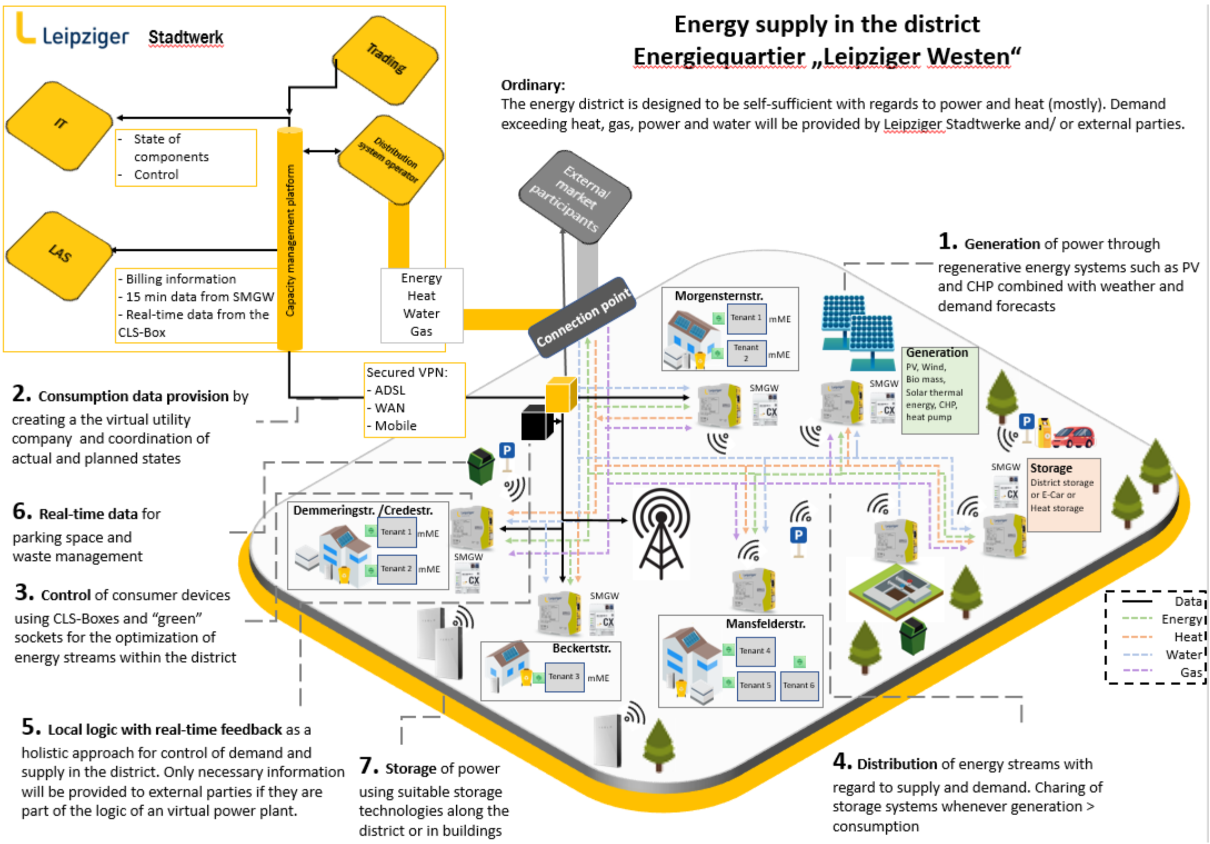
L9-2 Study the replication potential of the positive energy community in the replication districts "Leipzig 416" and Stadtraum "Bayrischer Bahnhof"

Fig. 9: Energy supply in the Positive Energy Community



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.
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 decentralized 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 Baumwollspinnerei (realized by CEN). LSW interacts with the

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<table>
<tr><td></td><td colspan="2">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. 9: 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 optimization 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 done, LSW can rollout the solution to connect all assets of the same kind. The data transmission is standardized; 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).</td></tr>
<tr><td>Roles and responsibilities</td><td colspan="2"><u>LSW: task leader, coordinator</u>

WSL</td></tr>
<tr><td rowspan="2">Schedule</td><td colspan="2">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.</td></tr>
<tr><td>M12</td><td>Integration of RES part I.1:</td></tr>
</table>

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		Define a first interface for data exchange with ULEI, WSL, LWB etc. Calculate first energy generation forecast for each single solar power plant 4
	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: Optimization 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 Optimization 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
Monitored KPIs	• Assets added vs. total assets (ratio of connected assets) • Data availability of each asset (ratio) • Total energy production per asset, per asset class • Total energy production of the generation portfolio (ratio) • Data quality in asset inventory: existing non-NULL values vs. possible values (ratio) • Frontend for Monitoring is available (boolean KPI) • Number of assets which get a forecast (total number, ratio) • Uptime of platform, processes, micro services	

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<table>
<tr><th>Action L10-1</th><th colspan="2">Integration of standardized sensors and systems within wide area networks (WAN) utilizing 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="4">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>
<tr><td>M24</td><td>• Roll out several sensors
• Roll out LoRaWAN-net in the demo district area in Leipzig West</td></tr>
<tr><td>M27</td><td>Use data and provide data to third parties</td></tr>
<tr><td rowspan="2">Milestone/ Tangible outcome</td><td>M24</td><td>LoRaWAN-net has been established and first sensor are working</td></tr>
<tr><td>M27</td><td>Use data from LoRaWAN sensor for services and other purposes</td></tr>
<tr><td>Monitored KPIs</td><td colspan="2">• Number of (active) sensors
• Amount of sent data
• Number of applications based on this data</td></tr>
</table>

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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	**LSW: task leader** 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
	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
Milestone/ Tangible outcome	M12	Analysis, evaluation and preparation of business models
	M14	Market
	M18	Conception
	M30	Implementation
	M34	Product is established in the market
Monitored KPIs	• Number of installed "zero carbon communities"	

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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	**LSW: task leader** 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 stabilization or maximizing 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 optimizations or simulations of the energy system) Reporting advantages and disadvantages of using this battery
Monitored KPIs	• Report/ study • Can the share of renewable energies in the grid be raised if batteries are added? How high is the rate of improvement? • How much energy will be stored in the battery over several time ranges (max, min, mean value) • How often is the battery charged or discharged during different time ranges? • What lifetime of a battery is expected under those circumstances? • improvement of renewable energy share	

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Action L9-2	Study the replication potential of the Positive Energy Community in the replication districts "Leipzig 416" and Stadtraum "Bayrischer Bahnhof"	
Demonstration plan	Study the replication potential of the Positive Energy Community in the replication districts "Leipzig 416" and "Bayrischer 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	**LSW: task leader** LPZ: link to L19-2 and T4.7 Replication and Exploitation preparation	
Schedule	M24-M33	Analysis of the neighborhoods for similarities / differences to the reference project
	M34-M35	Examination of transferability to "Leipzig 416" / "Bayerischer Bahnhof"
Milestone/ Tangible outcome	M36	Creation of replication patterns for other quarters
Monitored KPIs	None	

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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 conceptualization 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, responsible**	
Schedule	M1-M25	Feasibility study
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
Monitored KPIs	Report/Study	

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

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	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.
Monitored KPIs	• none	
ditional 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 decentralized 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 decentralized 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) assets. Stadtwerke Leipzig has a fully functional prototype for this.	
Roles and responsibilities	<u>**LSW: task leader**</u>	
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-M30	Further development of the pilot application /system with the goal to deploy it for all zero-carbon-community participants.

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Milestone/ Tangible outcome	M24	Roll-out for friendly user Production readiness
Monitored KPIs	• Number of (active) participants • Number of transactions • Sum of totally traded energy • Turnover • Availability of the system (uptime, stability)	

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 optimization 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 optimization (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 interface to the municipal data platform. (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.

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Action L18-1	Further developing and refining the resource planning and optimization (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 modeling framework of IRPopt is already in a mature state, the focus of the research in SPARCS requires the 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 L18-3,4 (report)
	M36	Extension of the documentation as part of the detailed reporting of the actions
Monitored KPIs	Report/Study	

Action L18-2	Defining and developing the interface to the municipal data platform. (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 L19-1	
Roles and responsibilities	**ULEI: task leader** LSW: data provision	
Schedule	M1-M12	Definition of data requirements
	M13-M36	Data collection

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	M13-M36	Establishment and provision of data transfer
	M18-M36	Data quality check
	M24-M36	Provision of metering data for modeling purposes
	M21	Finish of the task June 2021 (LSW)
Milestone/ Tangible outcome	M24	Data flow established
Monitored KPIs	Report/study	

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
	M28-M30	Evaluation of model results

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	M32-M48	Iteration of actions with regularly updates data set (provided by L18-2)
Milestone/ Tangible outcome	M18	Stadtwerke Leipzig and ULEI established an ongoing data exchange to have a common basis for the prediction model of ULEI
	M36	Report (Scope, Research question, data, modeling results, conclusion)
Monitored KPIs	• Flexible Loads: number of smart meters • Peak Demand • Share of RES • Real LCOES, LVOES, PBP	

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	**ULEI: task leader** 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
	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

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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
Monitored KPIs	• Share of RES • GHG emission reduction	

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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 utilizing 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.

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

Planned activities include:

- Optimizing electricity consumption through the identification of energy-hungry behaviors, providing meaningful energy-use feedback to occupants
    - Informative billing; monitoring, controlling and normative feedback about the individual energy consumption.
    - Demonstration of energy behavioral profiles, allowing for self-evaluation and normative comparisons of energy behavioral patterns.
    - Commissioning on specific energy savings targets and verification of achievements.

After extensive discussions with the local partners, specific conditions and limitations, as well as available equipment that can be utilized for the purposes of the demo are

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identified. In the following section, the way that these findings affect the actions described in the contract are clearly described, followed by the possible workarounds and proposed alternatives.

Findings, limitations and workarounds:

- Informative billing – Providing an overview of the consumption and the billing.
  - Can be delivered if electricity smart meters are in place for each apartment
- Compare consumption with similar peers (neighbors, best/average/worst consumers, etc.) to motivate a change towards lower consumption.
  - Can be delivered if electricity smart meters are in place for each apartment
- Common goals setting and verification of achievements; cost savings to be offered on social welfare projects.
  - Can be delivered if electricity smart meters are in place for each apartment

Similarly, to the thermal profiling, having additional sensors in place, providing for example occupancy, luminance or plug consumption readings, will allow enhanced personalized information and guidance actions.

For example, absence in the room and the lights are on; via the app suggest dimming or switching off the lights.

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. • Visualization 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. • Providing super user capabilities to the building manager, for agregated building information and overview.

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	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.
	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-M20	Development of application, delivery of ready to test software by M20
	M20-M24	Verification and testing of application
	M24-M26	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
Monitored KPIs	• Total electricity demand reduction (apartment and building level) • Peak demand reduction • CO_2, GHG emissions reduction • Increased user engagement	

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<table>
<tr><th>Action L13-1</th><th colspan="2">Demonstration of Energy Behavioral Profiles, revealing the energy related aspects of behavioral profiles and allowing for self-evaluation and normative comparison 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.</th></tr>
<tr><td>Demonstration plan</td><td colspan="2">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.
• Visualization of the current performance vs. similar peers via a ranking.
• Check of historical performance and rankings achieved.
• Providing super user capabilities to the building manager, for agregated building information and overview related to ranking achieved per peer group.</td></tr>
<tr><td>Roles and responsibilities</td><td colspan="2"><u>Suite5: task leader</u></td></tr>
<tr><td rowspan="6">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 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.</td></tr>
<tr><td>M10-M12</td><td>Deliver specs and mockups
Finalize equipment specifications
Make data samples available
Local stakeholders to provide historical data
Co-creation approach to be followed</td></tr>
<tr><td>M12-M20</td><td>Development of application
Delivery of ready to test software by M20</td></tr>
<tr><td>M20-M24</td><td>Verification and testing of the application</td></tr>
<tr><td>M24-M36</td><td>Deployment and validation</td></tr>
</table>

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		Replication
	M36-M60	Replication to other buildings
Milestones/ Tangible outcome	M12	Concrete application specifications and mockups
	M24	Tested and ready to be deployed application
Monitored KPIs	• Total electricity demand reduction (apartment and building level). • Peak demand reduction • CO_2, GHG emissions reduction • Increased user engagement	

Action 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.**	
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. • Visualization of the current performance vs. targets set and achievements. • Check of historical performance and targets achieved. • Providing super user capabilities to the building manager, to be able to set targets and bind them to social welfare projects and benefits. • Providing super user capabilities to the building manager, for agregated building information and overview related to targets achieved per apartment.	
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.

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	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-M20	Development of application Delivery of ready to test software by M20
	M20-M24	Verification and testing of the application
	M24-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
Monitored KPIs	• Total electricity demand reduction (apartment and building level). • Peak demand reduction • CO_2, GHG emissions reduction • Increased user engagement	

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4. E-MOBILITY INTEGRATION IN LEIPZIG LIGHTHOUSE DEMONSTRATIONS

4.1 Introduction to task 4.4 (FHG)

The aim of WP 4.4 is to integrate electric mobility into the positive energy community in Leipzig. Electric vehicles und electric buses offer the opportunity for high flexibility and through intelligent charge control and charge management, control signals given by the energy community can be taken into account while charging electric vehicles.

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 within the mathematical optimization as well.

In addition to electric passenger cars, charging stations for electric buses will be part of the research. Charging stations with very high charging rates are used for charging electric buses and provide high flexibility in charging processes. To utilize the previous mentioned flexibility the corresponding charging stations and backend systems necessary for operation will need to react to and send appropriate control signals.

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. Die LVB is owner and operator of the network for busses and trams.

During the last few years, the company participated on 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. The bus line 60 will transform in the year 2020 and leads through “Leipzig West”.

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.

The following section describes the integration of e-busses into the local system. In order to integrate electric bus charging into the energy management system, the disposition of the fleet must be integrated into a charging optimization module. This effort aims to collect the data from the disposition management of the electric busses, the grid congestion constraints from the virtual district network and the allocation of the busses to the charging stations, to come up with a calculation of an optimized charging profile for the whole fleet. Using this approach, the e-bus charging can be integrated into the virtual

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district network by providing balancing capabilities by regulated, deferred, or interrupted charging processes. Furthermore, overproduction of local or distributed RES can be fed into the e-bus fleet to increase local consumption and automatic use of RES.

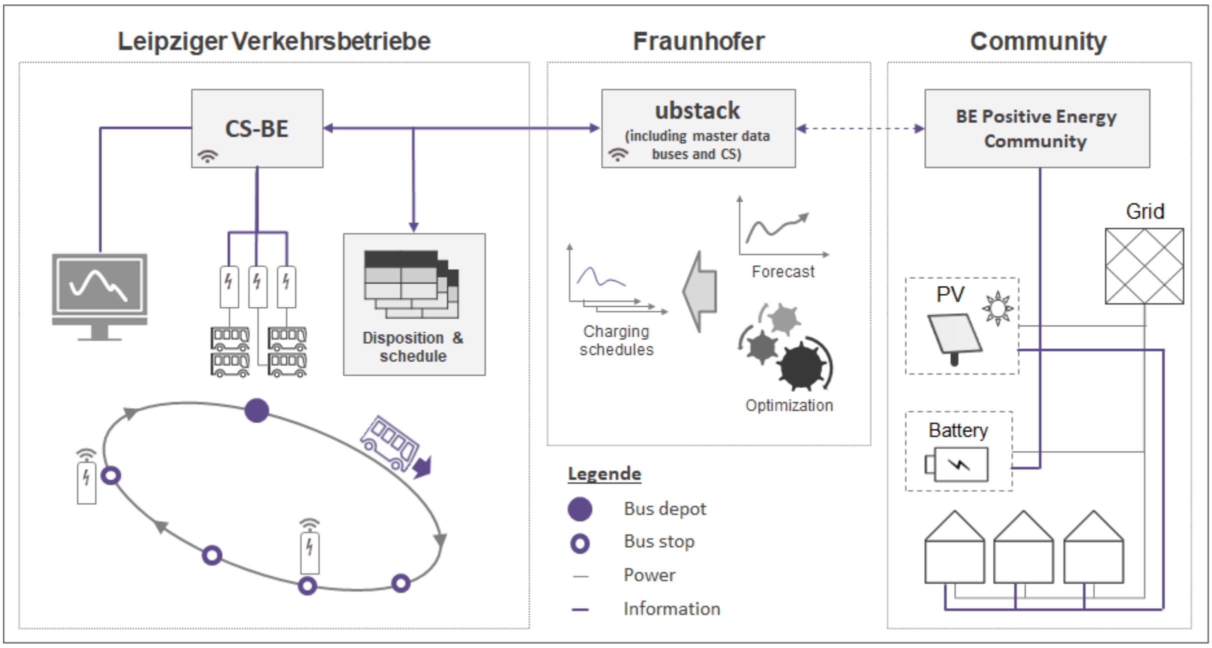
This includes:

Action L15-1: Integrating, balancing and optimizing load-depending electric busses charging stations into the Positive Energy Community (LSW, FHG)

Action L15-2: Integration of Bus disposition schedule into optimization, integration of real-time grid constraint forecasts emerging from planned demand and supply (LSW, FHG)

Action L15-3: Implementation of a standardized charging station monitoring and control protocol for electric bus charging stations (LSW, FHG)

Fig. 10: E-Bus Charging Integration



Action L15-1	Integrating, balancing and optimizing load-depending electric buses charging stations into the Positive Energy Community (LSW, FHG).
Demonstration plan	A backend system for controlling the electric buses charging stations (Bus-LI-BE) is to be procured. This backend system shall be connected to a backend system generating charging schedules (ubstack). Ubstack in turn will be connected to the positive energy community and a corresponding interface will be implemented to ensure the necessary data exchange. Depending on the functionality of the positive energy community, there are two options:

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<table>
<tr><td></td><td colspan="2">1. Bus-LI-BE is merely a data consumer and the data flow is unidirectional. The signals generated by the community are taken into account for optimization.
2. Data flow is bidirectional and signals are given by both systems. Market mechanisms will be implemented and the allocation will become more efficient.

To implement the interface, the conditions of the community need to be defined. Therefore, the concrete technical implementation will not happen until 2021.</td></tr>
<tr><td>Roles and responsibilities</td><td colspan="2"><u>LSW: task leader</u>
• Coordinator between LVB and FHG
• Install electric busses charging stations
• Integrate the charging stations into Bus-LI-BE
• Implement an API to ubstack
• Provide the Positive Energy Community API

FHG:
• Develop an architectural design
• Integrate the charging stations into ubstack
• Implement an API to Bus-LI-BE
• Define and implement an API to the Positive Energy Community</td></tr>
<tr><td rowspan="7">Schedule</td><td>M7-M16</td><td>Planning the functionalities of the community</td></tr>
<tr><td>M17-M22</td><td>Definition of the interfaces, the signals and the corresponding mechanisms to the community</td></tr>
<tr><td>M23-M22</td><td>Implementation of the interfaces, the signals and the corresponding mechanisms to the community</td></tr>
<tr><td>M31-M36</td><td>Test of functionalities and interaction</td></tr>
<tr><td>M7-M19</td><td>Construction of the charging infrastructure and connection to the charging station backend</td></tr>
<tr><td>M20-M22</td><td>Integrate the buses and charging stations into the backend system generating the charging schedules</td></tr>
<tr><td>M23-M26</td><td>Implement the API to transmit the charging schedules (charging station backend and backend to generate the charging schedules)</td></tr>
<tr><td rowspan="2">Milestones/ Tangible outcome</td><td>M22</td><td>The buses are integrated into ubstack</td></tr>
<tr><td>M36</td><td>The signals generated by the Positive Energy Community are taken into account for optimization.</td></tr>
<tr><td>Monitored KPIs</td><td colspan="2">• Number of integrated charging stations</td></tr>
</table>

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<table>
<tr><th>Action L15-2</th><th colspan="2">Integration of bus disposition schedule into optimization, integration of real-time grid constraint forecasts emerging from planned demand and supply (LSW, FHG).</th></tr>
<tr><td>Demonstration plan</td><td colspan="2">The backend system generating the charging schedules (ubstack) will be developed in such a way that it can meet the buses needs. The relevant master data (buses and infrastructure) will be transferred to the backend system ubstack and a forecast service to determine loads will be set up. The bus disposition system will be connected to ubstack and the optimization algorithm will be adapted to the busses needs. For this purpose, the corresponding interfaces need to be defined und implemented.</td></tr>
<tr><td>Roles and responsibilities</td><td colspan="2"><u>LSW: task leader</u>
Defining the bus fleet (including data concerning the buses)
Define and provide the grid constraints and the necessary data to predict grid constraints
FHG:
Integrate the buses into the fleet management software
Set up a fleet disposition tool - data regarding buses and routes is needed, an API may has to be implemented
Adapt the optimization algorithms regarding the buses needs
Define the grid constraints and the necessary data to predict grid constraints
Set up a forecast service to predict the state of the grid</td></tr>
<tr><td rowspan="8">Schedule</td><td>M7-M19</td><td>Planning and construction of the charging stations and its backend system, procurement of the buses</td></tr>
<tr><td>M17-M22</td><td>Define the API "disposition tool - ubstack"</td></tr>
<tr><td>M20-M22</td><td>Integrate the buses and charging stations into ubstack and adjust the fleet disposition tool</td></tr>
<tr><td>M20-M22</td><td>Definition of grid constraints and necessary data for prediction</td></tr>
<tr><td>M22-M25</td><td>Conception and setup of a forecast service</td></tr>
<tr><td>M23-M26</td><td>Implement the API "disposition tool - ubstack"</td></tr>
<tr><td>M23-M28</td><td>Adapt the optimization algorithm regarding the buses needs</td></tr>
<tr><td>M28</td><td>Finish of the task June 2022</td></tr>
<tr><td rowspan="2">Milestones/ Tangible outcome</td><td>M22</td><td>Grid constraints are defined</td></tr>
<tr><td>M25</td><td>A forecast service is set up and the forecast is considered for optimization</td></tr>
</table>

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	M28	The optimization algorithm is able to handle the buses needs
Monitored KPIs	Number of integrated electric buses	

Action L15-3	**Implementation of a standardized charging station monitoring and control protocol for electric bus charging stations (LSW, FHG).**	
Demonstration plan	To provide the functionalities of L15-1 and L15-2, protocols have to be implemented by which control commands can be transferred from Bus-LI-BE to ubstack. Both systems need to provide these protocols and standards. In addition, a frontend for ubstack will be set up. Thereby evaluations of the charging processes and schedules are possible.	
Roles and responsibilities	**LSW: task leader** • Define the relevant views • Planning and implementing protocols for electric bus charging stations FHG: • Define the relevant views • Set up a user interface regarding charging schedules and charging stations • Planning and implementing protocols for electric bus charging stations	
Schedule	M11- M17	Planning and implementing protocols for electric bus charging stations
	M18-M20	Define relevant views
	M21-M25	Set up a user interface regarding charging schedules and charging stations
Milestones/ Tangible outcome	M25	Relevant views are implemented and communication is ensured
Monitored KPIs	• Electricity for charging the electric buses [kWh] • Utilization of charging stations [%]	

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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 (FHG, LSW, WSL, LPZ)

Action L16-4: Demonstrate load-balancing with an electric vehicle fleet in accordance to local grid needs (FHG, LSW, 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 realization plan: The aim is to upgrade the existing network of public charging infrastructure of the LSW with the intelligent or bi-directional 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 analyzed. Possible use cases are a reservation function of charging

	stations to optimize charging infrastructure utilization, as well as a network-serving charging in conjunction with new business models for electric mobility.	
Roles and responsibilities	**<u>LSW: task leader</u>** • 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 up to 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 systems (including bidirectional charging). 200 charging point with an upgrade for intelligent or bi-directional charging.
Monitored KPIs	• Number of upgraded charging stations	

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<table>
<tr><th>Action
L16-2</th><th colspan="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).</th></tr>
<tr><td>Demonstration plan</td><td colspan="2">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.</td></tr>
<tr><td>Roles and responsibilities</td><td colspan="2"><u>FHG: task leader</u>
Define framework conditions
Identify relevant standards and protocols
Develop business models 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</td></tr>
<tr><td rowspan="2">Schedule</td><td>M3-M8</td><td>Identify the relevant protocols and its tariff modules</td></tr>
<tr><td>M9-M19</td><td>Development of the tariff and business models</td></tr>
<tr><td rowspan="2">Milestones/ Tangible outcome</td><td>M8</td><td>Relevant standards, protocols and existing services are identified</td></tr>
<tr><td>M19</td><td>Business models and services are developed</td></tr>
<tr><td>Monitored KPIs</td><td colspan="2">Report with the description of the components</td></tr>
</table>

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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 (FHG, LSW, 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 finalized after the charging infrastructure and user group are defined.	
Roles and responsibilities	**FHG task leader** • Define framework conditions • Develop the views to be implemented • Implement the relevant views 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
Monitored KPIs	• Number of views describing the app	

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Action L16-4	**Demonstrate load-balancing with an electric vehicle fleet in accordance to local grid needs (FHG, LSW, WSL, LPZ).**	
Demonstration plan	The bookings of a fleet management system serve as input for the optimization 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	**<u>FHG: task leader</u>** • Define framework conditions • Set up fleet management software • Integrate vehicles into the fleet management software LSW, WSL, LPZ: • Define framework conditions • Define and provide a fleet support • Define and provide charging stations support • Provide communication between optimization 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
Monitored KPIs	Electricity for charging the electric fleet [kWh]	

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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 optimization. To facilitate the subtask, the charging optimization 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 optimization 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 Baumwollspinnerei 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. Furthermore, the regeneration of the roof of a former petrol station that still stands in the Baumwollspinnerei as a solar PV carport. The charging station is purchased from the manufacturer Walther-Werke GmbH. According to its information, a charging controller is expected to be available in mid-2020, which has integrated the functionality of the bi-directional charging. Corresponding electric vehicles with the bi-directional charging function are already available on the market. The first step is to design the technical specification of the charging station and local battery storage. By the end of 2020, the charging station will be installed on the area of the Baumwollspinnerei.
Roles and responsibilities	**CEN: task leader** LSW: responsible for the construction and operation of the new constructed charging station

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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-M12	Collaboration with partners to agree on the timeline, design and concept in order to prepare the construction through selection of technology and contractors.
	M12-M18	The installation of the bi-directional charging station in the Baumwollspinnerei.
	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 (action L1-4). A showcase to allow fellow city consortiums to see the bidirectional loading of the electrical car with a visualization, 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.
	M18	Installation of bidirectional charging station, solar PV roof on the carport and the necessary integration of both into an electrical system.
	M24	The purchase and integration of an electrical vehicle with bidirectional charging capability.
	M30	A showcase to allow fellow city consortiums to see the bidirectional loading of the electrical car with a visualization, 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.
Monitored	• EV Car Sharing Rate • Share of electric vehicles in local transportation (%)	

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KPIs	• Engagement, modal split, mobility habits (car, EV car, bicycle, walking, transport • (Smart) EV charging services (car and BUS), V2G • Parking places (car and bicycle) (number) • Energy Storage (kWh) • Peak Demand (kWp)

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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 Baumwollspinnerei 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 Baumwollspinnerei 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	<u>**CEN: task leader**</u>	
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. A letter of intent with teilAuto, especially in regards to data sharing and data collection.
	M24-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
	M18	Letter of Intent with teilAuto
	M18	Installation and qualification of the bidirectional charging station.
	M30	A showcase to allow fellow city consortiums to see the bidirectional loading of the electrical car with a visualization, for example LEDs with a colour system to indicate charging and discharging of electrical energy into the car.
Monitored KPIs	• EV Car Sharing Rate • Share of electric vehicles in local transportation (%)	

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	• Engagement, modal split, mobility habits (car, EV car, bicycle, walking, transport • (Smart) EV charging services (car and BUS), V2G • Parking places (car and bicycle) (number) • Energy Storage (kWh) • Share of integrated systems (smart control/ VPP/ storage)

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 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-M18	The installation of the bi-directional charging station in the Baumwollspinnerei.
	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.

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Milestones/ Tangible outcome	M36	Demonstration of the bidirectional capability of the charging station A showcase to allow fellow city consortiums to see the bidirectional loading of the electrical car with a visualization, for example LEDs with a colour 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.
Monitored KPIs	• EV Car Sharing Rate • Share of electric vehicles in local transportation (%) • Engagement, modal split, mobility habits (car, EV car, bicycle, walking, transport • (Smart) EV charging services (car and BUS), V2G • Parking places (car and bicycle) (number) • Optimization algorithm that provides bidirectional charging • Energy storage (kWh) • Peak Demand (kWp)	

Action L1-4	**Extend the charging optimization algorithms for EVs bi-directional charging.**	
Demonstration plan	Version 1 of the charging station optimization 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	<u>**FHG: task leader:**</u> Extend and adjust constraints regarding bidirectional charging CEN: technical support	
Schedule	M20-M24	Idea and how can it be realized, how can the consumers be integrated (communication-strategy), clarify demonstration building in demonstration area (Baumwollspinnerei) and develop the extension for the charging optimization algorithms.
	M24-M32	Extend the algorithm

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Milestones/ Tangible outcome	M24	Necessary installation is finished and target is defined
	M32	Extended algorithm exists
Monitored KPIs	Bidirectional optimization algorithm (binary)	

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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.
	M36	Determine possible use cases for the integration of the data into the urban data platform.

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SPARCS

	M36-M60	Integration of energy and building data into the urban data platform.
Milestone/ Tangible outcome	M24	RoadMap for implementing data into urban data platform Leipzig
	M48	1st integration of energy and building data into urban data platform Leipzig
Monitored KPIs		
Additional info	Implementation road map (M24) is basis for T4.7, 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. Determine the technologic requirements (sensors, smart meters, connectivity etc.) and next steps to integrate buildings into the positive energy community. 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 PEDs in Leipzig.	
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 of building integration (T4.2 - T4.4)
Milestone/ Tangible outcome	M60	Integration of results in D4.7 on requirements and recommendations for integrating buildings in the positive energy community
Monitored KPIs	Report/ Study	

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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 synchronization 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 synchronization 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 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
Monitored KPIs	Report/study	

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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 mainly through the interaction with the local communities.
- General coordination and on-schedule control (reference: participation concept).

L21-2, 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 expantion 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. The document will include participation formats and information deliverance strategies that will help to raise awareness of diverse measures undertaken on individual and local level that contribute in building carbon neutral, energy positive and climate-friendly living space - to involve the relevant target groups a part of activities will be scheduled in form of regular workshops (L21-3). 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

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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.

After the submission of the participation concept, begin two implementation phases, intersected into one-year cycles (M24, M36, M48, M60) - at the end of each period the Leipzig consortium will evaluate the undertaken measures and either adjust the timeline or confirm the initial plan.

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 conceptualized 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.

At the same time, an overarching empirical research programme on the impact of individual and community factors (e.g. personal preferences, social diversity factors, and individual identity) on the development of energy positive neighbourhoods and communities is being prepared. In particular, the aim is to identify factors that can be used to successfully communicate a societal shift towards sustainability and change people's individual behaviour (L21-4).

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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. 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). Involvement of Baumwollspinnerei commercial tenants into the participation process. Involvement of further external partners. Involvement of communication department of LSW in selected participation and communication activities.
	M18-M24	Involvement of Duncker neighborhood tenants into an application development process. First events at Baumwollspinnerei and at Duncker neighborhood.
	M24-M30	M24: Evaluation of the participation process. Adjustments and expansion of the participation options. Initial development of guidelines as basis for replicability.

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	M30-M60	Active desk support, workshop conduction, expansion of participation option through new, preferably innovative measures like geoAR.
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	Conceptual phase
	M12-M24	First implementation phase. Only a few technical products are ready for demonstration and evaluation at this point, therefore 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.
	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. 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.
Monitored KPIs	• Advice / contacting; • Advice apartment / number of apartments in the building; • Number Advice building • Number Buildings in the district • Increase citizens quality of life, health and well-being • CO_2 reduction till zero carbon footprint	

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	• Greenhouse gas emissions reduction • Share of RES

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 M30 a decision on the form and location of the desk support that would align with the DPCA will to be made. The major factor in forming the desk support is to collaborate with the key external partners, especially with the quartier management Leipzig West, who have a substantial experience in community support. 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	**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	Definition of key goals behind the desk support based on SPARCS-measures, implementation premises and allocation in the participation concept (M12).
	M12-M18	Expansion of planned activities after the final agreements on cooperation with strategical partners and LSW's communication department.

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	M12-M24	First implementation phase. The phase will be evaluated in M24.
	M24-M48	Second 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.
Monitored KPIs	• Advice / contacting; • Advice apartment number of apartments in the building; • Advice on business number of businesses in the district • Greenhouse gas emissions reduction • Share of RES	

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.

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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)
	M48	Input for the Report on Citizens and stakeholders in Leipzig's energy transition
Monitored KPIs	• Increased people's awareness for energy efficiency (survey) • Increased people's acceptance for smart energy solutions (survey) • Participation of relevant actors in project activities	

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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.

ULEI also investigates in experimental sections of the questionnaires how different communication strategies affect people's attitudes. UELI will analyze the impact of these factors and their interplay in predicting citizens' attitudes and actual participation and involvement in the project (e.g., supporting the project or using smart energy appliances in everyday life).

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 is scheduled to begin in autumn 2020. Public information events will be used for Duncker neighbourhood citizens (part of L21-1 und L21-2) to explain our research and to invite citizens to collaborate by filling out questionnaires at different stages of the implementation process, aiming at 3 points of measurement. Depending on individual preferences, the survey will be accessible online or as paper-pencil questionnaire. The data will be analyzed 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). Intending to replicate our study in a different context within SPARCS, time and place of 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).

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Roles and responsibilities	**<u>ULEI task leader:</u>** Conducting empirical survey and experimental research on person-	
Schedule	M11-M16	preparations & data collection at Duncker neighbourhood
	M17-M24	data analyses and reporting
	Approx. M36-M60	Replication survey with analyses and reporting
Milestones/ Tangible outcome	M24	Presentation of Results of the Duncker neighbourhood study
	M30	Presentation of the replication study
Monitored KPIs	As detailed in the description above, personal and collective socio-psychological predictors of positive energy district project involvement as well as inhabitants actual involvement will be measured.	
Additional info	Due to current circumstances of COVID-19 the starting point for data collection at Duncker neighbourhood might be postponed.	

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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 including Leipzig 416 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 neighborhoods 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 SPARCS demonstrations towards the achievement of the set goals will be illustrated. 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	**LPZ: task leader**

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	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 visualization of Energy Positive Districts (in connection to Action L19-1)
	M36-M60	Prepare for immediate replication in selected energy districts, e.g. Leipzig 416 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)
Monitored KPIs	Report / Study	

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7. ACRONYMS AND TERMS (ALL)

API: Application programming interface

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

EPB: energy positive blocks

EV: electric vehicle

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 Optimization (ULEI)

KPI: Key Performance Indicator

LCOES: levelized cost of energy storage

LED: light-emitting diode

LoRaWAN: Long Range Wide Area Network

LVOES: levelized value of energy storage

MILP: mixed integer linear program

MQTT: Message Queuing Telemetry Transport

PBP: payback period

PECM: positive energy community management

PED: Positive energy district

PV: photovoltaic panels

P2H: Power-to-Heat

RES: Renewable energy system

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SC: self-consumption

SCR: self-consumption ratio

SME: System Management Entity

STP: Spanning Tree Protocol

VPP: Virtual Power Plant

V2G: Vehicle-to-Grid

WAN: Wide Area Networks

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8. GANTT CHART - D4.1 DETAILED IMPLEMENTATION STRATEGY LIGHTHOUSE CITY LEIPZIG

Month

	Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
L6-1	Demonstration of integration of RES in the central district heating network (LSW, LPZ, ULEI)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L6-2	Estimating potential for using additional RES in the central district heating network (LSW, LPZ, ULEI)									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L7-1	Integration of a Power2Heat (LSW, ULEI)				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L8-1	Linking of the existing and newly constructed heat storage solutions with the demand (LSW, ULEI)			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
L6-3	Research to increase the share of renewable energies in the district heating network (LSW, LPZ, ULEI)													X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L6-4	Assessing waste heat potential (LSW)										X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L2-1	Installation of equipment (CEN)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L2-2	Balancing the micro Grid (CEN, LSW)																					X	X	X	X	X	X	X	X	X	X	X	X				
L2-3	Analysing and integrating Energy storage solution (CEN, SEE, FHG)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L3-1	Coupling the heating needs (CEN)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L3-2	Provide user-interface (CEN)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L4-1	Peronalized informative Billing (WSL, Suite5)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L4-2	Demonstration of Dynamic Thermal Energy Tariff (WSL, Suite5)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L5-1 u. L5-2	Human-Centric Energy Management and Control Decision Support (Suite5, WSL)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L4-3	Appropriate normative comparison mechanisms will be applied	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L4-4	Improving the connectivity of buildings (WSL, Suite5)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
L4-5	Assessment of different tariff schemes (WSL)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												
L4-6	Feasibility study (WSL)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												
L4-7	Demonstration of decentralised energy storage within building blocks (WSL)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L9-1	The integration of RES (LSW, WSL)												X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L10-1	Integration of standardized sensor (LSW)																			X	X	X	X	X	X	X	X	X									
L11-1	Establishment of a distributed cloud-centric ICT System (LSW, WSL)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																		
L11-2	Real-time simulation of the integration of an existing 10 MW battery storage (LSW, BMW)																								X	X	X	X	X	X	X						
L9-2	Study the replication potential of the Positive Energy Community(LSW, LPZ)																								X	X	X	X	X	X	X	X	X	X	X	X	
L17-1	Feasibility study on the coordinating role of blockchai (LSW)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X											
L17-2	Developing new potential blockchain-based solutions (LSW, StromDOA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L17-3	Demonstration of the integration and interactions of IoT devices (LSW)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						

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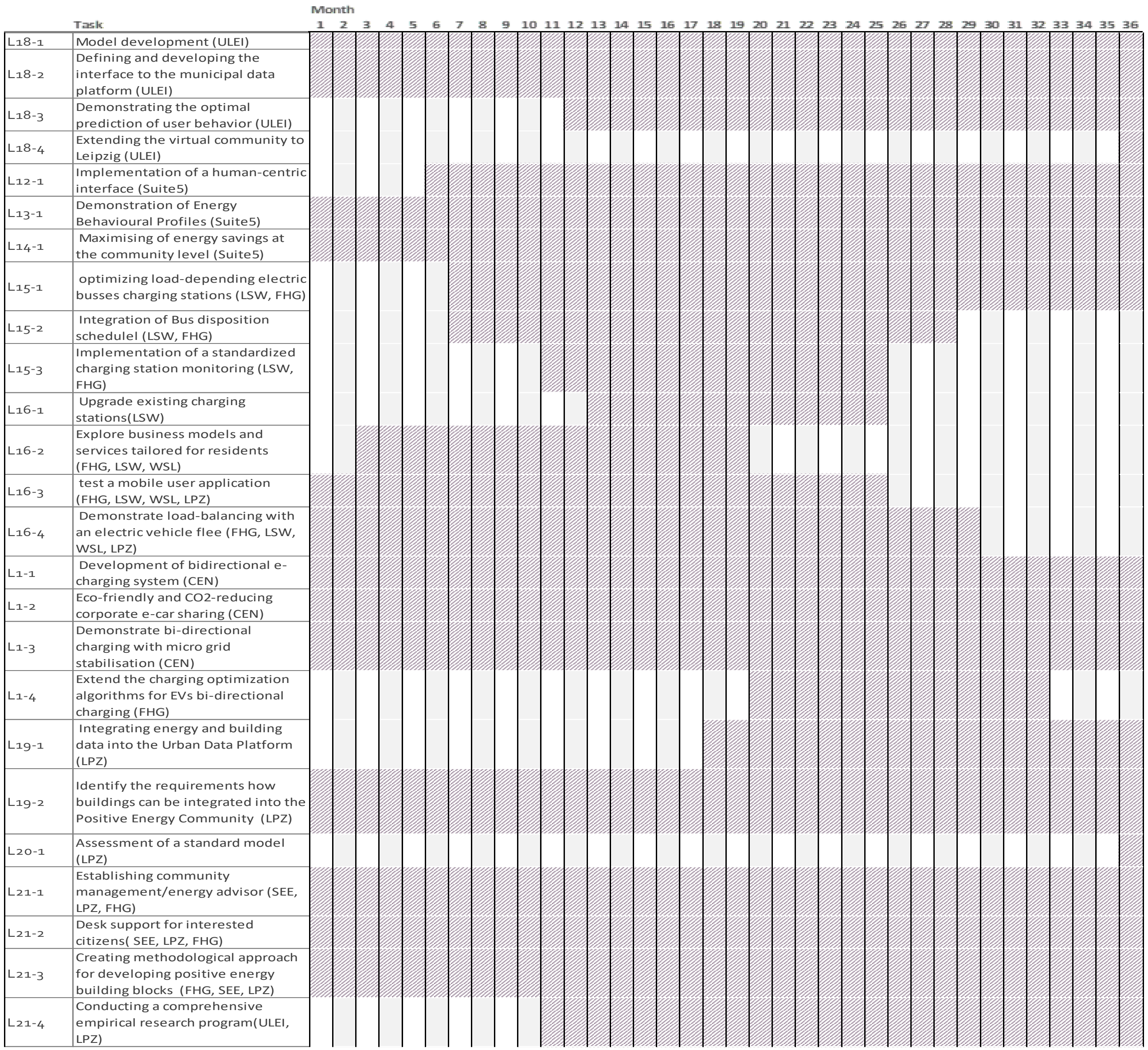

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