# MAtchUP

## D3.16: New Concept of high performance district in Dresden

**WP 3, T 3.3**

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MAtchUP - SCC-1-2016-2017

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## Technical References

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|---|---|
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| Project Coordinator | Ernesto Faubel<br>Ayuntamiento de Valencia<br>efaubel@valencia.es |
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### Abbreviations and Acronyms

| Acronym | Description |
|---|---|
| D | Deliverable |
| PV | Photovoltaic |
| VON | Vonovia |
| DRE | City of Dresden |
| TUD | University Dresden |
| FHG | Fraunhofer Gesellschaft |
| DWG | Drewag |
| KfW | Kreditanstalt für Wiederaufbau (Credit Institute for Reconstruction) |
| BSI | Bundesamt für Sicherheit in der Informationstechnik (Federal Office for Information Security) |
| SMGW | Smart Meter Gateway |
| ICT | Information and communications technology |
| kWp | Kilowatt Peak |
| EEG | Erneuerbare-Energien-Gesetz (German Renewable Energy Sources Act) |
| CBCC | Central Building Control Center |
| EASD | EA Systems Dresden |

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# Abstract

This report constitutes Deliverable "D3.16 New Concept of high performance district in Dresden– Final version", which is the main outcome of "Task 3.3 High-Performance District and Smart Homes" with the Subtasks "Subtask 3.3.1 Retrofitting actions" One of the core objectives of this document is to describe the detailed design of the interventions done by VON during the retrofitting and energetic restoration processes. Furthermore, the project should serve as a demonstration of the usage of sustainable technologies and future construction methods, the development of new business strategies and as a support for the urban transformation. This document includes unchanged and updated parts from D3.4 which will be mentioned at the beginning or within the sections.

This deliverable focuses on the definition of a new concept of interventions to achieve high-energy efficiency rates in Johannstadt district in Dresden. The actions include extensive retrofitting and energy management programs as well as smart home developments for the City of Dresden.

Led by VON, retrofitting actions will be implemented in several 10-storey buildings located in Pfotenhauer Str. as well as in Elisenstr. and will affect the windows, doors, facade, roof and the renovation of the heating system. Technical specifications and program of works (including energy, social and technical diagnosis) will be discussed with dwellers of the committed retrofitting programs.

Further actions all around Johannstadt district will include the integration of renewable energy systems as well as saving technologies. The planning, installation and construction supervision of the photovoltaic system, as well as implementation of a tenant electricity model is led by project partner DWG. This includes integration into billing systems. Furthermore, the tasks of DWG involve to provide information about generated energy that allows the tenants to use the generated energy from renewable energies themselves in their quarters. Exemplary flexible electricity tariffs are integrated as well.

The whole implementation process will be monitored and evaluated in order to develop a business model for energetic transformation leading to energy cost reduction.

# 1 Introduction

## 1.1 Purpose and target group

This report constitutes Deliverable *"D3.16 New Concept of high performance district in Dresden– Final version"*, which is the main outcome of "Task 3.3 High-Performance District and Smart Homes" with the Subtasks *"Subtask 3.3.1 Retrofitting actions"* The first version of this report (D3.4) was delivered in September 2019 (project month M24). One of the core objectives of this document is to describe the detailed design of the interventions done by VON during the retrofitting and energetic restoration processes. Furthermore, the project should serve as a demonstration of the usage of sustainable technologies and future construction methods, the development of new business strategies and as a support for the urban transformation.

## 1.2 Contribution of partners

**Table 1: Contribution of Partners**

| Participant | Contributions to |
|---|---|
| DRE | DRE is one of the lighthouse cities of the project and work package leader of WP3.<br>Furthermore DRE is responsible for the topics in urban mobility assistance (Action 25) and citizen's feedback regarding the assessment of all implemented actions |
| FHG | FHG is an ICT expert of the local team and thus involved in the monitoring activities and the Urban Platform developments in Dresden within WP3. It is also responsible for mobility actions in regard to electric vehicles, charging stations and new services on sustainable mobility. FHG is in charge of installing and monitoring the data loggers equipped to the e-vehicles. |
| DWG | DWG is a main actor in the energy actions carried out in Dresden within WP3. In detail it is responsible for the equipment with a PV system in connection with a battery storage in the DFH and their intelligent linkage to implement smart electricity models and flexible tariffs for the tenants. |
| VON | VON is the task and deliverable responsible party. VON is responsible for all energetic restorations and retrofitting measurements done at the selected buildings in Dresden including the supply of 3 E-Vehicles to advert the concept of car sharing as well as the development of an overall strategy regarding energetic modernisation in the building sector. |

## 1.3 Relation to other activities in the project

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**Table 2 Relation to other activities in the project**

| Deliverable | Relation to D3.16 |
|---|---|
| D3.14 | D3.14 describes the detailed design of the interventions to be implemented in the city of Dresden and is the basis for all further tasks and deliverables in WP3.<br>Therefore, D3.14 gives a more detailed description of the design and the status of the interventions about innovative mobility solutions and measures defined in the Dresden to boost the e-mobility in the city. |
| D5.5 – D5.7x | The objective of WP5 “Technical, social and economic evaluation” is to setup a strong evaluation framework to be deployed in each lighthouse city with the aim to assess the effectiveness of the proposed intervention, deployed in the associated individual actions.<br>Therefore, D3.16 is linked to WP5 deliverables. |
| D6.5 | The objective of WP6 “Exploitation and market deployment – innovative business models” is to design innovative business models and financial mechanisms to foster the implementation of smart city solutions, to identify exploitable results and to design an ad hoc strategy for their deployment and replication. |
| | |

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# 2 State of the art and future vision related to New Concept of high performance district in Dresden

The existing buildings have been constructed between 1960-70. Their **54,838** m² (living **35,650** m²) are distributed in 10-storey buildings in transverse wall construction with mainly north-facing staircases. There are 14 entrances to 560 residential units (about 1,200 inhabitants) divided in 2 and 3 room apartments (48 m² and 79 m² respectively). Until 2022, the referred buildings will receive comprehensive modernisations and retrofitting that involve the redesigning and replacement of various parts of the buildings as well as energetic insulation of facades and roofs. The planned structural measures do not just serve as external improvements but in the end should help to reduce emissions and to create a sustainable living space. In cooperation with DWG, tenant electricity models are promoted with the objective to increase the flexibility of the smart energy systems. Tenants are allowed to directly use the renewable electricity generated on their buildings: A photovoltaic system is installed on an existing building and the required metering systems are being installed. Furthermore, the effect of retrofitting existing buildings on energy demand is being monitored.

Simulations regarding photovoltaic systems generation and tenant's demand of electricity are being performed. Additionally, the integration of storage is simulated.

The newly construction of the District Future House will function as an innovation hub for modern sustainable housing. At the same time, it will work as research facility for several

To support the mobility transformation within in this district and in Dresden in general, the selected building has received 36 charging points including two fast-charge stations. FHG will equip the charging points with Smart Metering. In addition, VON employees have access to 3 E-vehicles, which can be used as pool cars while doing the necessary maintenance within this district. This aims at reducing negative impacts on the environment as well as promoting the concepts of E-Mobility and car sharing.

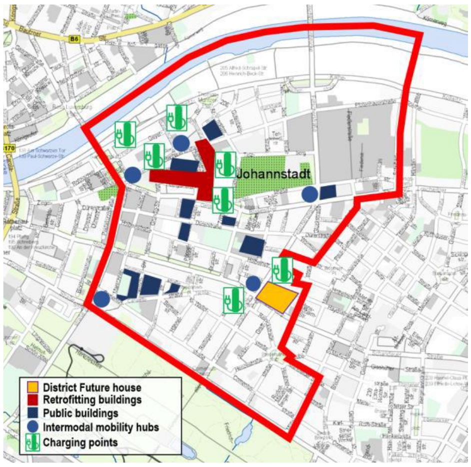


**Figure 1: Johannstadt District in Dresden**

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# 3 Technical definition of the interventions

## 3.1 Action 07: Pfotenhauer Str. Retrofitting project

The existing buildings have been constructed between 1960-70. Their 54,838 m² (living 35,650 m²) are distributed in 10-storey buildings in transverse wall construction with mainly north-facing staircases. There are in total 14 entrances to 560 residential units (about 1,200 inhabitants) divided in 2 and 3 room apartments (48 m² and 79 m² respectively).

The buildings will be retrofitted according to current energy consumption and saving standards. Current windows and doors will be replaced by elements meeting the standards of KfW program-151 and facades and roofs will be insulated using a thermal insulation system also according to the requirements of KfW program-151 (KfW-Effizienzhaus). Decreased energy consumption based on the retrofit measures and generation from action PV new-built (Action 4) will be taken into account in the heating system design (Action 17). A charging pole (Action 22) will be included for e-mobility. This will lead to a reduction of the heating systems dimension compared to the current status together with lower energy consumption and thus a $CO_2$-reduction.

## 3.2 Action 09: District Future House

District Future House will be a housing cooperative with 2,287 m² (living space 1,191 m²) distributed in 14 dwellings. Its thermal demand will be covered through the DH while up to 40% of the electric one by the PV installed in the building (Action 41). Several "individual" technologies will be tested together in this new building. The Smart Meter/ Smart Meter Gateway-system (Action 43) will provide opportunities which need to be applied under real conditions to produce several benefits for the tenants.

The interaction between the classical supply concepts (district heating station), the technical building equipment (heating system, central domestic hot water preparation) and the additional technologies will be tested both technically and communicatively, and fully monitored among all the building. In addition to the energy-related part (consumption "house" and "housing" over all media, tenant electricity model, load-variable tariffs ...), other services and housing management should also be possible via the energy management system. Data transmission within the property and "outwards" (both for measuring point operation and for sub-meter) is to be carried out through the iMSys system as a modern communication infrastructure. Relating the energy management of this future house, it will be a smart building, which is managed by hierarchic management systems – one for the entire building and one for each single flat. The following functions are more possibilities need to be finalized during the project.

Dwelling Energy Manager, will be the future central information and communication platform for tenants. It will provide information on demand of electricity, heat, water. The tenant will be able to choose ventilation, temperatures and times at this central service unit of for his apartment. There are different sensors for temperature and actors (floor heating valves). All the data are submitted to the Building Management and participate

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in optimizing the heat consumption. Information of the property management, weather forecast, contact data of housekeeper and others are given on the home display too. Also the consumption of the flat can be monitored by the tenant via his display.

Building Energy Manager: This collects and achieves all relevant data from the Dwelling Energy Manager. It regulates the central district heat feed-in and the central building ventilation.

**SUBCONTRACT**: Commissioning of the construction management, implementation of the PV panels, the system connections storage integration – Budget: 12,000 €

Scope of the subcontract: District Future House will be a housing cooperative with 2,287 m² (living space 1,191 m²) distributed in 14 dwellings. Its thermal demand will be covered through the DH while up to 40% of the electric one by the PV installed in the building (Action 41). Several "individual" technologies will be tested together in this new building. The Smart Meter/ Smart Meter Gateway-system (Action 43) will provide opportunities which need to be applied under real conditions to produce several benefits for the tenants. The tasks of the subcontracting will cover the commissioning of the construction management, the implementation of the PV panels, and the integration of the system connection storage.

Cost estimation: The costs have been estimated based on a cost calculation of all appearing categories and costs for service offers made by several providers.

Type of procedure: The subcontracts will be awarded according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA).

## 3.3 Action 01: Smart Tenants

With the objective to increase the flexibility of the Smart Energy Systems, tenant electricity models will be promoted through this action. Through tenant electricity models, tenants are allowed to use the generated energy from renewable energies themselves in their quarters. The intelligent linkage of photovoltaics (Action 4) and storage (Actions 5 & 18) decouples on-site production and consumption and increases the autonomy of the district. This can increase the attractiveness of tenant flows and enable economic and ecological participation in the urban energy market for a large number of tenants. Integration of electromobility (Action 23) in conjunction with the photovoltaic system, the indirect CO2 emissions from the electric vehicles can thus be further reduced and a positive contribution to the energy balance of the district can be achieved. As a result of the reduction in the feed-in into the public electricity grid, expected peaks in consumption and decentralized production will be reduced in the future (Action 54). The consumption-oriented and -oriented expansion of renewable energies in the district is thus promoted.

For taken decisions among the different stakeholders involved in this action, providing information for tenants and power producers about their feed-in, consumption or efficiency is one of the main aspects to treat. For this, the buildings (Action 7) will have installed Intelligent metering systems (iMSys) that consists of modern measuring equipment (mME) and a smart meter gateway (SMGW), which collects, stores and transmits measured values to authorized market participants (AMT), taking into account the requirements of the BSI (high data protection and data security requirements). The

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implementation of iMsys provides the basis for the information and communication technology for linking the previously separate energy systems. IMsys are remotely communicable electricity meters that meet the high data protection and data security requirements. The iMSys are connected to the Urban Platform by gateway (SMGW- Smart Meter Gateway), which allows remote access via a communication link (based on the ICT infrastructure). The data from the gateway is then made available through the Urban Platform. The group of producers (CHP, PVA) is integrated into the iMSys via the control box. The active market partners (aAMP) form the authorized subscriber body who communicate the switching operations via the secure ICT infrastructure of the control box. Hence, iMsys allow only the previously sketched concepts as well as the provision of information to among other things on-site production, consumption, CO2 savings and efficiency for a "smart" tenant.

Additionally, to the monitoring of the dwellings, simulation will be used for creating functional connections between modules like photovoltaics, storage batteries, controlled EV charging infrastructure as well as HVAC and district heating adds a lot of complexity to the energy system. Also to layout and test these systems regarding component sizing and functional interaction using dynamic systems simulation based on modelica is state of the art. For the simulation, computational models of battery storages, buildings user behavior, etc. are connected in the proposed layout and functionality of the future district. The system is then valuated for typical usage scenarios, and afterwards the model gets adjusted until the system works as desired. Based on the results, the real world components are built. So, this process helps to reduce in site commissioning efforts and greatly improves quality. Currently these technologies are mainly used for high profile buildings.

## 3.4 Action 02: Building Control Center: 12 Public Buildings Energy Managed

5 schools, 6 children's day care facilities and 1 administrative building, all of them located in Dresden's high-performance district Johannstadt, will be connected to a Central Building Control Center (CBCC), which although currently being constructed in another Dresden district, will allow increasing the effective energy management of the selected 12 public Johannstadt buildings (VON). This increment will be obtained through the permanent timely adaptation of the building heating systems with the current internal and external climatic conditions, exhausting the existing energy savings potential. All data acquired by the CBCC will be integrated into the Dresden Urban Platform and will be released as Open Data.

<u>Role of the Third Party EASD:</u>

Main goal of Action A2 is to improve the energy efficiency of public buildings. Therefore, EASD models one representative school building in the district using the A1 modeling approaches. Besides building performance analyzes and optimization, the models are used to implement and test predictive heat control algorithms, mainly regarding a permanent adaptation of heating depending on outdoor and indoor conditions. Dresden wants to add the public buildings to its Central Building Control Center (CBCC), a platform for data monitoring and evaluation and building energy management. To

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support a permanent high energetic standard of the connected buildings, EASD exemplary shows efficient measures of data evaluation and system optimization including models and monitoring data for the selected representative school building.

## 3.5 Action 43: Smart-Meter-Gateway in District Future House

In the District Future House (Action 9) one of the main project targets is to implement a joint metering concept for all media in the building – such as electricity, natural gas, (district) heat and (hot and cold) water. The energy management systems provide information to the tenant and the entire building. A reduction of the energy demand, hence resource-saving by a control-system is going to be enabled by active involvement of the tenants. The expectations in the District Future House project are to find a scalable and useful solution for other apartment buildings in the city of Dresden.

All the flats are going to be integrated into a complete metering and management system by submeters. The projected configuration of electric submeters includes different shared electricity objects such as light, ventilation, circulation pumps, electronic information tables, elevators, smoke evacuator etc. Therefore, submetering systems are needed for heat cost allocation (for heating and domestic hot water) and will be additionally used for the management of drinking cold water. The entire building will be prepared for a future secure and reliable communications infrastructure. Additional equipment with empty conduits is designed for uncertain future communications requirements (wide-area-network – WAN) and future services. This smart-meter-gateway will provide data to Dresden Urban Platform.

## 3.6 Action 04: 33 kWp Photovoltaic System on existing Buildings

A photovoltaic system will be installed on the existing buildings at Blasewitzer Str. 36 a-c that were constructed in 1990. Other apartment buildings at Pfotenhauer Str. will be retrofitted inside the MAtchUP project (Action 7).

In the 61 flats that comprise the buildings located on Blasewitzer Str., the total roof surface is about 570 m². Given the architecture, about 33 kWp of PV generation may be installed, depending on the actual circumstances. These will be included in the potential energy storage and total annual electricity generation should sum up at around 30,000 kWh. As the total electricity consumption of the building (its inhabitants) is around 105,000 kWh/a, 100 % of PV generation will theoretically be used in the building itself. Due to the planned storage (Action 5), the generation and demand mismatch should be covered. A $CO_2$ reduction of around 28 % can be reached due to the use of PV generation.

## 3.7 Action 41: 9.9 kWp Photovoltaic System in District Future House

In the District Future House that will be built within the project (Action 9), PV energy will be produced and stored in the building itself. With a nominal power of 9.9 kWp and a

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generation of 950 kWh/kWp the solar panels installed will be able to provide the 75 % of the energy own consumption of the building. For the installation of the PV panels, two different concepts will be taking into consideration, aligning south and aligning east-west. Both concepts differ in the installable capacity and the time of production, so the decision will be made by taking into account statics of the roof, the costs and the benefit (maximum use of the RES in the building).

## 3.8 Action 05: Integration of the power supply system of the retrofitted buildings with the District Storage System

A district storage was initially planned to be constructed. First analyzes of renewable power availability and individual power demand of building and inhabitants (c.f. A1) indicate that a district storage system does, however, not well match with current economic and technical boundaries. Thus, there won't be the need to build an advanced power supply system.

However, future energy market developments as well as increasing requirements on grid stability will change this situation. To already meet these challenges, the considered retrofitted buildings will be analyzed with the developed simulation models to identify break-even conditions and future state of the market regarding suitable storage sizing and integration measures. Currently we are thus redesigning this task, taking into consideration new projects to be implemented into the electric grid and to houses. We started an initiative with Deutsche Telekom AG and several scientific partners to find a testing-area for the new telecommunication standard 5G with focus of its use in the energy market. The smart tenant project will be considered as a part of an intelligent grid cell. Thus, as part of the 2nd amendment, this action is canceled.

## 3.9 Action 42: Power Storage in District Future House

For a better management of the PV power generated in the District Future House (Action 41), a Varta-Energy Storage system with a nominal capacity of 3,3 kWh will be installed (Action 9). The energy from this storage will be used for covering the building demand, but the possibility to be used for Electrical Vehicle charging will exist in the future.

## 3.10 Action 38: Energy efficient design of the real estate

Development of a business model for energetic transformation of the real estate with guarantee of energy cost savings. The implementation will consist on the analysis of current energy state of existing buildings followed by the definition of actions and finally the large scale modernization of building energy technologies with energy-saving contracts, monitoring, controlling, energy consulting and performance optimization.

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# 4 Executive project description of each action

## 4.1 Action 07: Pfotenhauer Str. Retrofitting project

### 4.1.1 Management structure

The actions are led by VON who is responsible for all retrofitting measures as well as all energetic restoration measures.

### 4.1.2 Technical specification

Within the MAtchUP project, ~12 selected public buildings in the high-performance district Johannstadt will be retrofitted and modernised. With regard to energetic and ecological standards linked to KfW-fundings, the buildings will receive an extensive energetic restoration, which includes the modern insulation of facades and roofs as well as the (partially) renewal of heating elements. The modernisation also includes the installation of balconies and the replacement of Windows and doors. Entrance areas, facades and stairways/elevators will be redesigned.


Figure 2: Referred Buildings in Johannstadt

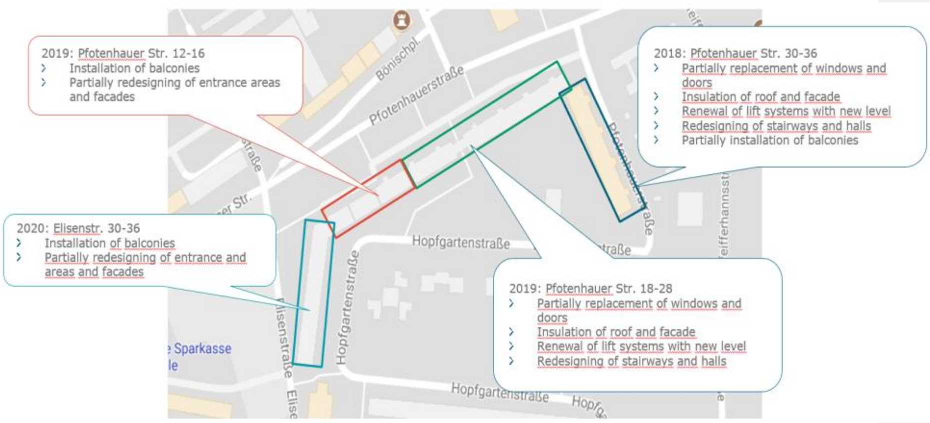


Figure 3: Planed Measurements for each building

The technical improvements are described in the following.

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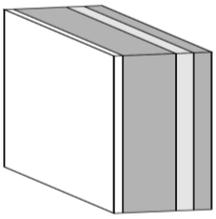
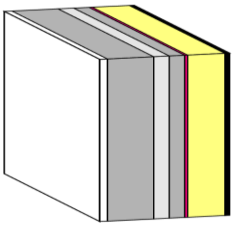
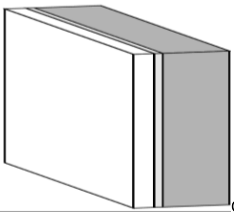
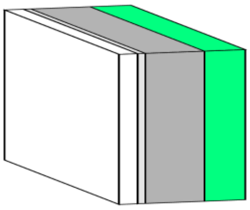

Outside Walls before


Outside Walls after

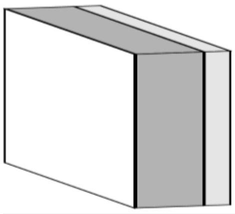
Currently the materials used for the outside walls include plaster mortar (limestone, 25mm), concrete (200mm), and expanded polystyrene foam (50mm) with a total thickness of 275mm. The thermal transmittance for the complete external surface is 0.63.

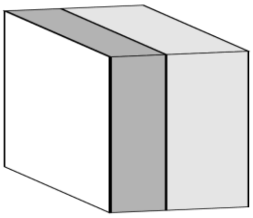
The constructional measures plan to add layers of mineral wool, lime-cement mortar as well as adhesive mortar. The restoration will increase the thickness about 125mm to a total of 420mm, resulting in an improved thermal transmittance of 0.20.


Cellar Ceiling before


Cellar Ceiling after

The cellar ceiling consists of cement (50mm), climate membrane (KM Duplex UV, 1mm), polystyrene foam (20mm), and concrete (160mm) with a total thickness of 231 mm and a thermal transmittance of 1.01, with regard to the overall surface of 1,073.5m². The future construction will also receive a layer of mineral wool increasing the thickness to a new total of 341mm and leading to a new thermal transmittance of 0.23.


Top Floor Ceiling before


Top Floor Ceiling after

The used materials regarding the top floor ceilings are mortar (limestone, 5mm), concrete (160mm), bitumen sheeting (3mm), climate membrane (KM Duplex UV, 1mm), and expanded polystyrene foam (60mm). The overall surface is 583.5 m², with a thickness of 229mm and a thermal transmittance of 0,56. To improve the thermal transmittance, the layer of expanded polystyrene will be extended to 240mm. The new transmittance is expected to be about 0.14.

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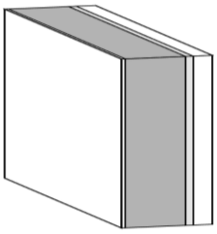
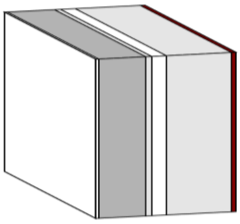

Ceiling against the attic before


Ceiling after

Currently the ceiling against the attic consist of plaster mortar (limestone, 10mm), cement (50mm), concrete (160mm), and expanded polystyrene foam (20mm) with a total thickness of 240 mm. The thermal transmittance for the complete external surface (490 m²) is 1.16.

After the restoration, the ceiling will have a new layer of expanded polystyrene foam (220mm) and a layer of OSB-panels (15mm). The thickness of the ceilings will be 475mm and the thermal transmittance will be around 0.14.

In combination the planned contractual measures and energetic restoration should lead to a reduction of monthly heating costs of 60% from 0.53 €/m³ to 0.32 €/m².

### 4.1.3 Planning of the tasks

Termination of all retrofitting work until January 2021.

### 4.1.4 Health, safety and waste management requirements

1. General requirements related to regular construction and renovation projects.
2. Extraction of asbestos probes as well as the analysation of possible hazardous substances or materials. Regular process that should be operated by professional companies.
   - ➔ Probes have been extracted and analysed by Ergo Umweltinstitut GmbH in July 2018.
   - ➔ Each finding is listed, documented and the necessary corrective actions were determined
3. Joint restructuring / large scale withdrawing of joints. A professional company should operate execution and disposal.

### 4.1.5 Risks considered ex-ante and proposed risk-mitigation measures

Not applicable for this Action.

## 4.2 Action 09: District Future House

### 4.2.1 Management structure

DREWAG is responsible for the planning, erection (by subcontractors) and construction supervision of the **photovoltaic and storage system**, as well as calculation of the **tenant electricity model** and acquisition of participating tenants.

DWG also is in charge of simulating and implementing **flexible tariffs**.

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WGJ provides roof areas and access to the building as well as to the building and apartment management system.

EASD develops suitable simulation models which are necessary and used to evaluate an adequate system layout and to test suitable smart electricity tariffs before the actual system implementation. After the implementation, the calibrated models can be an essential application to evaluate the performance of the system as they provide reliable data when measurement values are not available.

### 4.2.2 Technical specification

The District Future House is a new constructed building within the MAtchUP district of Johannstadt which provides alternative requirements on the smart electricity tariffs and the renewable power supply system integration than the retrofitted existing building of Action 01. Because of its internal ventilation system as well as the predefined battery system integration, the resultant power consumption profile can significantly differ and provides at least a broader scope for system control.

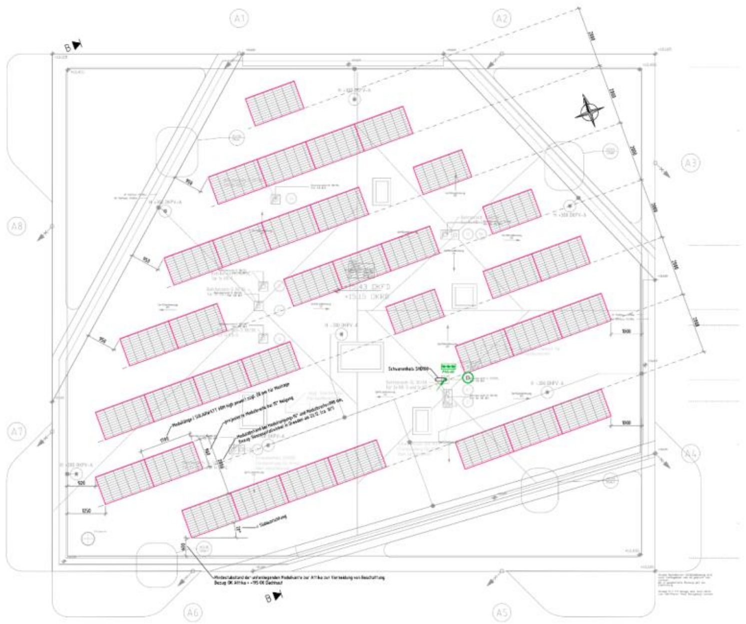

**Figure 4: System layout of the roof-top photovoltaic system**

However, the major energetic benefit of the building is provided by the photovoltaic system on the roof which operates in close interaction with the installed battery system. Following characteristics of the power supply system have to be taken into account for the smart tariffs development:

- Nominal output PV system 9.92 kWp
- High-performance modules from LG with 320 Wp each
- Expected Power generation of around 9,200 kWh/a

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- Varta storage system, usable capacity 3.3 kWh
- Expected own consumption rate of up to 80 %.
- Expected degree of self-sufficiency up to 40 %.

This action includes the development and utilization of dynamic system and occupancy simulation models which are especially necessary to get a better indication of the multiple influencing factors on smart electricity tariffs for residents, even before measurement data is available.

In many building simulations and design calculations, the standard load profile (SLP) is used to determine the electrical energy demand. This corresponds to the average annual load profile of 10,000 residential units and is standardized to an annual energy requirement of $_{Eel}$ = 1,000 kWh/a. Peak characteristics of the resultant power consumption profile are thus significantly smoothed which causes undesirable superimposition effects. A suitable realistic scenario with less considered residential units represents a significantly higher peak-to-baseload ratio and has thus different influences on power supply system control (i.e. battery control) and resulting self-sufficiency ratio.

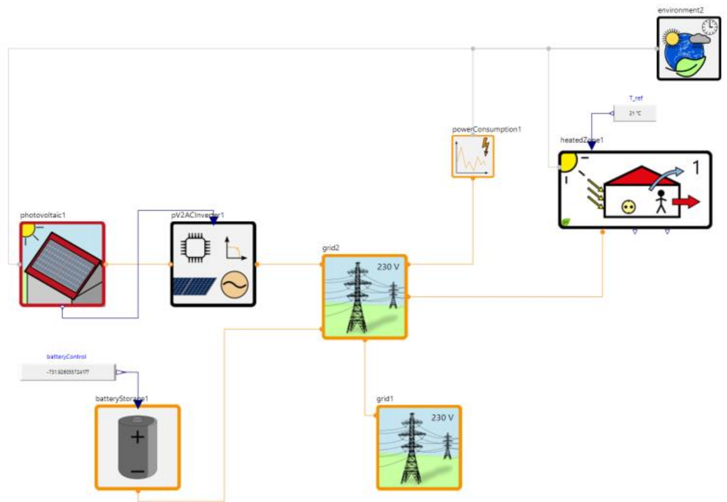


**Figure 5: Modelica-based power supply system model incl. variable power consumption profiles as well as building internal power consumption by controlled ventilation**

The implemented Modelica-based dynamic simulation model (c.f. Figure 5: ) includes the behavior of the PV systems, the battery system as well as system control units. The residents' behavior is taken into account by offline pre-simulated power consumption profiles which represent different shares of residents' participation and structure.

Photovoltaic system behavior depends only on the local weather conditions. This key fact results in a volatile availability of local renewable power sources. The battery model describes the availability of storage capacity depending on the deviations between local generation and the occupancy-depending power consumption profile. Furthermore, the

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model adds the additional but significant volatile power consumption of the building's ventilation system.

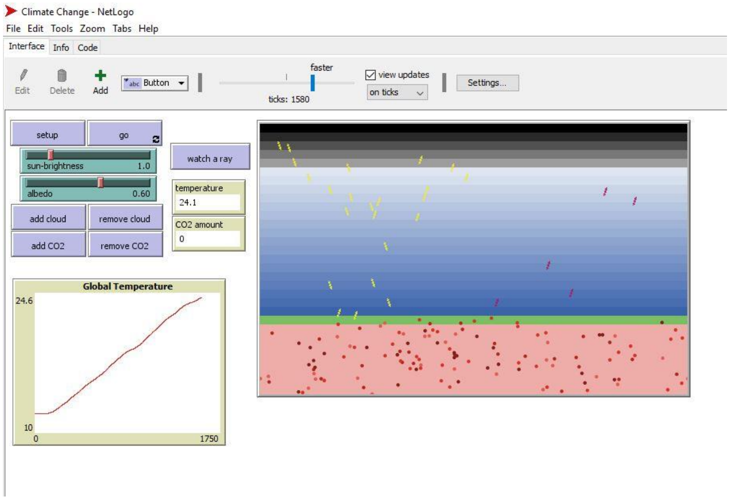


Figure 6: Example of multi-agent simulation model in Netlogo

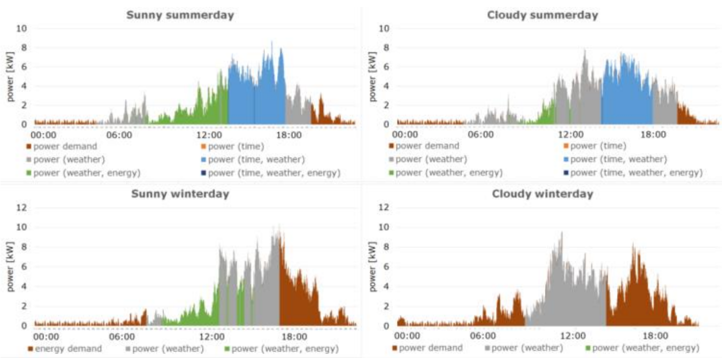


**Figure 7: Exemplary daily power consumption profiles with different assignments to different tariffs**

The various power consumption profiles were generated in advance depending on different pre-sets by use of the versatile multi-agent simulation platform Netlogo. They are thus highly precise with reference to single electric devices used in typical apartments as well as a high temporal resolution of up to 1 min. GDPR is thus not an issue during the testing phase as all data is based on generic sources. The resulting individual profiles of different simulated occupancy scenarios are summarized in an average power consumption profile as input of the dynamic simulation model (see examples in Figure 6). Based on a comprehensive set of different occupancy characteristics, the simulation results of the models were used to evaluate different

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tested smart tariff strategies regarding the influence of monetary remuneration and motivation on the residents' energetic behaviour and the resultant energetic benefits of these tariffs. Furthermore, the influence of the building's self-consumption by the ventilation system was analyzed regarding energy saving potentials and tariff benefits. After investigation, the first stage of the tariff models was implemented. The 2nd stage currently still takes place in the laboratory. It is planned to complete it in the Q2/2021. Further information on the various implementation stages is provided under the point "Progress description" below.

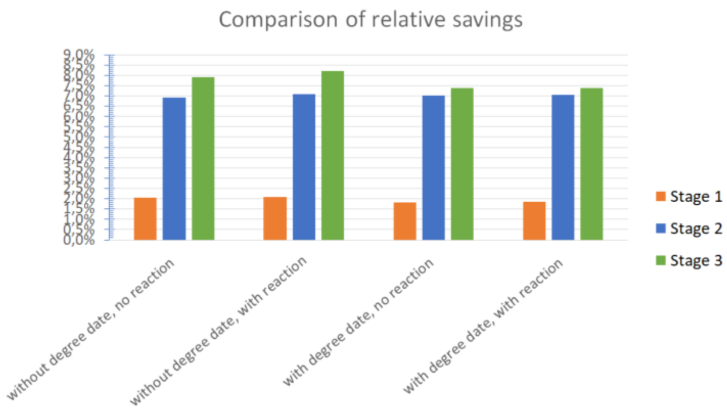


**Figure 8: Evaluation of energy saving potentials regarding different analyzed flexible tariff stages**

### 4.2.3 Planning of the Taks

- M1: Q 4/20: Implementation of second level variable electricity tariff
- M2: Q 2/20: Feedback of apartment house owner to energy management and RES-generation
- M3: Q4/20: At the end of 2020, a survey of tenants will be conducted to find out how satisfied they are. We expect to derive appropriate conclusions for future product development. Furthermore, the development of the flexible solar power tariff of level three and its accounting procedure is on our agenda.
- M4: Q2/21: Implementation of third level of the variable electricity tariff
- Until 01/21 [M40]: Update of simulation models (calibration) regarding measurement data
- Until 03/21 [M42]: Evaluation of smart tariffs depending on measurement data and simulation models
- Until 09/2022 [M60]: Continuous monitoring and evaluation

### 4.2.4 Health, safety and waste management requirements

Not applicable for this Action.

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### 4.2.5 Risks considered ex-ante and proposed risk-mitigation measures

On-schedule installation of the photovoltaic system

Interest of the tenants in the tenant electricity model and flexible tariffs, therefore high contraction-rate

## 4.3 Action 01: Smart Tenants

### 4.3.1 Management structure

DREWAG is responsible for the planning, erection (by subcontractors) and construction supervision of the photovoltaic system, as well as calculation of the tenant electricity model and acquisition of the participating tenants.

VONOVIA provides roof areas and access to the building.

EASD develops suitable simulation models which are necessary and used to evaluate an adequate system layout and to test suitable smart power electricity tariffs before of the actual system implementation. After the implementation, the calibrated models can be an essential part application to evaluate of the performance of the system evaluations they provide better inside reliable data in the system behavior when measurement values are not available. EASD simulates the energy model data.

### 4.3.2 Technical specification

This action is focusing on feasibility of smart city solutions in a typical existing apartment building with tenants from a lower income range. As there is a whole series of similar objects in Dresden this Action is a good sample for future replication.

The main aim of this action is to test and to implement business models to directly supply locally produced renewable energy on an apartment building's roof to the residents. In order to make this attractive for the residents and commercially feasible for the operator. These tests require extensive detailed examination in advance. It is necessary to take into account different shares of tenant participation as well as sizes of the considered power supply system components (i.e. PV and battery system). Therefore, suitable simulation model was developed which use the versatile modelling language Modelica to describe the technical system functionality as well as common multi-agent simulation approaches representing the residents' behavior and interactions resp. reactions.

During the implementation of the model structure, the chosen example building was changed from a 10-storey building of type IW 67 in Pfotenhauer Str. to a 6-storey building of type WBS 70 in Blasewitzer Str. 36 a-c due to the existing requirements for the available maximum roof loads. In this apartment building, the desired tenant (i.e. residents) electricity model is implemented. This is aimed to lead to a positive mood of the residents for the new offer on local renewable energies.

The supply of renewable energy is provided by a PV-system on the roof of the apartment building. The building has three entrances and 61 residential units in total. The resident structure can be characterized as mixed. The average electricity consumption per apartment is 1,400 kWh per year. For the entire property, this sums up to an annual electricity consumption of approximately 85,000 kWh.

The roof-top was equipped with a photovoltaic system by DWG (c.f. Figure 8). It consists of two roof-top areas with one inverter each. The first part includes 2x40 PV modules, the second part include 2x20 modules. The characteristics of the PV modules and the inverters provide the basic parameters of the implemented simulation model. Thus, the total system power output is 33 kWp. The modules were arranged at an angle of 5° with an east-west orientation. This results in an annual electricity yield of around 30,000 kWh.

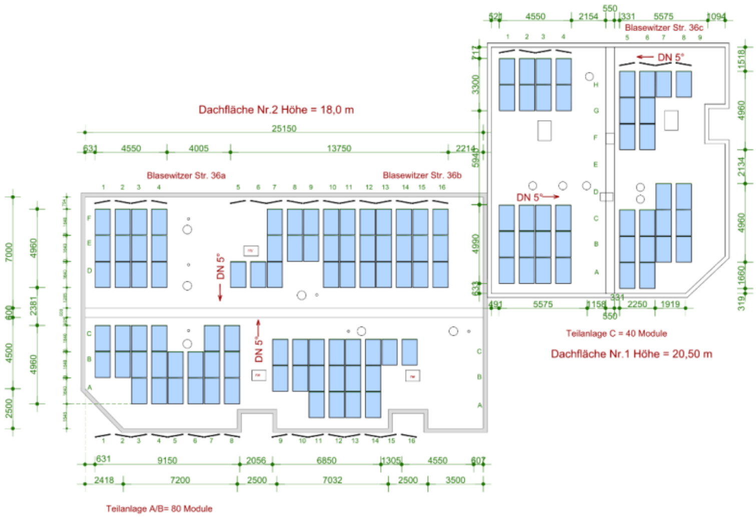


**Figure 9: Layout of PV system on the roof-top**

In many building simulations and design calculations, the standard load profile (SLP) is used to determine the electrical energy demand. This corresponds to the average annual load profile of 10,000 residential units and is standardized to an annual energy requirement of $E_{el}$ = 1,000 kWh/a. Peak characteristics of the resultant power consumption profile are thus significantly smoothed which causes undesirable superimposition effects. A suitable realistic scenario with less considered residential units represents a significantly higher peak-to-baseload ratio and has thus different influences on power supply system control (i.e. battery control) and resulting self-sufficiency ratio.

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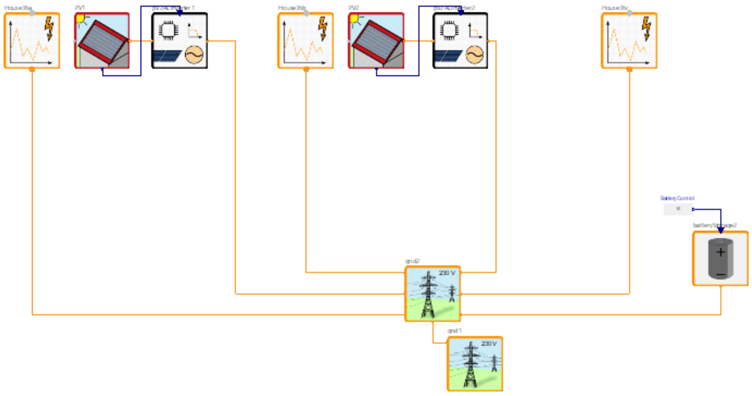

**Figure 10: Modelica-based power supply system model incl. variable power consumption profiles**

The implemented Modelica-based dynamic simulation model (c.f. Figure 10 includes the behavior of the PV systems, the battery system as well as system control units. The residents' behavior is added by offline pre-simulated power consumption profiles which represent different shares of residents' participation and structure.

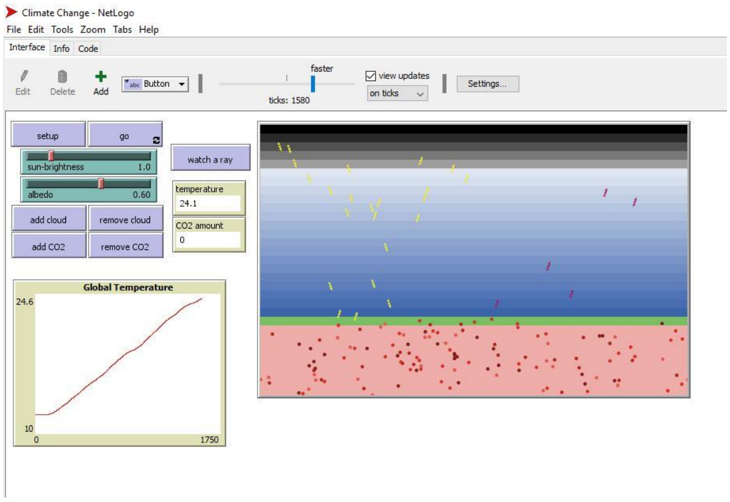


**Figure 11: Example of multi-agent simulation model in Netlogo**

The various power consumption profiles were generated in advance depending on different presets by use of the versatile multi-agent simulation platform Netlogo. They are thus highly precise with reference to single electric devices used in typical apartments as well as a high temporal resolution of up to 1 min. GDPR is thus not an issue during the testing phase as all data is based on generic resources. The resulting individual profiles of different simulated occupancy scenarios are summarized in an average power consumption profile as input of the dynamic simulation model.

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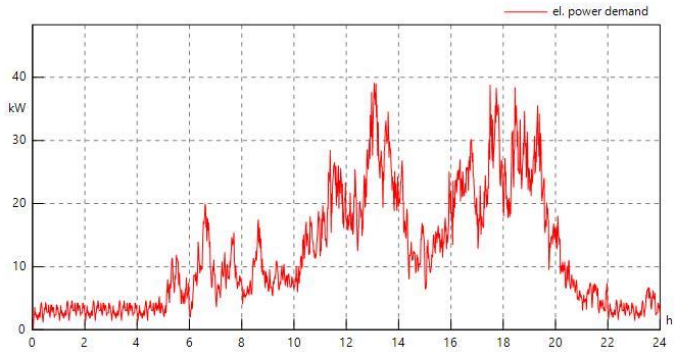


**Figure 12: Exemplary generated average power consumption profile of one day**

Based on a wide-spread set of different input characteristics and participation shares, the system layout of the renewable power supply components was evaluated with the help of various simulation runs. These runs provide a well-suited indication which size of PV system has which influences on the local autarky level depending on the residents' interests on participation. Furthermore, it led to the insight that even a small battery system causes additional costs which excel the benefits of a higher autarky level.

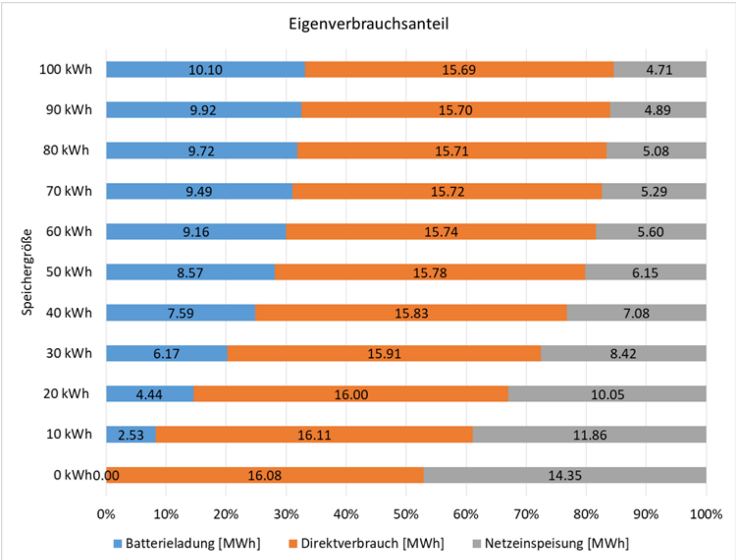


**Figure 13: Exemplary results of self-sufficiency ratio depending on battery size for 50 % residents participation**

As a significant result of the simulations, the decision was made to neglect a battery system in the considered apartment building at Blasewitzer Str. 36 a-c. Hence, we achieve a higher total profitability of the implemented measures for the leading company

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DWG. This result is caused by the ratio of available roof-top area and the self-consumption inside the building, especially during the day.

Furthermore, the implemented model framework was used as one major test application for the evaluation of adequate smart tenant tariffs even before the final installation of the technical system and the availability of measurement data.

In addition to the electrical demand of the building, this model also simulates the proportion of solar power for the building on the basis of regional weather data. Elements such as the PV, the inverter and the electrical storage are modeled with all physical conditions and thus enable a detailed and physically accurate simulation of different use case scenarios. These are described in more detail under Action 18. The model is shown schematically in the

### 4.3.3 Planning of the Tasks

The next project year will already include the first year of monitoring of the achieved energy saving potential. Next milestones regard the final implementation, test and evaluation of the smart tariffs as well as the process start of monitoring:

- Until 11/2020 [M38]: Test phase and completion of the automated billing of the tenant electricity model
- Until 01/2021 [M40]: Update of simulation models (calibration) regarding measurement data
- Until 03/2021 [M42]: Evaluation of smart tariffs depending on measurement data and simulation models
- Until 09/2022 [M60]: Continuous monitoring and evaluation
- Facilitation of electromobility solutions for tenants (Action 40)

### 4.3.4 Health, safety and waste management requirements

Not applicable for this Action.

### 4.3.5 Risks considered ex-ante and proposed risk-mitigation measures

- Despite of our intensive research on mounting systems, the static engineer of VON identified insurmountable problems of the roof in a late stage of the planning phase. This led to a change of the apartment building to be used as within the MAtchUP-project and to adjust the energy model to the new building block.
- Interest rate of the tenant electricity model is poor.
- Depending on ongoing investigations on economic feasibility and partners for the Car sharing to tenant's milestone M2 is still vague.
- For the automation of the billing of the tenant electricity model: scarcity of resources and adjustment possibilities of the billing system

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## 4.4 Action 02: Building control centre: 12 Public Buildings energy managed

### 4.4.1 Management structure

The action is led by and executed by DRE (building owner, operator of building control center) with technical and scientific support of EASD as a Third Party (simulation, monitoring concept and concept for technical equipment).

### 4.4.2 Technical specification

Within the MAtchUP project, around 12 selected public buildings in the high-performance district Johannstadt shall be equipped with intelligent metering devices (for the heating system) and connected to the Building Control Center, which is an essential part of the MAtchUP project. In the near-term, the initiative will be upscaled to public buildings across the city of Dresden.

Since the utility (Drewag) operates a district-heating-control-center at which the district-heating-stations of 7 (from the 12 buildings in Johannstadt) are already connected, DRE got access to this control-center (Energy-Terminal). In addition to this DRE is currently building an own Building Control-Center at which the rest of the 12 building will be connected. In addition to the heating-units, DRE will also connect other technical installations like the ventilation system to their own BCC.

With the Energy-Terminal DRE can oversee the district-heating-stations with the following parameters: flow-temperature, return-temperature, ambient-temperature circulation-pump on/off, heating-curve and heating-time (time of operation of the heating-systems/ night setback).

DRE analysed these parameters in relation to measured indoor-temperatures and adapted control-parameters. After the final outcome of the EASD analysis of the pilot-building, the control-parameters will be further adapted.

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| No. | Building | Indoor-temp-erature mesure-ment | Optimi-sation of heating-time | Optimi-sation of heating-curve | Optimi-sation of switch-off in summer-time | Comment |
|---|---|---|---|---|---|---|
| 1 | Gymn. BB, SG Dürerstr. (school) | no | no | no | yes | heating-time, heating-curve ok, so no priority for indoor-temperature measuerent |
| 2 | Gymn. BB, Sporthalle (gym) | - | - | - | - | Not yet connetcted to BCC |
| 3 | BSZ Technik (profession school) | no | no | no | no | Optimisation possible, indoor-temperature measurement is planned for heting-period 2020/2021 |
| 4 | BSZ Ernährung (profession school) | no | no | no | yes | heating-time, heating-curve ok, so no priority for indoor-temperature measuerent |
| 5 | Schule zur Lernförderung (school) | yes | no | no | yes | indoor-tempereatzure measurement shows no optimisation-potential |
| 6 | 101. MS (school) | yes | yes | yes | no | |
| 7 | 102. GS (school) | no | no | no | no | pilot-school analysed by EASD |
| 8 | 113. GS (school) | no | no | yes | yes | optimisation of heating-curve because of energy-efficient retrofitting of the buidlung in 2016 |
| 9 | Kita (children's day care facility) | - | - | - | - | Not yet connetcted to BCC |
| 10 | Kita ((children's day care facility) | - | - | - | - | Not yet connetcted to BCC |
| 11 | Kita ((children's day care facility) | - | - | - | - | Not yet connetcted to BCC |
| 12 | Verwaltung (administrative building) | no | no | no | no | heating-time, heating-curve ok, so no priority for optimisation |

**Table 3: Planned measures in each building**

To evaluate specific use-cases of a central building control center for public buildings, the collection of relevant data as well as different strategies of data application as well as suitable system interventions of this new superordinate control entity need to be tested in advance on a specific example building.

This pilot building in MAtchUP is the 102nd elementary school (i.e. Pfotenhauer Str. 40 in the smart city district Johannstadt). This school building is a standardized building type. Thus, results can be transferred to many other buildings in the city and beyond.

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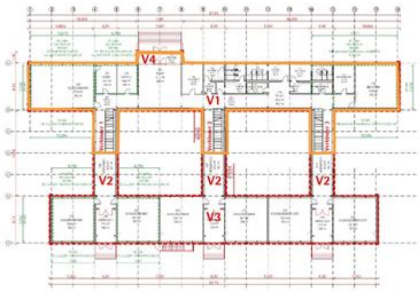


**Figure 14: Floor plan pilot building (standardized school building type)**

There shall be tested and demonstrated how to collect data with a consistent monitoring system (*1) as well as the effects of data-based system optimization (*3) and smart interactive control algorithms (*4) with the help of adequate hybrid digital twin models (*2).

***1: Monitoring system infrastructure:***

Suitable data with adequate temporal resolution and accuracy requires both suitable meters at relevant positions as well as a consistent data transfer infrastructure.

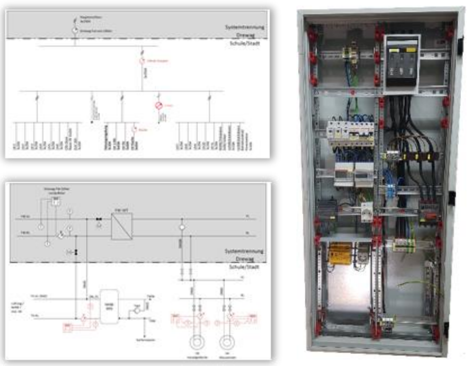

**Figure 15: Monitoring concept (left) and final implementation of metering infrastructure (right)**

The implemented metering infrastructure allows to directly transfer measurement data of heating and power supply system as well as local weather data to the Building Control Center. Permanently installed room temperature measurement will be added in the next months to replace temporal mobile measurement devices.

There, the data is used for different use cases, e.g. engineering-based data evaluation and system optimization, model calibration, test of advanced control algorithms incl. forecast and retrodiction or at least public services.

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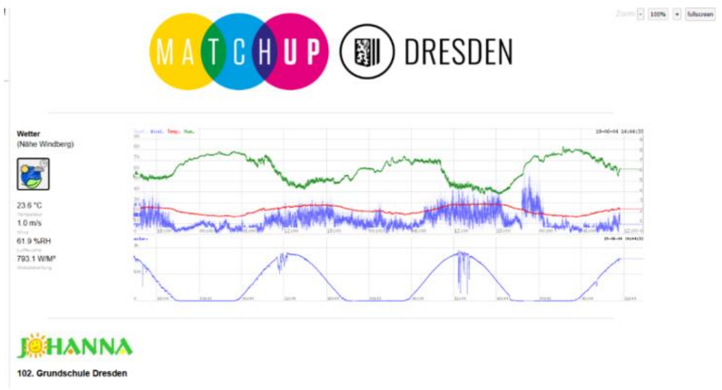


Figure 16: Data visualization by the monitoring platform

The implemented platform allows to visualize, export or convert the collected data for any relevant purposes which might occur in public use cases. It is thus an ideal platform to test new methods of data handling in the field of public buildings for the whole city.

***2: Hybrid digital twin model:***

In this energy-related action, simulation models are necessary to evaluate different measures of system optimization regarding both energy system configuration (e.g. hot water supply of the school building) and system control (e.g. flow temperature control of the heating system).

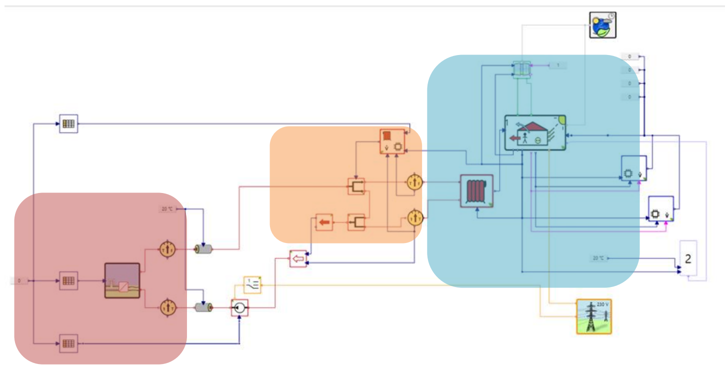

Figure 17: Structure of implemented hybrid digital twin model

The implemented simulation models represent the thermal behavior, power consumption and occupancy of different relevant rooms with high accuracy. To increase this accuracy, they have been calibrated with the collected measurement data from the first year of measurements, i.e. a hybrid digital twin model has been built.

With the help of the implemented and calibrated models, the energetic behavior of the building including occupancy has been digitally replicated. They are thus the basis of further analyzes regarding system optimization (*3) and controller optimization (*4).

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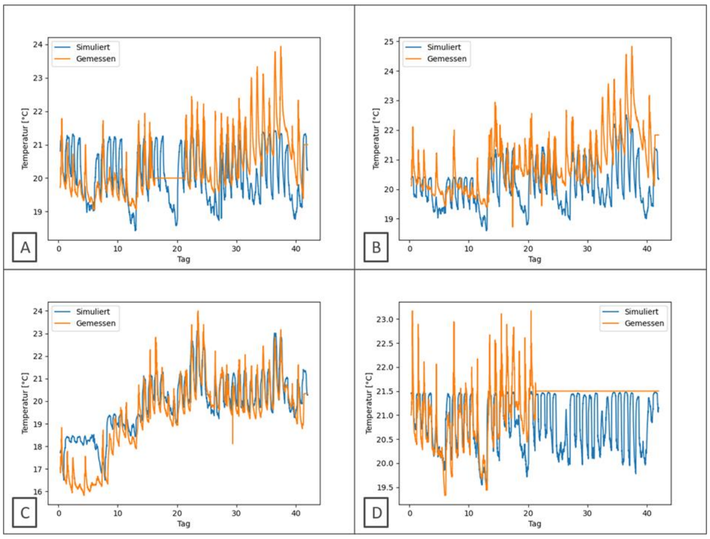


**Figure 18: Exemplary calibration results**

***3: System optimization:***

System optimization based on engineering analyzes is one of the major use cases of the Building Control Center. This use case has been conducted with both developed platforms and toolsets, the monitoring infrastructure and the digital twin model.

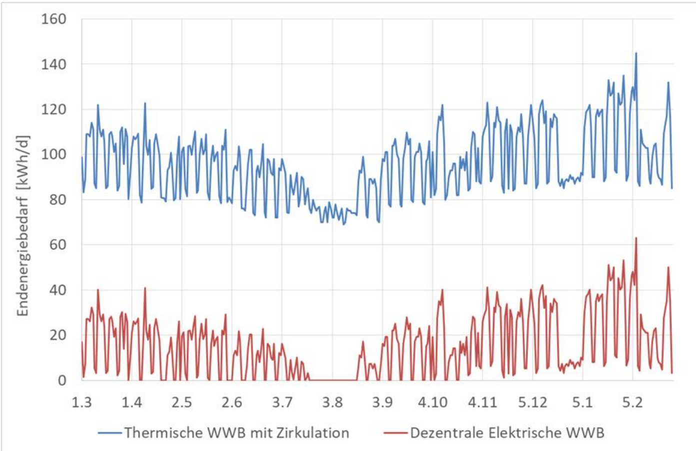


**Figure 19: Evaluation of results of different hot water supply methods**

As an example of the results, Figure 19: show an evaluation of the heat vs. power consumption curve of different system variants which have been evaluated with the measurement data (i.e. blue curve representing current status) and the model (i.e. red curve, representing alternative solution).

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***4: Smart interactive control algorithms:**

The controllability of the energy supply systems in public buildings is often very low as they mainly consist of mono-valent heat and power supply systems (i.e. heating via district heating grid and power supply via public power grid) and thus the degree of freedom is low.

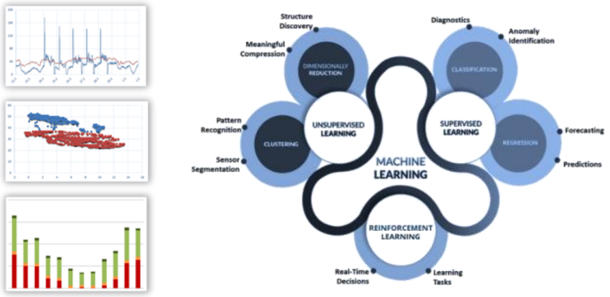


**Figure 20: Test and implementation of Machine Learning algorithms based on available data**

However, the heating system, as the main energy consumer in the 102nd elementary school, provides one relevant access for superordinate controllers, the flow temperature. It is currently controlled depending on the outdoor temperature as well as the building occupancy. Extensive investigations showed based on available data and simulation results that an optimized flow temperature control can provide additional energy savings of up to 20%.

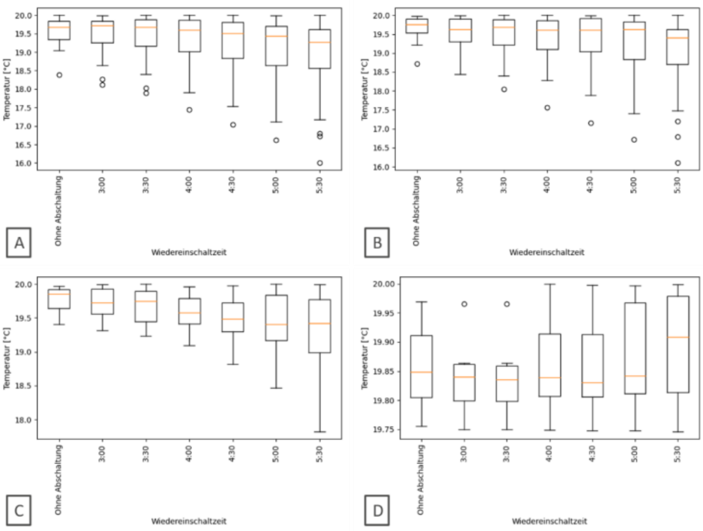


**Figure 21: Simulation-based optimization of controller set points**

These comparatively high saving potentials however require a very detailed knowledge of (future) building behaviour and occupancy. Therefore, machine learning algorithms as well as other smart control approaches are currently tested and trained with the calibrate digital twin models before the later implementation in the Building Control Center

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platform. Besides that, an optimized set of control parameters was analyzed and defined with the help of the models. Final implementation is planned until the end of 2020.

### 4.4.3 Implementation status

During the first two MAtchUP project year [M1-M24], the following steps could be finalized:

- Selection of public buildings to be connected to the CBCC and selection of one representative public building for the simulation model.
- Simulation model for the pilot building
- Measurement and monitoring concept for the pilot building
- Tender for the supply of measurement, monitoring and control elements. Choice of specific technical components and respective order.

During the first three years of the MAtchUP project (i.e. M1 to M38) most of the planned work has been done and measures were implemented. This included:

- Selection of public buildings to be connected to the CBCC and selection of one representative public building for extensive tests and implementation of exemplary measures.
- Concept development and implementation of a holistic monitoring infrastructure in the pilot building
- Collection and evaluation of at least 1.5 years of measurement data with high accuracy and temporal resolution, evaluation of system and control efficiency as well as suitable optimization measures, monitoring reports regarding winter and summer months for the selected pilot building
- Hybrid digital twin model of the selected pilot building incl. measurement data calibration
- Test and development of system optimization measures (i.e. hot water supply) and controller set point values (i.e. flow temperature control) with the help of measurement data and the simulation models
- Development and test of Machine Learning algorithms (predictive, retrodictive) as basis of smart flow temperature control, implementation as part of the monitoring platform
- Implementation of a measurement data based process of monthly KPI delivery, delivery of baseline data
- Access to DREWAG owned district-heating-control-center since 04/2019
- Detailed engineering and call for tenders for CBCC
- Start of on-site work for the CBCC
- Material for —climate education (e.g. in schools) based on the simulation model and the evaluation with real data (monitoring concept by EASD) and data from the CBCC

The next project year will already include the first year of monitoring of the achieved energy saving potential. Next milestones regard the final implementation, test and evaluation of the smart tariffs as well as the process start of monitoring:

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- Until 11/2020 [M38]: Test phase and completion of the automated billing of the tenant electricity model
- Until 01/2021 [M40]: Update of simulation models (calibration) regarding measurement data
- Until 03/2021 [M42]: Evaluation of smart tariffs depending on measurement data and simulation models
- Until 09/2022 [M60]: Continuous monitoring and evaluation
- Facilitation of electro mobility solutions for tenants (Action 40)

### 4.4.4 Health, safety and waste management requirements

Not applicable for this Action.

### 4.4.5 Risks considered ex-ante and proposed risk-mitigation measures

1. The initial list of buildings envisaged to be connected to the CBCC (i.e. 5 schools, 6 children's day care facilities and 1 administrative building) had to be updated. It now includes 5 schools, 2 profession schools, 1 gym, 3 children's day care facilities and 2 administrative buildings.

This deviation will neither cause any delays, nor will it have an impact on the project budget.

2. The permanent timely adaptation taking into account internal and external climatic conditions will target only the heating system for certain buildings, i.e. for the cases where no ventilation system is in place.

This deviation will neither cause any delays, nor will it have an impact on the project budget.

3. Not all data will be integrated into the Dresden Urban Platform, but rather selected and useful data. Moreover, it still has to be decided, which (anonymized) datasets under which level of aggregation can be released as Open Data.

This deviation will neither cause any delays, nor will it have an impact on the project budget.

## 4.5 Action 43: Smart-Meter-Gateway in District Future House

### 4.5.1 Management structure

DWG assumes a managing and coordinating role within A43. Departments of sales are in contact with tenants and employees from the network department, together with IT-department, develop the technical measuring station operation and the exchange of information. WGJ provides roof areas and access to the building.

### 4.5.2 Technical specification

The District Future House has a variety of measurement and sub measuring issues. The evaluation is done via an implemented energy management system (housing manager), the RIECON-system. The housing manager serves as a platform for the energy demand in the flats, such as heating and ventilation control, consumption recording for heat, water and electricity as well as a terminal for operation, display and communication with the apartment manager or service providers. Communication to the actuators and sensors takes place via standardized interfaces and via a company-specific RIECON bus. The building manager collects and archives all consumption data from the connected building energy management system, analyses the demand requirements for heating and ventilation. It determines the optimal control parameters for the heat generators and ventilation units. At the same time, the building manager is in communication via interfaces for connected service portals, such as the Urban City platform.

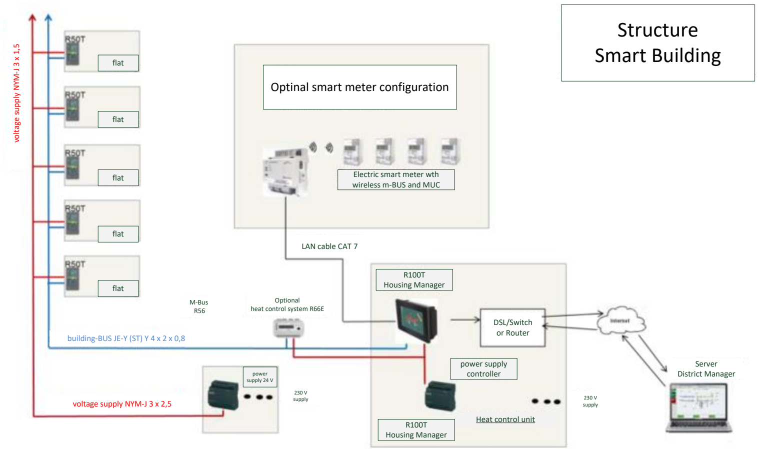


**Figure 22: Scheme Measurement System RIECON (Source: Regelungskonzept RIEcon Smart Building, RIEDEL)**

In addition to the data of the housing manager, data from the PV system (Action 4), the house lighting, the apartment meter system (Smart meter), the district heating system, the underground car park, the battery storage and other potential systems (e.g. electric storage systems) can be added to the building energy management system.

Partners are involved for the structured evaluation of the energy data. Daily meter data of the apartments, the PV system, the energy storage and the water consumption are handled in a 15 minute granularity. As well as historical data, the high-resolution meter data is visualized on this base.

Based on a forecast, the user will be enabled to estimate his future consumption as an added value and assess his previous consumption. Figure 23 shows the system image of the data analysis.

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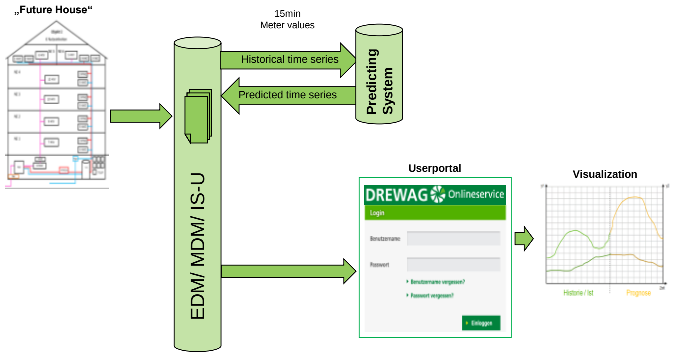


**Figure 23: System image of data analysis and forecast**

This analysis based on metering data facilitates different services which are available for the user and other market participants. Together with the data of the PV feed-in new flexible energy tariffs can be offered (Action 1).

### 4.5.3 Planning of the Tasks

The action started in month 07 and was terminated in month 25 of MAtchUP.

### 4.5.4 Health, safety and waste management requirements

Not applicable for this Action.

### 4.5.5 Risks considered ex-ante and proposed risk-mitigation measures

GDPR compliant data acquisition of measurement and sub-measurement systems is linked to the consent of end customers.

## 4.6 Action 04: 33kWp photovoltaic system on existing buildings

### 4.6.1 Management structure

DREWAG is responsible for the planning, erection (by subcontractors) and construction supervision of the photovoltaic system, as well as calculation of the tenant electricity model and acquisition of participating tenants.

VONOVIA provides roof areas and access to the building.

### 4.6.2 Technical specification

Planning status of PV-system Blasewitzer Str. 36:

- Nominal power PVA 33 kWp (11 kWp for each stairway)
- Specific solar yield 900 kWh/kWp

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- Annual PV-generation 30.000 kWh/a

Commentato [ef1]: Is it year?
Commentato [BM2R1]: yes a=anno

The projected power consumption in the object is about 85,000 kWh/a and the own consumption has been determined to 22.275 kWh/a, if 75 % of the tenants participate. This leads to an own consumption rate of 75 % (without a storage system, see Action A42) and an autarky ratio of 35 % for the participating tenants. Using the $CO_2$ intensity of the German electricity mix (471 g/kWh), this PV system will save approximately 14,1 t of CO2 per year.

The photovoltaic system was planned in 08 and 09/2018.

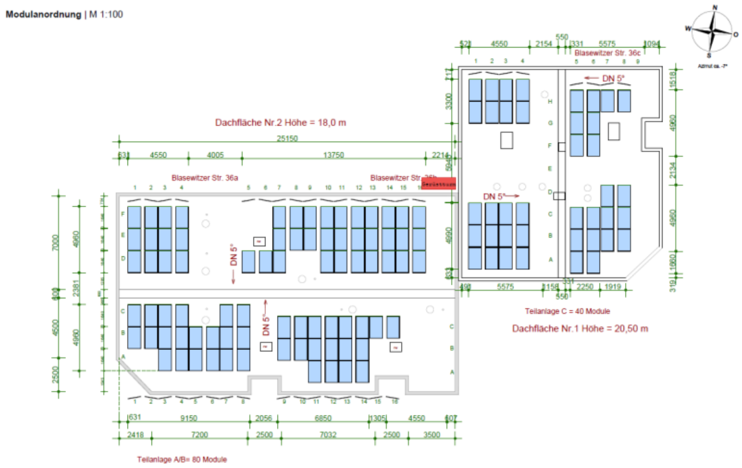


**Figure 24: Module layout plan**

### 4.6.3 Implementation status

- 09/2020 [M36]: Determination of displayed content
- 10/2020 [M37]: Decision about the content layout
- 12/2020 [M38]: Monitoring of energy data and improvement of tenant electricity simulation.

### 4.6.4 Health, safety and waste management requirements

Not applicable for this Action.

### 4.6.5 Risks considered ex-ante and proposed risk-mitigation measures

The start of the construction and commissioning of the PV-system was delayed by approx. 6 months due to static problems in the originally focused apartment building (Pfotenhauer Str.)

By changing the apartment building for this action, there was also a spatial separation of the actions for energetic renovation (Action A7) and PV/ tenant electricity model.

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## 4.7 Action 41: 9.9 kWp photovoltaic system in District Future House

### 4.7.1 Management structure

DREWAG is responsible for the planning, erection (by subcontractors) and construction supervision of the photovoltaic system, as well as calculation of the tenant electricity model and acquisition and customer-care of clients of the tenants' electricity model.

### 4.7.2 Technical specification

Here are the main characteristics of the PV-system:

- Nominal output PV system 9.92 kWp
- High-performance modules from LG with 320 Wp each
- Power generation 9,200 kWh p.a.
- Varta storage system, usable capacity 3.3 kWh
- Expected own consumption rate of up to 80 %.
- Expected degree of self-sufficiency up to 40 %.

Figure 25 represents the results of the planning phase concerning the yield-optimized PV-module assignment on the rooftop. In the planning-phase, we also had to proof roof-statics which lead us to a system-choice of the mounting-system (Figure A41-2).

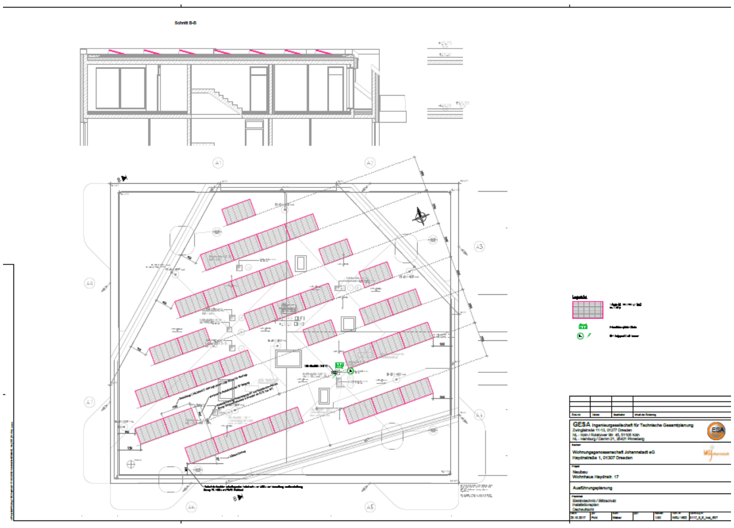

**Figure 25: PV-module assignment plan at Haydnstr.**

### 4.7.3 Planning of the tasks

- Qu 04/2020 checking the network registrations

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- Qu 01/2021 Monitoring: collecting data, optimization of monitoring process
- Qu 02/2021 Monitoring: survey about tenants' experiences
-

### 4.7.4 Health, safety and waste management requirements

Not applicable for this Action.

### 4.7.5 Risks considered ex-ante and proposed risk-mitigation measures

- Considerable delivery delays of components
- Cost increase due to the very individual production of the substructure of the PV system.
- Correct integration of the photovoltaic system into the existing electrical installation on site

## 4.8 Action 42: Power Storage in District Future House

### 4.8.1 Management structure

DREWAG is responsible for the planning, erection (by subcontractors) and construction supervision of the photovoltaic system, as well as calculation of the tenant electricity model and acquisition of the tenants.

WGJ provides roof areas and access to the building

EASD develops suitable simulation models which are necessary and used to evaluate an adequate system layout and to test suitable smart electricity tariffs before the actual system implementation. After the implementation, the calibrated models can be an essential application to evaluate the performance of the system as they provide reliable data when measurement values are not available.

### 4.8.2 Technical specification

Planning of the electric storage is an integral part of the project Future House.

We planned with a storage system with following parameters:

- Manufacturer / Type: Varta Element 3
- Technology: Lithium
- usable capacity: 3,3 $kWh_{el}$
- Battery connection: AC
- Electrical power: 1,6 $kW_{el}$

### 4.8.3 Planning of the tasks

Q3/2020: storage system troubleshooting by an external service provider

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### 4.8.4 Health, safety and waste management requirements

Not applicable for this Action.

### 4.8.5 Risks considered ex-ante and proposed risk-mitigation measures

No risks could be foreseen.

## 4.9 Action 38: Energy efficient design of the real estate

### 4.9.1 Management structure

The actions are led by VON.

### 4.9.2 Technical specification

To analyse the efforts done in the previous actions and decrease future efforts regarding planning, profitability and timing, VON plans to develop a business model for energetic transformation of real estates. with guarantee of energy cost savings. The implementation will consist on the analysis of current energy state of existing buildings followed by the definition of actions and finally the large scale modernization of building energy technologies with energy-saving contracts, monitoring, controlling, energy consulting and performance optimization.

### 4.9.3 Planning of the tasks

Termination of all retrofitting measures until Jan 2021.

### 4.9.4 Health, safety and waste management requirements

Not applicable for this Action.

### 4.9.5 Risks considered ex-ante and proposed risk-mitigation measures

Not applicable for this Action.

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# 5 Status of the intervention

## 5.1 Action 07: Pfotenhauer Str. Retrofitting project

### 5.1.1 Status of the intervention

The retrofitting project started on 23rd April 2018 in Pfotenhauer Str. 30 and included the installation of balconies and new windows.All measures successfully ended mid-December 2018 without any delays.

The next part of the retrofitting project (Pfotenhauer Str. 32-36) started on 30th August 2018. Besides fire protection measures and an additional elevator access, it included several energetic improvements: Installation of a thermal insulation of facades with a so-called "Wärmedämmverbundsystem" (Heat Insullation System) consisting of Stone-Mineral Wool Type 1/B with a thermal conductivity of 0.035 and 120mm thickness, the Insulation of top floor ceiling and cellar ceiling, the hydraulic balancing of the heating system, substitution of the windows with triple glazing and a heat transition coefficient of 0,7 W/m²K and staircase vitrification.

All measures were successfully implemented by end of November 2019 without any issues or delays.

The retrofitting of buildings 12-16 started in June 2018 included the installation of balconies and a full energetic restoration. The construction ended in December 2019 with a minor delay due to wild life (birds) protection measures.

The last part of the project involved the buildings in Pfotenhauer Str. 18-28 have as well started in June 2018. Besides fire protection measures and the additional elevator access, the following measures should be executed by January 2021:

- The thermal insulation of facades with of Sto-Mineral Wool Type 1/B with a thermal conductivity of 0,035 and 120mm thickness
- Insulation of top floor ceiling and cellar ceiling
- Hydraulic balancing of the heating system
- Substitution of the windows with triple glazing and a heat transition coefficient of 0,7 W/m²K
- Staircase vitrification

The work will be completed with a minor delay due to wild life (birds) protection measures.

As for today ca. 90% of all retrofitting measures were implemented successfully. Minor delays or issues could be compensated so that Action 07 will be completed in 2021 according to plan.

### 5.1.2 Risks found and corrective actions performed

1. The installation of the PV-system was not possible on this building due to statics and were built on Blasewitzer Str. 36a-c, c.f. Action A4.
   ➔ This deviation did not cause any delays or had an impact on budget and planning issues.

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2. Animal welfare regulations regarding certain bird species and bats that nest within the building complex. Therefore, scaffolds could only be put up during March-April or August-September. Scaffolds were covered with a net in order to keep birds from settling down.
   - ➔ These regulations caused minor delays and had very little impact on planning and budget issues.
   - ➔ Partially resistance from of tenants by not opening doors / refusing to give access to their apartments. Site manager took care of the respective residents by talking to them. No further steps were needed, thus all construction work could be completed with any further delays or budget issues.

### 5.1.3 Business model and financial scheme applied

- All retrofitting measures were fully covered by own investments. These investments may result in adjustment of rent. The amount to which the rent will be changed is limited by legal registrations and will be calculated with regard to the savings resulting from energy savings per living unit/m² making it cost-neutral for the tenants.
- Part of the budged was financed by KfW-Effizienzhaus credits (151/152). The amount is calculated separately for the affected building and depends on the ex post energy efficiency of the buildings modernised. Energetic restorations are planned and operated by VON and aim at reaching KfW-Effizienzhausstandard 100 (Efficiency House) for each eligible building.
   - ➔ The calculated KfW-fundings provided for Pfotenhauer Str. 18-22 are € 4,430,000. Besides the restorations explained above, the buildings will receive a renewed warm water and ventilation system.
   - ➔ Similar energetic retrofitting measures are planned for the Pfotenhauer Str. 24-28, financially supported by € 4,400,000 KfW-Credits.
   - ➔ Another € 3,730,000 are provided for energetic restorations in Pfotenhauer Str. 32-36.
- The combined credits provided by KfW result in a total KfW-funding of € 12,560,000.00
- All credits have to be repaid in full

Meeting these KfW-Standards, the retrofitted buildings will show a significant reduction of annual energy consumption (sum of thermal (heating or cooling) energy consumption and electrical energy consumption). This will not just lead to lower energy costs for the inhabitants but also to reduced greenhouse gases and $CO_2$ emissions, contributing to the urban development on climate change. The estimated savings per m² is about 0.25€/month. The non-energetic measures aim at embellishing the whole district and therefore increasing the general living standard for all inhabitants.

### 5.1.4 Citizen engagement strategy implemented

Citizens/tenants are being informed about the measures by mail as legally required. In case of resistance, site managers reach out to the tenants in order to talk about and clarify controversial issues. Smart Infoscreen at outer wall/or staircase of Blasewitzerstraße 36 to show results of PV-system.

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## 5.2 Action 09: District future house

### 5.2.1 Status of the intervention

The construction of the building and the implementation of all MAtchUP measures are carried out in close coordination with the apartment building owner Wohnungsbaugenossenschaft Johannstadt (WGJ). The construction of the building shell was carried out by the apartment building owner within the first MAtchUP months. Meanwhile, DREWAG carried out different preparations of the MAtchUP actions, such as:

- Design of PV generator (alignment, size, roof statics)
- Redesign of the storage unit
- Final design of intelligent measuring system (iMSys)
- Final design of sub-metering and energy management systems of apartment and flat

**Figure 26: Unfinished construction in 02/2018 (left) & finished house in 09/2018 (right)**

The energy management system and intelligent measuring systems are located in the basement. Sub-metering and flat energy management systems are installed in the flats. The energy management will provide a technical and communicative interaction of:

- PV generation/ storage within the tenant electricity model
- Smart Home Real Estate Industry ("RIECON" system) with displays for the apartment building and each flat
- Intelligent metering systems
- Operating costs billing (heat, water)
- Heat supply (district heating)

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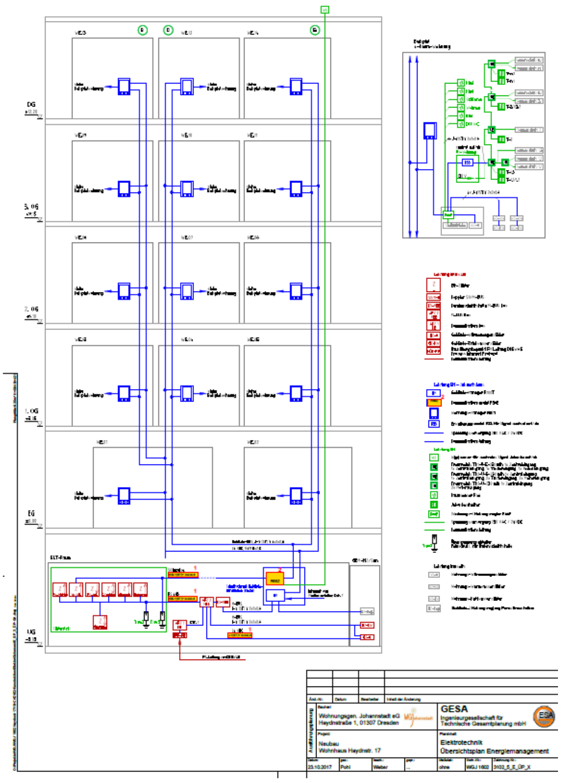


**Figure 27: General layout plan energy management**

Within this action, we aim to analyse the connection of apartment building and flat energy systems to identify advantages in daily life. Therefore, we combine the energy balance of an apartment (electricity, heat, water) with flat energy systems. To reach this, we divided our efforts in 2 steps:

1. The first step is to get comprehensive information about the energy status of flats and the apartment building.

- European legislation (RED2, Energy efficiency regulation) foresees direct information of tenants of their energy use in a monthly base. Our project is one preparation to this.
- We moreover want to identify energy losses and reduce energy demand (heat).

2. As a second step, we aim to identify the need for flexible tariffs. Useful business models are going to be developed. To achieve this, there is a cooperation between the owner of the apartment building and DWG/ DWNTZ.

The calculation of the tenant model is derived from the energy autarky ratio (see Action A 41). This ratio depends on the number of participants (tenants) which will take part. This is going to be monitored during the project. We calculated two variants with German

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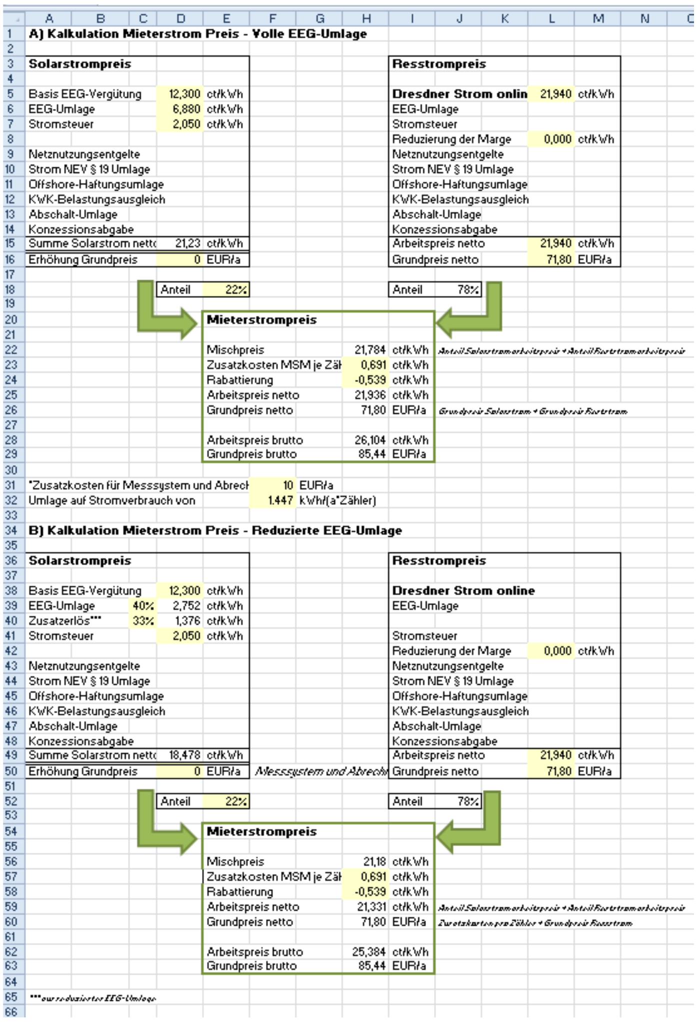
RES-fee (EEG-Umlage). The current legislation leads us to use variant A below. It takes into account the estimated own consumption rate.

We will offer **tenants energy model —"Mein Mieterstrom"** with a price line 0,5 ct./kWh below the regular DREWAG product —"Dresdner Strom privat".



| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **A) Kalkulation Mieterstrom Preis - Volle EEG-Umlage** | | | | | | | | | | |
| 3 | **Solarstrompreis** | | | | | | | **Resstrompreis** | | | |
| 5 | Basis EEG-Vergütung | | 12,300 | ct/kWh | | | | **Dresdner Strom onlin** | 21,940 | ct/kWh | |
| 6 | EEG-Umlage | | 6,880 | ct/kWh | | | | EEG-Umlage | | | |
| 7 | Stromsteuer | | 2,050 | ct/kWh | | | | Stromsteuer | | | |
| 8 | | | | | | | | Reduzierung der Marge | 0,000 | ct/kWh | |
| 9 | Netznutzungsentgelte | | | | | | | Netznutzungsentgelte | | | |
| 10 | Strom NEV § 19 Umlage | | | | | | | Strom NEV § 19 Umlage | | | |
| 11 | Offshore-Haftungsumlage | | | | | | | Offshore-Haftungsumlage | | | |
| 12 | KWK-Belastungsausgleich | | | | | | | KWK-Belastungsausgleich | | | |
| 13 | Abschalt-Umlage | | | | | | | Abschalt-Umlage | | | |
| 14 | Konzessionsabgabe | | | | | | | Konzessionsabgabe | | | |
| 15 | Summe Solarstrom netto | | 21,23 | ct/kWh | | | | Arbeitspreis netto | 21,940 | ct/kWh | |
| 16 | Erhöhung Grundpreis | | 0 | EUR/a | | | | Grundpreis netto | 71,80 | EUR/a | |
| 18 | Anteil | | 22% | | | | | Anteil | 78% | | |
| 20 | | | | | **Mieterstrompreis** | | | | | | |
| 22 | | | | | Mischpreis | 21,784 | ct/kWh | | | | Anteil Solarstromarbeitspreis + Anteil Reststromarbeitspreis |
| 23 | | | | | Zusatzkosten MSM je Zäh | 0,691 | ct/kWh | | | | |
| 24 | | | | | Rabattierung | -0,539 | ct/kWh | | | | |
| 25 | | | | | Arbeitspreis netto | 21,936 | ct/kWh | | | | |
| 26 | | | | | Grundpreis netto | 71,80 | EUR/a | | | | Grundpreis Solarstrom + Grundpreis Reststrom |
| 28 | | | | | Arbeitspreis brutto | 26,104 | ct/kWh | | | | |
| 29 | | | | | Grundpreis brutto | 85,44 | EUR/a | | | | |
| 31 | *Zusatzkosten für Messsystem und Abrech | | | | 10 | EUR/a | | | | | |
| 32 | Umlage auf Stromverbrauch von | | | | 1.447 | kWh/(a*Zähler) | | | | | |
| 34 | **B) Kalkulation Mieterstrom Preis - Reduzierte EEG-Umlage** | | | | | | | | | | |
| 36 | **Solarstrompreis** | | | | | | | **Resstrompreis** | | | |
| 38 | Basis EEG-Vergütung | | 12,300 | ct/kWh | | | | **Dresdner Strom online** | | | |
| 39 | EEG-Umlage | 40% | 2,752 | ct/kWh | | | | EEG-Umlage | | | |
| 40 | Zusatzerlös*** | 33% | 1,376 | ct/kWh | | | | | | | |
| 41 | Stromsteuer | | 2,050 | ct/kWh | | | | Stromsteuer | | | |
| 42 | | | | | | | | Reduzierung der Marge | 0,000 | ct/kWh | |
| 43 | Netznutzungsentgelte | | | | | | | Netznutzungsentgelte | | | |
| 44 | Strom NEV § 19 Umlage | | | | | | | Strom NEV § 19 Umlage | | | |
| 45 | Offshore-Haftungsumlage | | | | | | | Offshore-Haftungsumlage | | | |
| 46 | KWK-Belastungsausgleich | | | | | | | KWK-Belastungsausgleich | | | |
| 47 | Abschalt-Umlage | | | | | | | Abschalt-Umlage | | | |
| 48 | Konzessionsabgabe | | | | | | | Konzessionsabgabe | | | |
| 49 | Summe Solarstrom netto | | 18,478 | ct/kWh | | | | Arbeitspreis netto | 21,940 | ct/kWh | |
| 50 | Erhöhung Grundpreis | | 0 | EUR/a | *Messsystem und Abrech* | | | Grundpreis netto | 71,80 | EUR/a | |
| 52 | Anteil | | 22% | | | | | Anteil | 78% | | |
| 54 | | | | | **Mieterstrompreis** | | | | | | |
| 56 | | | | | Mischpreis | 21,18 | ct/kWh | | | | |
| 57 | | | | | Zusatzkosten MSM je Zäh | 0,691 | ct/kWh | | | | |
| 58 | | | | | Rabattierung | -0,539 | ct/kWh | | | | |
| 59 | | | | | Arbeitspreis netto | 21,331 | ct/kWh | | | | Anteil Solarstromarbeitspreis + Anteil Reststromarbeitspreis |
| 60 | | | | | Grundpreis netto | 71,80 | EUR/a | | | | Zusatzkosten pro Zähler + Grundpreis Reststrom |
| 62 | | | | | Arbeitspreis brutto | 25,384 | ct/kWh | | | | |
| 63 | | | | | Grundpreis brutto | 85,44 | EUR/a | | | | |
| 65 | ***nur reduzierter EEG-Umlage | | | | | | | | | | |

**Figure 28: Calculation scheme of tenant electricity model (draft)**

### Planning and construction of the photovoltaic system and the electricity storage system

The planning of the photovoltaic system and the storage system took place from 03/2018 to 06/2018. The heavily built-up roof (roof hatches, terraces etc.) proved to be particularly

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challenging. To ensure that sufficient electrical power could be installed, an individualized assembly system had to be planned, the purchase of which entailed considerable additional costs. In addition, high-performance photovoltaic modules were used. Another challenge was the interim replanning of the storage system, as the manufacturer of the already planned system unexpectedly stopped production.

Delivery and installation of the **PV system and storage system** started in 11/2018 and was completed in 05/2019 so that the system could be commissioned in 05/2019.

**Figure 29: Photovoltaic system on the future house**

**RIECON Smart Home System**

The RIECON Smart Home System was assembled and put into operation in 10/2018. Previously, the system was extensively tested on the DREWAG test stand. In addition to the functions of the Smart Home System shown in the two following illustrations, the owner can also import contact data for service providers, appointments (e.g. water cut-off) and messages into an apartment.

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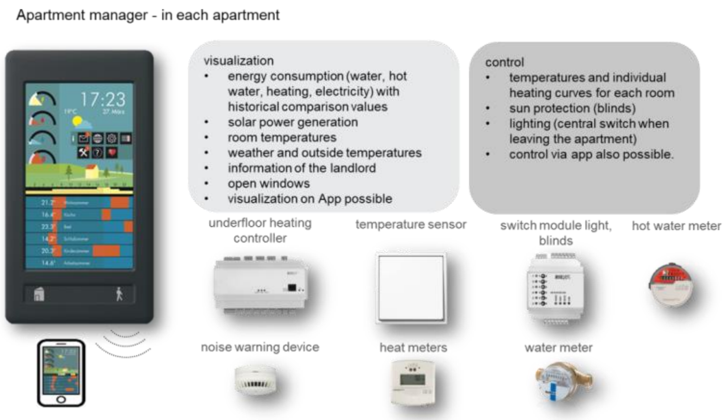


**Figure 30: System layout of the roof-top photovoltaic system**

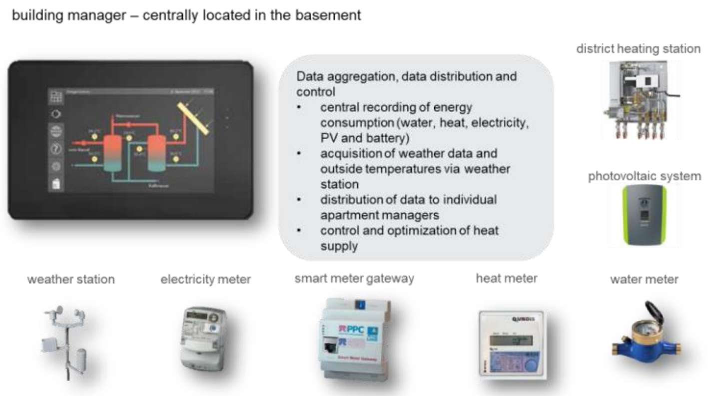


**Figure 31: Functions of building manager**

### Tenant electricity model

The acquisition of the tenant electricity model started with the move of the tenants into the flats in 11/18. The tenants each received their tenant electricity contract (contract conclusion on a voluntary basis) and supplementary product information in the form of a flyer. Within very few days 12 of 14 tenants locked the tenant electricity contract and thereby exceeded the expectations. The Figure 32 illustrates the function of the tenant electricity model.

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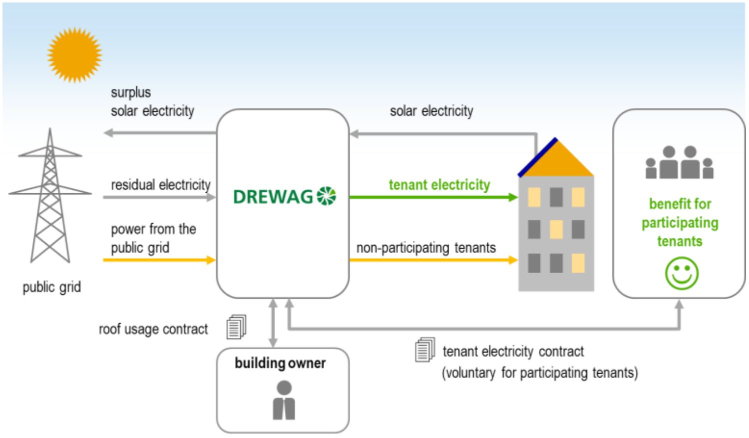


**Figure 32: Scheme tenant electricity model**

Irrespective of the provision of the technology, the tenants were billed at the more favorable tenant electricity tariff immediately after conclusion of the contract in 11/2018.

**The tenant electricity model becomes smart & flexible**

In the project future house, the tenant electricity is to become smart. Therefore, in addition to the technical implementation of the photovoltaic system and the storage system, a tenant electricity tariff was developed, which will be explained in the following: The solar power generation depends on the respective solar radiation and does not always match the current electricity consumption. This results in surplus feeds into the public power grid. Through the use of a storage system, we can already minimize these to some extent. However, we want to go one step further and relieve the load on the electricity grids. In addition, we discount the electricity price in phases of the surplus feed-in (load variable electricity tariff), thereby we animate the tenant to put the electricity consumption in low-priced times and to further reduce the feed-in into the electricity grid. The following chart illustrates this approach.

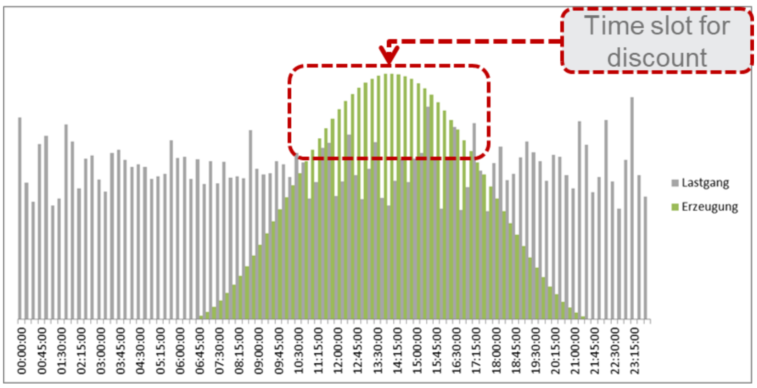


**Figure 33: Generation curve photovoltaic system and electricity consumption for one day**

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The tenants should be informed in each case about the display of your apartment manager to the favorable electricity tariff. We present the pricing of the future in three stages:

**Table 4: Development stages of the load-variable electricity tariff in the project**

| Level | Load variable electricity tariff depending on | Period for discount | Discount |
|---|---|---|---|
| 1 | Fixed period | From 01.04. to 30.09. between 14:00 and 18:00 o'clock | 2 ct/kWh gross |
| 2 | Time and weather | Depending on locally recorded weather data | At least 2 ct/kWh gross |
| 3 | Time, weather and energy data | Depending on current energy data of the photovoltaic system and weather forecast data | At least 2 ct/kWh gross |

We implemented the first stage of the load variable electricity tariff from 01/ to 04/2019. The Figure 15 shows the underlying communication concept and the selection of the preferred solution.

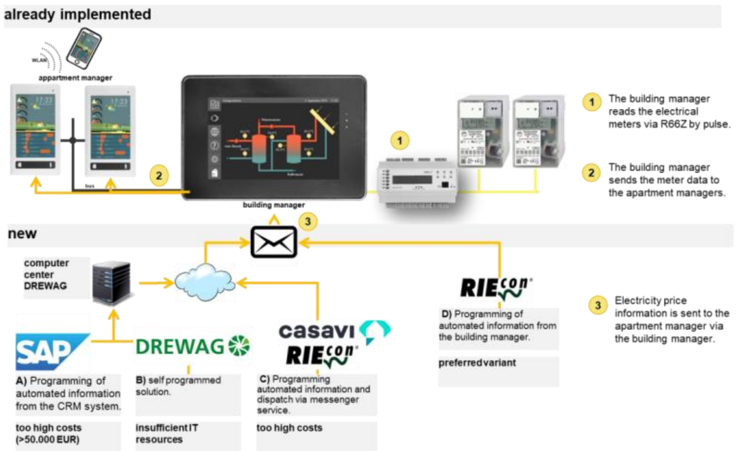


**Figure 34: Communication concept for the load-variable electricity tariff Level 1**

To visualize the smart tariff for the tenant, we decided to program a tariff bar on the apartment manager. The tenants were also informed in a separate letter about the start of the discount on 01/04/2019. Presently, 12 of 14 tenants participate in the intelligent tariff system.

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# Dresdner.Strom.Mieter wird Smart
## im Zukunftshaus Haydnstr. 17

**Gemeinsam mit Ihnen und der Wohnungsgenossenschaft Johannstadt eG wollen wir in die Zukunft der intelligenten Stromversorgung blicken.**

### So funktioniert Dresdner.Strom.Mieter:

Die WGJ und wir installieren eine Photovoltaikanlage und ein Speichersystem im Zukunftshaus auf der Haydnstraße 17. Als Mieter erhalten Sie den vor Ort erzeugten Solarstrom. Wenn dieser verbraucht ist, versorgen wir Sie weiter ganz bequem und zuverlässig mit 100% Ökostrom.

Obendrauf reduzieren wir Ihre Stromkosten. Der Arbeitspreis von Dresdner.Strom.Mieter ist immer 0,5 ct/kWh brutto[1] günstiger als Dresdner.Strom.privat.

### Warum wird Dresdner.Strom.Mieter smart?

Die Solarstromerzeugung ist abhängig von der jeweiligen Sonnenstrahlung und passt zeitlich nicht immer zum aktuellen Stromverbrauch. Daraus resultieren Überschusseinspeisungen ins öffentliche Stromnetz. Durch den Einsatz eines Speichersystems können wir diese schon zum Teil minimieren. Gemeinsam mit Ihnen wollen wir noch einen Schritt weitergehen und die Stromnetze zusätzlich entlasten.

### Wie wird Dresdner.Strom.Mieter smart?

Wir rabattieren den Strompreis in Phasen der Überschusseinspeisung (Lastvariabler Stromtarif), dadurch können Sie Ihren Stromverbrauch in sehr preisgünstige Zeiten legen und die Einspeisung ins Stromnetz weiter reduzieren. Dazu informieren wir Sie über das **Display Ihres Wohnungsmanagers**. Die Preisgestaltung der Zukunft stellen wir uns in drei Stufen vor:

| Stufe | Lastvariabler Stromtarif abhängig von: | Rahmenzeit für Rabatt | Rabatt | Starttermin* |
|---|---|---|---|---|
| 1 | Zeit | Jeweils vom 01.04. bis 30.09. zwischen 14:00 und 18:00 Uhr | 2 ct/kWh brutto.[1] | Start: 01.04.2019 |
| 2 | Zeit und Wetter | Abhängig von örtlich erfassten Wetterdaten | mind. 2 ct/kWh brutto.[1] | Start: 01.01.2020 Ankündigung 12/2019 |
| 3 | Zeit, Wetter- und Energiedaten | Abhängig von aktuellen Energiedaten der Photovoltaikanlage und Wetterprognosedaten | mind. 2 ct/kWh brutto.[1] | Start: 01.01.2021 Ende: 31.12.2022 Ankündigung 12/2020 |

* Die aktuelle Entwicklungsstufe ersetzt jeweils ihre Vorgängerin. Die Umsetzung von Stufe 2 und 3 basiert derzeit auf unsicheren Faktoren. Sollten Stufe 2 und 3 auf Grund unverhältnismäßiger technischer Maßgaben nicht realisierbar sein, wird Stufe 1 bis einschließlich 2022 fortgesetzt.

[1] Die Bruttopreise beinhalten die gesetzliche Umsatzsteuer (zurzeit 19 %).

Stand: 10/2018

Alles da. Alles nah. Alles klar. DREWAG

**Figure 35: Information letter about flexible tariffs for the tenants (german)**

The automation of the accounting procedure of the tenant electricity model was described for the existing building in Action 1. However, the accounting procedure of the District Future House is faced with further challenges. During the first stage, a discount was granted at fixed times of day. This approach enables a feasible accounting solution since it is already established in the energy industry. During the second expansion stage, a discount will be granted if the generation capacity of the photovoltaic system exceeds a previously defined threshold value. For this purpose, the billing system must first evaluate the load curves of the photovoltaic system. Subsequently, a discount is calculated for the quarter of an hour in which the threshold value is reached. The following Figure 35 forecasts the frequency with which the threshold value is exceeded by season and over the course of the day.

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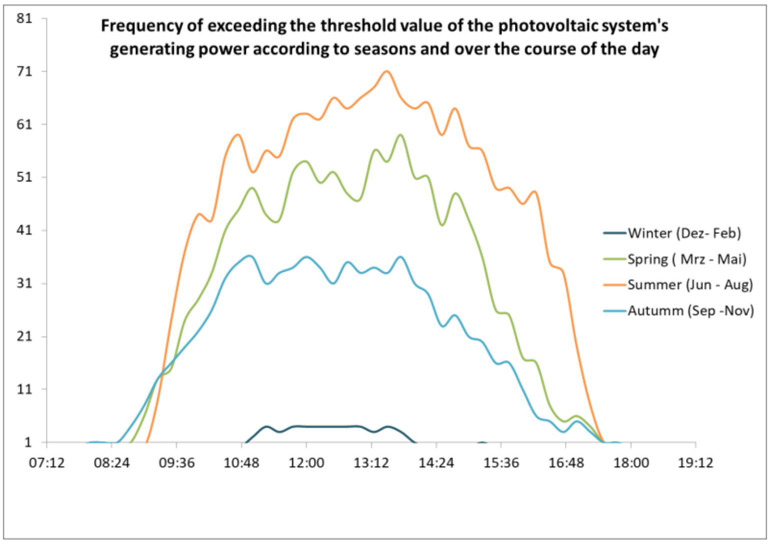


**Figure 36: Frequency of exceeding the threshold value of the photovoltaic system**

The accounting solution for the second stage of smart electricity tariffs are available by end of 11/2020 and forms the basis for a possible product launch of flexible electricity tariffs. The aim of the flexible electricity tariff is to minimize the feed-in of solar electricity into the public grid. Therefore, in addition to a well-functioning billing system for the dynamic electricity tariff, the tenants must be informed about the discount period in order to achieve that they shift their electricity demands into designated periods. For this purpose, the generation meter of the PV system should be read out by the building manager via the pulse interface. When the threshold value is reached, i.e. a defined number of pulses, the discount time slot is displayed to the tenants on their building manager as a tariff pop-up bar. The same display is to be selected as with the flexible electricity tariff of the first expansion stage implemented so far. Due to lack of resources of the executing service provider, the visualization of the tariff is clearly behind schedule. Originally, the new discount time slots were supposed to be available from 04/2020. Currently we are expecting to offer this opportunity by end of 2020.

One objective of the project is also to gather relevant technical insights in order to improve future project simulations. Therefore, we use the existing measurement data to verify previously made assumptions regarding the own consumption of the PV system and the building's electricity savings. The following Figure 37 shows schematically the structure of the electricity balance in the building.

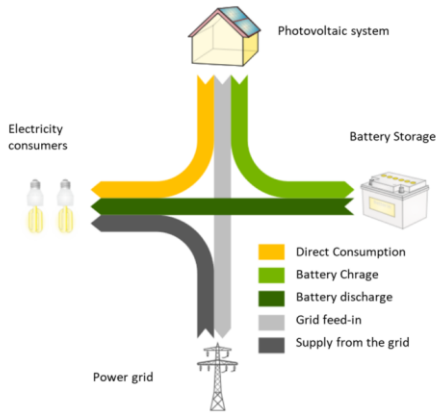


**Figure 37: Electricity balance in the building**

A comparison of planned and actual figures was carried out on the basis of the key electricity figures shown in the diagram. The following overview (Figure 38) shows the results.

| **Electricity balance in kWh per year** | Plan electricity balance building | Real electricity balance Building 31.10.2018 bis 31.10.2019 |
|---|---|---|
| Power consumption | 22.757 | 35.915 |
| Of which general electricity | 2.500 | 14.891 |
| Of which electricity for the apartments | 20.257 | 21.024 |
| Solar Power Generation | 8.091 | 9.186 |
| Nominal power of photovoltaic system | 8,7 kWp | 9,9 kWp |
| Specific yield | 930 | 928 |
| Direct consumption | 5.016 | 7.462 |
| Grid feed-in (surplus) | 3.075 | 1.724 |
| Supply from the electricity grid | 17.741 | 28.453 |
| Own consumption rate | 62% | **81%** |
| Self-sufficiency rate | 22% | **21%** |

**Figure 38: Comparison of planned and real electricity transfers in the DFH**

Deviations from the planned power consumption result from the fact that the supply of electricity for construction measures was not taken into account. Despite the higher real power demand in relation to solar power generation, the self-sufficiency rate (reduction of grid usage) is almost identical to the planning. This means that the real own consumption is significantly higher than assumed, although the solar power storage is not working properly yet. The evaluation of the load curves has shown that the electricity storage unit has performed almost no charging and discharging processes. Troubleshooting was enabled in August 2020, as there was previously no sufficiently

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trained staff available at our preferred subcontractor. In addition, the Covid-19 crisis with the accompanying restrictions delayed the detailed inspection of the battery malfunction by a technician. With the integration of the electricity storage tank, the self-sufficiency rate will be probably further increased.

### 5.2.2 Risks found and corrective actions performed

Additional costs for the individualization of the assembly system.

The current Covid-19 crises and the associated restrictions will have a major impact on the evaluation of the conducted optimization measures during the monitoring phase. The baseload data (e.g. E2 indicator) was defined by use of generic and standardized load profiles which assume an annual deviation of power consumption in residential buildings. This might result in partly significant deviations regarding the measurement values which are collected after the COVID security measures started.

Covid-19 restrictions came into force in March 2020 and hence the occupancy of the building has changed which, in turn, will be visible in the total power consumption and thus in the self-sufficiency ratio.

To address this topic, measurement data from March 2020 to July 2020 will be taken into account to get a proper indication of the “new normality” after the restrictions will be widely removed. Discussions about the data evaluation are in progress with all WP 5 partners.

An expected higher direct self-consumption ratio of locally produced power will affect the utilization of the battery. If this underruns a certain minimum level, an adequate evaluation of the battery operation is not suitable anymore.

Unfortunately, the solar power storage is not working properly yet. The evaluation of the load curves has shown that the electricity storage unit has performed almost no charging and discharging processes. Troubleshooting was enabled in August 2020, as there was previously no sufficiently trained staff available at our preferred subcontractor. In addition, the Covid-19 crisis with the accompanying restrictions delayed the detailed inspection of the battery malfunction by a technician.

### 5.2.3 Business model and financial scheme applied

The total DWG-budget for this action is 194,012.50 €.

- 135,808.75 € of this amount will be financed by MAtchUP funds, the rest of 58,203.75 € will be funded by DWG.
- 112,710.00 € for 5 employees pro rata temporis over three years. After the end of the MAtchUP-project in 2022 the employees will work for DWG, DWG NTZ or ENSACH in other projects.
- 12,000.00 € for subcontracting for commissioning of the construction management, implementation of the PV panels and the system connections storage integration.
- 32,900.00 € for other goods. Therefore 29,900.00 € for service fee housing cooperative for energy management system (building and apartment managers) and 3,000.00 € for audits.

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- 36,402.50 € indirect costs declared on the basis of the flat-rate of 25 % of the eligible direct costs [without subcontracting] (= 0.25 x (112,710.00 € + 32,900.00 €)).

### 5.2.4 Citizen engagement strategy implemented

from D3.1 Action Card:

By actively involving the tenants in the test cases, digital literacy will be increased within this group. Both DWG and tenants are going to learn about how to use advanced building infrastructures properly and how to integrate them into a regular everyday operation. Based on a tenant electricity model, we offer a further expansion stage: flexible tenant electricity tariffs.

Tenants have access to data of consumption and generation via personalized displays installed in their flats. Thus, we achieve an active involvement of residents and strengthen awareness for a sustainable use of energy and resources by digital solutions. By use of the displays we make sure that tenants will be informed about the positive contribution of ‘their‘ building in terms of electricity generation and reducing $CO_2$ emissions.

**Figure 39: One of the tenants is checking his display**

The District Future House forms the platform for the tenant community to decouple themselves from the role of a mere consumer of energy. Instead, they become prosumers, since the tenants generate partly their own clean energy. We hope that this will strengthen the sense of community within the house since all tenants are part of an innovative housing concept.

Furthermore, we are planning to conduct a comprehensive tenant survey to gather feedback and to compare tenants’ experience with our insights. Moreover, we pursue the objective to present the taken actions through interesting press reports to keep citizens informed. In case of the District Future House with Actions 9, 41, 42, 43 and 53 we initiated two publications in the local press in November 2019 (see Figure 40: below).

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**Figure 40: Released press photo shows our project managers in the utility room of the DFH**

## 5.3 Action 01: Smart tenants

### 5.3.1 Status of the intervention

The PV system part of this action started in month 03 and was finally installed in month 20 of the MAtchUP-project (see below).

During the first project year we carried out a detailed planning of the initially planned apartment building at Pfotenhauer Str. We already

- developed and negotiated contracts concerning roof rent,
- adapted the DWG-contract for tenants' energy model including the economic model
- calculated the tariff for the tenant energy model
- executed an energetic modelling specific demand./. RES-generation in a minute-scale-resolution (MAtchUP-Partner EASD)
- developed variants of PV allocation on the rooftop,
- carried out planning of measuring system location in the floors and the cable layout,
- checked the fire protection of the new installations,
- prepared purchasing the PV- and roof mounting systems

Some of these progress statuses could be used in an adapted version for the new project site, i.e. Blasewitzer Str. 36 a-c.

The structure of integration of intelligent Measuring Systems (iMSys) which are connected to the Urban Platform via a gateway (SMGW – smart meter gateway) is designed in the associated Action A11.

Due to the insufficient load capacity reserve of the roof on Pfotenhauer Str., Vonovia identified a new building for the construction of a photovoltaic system. The tenant electricity model is now being implemented on Blasewitzer Straße 36 a-c. For this purpose, DREWAG and VONOVIA have concluded a separate roof usage agreement in 07/2018, which regulates the planning, installation and operation of the system by DREWAG on the VONOVIA building.

The aim is to supply the 61 apartments with proportionate solar power from the photovoltaic system and thus reduce the tenants' electricity costs. For this purpose, a photovoltaic system with a peak output of 33 kWp was installed. The system generates almost 30,000 kWh p.a. and was completed in December 2018 following the start of construction in October 2018.

Figure 41: DREWAG photovoltaic system

With the photovoltaic system, the tenant has the opportunity to obtain solar power efficiently and ecologically directly from his own roof and to participate in the energy revolution. To this end, the tenant can conclude a solar power contract with DREWAG on a voluntary basis. Solar power generation and electricity consumption do not always coincide. This is why DREWAG also supplies green electricity from the public grid. In this way, the tenant is always reliably supplied with electricity, even when the sun is not shining. The tenant not only receives and uses the solar power generated directly on site, but also saves electricity costs. With an electricity consumption of 1,400 kWh per year, the electricity costs decrease by up to 10 % compared to the previous electricity bill.

The following Figure 42 shows the simulated energy balance in the property and the expected solar power share in the tenant electricity tariff.

| | | |
|---|---|---|
| **Gebäude** | Blasewitzer Straße 36 a-c; Version: 20.09.18 | |
| Anzahl Hauseingänge | Zusammensetzung der Wohnungen | 3 |
| Wohnungen je Hauseingang | Leerstand: 4% | 20,33333333 |
| Gesamtanzahl Wohnungen | - 3 Eingänge (a, b und c) | 61 |
| **Photovoltaikanlage** | - 61 Wohnungen: | |
| Nennleistung PVA [kWp] | o 23 WE in 36a (3 im EG, 4 je Etage, 5-Geschosser) | 33 |
| Spezifischer Ertrag [kWh/kWp] | o 12 WE in 36b (2 je Geschoss, 5-Geschosser) | 900 |
| Jahresenergieertrag [kWh] | o 26 WE in 36c (2 im EG, 4 je Etage, 6-Geschosser) | 29.700 |
| Nennleistung PVA je Hauseingang [kWp] | | 11,00 |
| **Strombedarf** | | |
| ø Verbrauch je Wohnung p.a. [kWh] | | 1.400 |
| Gesamtbedarf [kWh] | | 85.400 |
| **Abschätzung der teilnehmenden Mieter** | | |
| Auswahl: Neubau oder Bestand | | Bestand |
| Teilnehmende Mieter | | 75% |
| Stromlieferung Mieterstrom [kWh] | | 64.050 |
| **Abschätzung Eigenverbrauchs- und Autarkiequote in der Mieterstrom-Bilanz** | | |
| Stromlieferung Mieterstrom [kWh] | | 64.050 |
| Jahresenergieertrag PVA [kWh] | | 29.700 |
| Eigenverbrauchsquote (EVQ) | | 75% |
| Solarer Anteil Mieterstrom im Objekt [kWh] | | 22.275 |
| Autarkiequote (ATQ) | | 35% |
| Reststromlieferung Mieterstrom im Objekt [kWh] | | 41.775 |

Figure 42: Simulated energy balance in the tenant electricity tariff

The calculation of the tenant electricity tariff is based on the expected mix of the solar electricity supply from the photovoltaic system and the residual electricity supply from

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the public electricity grid. The mix is simulated and determined for the observation period of a calendar year. The following illustration shows the calculation of the tenant electricity tariff based on this.

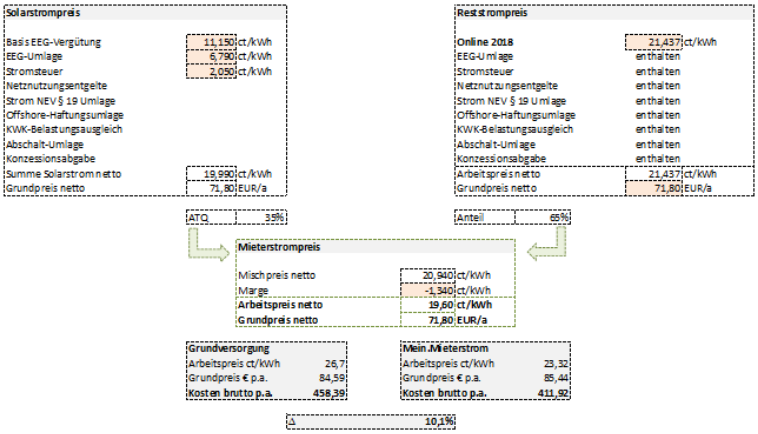


**Figure 43: Calculation of the tenant electricity tariff**

The basis for determining the solar electricity price is the EEG remuneration for solar electricity fed into the public grid that is valid in Germany. This secures the financing of the system regardless of the number of tenants participating in the tenant electricity model.

In the course of the installation of the photovoltaic system, DREWAG NETZ determined that the meter systems no longer comply with the current valid technical regulations. In the course of this, the old meter systems were dismantled and new, regulation-compliant meter stations were erected at considerable additional expense. The new meter stations were put into operation on 15.05.2019.

In the same calendar week, DREWAG started selling the tenant electricity model. All 61 tenants received a cover letter and information sheet as well as their tenant electricity contract. In week 23, those tenants who have not yet returned their registration received a reminder letter in order to attract as many participants as possible to the model.

In total, 9 out of 61 tenants have opted for the tenant electricity model. This brings the completion rate to just under 15 %. This compares to the Future House, where 12 of 14 tenants (85 %) opted for the tenant flow model. What is the reason for this? One reason for the lower take-up rate is that this is an existing building. The tenants already had current electricity contracts and would have to switch to a new tariff, whereas in the new building of the future house the tenants have to conclude new electricity contracts anyway. A corresponding tenant electricity contract was then handed over together with the tenant contract. On the other hand, the tenants have a different sociographic background, which may be linked to a lower interest in alternative electricity supply. Another not inconsiderable influence for a successful acquisition is the commitment of the rental company. The aim of the project is also to efficiently implement the billing of

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the tenant electricity model, as the billing system has not been able to map tenant electricity models automatically until now. Therefore, an employee had to evaluate the monthly meter readings and determine the consumption quantities of the tenants participating in the tenant electricity model. The challenge here is to balance the amount of solar power generated, the electricity consumption of the tenants participating and non-participating in the tenant electricity model, the surplus feed-in and the residual electricity consumption. The following figure illustrates the tenant electricity model as an example:

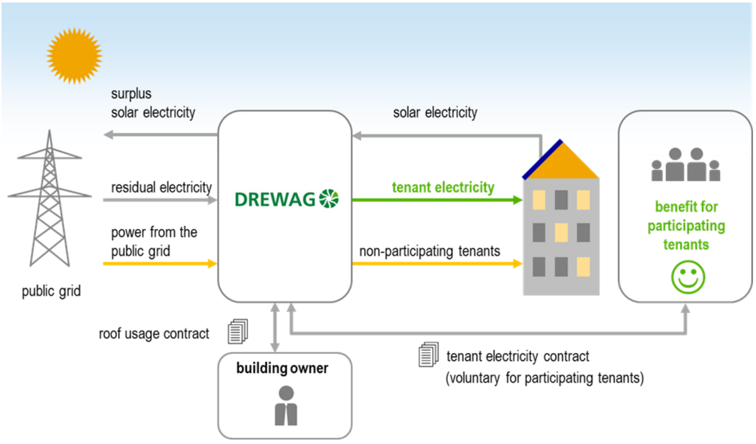


**Figure 44: Scheme tenant electricity model**

After sending the consumption quantities to the billing department, the tenant electricity bills were prepared manually. With the automation of the tenant electricity model, the manual allocation of consumption quantities and manual invoicing will no longer be necessary in the future. This has created an improved framework for marketing and scaling of tenant electricity projects. However, due to the individuality and complexity of the tenant electricity model, manual effort will continue to be required for the initial setup of individual projects in the billing system and when tenants move house or change tariffs.

In order to form the baseline and indicators, the previous energy consumption quantities were recorded and evaluated. Based on this, a monitoring procedure was developed which enables the remotely read meter data to be analyzed and made available for determining the indicators. The following Figure 45: symbolizes the measurement and transmission of the energy data.

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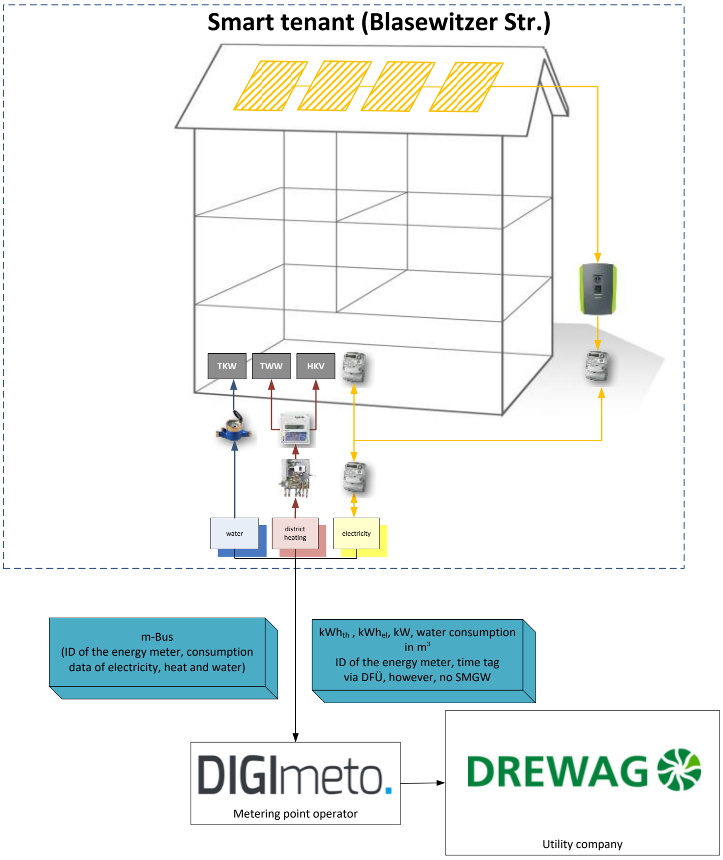


**Figure 45: Measurement and transmission of energy data**

The provision of all necessary energy data (consumption quantities and peak power) can thus be made available with an offset of at least one month.

### 5.3.2 Risks found and corrective actions performed

As a result of the analysis of the roof, it was determined that the Pfotenhauer Str. building contained in the project application / GA does not allow any additional roof load at all. Therefore, our project partner VON offered the building in Blasewitzer Str. 36 a-c as a replacement object for use within the MAtchUP project.

This change will reduce the PV capacity that can be installed to approx. 30 kWp and the number of flats to 61.

In the course of the installation of the photovoltaic system, DREWAG NETZ determined that the meter systems no longer comply with the current valid technical regulations. In the course of this, the old meter systems were dismantled and new, regulation-compliant

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meter stations were erected at considerable additional expense. The new meter stations were put into operation on 15.05.2019.

The current Covid-19 crises and corresponding confinements will have major impact on the evaluation of the conducted optimization measures during the monitoring phase. The baseload data (e.g. E2 indicator) was defined using measurement data of the year 2019 which ended before any security measures started.

The effects of the Covid-19 confinements mainly influence the occupancy of the building which will be visible in the total power and thus the self-sufficiency ratio of the new power supply system.

To address this topic, measurement data from March 2020 to July 2020 will be taken into account to get a proper indication of the “new normality” after the confinements will be widely removed. Discussions about the data evaluation are in progress with all WP 5 partners.

### 5.3.3 Business model and financial scheme applied

The total DWG-budget for this action is 130,181.25 €.

- 91,126.88 € of this amount will be financed by MAtchUP funds, the rest of 39,054.37 € will be funded by DREWAG.
- 76,245.00 € for 4 employees pro rata temporis over three years. After the end of the MAtchUP-project in 2022 the employees will work for DWG, DWGNTZ or ENSACH in other projects.
- 24,900 € for equipment. 10,500 € depreciation of 1 smart meter/smart meter gateway (total cost: 35,000.00 € – duration: 10 yr – use in the project 3 yr – depreciation ratio: 30 %) and 14,400.00 € depreciation of 1 building control system (total cost: 24,900.00 € – duration: 10 yr – use in the project 3 yr – depreciation ratio: 30 %).
- 3,000.00 € consumables for smart metering installation and office supplies.
- 26,036.25 € indirect costs declared on the basis of the flat-rate of 25 % of the eligible direct costs (= 0.25 x (76,245.00 € + 24,900.00 € + 3,000.00 €)).

EASD contributes to this action as linked third party of DRE. EASD has planned a total budget of 99,375.00 € which are 100 % financed by DRE. Total budget is planned for engineering and scientific support (modelling, simulation and energy monitoring) of DRE within this action. 1 employee is funded for 12 month and will work for EASD afterwards in other EASD projects.

### 5.3.4 Citizen engagement strategy implemented

It is assumed a low monthly income of tenants living in Blasewitzer Str. 36. We expect, therefore, a negative impact on interest in new products and services if there is no obvious added value for the tenants. Eventually, this assumption has to be re-evaluated during the further project development.

However, via the planned tenants’ electricity model we allow these characteristic tenants of a typical apartment building to participate in the local RES-generation in the district without being charged with extra fees.

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Moreover, both tenants and locals will be informed about positive contribution of 'their' building in terms of electricity generation and $CO_2$-emissions reduction. By means of a large screen installed in the entrance area of the building we pave the way for a high citizen involvement, since residents are informed about consumption and generation statistics, e.g. daily generation of the installed PV-system. Thus, we enable a high citizen engagement, since the benefit is made visible and the usefulness can be better understood.

Furthermore, participating tenants will have the opportunity to be part of the innovative tenant energy model to achieve a lower price for their electricity consumption in comparison to the standard tariff. Due to reduced electricity costs, it is expected a monetary benefit for actively participating tenants, which is important since most tenants have a low monthly income.

It is also worth mentioning that we are planning to conduct a tenant survey at the beginning of 2021 in order to gather feedback and to include the opinion of tenants in our further decision making process.

## 5.4 Action 02: Building control center: 12 Public Buildings energy managed

### 5.4.1 Status of the intervention

During the first two MAtchUP project year [M1-M24], the following steps could be finalized:

- Selection of public buildings to be connected to the CBCC and selection of one representative public building for the simulation model.
- Simulation model for the pilot building
- Measurement and monitoring concept for the pilot building
- Tender for the supply of measurement, monitoring and control elements. Choice of specific technical components and respective order

As for M38 80% of progress can be reported so that all work will be completed by Q1 2021.

### 5.4.2 Risks found and corrective actions performed

1. The initial list of buildings envisaged to be connected to the CBCC (i.e. 5 schools, 6 children's day care facilities and 1 administrative building) had to be updated. It now includes 5 schools, 2 profession schools, 1 gym, 3 children 's day care facilities and 2 administrative buildings.

-> This deviation did not cause any delays, nor did it have an impact on the project budget.

2. The permanent timely adaptation taking into account internal and external climatic conditions will target only the heating system for certain buildings, i.e. for the cases where no ventilation system is in place.

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-> This deviation did not cause any delays, nor did it have an impact on the project budget.

3. Not all data will be integrated into the Dresden Urban Platform, but rather selected and useful data. Moreover, it still has to be decided which (anonymized) datasets under which level of aggregation can be released as Open Data.

-> This deviation did not cause any delays, nor did it have an impact on the project budget.

The current Covid-19 crises and corresponding confinements will have major impact on the evaluation of the conducted optimization measures during the monitoring phase. The baseload data (i.e. E2 indicator) was defined using measurement data of the period March 2019 to February 2020 which ended before any security measures started.

The effects of the Covid-19 confinements mainly influence the occupancy of the building which will be visible in the total power and hot water consumption but also regarding internal heat gains in the rooms which have a major impact on the implemented flow temperature control.

To address this topic, measurement data from March 2020 to July 2020 will be taken into account to get a proper indication of the “new normality” after the confinements will be widely removed. Discussions about the data evaluation are in progress with all WP 5 partners.

### 5.4.3 Business model and financial scheme applied

Via MAtchUP the following funds are available:

- 127.934 € for 1 employee (engineer CBCC) over two years. The funding of this engineer after this period will be secured via public city funds.
- 10.000 € for measurement & control equipment. Any additional equipment needs will be funded via public city funds.
- 240 € for information material for building users.

The CBCC shall be extended to the whole city of Dresden. It is planned to connect up to 200 public buildings during the coming five years. Without consideration of the project funds, an amortization of the technical equipment via energy savings is expected about 6 years after the connection of ~200 buildings.

EASD contributes to this action as linked third party of DRE. EASD has planned a total budget of 37.266 € which are 100% financed by DRE. Total budget is planned for engineering and scientific support (modelling, simulation and energy monitoring) of DRE within this action. 1 employee is funded for 4.5 month and will work for EASD afterwards in other EASD projects.

### 5.4.4 Citizen engagement strategy implemented

First, an internal communication with the building users shall increase transparency, public acceptance of the remote control of the energy system, and awareness for energy saving potentials, ideally triggering further energy savings.

- Means: Flyer, dedicated events e.g. once a building is connected to the CBCC, link to teaching activities in schools, etc.

Second, an external communication shall support the upscaling of the Action within the city of Dresden, as well as the replication in other cities.

## 5.5 Action 43: Smart-Meter-Gateway in District Future House

### 5.5.1 Status of the intervention

Action 43 is strongly linked to the progress of the District Future House (Action 9) and the PV system (Action 41). The implementation of the RIECON system is up-to-date. For now, it is not possible to implement intelligent measurement systems (in accordance with Section 2 (7) of the German regulation framework on Smart Meter) as it is shown in Figure 223, due to the currently pending certification. Furthermore, data analysis showed that compliance with data protection (according to EU GDPR) plays a very important role.

For the evaluation and forecast of the apartment meters, the data of 16 electricity meters (14 of residential units, 1 of PV system, 1 house light) have to be transmitted. Drinking water and district heating data are considered aggregated for the entire house. In addition, disturbance detection data should be incorporated. The exchange of data takes into account the current legislation regarding the transmission, processing and visualization of customer data.

Other topics include the development of the data interfaces and the visualization in the customer interface with the support of an external provider.

The development of functions for the presentation and prognosis of time series of an electricity meter based on intelligent measurement system at the residential and connection level has to be completed as the next steps. The development of a web-frontend of visualize the demand of tenants has started.

The action started in month 08 and is expected to end in month 45 of MAtchUP.

### 5.5.2 Risks found and corrective actions performed

Problems with privacy agreement for tenants. Currently, there is no consent for data analysis.

Also no access to existing “smart home devices” (Building Manager) for Data; Currently, only data access to the apartment counter data, as well as connection counters, is possible.

While MAtchUP there were changes in the IT system environment of DWG and DWGNTZ, which affected the project timeline. The originally planned partner company LEM which was supposed to deliver a forecast of the future time series with the help of historical data wasn’t able to fulfill the technical requirements; we are currently searching for a new development partner.

### 5.5.3 Business model and financial scheme applied

All measures of this action are financed by DREWAG without directly allocated MAtchUP funding to this action.

There are several interconnections within the Intervention consisting of A9; A41; A42; A53.

### 5.5.4 Citizen engagement strategy implemented

By actively involving the tenants in the test cases, digital literacy will be increased within this group. Both DWG and tenants are going to learn about how to use advanced building infrastructures properly and how to integrate them into regular everyday operations.

Via the planned tenant's electricity model we allow tenants of a modern apartment building to participate in local RES-generation.

Tenants have access to consumption and generation data via personalized displays installed in their flats. Thus, we achieve an active involvement of residents and strengthen awareness for a sustainable use of energy and resources by digital solutions. By use of the displays we make sure that tenants will be informed about the positive contribution of 'their' building in terms of electricity generation and $CO_2$ emissions reduction.

The District Future House forms the platform for the tenant community to decouple themselves from the role of a mere consumer of energy. Instead, they become prosumers, since the tenants generate partly their own clean energy. We hope that this will strengthen the sense of community within the house since all tenants are part of an innovative housing concept.

Moreover, we pursue the objective to present the taken actions through interesting press reports to keep citizens informed. In case of the District Future House with Actions 9, 41, 42, 43 and 53 we initiated two publications in the local press in November 2019 (see Figure 46: below).


EU-PROJEKT MATCHUP

**Zukunftshaus in Dresdner Johannstadt**

Intelligente Gebäudetechnik im Test auf Alltagstauglichkeit

**In der Haydnstraße 17 in der Dresdner Johannstadt wurde Ende 2019 das erste Zukunftshaus mit einem innovativen Energiemanagementsystem eröffnet. Die digitale Gebäudetechnik soll den Alltag erleichtern und dabei helfen, Energie zu sparen.**

Was macht das Zukunftshaus smart und besonders? Das neu errichtete Haus wurde mit einer Photovoltaikanlage auf dem Dach und entsprechenden Batterien zur Speicherung der Energie im Keller des Gebäudes ausgerüstet. Verbunden ist das Ganze mit einem modernen Energiemanagementsystem: In jeder Wohneinheit und im Keller sind Bediendisplays installiert. Wenn günstiger ökologischer Strom aus der Anlage zur Verfügung steht, bekommen die Mieter dies angezeigt und können als Ergänzung zur üblichen konventionellen Stromversorgung einen klimaneutralen und günstigeren Strom nutzen.

Über das Display lassen sich ebenfalls die Heizungsanlage in jeder Wohnung steuern und entsprechende Verbrauchswerte ablesen. Die Energie- und Gebäu-

Im Johannstädter Zukunftshaus gibt es 14 Mietwohnungen.

**Smart City-Projekt MAtchUP**

Dresden arbeitet mit Partnern aus Wirtschaft, Wissenschaft und Verwaltung sowie Bürger*innen an Vorhaben zur nachhaltigen Stadtentwicklung zusammen, um gemeinsam den Weg hin zu einer intelligenten, zukunftsfähigen Stadt (Smart City) zu gestalten, die den Herausforderungen des Klimawandels begegnen kann. Dresden wurde 2017 im Rahmen der europaweiten Initiative „Horizon 2020 – Smart Cities and Communities" ausgewählt, das von der Europäischen Kommission geförderte Leuchtturmprojekt als sogenannte Lighthouse City – neben Valencia (Spanien) und Antalya (Türkei) – umzusetzen. Insgesamt besteht das MAtchUP-Konsortium aus 28 Partnern in acht verschiedenen Ländern. Für die Jahre 2017 bis 2022 fördert die Europäische Union das Vorhaben mit insgesamt rund 17,5 Millionen Euro. Etwa 4,5 Millionen Euro davon entfallen auf die Dresdner Partner.

**www.dresden.de/matchup**

**Dresdens Haus der Zukunft**

In Striesen entsteht ein Wohnhaus mit vielen technischen Spielereien. Was die Mieter dort erwartet:

© Symbolfoto Shutterstock

**Figure 46: Local press release in November 2019 and January 2020**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

## 5.6 Action 04: 33 kWp photovoltaic system on existing buildings

### 5.6.1 Status of the intervention

Due to static issues of the roof at Pfotenhauer Str. there was the need for changing the apartment building to install a PV-system

To avoid any project delay, we already carried out a quite complete planning of the PV system (number and alignment, cabling, contracts). As there is no certified mounting system of PV panels at a height of > 30m, we had to analyze the static roof situation in detail. In consequence, no additional roof load could be accepted. Thus, we had to cancel the approach for the originally envisaged apartment building.

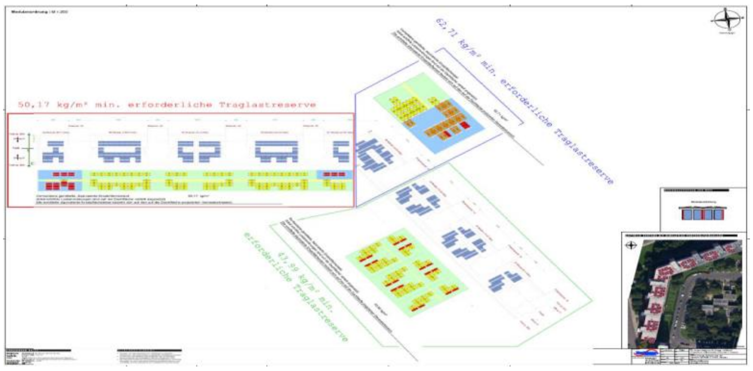

**Figure 47: Planning status of PV-system Pfotenhauer Str.**

Our project partner VON identified and put at disposal for the MAtchUP project an alternative building at Blasewitzer Str. That is where we started the planning again.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement N°774477

**Planning status of PV-system Blasewitzer Str. 36**

| | |
|---|---|
| **Building** | **Blasewitzer Straße 36 a-c; Version: 20.09.18** |
| Number of house entrances | 3 |
| Apartments per house entrance | 20,3 |
| Total number of apartments | 61 |
| | |
| **Photovoltaik system** | |
| Rated power PVA [$kW_p$] | 33 |
| Specific energy output [$kWh/kW_p$] | 900 |
| Annual energy output [kWh] | 29.700 |
| Rated power PVA per house entrance [$kW_p$] | 11,00 |
| | |
| **Power consumption** | |
| ø consumption per apartment p.a. [$kWh_{el}$] | 1.400 |
| Total demand [$kWh_{el}$] | 85.400 |
| | |
| **Estimation of the participating tenants** | |
| Selection: New construction or existing building | stock |
| Participating tenants | 75% |
| Electricity supply Tenant electricity model [$kWh_{el}$] | 64.050 |
| | |
| **Estimation of own consumption and self-sufficiency rate in the tenant electricity balance** | |
| Electricity supply Tenant electricity [$kWh_{el}$] | 64.050 |
| Annual energy return PV system [$kWh_{el}$] | 29.700 |
| Self consumption rate (PV system) | **75%** |
| Solar share of tenant electricity in the property [$kWh_{el}$] | 22.275 |
| Self-sufficiency rate (SSR) | **35%** |
| Residual electricity supply Tenant electricity in the property [$kWh_{el}$] | 41.775 |

**Figure 48: Energy balance in the tenant electricity model**

The plan of roof load, roof ballasting is currently under revision. Technical issues such as mounting method via crane and cabling plan have been solved already.

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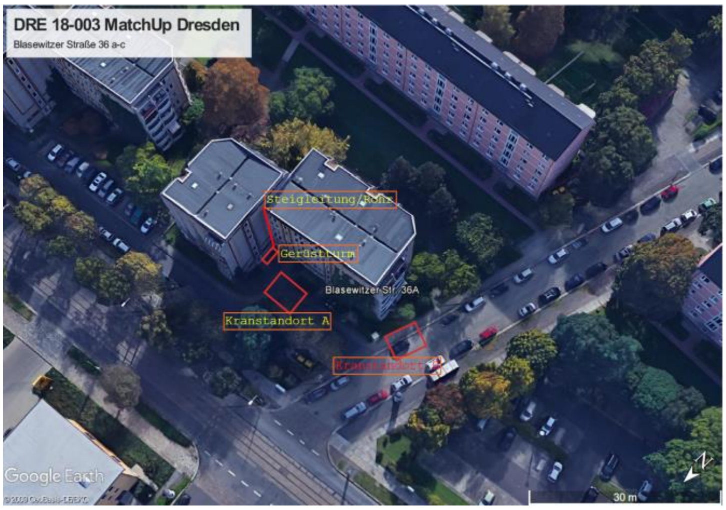


**Figure 49: Construction plan (scaffolding, cable and crane location)**

For the construction of the photovoltaic system, DREWAG has concluded a separate roof usage agreement with VONOVIA in 07/2018, which regulates the planning, installation and operation of the system by DREWAG on the VONOVIA building. The photovoltaic system was planned in 08 and 09/2018 and completed in 12/2018 after the start of construction in 10/2018.

**Figure 50: Photo of the construction process of the photovoltaic system**

In the course of the installation of the photovoltaic system, DREWAG NETZ determined that the meter systems no longer comply with the current valid technical regulations. In the course of this, the old meter systems were dismantled and new, regulation-compliant

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meter stations were erected at considerable additional expense. The new meter stations were put into operation on 15.05.2019.

In the same calendar week, DREWAG started selling the tenant electricity model. All 61 tenants received a cover letter and information sheet as well as their tenant electricity contract. In week 23, those tenants who have not yet returned their registration have received a reminder letter in order to attract as many participants as possible to the model.

The further description of the results of the tenant electricity model is part of the EAC of Action 1.

In 12/2019, a contract was signed with the project partner Vonovia for the installation of a digital visualization display. The display is to be installed on the facade of the building and, among other things, visualize the generation of the PV system. This is intended to communicate the MAtchUP-project in this building, the positive effects of the PV system and, if necessary, to attract additional tenant electricity customers. The following illustrations show the planned location of the display.

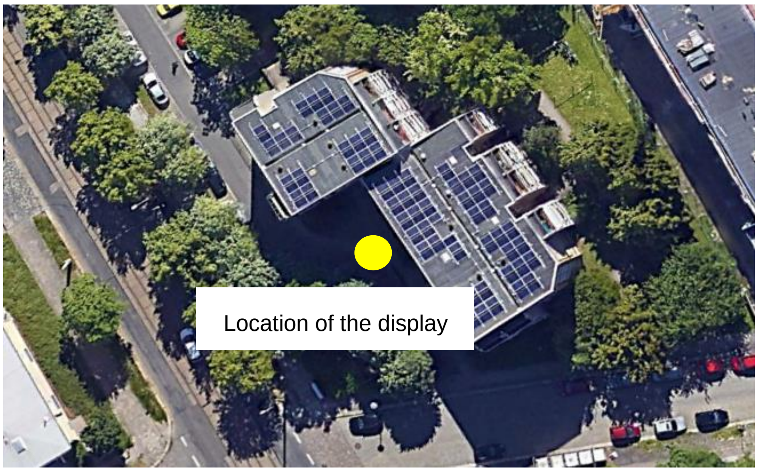


**Figure 51: Location of the display from above**


**Figure 52: Location of the display front view**

The detailed planning of the display including the technical execution and the location took a long time. As a consequence, the display could not be ordered until 07/2020. The installation took place in 09/2020.

### 5.6.2 Risks found and corrective actions performed

In the course of the installation of the photovoltaic system, DREWAG NETZ determined that the existing metering systems no longer comply with the current valid technical regulations. In the course of this, the old meter systems were dismantled and replaced by new, regulation-compliant meter stations at considerable additional expense. The new meter stations were put into operation on 15.05.2019. There is a risk that only very few tenants will participate in the tenant electricity model.

The current Covid-19 crises and the associated restrictions will have a major impact on the evaluation of the conducted optimization measures during the monitoring phase. The baseload data (e.g. E2 indicator) was defined by use of measurement data of 2019 which ended before Covid-19 restrictions came into force.

Therefore, the occupancy of the building has changed which, in turn, will be visible in the total power consumption and thus in the self-sufficiency ratio. Currently there is a delay in installing visualization screen for the tenants due to the COVID-19-restrictions and delays of the systems-provider.

### 5.6.3 Business model and financial scheme applied

The total DWG-budget for this action is 212,918.75 €.

- 149,043.13 € of this amount will be financed by MAtchUP funds, the rest of 63,875.63 € will be funded by DWG.
- 162,435.00 € for 4 employees pro rata temporis over three years. After the end of the MAtchUP-project in 2022 the employees will work for DWG or ENSACH in other projects.

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- 7,900.00 € for equipment. 4,900 € depreciation of 1 innovative outdoor monitoring system (total cost: 7,900.00 € – duration: 3 yr – use in the project 3 yr – depreciation ratio: 100 %).
- 42,583.75 € indirect costs declared on the basis of the flat-rate of 25 % of the eligible direct costs (= 0.25 x (162,435.00 € + 7,900.00 €)).

### 5.6.4 Citizen engagement strategy implemented

Via the planned tenants' electricity model we allow tenants of a typical apartment building to participate in local RES-generation in the district. In essence, tenants get the chance to lower their electricity costs and to use energy which is produced on the building's roof. This means that the tenant community decouples themselves from the role of a mere consumer and become a prosumer, since they generate partly their own clean energy. We expect this might also strengthen the sense of community within the neighborhood.

Furthermore, a survey is to be conducted among the tenants in order to gather feedback and to compare tenants' experience with our insights.

Moreover, both tenants and locals will be informed about consumption and generation statistics by means of a large screen installed in the entrance area of the building. Thus, we pave the way for a high citizen engagement, since the benefit is made visible and the usefulness can be better understood.

## 5.7 Action 41: 9.9 kWp photovoltaic system in District Future House

### 5.7.1 Status of the intervention

Implementing a PV-system into an apartment building aims to provide the tenants a maximum ratio of an energy, which is produced in the object with renewable energies. Within the planning process we calculated the autarky rate of the apartment building.

If a participant quota of 75 % to the Tenant electricity model is assumed: The projected power consumption in the object is about 22,757 kWh/a and the own consumption has been determined to 28,350 kWh/a. This leads to an own consumption rate of 70 % and an autarky ration of 36 % of the entire apartment.

Hence, this PV will save appr. 3.8 t/year of $CO_2$.

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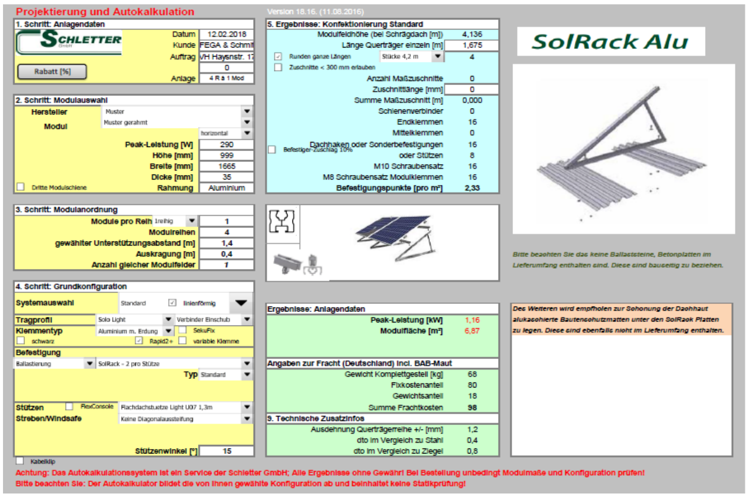


**Figure 53: Static report on mounting systems at Haydnstr.**

### Planning and construction of the photovoltaic system and the electricity storage system

The planning of the photovoltaic system and the storage system took place from 03/2018 to 06/2018. The heavily built-up roof (roof hatches, terraces etc.) proved to be particularly challenging. To ensure that sufficient electrical power could be installed, an individualized assembly system had to be planned, the purchase of which entailed considerable additional costs. In addition, high-performance photovoltaic modules were used. Another challenge was the interim replanning of the storage system, as the manufacturer of the already planned system unexpectedly stopped production.

Delivery and installation of the PV system and storage system started in 11/2018 and was completed in 05/2019 so that the system could be commissioned in 05/2019.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

**Figure 54: Photovoltaic system on the District Future House**

Currently, the amount of electricity generated and the output of the photovoltaic system is cyclically evaluated. As described in Action 9, a full operating year from October 2018 to October 2019 was analysed at the end of April 2020. The amount of electricity generated was within the expected range.

### 5.7.2 Risks found and corrective actions performed

- Considerable cost increase due to the individual production of the substructure and the associated ballasting.
- Difficulties with the registration of the photovoltaic system with the grid operator by the executing installation company.

### 5.7.3 Business model and financial scheme applied

All measures of this action are financed by DREWAG without any MAtchUP funding.

### 5.7.4 Citizen engagement strategy implemented

By actively involving the tenants in the test cases, digital literacy will be increased within this group. Both DWG and tenants are going to learn about how to use advanced building infrastructures properly and how to integrate them into regular everyday operations.

Via the planned tenants' electricity model we allow tenants of a modern apartment building to participate in local RES-generation.

Tenants have access to consumption and generation data via personalized displays installed in their flats. Thus, we achieve an active involvement of residents and strengthen awareness for a sustainable use of energy and resources by digital solutions. By use of the displays we make sure that tenants will be informed about the positive contribution of ‘their‘ building in terms of electricity generation and $CO_2$ emissions reduction.

The District Future House forms the platform for the tenant community to decouple themselves from the role of a mere consumer of energy. Instead, they become prosumers, since the tenants generate partly their own clean energy. We aim to strengthen the sense of community within the house since all tenants are part of an innovative housing concept.

Furthermore, a survey is to be conducted among the tenants in order to gather feedback and to compare tenants’ experience with our insights.

Moreover, we pursue the objective to present the taken actions through interesting press reports to keep citizens informed. In case of the District Future House with Actions 9, 41, 42, 43 and 53 we initiated two publications in the local press in November 2019 (see Figure 55).

Dresdens Haus der Zukunft

In Striesen entsteht ein Wohnhaus mit vielen technischen Spielereien. Was die Mieter dort erwartet

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**Figure 55: Local press releases about the DFH in Q1/2020**

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## 5.8 Action 42: Power Storage in District Future House

### 5.8.1 Status of the intervention

Planning of the electric storage is an integral part of the project Future House.

After the manufacturer was removed the originally planned storage-system from the market, the replanning took place in the period from 03/2018 to 06/2018 resulting the use of the above-mentioned storage system.


**Figure 56: Example illustration of the installed storage system**

It was important to find a system that could be integrated on the AC side. This enabled us to set a bidirectional electricity meter in front of the storage in order to model and bill the system in the tenant electricity model.

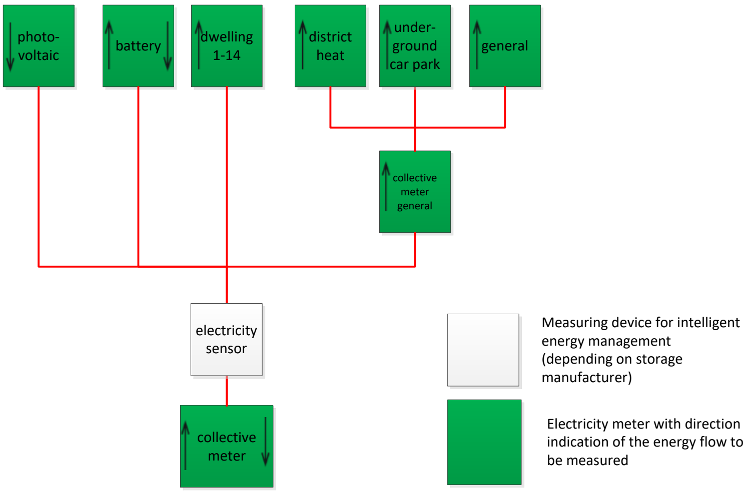


**Figure 57: Electricity meter concept for the District Future House**

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Delivery and installation of the PV system and storage system started in 11/2018 and was completed in 05/2019 so that the system could be commissioned in 05/2019.

The storage system is raising the own consumption rate of the PV-energy within the building.
As already described in Action 9, the evaluation of the load curves showed that the storage system performed almost no charging and discharging processes. Troubleshooting was enabled in August 2020, as there was previously no sufficiently trained staff available at our preferred subcontractor. In addition, the Covid-19 crisis with the accompanying restrictions delayed the detailed inspection of the battery malfunction by a technician.

### 5.8.2 Risks found and corrective actions performed

Unfortunately, the solar power storage is not working properly yet. The evaluation of the load curves has shown that the electricity storage unit has performed almost no charging and discharging processes. Troubleshooting could not be started before August 2020, as there was previously no sufficiently trained staff available at our preferred subcontractor. In addition, the Covid-19 crisis with the accompanying restrictions delayed the detailed inspection of the battery malfunction by a technician.

### 5.8.3 Business model and financial scheme applied

For this action, the total budget is 9,375.00 €.

- 6,562.50 € of this amount will be financed by MAtchUP funds, the rest of 2,812.50 € will be funded by DREWAG.
- 7,500.00 € for equipment. 7,500.00 € depreciation of 1 power storage (total cost: 12,500.50 € - duration: 5 yr – use in the project 3 yr – depreciation ratio: 60%).
- 1,875.00 € indirect costs declared on the basis of the flat-rate of 25 % of the eligible direct costs (= 0.25 x 7,500.00 €).

### 5.8.4 Citizen engagement strategy implemented

By actively involving the tenants in the test cases, digital literacy will be increased within this group. Both DWG and tenants are going to learn about how to use advanced building infrastructures properly and how to integrate them into regular everyday operations.

Via the planned tenants' electricity model we allow tenants of a modern apartment building to participate in local RES-generation. Especially it is worth mentioning, that residents rise the autarky ratio by using the storage system.

Tenants have access to consumption and generation data via personalized displays installed in their flats. Thus, we achieve an active involvement of residents and strengthen awareness for a sustainable use of energy and resources by digital solutions. By use of the displays we make sure that tenants will be informed about the positive

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contribution of ‘their‘ building in terms of electricity generation and $CO_2$ emissions reduction.

Furthermore, we are planning to conduct a comprehensive tenant survey in order to gather feedback regarding the storage system and to compare tenants’ experience with our insights.

Moreover, we pursue the objective to present the taken actions through interesting press reports to keep citizens informed. In case of the District Future House with Actions 9, 41, 42, 43 and 53 we initiated two publications in the local press in November 2019 (see **Errore. L'origine riferimento non è stata trovata.**).

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# 6 Conclusions

This report constitutes Deliverable "D3.16 New Concept of high performance district in Dresden– Final version", which is the main outcome of "Task 3.3 High-Performance District and Smart Homes" with the Subtasks "Subtask 3.3.1 Retrofitting actions". One of the core objectives of this document is to show a demonstration of the usage of sustainable energy technologies and future construction methods, the development of new business strategies as well as to support the urban transformation.

This deliverable aims to give a broad overview on the specific technological, ecological and social measures and strategies to be applied regarding the implementation of a new concept of a high performance district in Dresden. The combined actions will be carried out through a strong cooperation between partners from various branches and with different competences. It is this variety of partners that makes it possible to connect energetic and retrofitting constructions with an innovative energy supply system and new service offers for all inhabitants within one project.

The energetic refurbishment retrofitting and modernisations done by Vonovia serve groundwork for a broad range actions involved in this task, especially those done by DREWAG.

These retrofitting actions regarding the existing buildings, as well as the construction of the **District Future House** are part of an attempt for an innovative strategy for future holistic district developments. The building will serve as real laboratory in which several existing and new technologies regarding energy demand, supply and consumption can be tested in order to increase the general efficiency. DWG is investigating automated invoicing in order to offer tenants load-flexible tariffs. This is intended to enable tenants to profit specifically from the feed-in of renewable energy through discounts.

In addition to this attempt and to increase the flexibility of the Smart Energy Systems, **tenant electricity** models will be promoted within the Dresden project. Through tenant electricity models, tenants are allowed to use the generated energy from renewable energies themselves in their quarters. The **intelligent linkage of photovoltaics and storage** decouples on-site production and consumption and increases the autonomy of the district. This can increase the attractiveness of tenant flows and enable economic and ecological participation in the urban energy market as well as a reduction of costs for a large number of tenants. Thus, inhabitants can at the same time provide an active contribution to the urban energy transmission and profit from the energy produced on their own very buildings.

The connection of 5 schools, 6 children's day care facilities and 1 administrative building to a **Central Building Control Center (CBCC)** will help to increase the effective energy management also to **public** buildings within Johannstadt. This increment will be obtained through the permanent timely adaptation of the building heating systems with the current internal and external climatic conditions, exhausting the existing energy savings potential. All data acquired by the CBCC will be integrated into the Dresden Urban Platform and will be released as Open Data.

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To further promote the idea of a holistic, energy autarkic district, the installation **of charging points** will offer an incentive for tenants to buy an e-vehicle, as the lack of charging poles still keeps many drivers from doing so. This incentive will be strengthened by the replacing all fuel driven Vonovia company cars with new sustainable e-vehicles. By using e-vehicles, Vonovia employees advertise the concept of electric mobility as well as the idea of car sharing in order to reduce traffic generated $CO_2$ emissions. Both concepts will be professionally operated and managed and therefore not just serving the district community, but also creating an example on how future mobility transition can be implemented.

All involved actions will be monitored and documented, involving the successes as well as the emerging problems and failures, which might come up. This monitoring should end up in a general strategy, on how future district modernization projects should be managed and realised and what risks and challenges should be taken into account.

Once realised, the outcome of these tasks will not just lift the selected buildings to a modern day standard, but also to a significant increase of living standards, cost reduction and further benefits for all inhabitants and stakeholders.

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