



**Generalized Operational FLEXibility for Integrating
Renewables in the Distribution Grid (GOFLEX)**

**D9.3 Report on the System Prototype
Implemented in the Field - Use Case 3**

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Executive Summary

The goal of the GOFLEX project is to demonstrate how much of the flexibility in energy consumption can be harvested at prosumer levels. There are three different types of prosumers: households with some standard electrical appliances and PV (and battery), factories, including small and medium enterprises (SME) with industrial or production processes, as well as charging stations for electric vehicles. The GOFLEX system is tested in three different demonstration sites across Europe, representing different contexts.

The implementation of the system prototypes in the demonstration site of SWW area is presented in this report. At the time of this report, corresponding to the Milestone 4 of the project, the representative systems of the different types were all installed and this demonstrates the proper operation in the field of the whole system. Over the next months, an expansion in the number of connected systems will be prosecuted:

- Direct Control: the 10 first prosumers are installed and operational; the scaling up goes to 170 prosumers. The direct control system is normally installed in a house and the controlled flexible loads are a heat pump or a direct electrical heating appliance.
- Factory Energy Management Systems (FEMS): 5 industrial processes are installed and connected at the time of this report and the scaling up goes to 24 factories.
- Home Energy Management Systems (HEMS): 2 homes were connected at time of this report, one of it being a HEMS, and the scaling up will go up to 22 HEMS in the next weeks. The other one is a nonEMS and the scaling up will go up to 70.
- Charging energy management systems (CEMS): 4 CEMS are currently connected, encompassing 4 charging stations. One more charging station will be installed and connected. Despite it being mentioned in the D9.1, there will be no CDEMS installation in SWW.

The report will present technical aspects of the prototype, as well as wider aspects, such as installation routines and challenges, interaction with local inhabitant/operator, information provided to the client, etc.

Document History

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0.2	10.10	draft	SA	Multiple Input
0.3	14.10.	draft	GM	Advanced Version
0.4	14.10.	draft	SA	No-HEMS (AAU)

0.5	15.10.	draft	GM & SA	Ready to review
0.6	18.10.	draft	GM & SA	After Reviews
0.7	19.10.	draft	SA	Review Brad, Pictures
0.8	25.10.	draft	GM & SA	Insert school event, Abb., Impr.
1.0	29.10	For internal review	SA	DOMS, formalities
1.1	31.10.	For submission	SA	Formatting

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List of Acronyms and Abbreviations

Abbreviation	Definition
AAU	Aalborg University
ATP	Automatic Trading Platform
CA	Consortium Agreement
CDEMS	Charging/Discharging Energy Management System
CEMS	Charging Energy Management System
CHP	Combined Heat and Power
DOMS	Distribution Observability and Management System
DSO	Distribution System Operator
EC	European Commission
EMS	Energy Management System
ESR	equivalent series resistance
ET	elevated tank
ETREL	Company for charging systems
EV	Nicht vorhanden
FEMS	Factory Energy Management System
FMAN	FlexOffer Manager
FMAR	FlexOffer Market
FOA	Flex-Offer agent
FP2SH PLC	Programmable controller
GA	Grant Agreement
GOFLEX	Generalized Operational FLEXibility
GUI	Graphical user interface
HQ	headquarter
HEMS	Home Energy Management Systems
HP	Hewlett-Packard Company
IBM	International Business Machines Corporation
INEA	Networks Executive Agency
JSON	JavaScript Object Notation
KASA	App by TP-Link
Modbus RTU	Modbus Remote Terminal Unit
Modbus TCU	Modbus Telemetry Control Unit
MVIN	Move-in
OPC UA	Open Platform Communications Unified Architecture
OS	Operating system
PLC	programmable logic control
PV	Photovoltaik
RAM	Random-Access Memory

1 Introduction

1.1 Purpose

This document provides the results of the prototype installations at the Wunsiedel demo site. Basis for this prototype installation is the requirement and test specification developed during “WP 9 – Requirement Analysis” and documented in D_9_1. It includes all representative sites equipped with all categories and types of different Energy Management Systems (EMS), necessary to cover the existing and future operational and business model of SWW when dealing with flexibilities.

1.2 GOFLEX System

The GOFLEX system manages energy production and consumption at the local level, from the bottom up. In this way, consumers can participate actively in the future energy system by offering to be flexible in their energy production and/or consumption. In GOFLEX, end users of energy place offers to sell or activate discrete amounts of energy flexibility on a market. In the project demonstrations, the Distribution System Operator (DSO) accesses this flexibility by submitting a buy-offer to the market. Technology is also provided, in order for the DSO to automate and optimize the use of flexibility in the grid. Figure 1 illustrates these concepts.

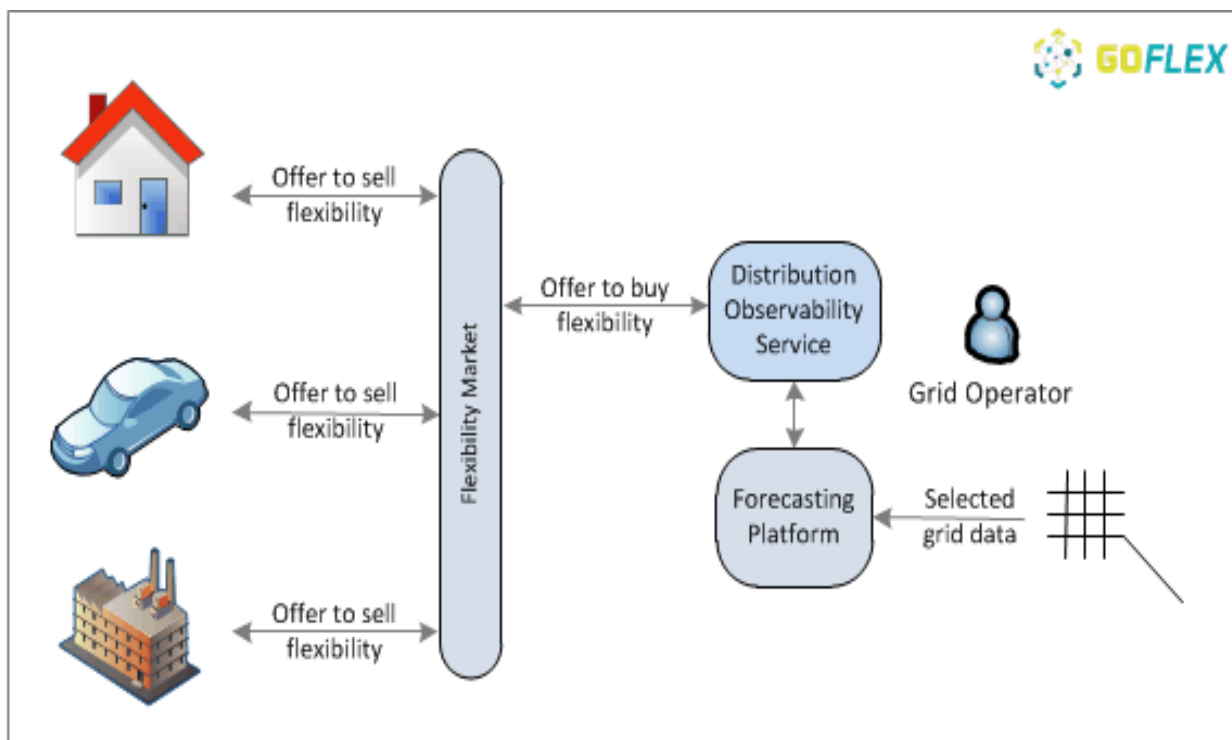


Figure 1: Illustration of GOFLEX Concept

Carrying out automatic trading of energy flexibility requires an integrated suite of technological components. Using a bottom-up approach, energy users, such as factories, homes, and electric vehicles each require a suitable energy management system to physically control the energy loads that deliver flexibility. Thus, a Factory Energy Management System (FEMS) controls factories and commercial buildings; a Home Energy Management System (HEMS) controls residential locations; a Charging Energy Management System (CEMS) controls electric vehicle charging stations; a Charging/Discharging Energy Management System (CDEMS) controls an electric vehicle, capable of discharging to the grid. Other types of energy management systems, such as smart plugs or direct controls are also used. The energy management systems are able to communicate available flexibility to a FlexOffer Agent (FOA). The role of the FOA is to transform ingoing information regarding available flexibility into a standard format, in order to provide it to a centralized Flexibility Manager (FMAN). The FMAN then places an offer to a Flexibility Market (FMAR) and receives notifications about whether the offer is accepted. When an offer is activated, the FMAN notifies the energy management system via the FOA. Collectively, the FMAR, FMAN, and FOA comprise an Automatic Trading Platform (ATP). The DSO accesses energy flexibility by trading on the market. When taking the perspective of the DSO, a Distribution Observability and Management System (DOMS) receives grid data and forecasts it from the Service Platform (SP). DOMS then optimizes where and when flexibility is needed, in order to meet operational needs. The required flexibility is expressed as a buy-offer and sent to the trading platform. Figure 2 summarizes the technological components of GOFLEX systems.

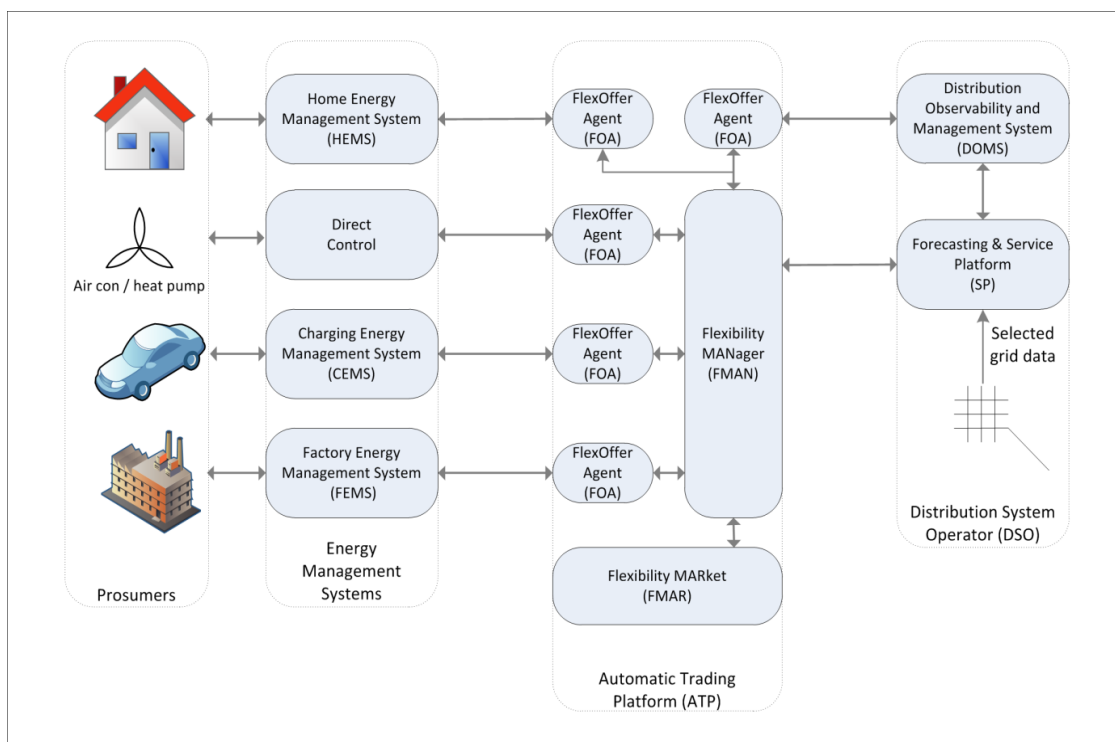


Figure 2: GOFLEX System Components

1.3 Related Documents

The related documents are D9.1., D9.2., D2.3., D3.3., D4.3., D5.3. and D6.3. The corresponding milestone terminates the preparation of the second integration cycle. It consolidates the results from the prototype tests into the technical work packages and completes the installation of the integrated solution at the demo site of SWW.

1.4 Document Structure

This document presents the D9.3 deliverables of WP9: Report on the System Prototype - Implemented in the Field [month 24]

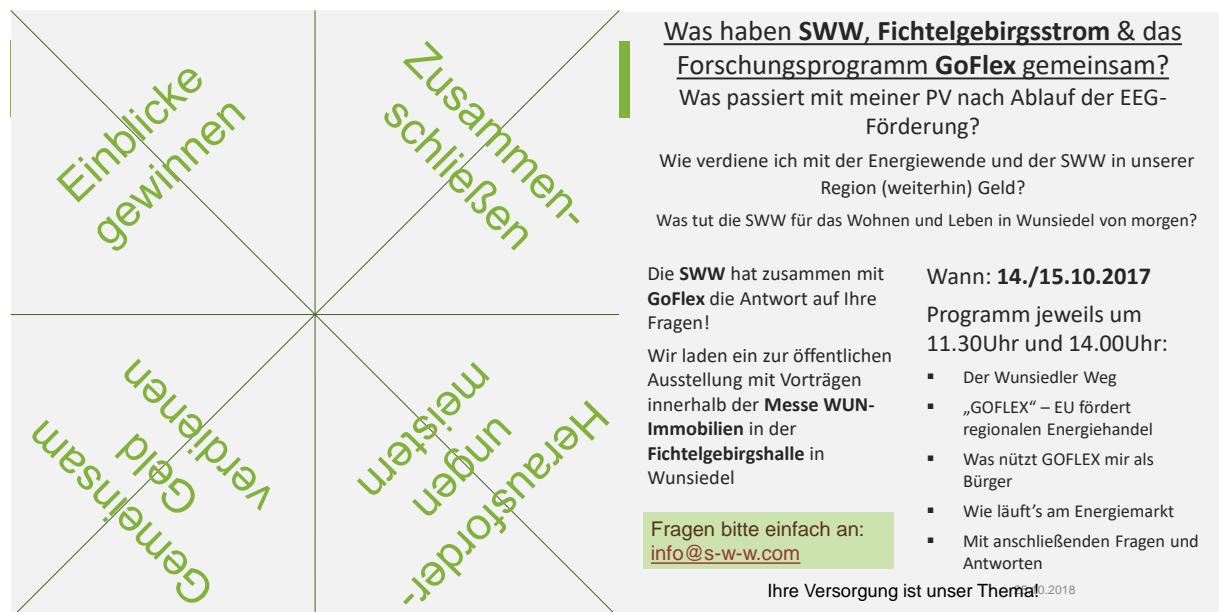
Section 2 follows this introduction and presents the process of prosumer participation. This includes a description of the acquisition process, the information given to the customers and all related publications and documents. The numbers for the different types of participants (factories, homes, smart plugs and charging stations) are listed.

Section 3 presents the installation documentation for the automatic trading platform, the different representative customers and their special types of energy management systems, the Distribution Observability Management System and the cloud service platform.

Finally, Section 4, followed by a short conclusion, describes the prototype testing with its test procedure and test results.

2 Prosumer Participation

The very first action towards the public SWW undertook was a lecturing day on renewables and energy future at the public school in Wunsiedel. The pupils got plenty of opportunity to ask all their questions on the subject. After this initial round of questions and answers they were invited to do an “energy origami” and a booklet on renewables. And finally, all participating pupils received an invitation for themselves and their parents to show up at the exhibition during the “Wunsiedel real estate fair” in October 2017.



Was haben **SWW, Fichtelgebirgsstrom & das Forschungsprogramm **GoFlex** gemeinsam?**
Was passiert mit meiner PV nach Ablauf der EEG-Förderung?

Wie verdiene ich mit der Energiewende und der SWW in unserer Region (weiterhin) Geld?

Was tut die SWW für das Wohnen und Leben in Wunsiedel von morgen?

Die **SWW** hat zusammen mit **GoFlex** die Antwort auf Ihre Fragen!

Wir laden ein zur öffentlichen Ausstellung mit Vorträgen innerhalb der **Messe WUN-Immobilien** in der **Fichtelgebirgshalle** in Wunsiedel

Wann: 14./15.10.2017
Programm jeweils um 11.30Uhr und 14.00Uhr:

- Der Wunsiedler Weg
- „GOFLEX“ – EU fördert regionalen Energiehandel
- Was nützt GOFLEX mir als Bürger
- Wie läuft's am Energiemarkt
- Mit anschließenden Fragen und Antworten

Fragen bitte einfach an: info@s-w-w.com

Ihre Versorgung ist unser Thema!

Figure 3: The heaven hell game, which was made together with the pupils in the school



Figure 4: Go Flex Stuff explain the world of regenerative energy's



Figure 5: The finished heaven-hell game

All possible HEMS and FEMS customers, as well as all GOFLEX partners were invited for a short information workshop during a public fair on October 15th and 16th 2017. The invitations were sent out as personal letters, which were accompanied by press articles in the local newspapers, in order to reach a wider audience. The invitation letter also asked for the built-in technique to

obtain a more precise picture of the prosumer. The workshop was held in a lecture hall next to the fair for all interested parties who wished to participate in a repetitive lecture series. In addition, a GOFLEX advertising booth was set up, which informed attendees about the project.



Figure 6: Advertising booth of GOFLEX at “Wun Immobilien” fair: GOFLEX staff Sebastian Auer explains the project to visitors



Figure 7: Advertising booth of GOFLEX at “Wun Immobilien” fair: GOFLEX staff explains the project to visitors GOFLEX



Figure 8: Advertising booth of GOFLEX at “Wun Immobilien” fair.

During the fair and the workshop an initial questionnaire was collected from the customer. Additionally, a data privacy statement was prepared for each participant, shown in Appendix ___.

The overall outcome of the weekend event for the GOFLEX project was quite promising. One hundred out of 700 invited customers (which all operate PV-installations) visited the fair, 27 wanted to invest in batteries, in addition to the PV. Eight newcomers wanted to start with the PV-investment, 14 even wanted to have charging stations and three are interested in CHP. The remaining 24 visitors were interested in providing their data of production and consumption for the project.

After this the HEMS customers that had documented their interest in participation in the project where invited for a design thinking workshop on May 3rd 2018 and their prosumer profiles were collected.

A complete prosumer profile is included in the appendix.

The corresponding household load guides and meter and sensors table can be found in the appendix.

The FEMS customers where visited and recruited by Markus Hausmann personally and individually. The presentation for the customers can be found in the appendix.

2.1 Factories

SWW could acquire 24 factories and some for participation.

Similarly, to the way the swiss colleagues suggested, all the participants were informed that:

- Companies will not be charged for the installations of the systems and for the different required meters,
- The FEMS installed will make it possible to visualize the energy consumption and will be able to propose analysis tools throughout the project,
- A complete analysis of overall consumption, as well as an overall report will be done at the end of project, including any possible detected problems, as well as advices on optimization,
- If the use of flexibility creates a proven financial interest, a fair remuneration will be discussed with SWW,

- The company is free to communicate about its participation in GOFLEX, regarding topics, such as marketing purposes, company-positioning, image towards the energy transition, etc.,
- The technical risks are low, as the current installation will keep its initial function at all times and the final decision to accept or refuse incentives from the FEMS belongs to the local control system,
- SWW is committed to provide technical support, in order to solve any problems which may arise. If modifications are suggested, they will be made with the agreement of the partner and will be carried out by professionals,
- GOFLEX is a research project, there is no guarantee of financial or energy gains,
- If the company would like to continue using the system at the end of the project, an arrangement will be made for the continuation of the service. Otherwise, we will proceed to uninstall all systems,
- The confidentiality of the data is guaranteed. The data will be stored and managed by SWW. Furthermore, part of the data will be forwarded to partners of the GOFLEX project for research, development of optimisation solutions, economic interest calculation and load management. In all cases, the data will be kept anonymous through the process of being transferred to any project partners. The relationship between the company's name and the data will only be known by SWW. Furthermore, the company's names will not be mentioned publicly.

Within the project team and in correspondence with INEA 3 categories of factory energy management system set-ups were figured out.

A	Storage, passive (oneway) flexibility
B	Generation + Storage
C	Generation

Category A 3 times



Figure 9: Representative Site Water Storage and pumping station Denglerquelle (Owned and operated by SWW)

Details see 3.2.1

Category B 4 times



Figure 10: Representative Site Breitenbrunn CHP (Owned and operated by SWW)

Details see 3.2.1

Category C 17 times



Figure 11: Representative Site Wastewater treatment plant combined with CHP (Owned and operated by SWW)

Details see 3.2.1

2.2 Homes

In the SWW demo installations, two types of homes are analysed separately within the group of participants:

Direct (single load) control of consumption for Non EMS heat storage or Non EMS heat pump systems

Out of 380 potential no-HEMS situations equipped with ripple control receivers the application for 70 customers is planned in the project.

The customers with a ripple control receiver already have controllable loads with the wiring done to the ripple control receiver. This wiring will simply be redirected to the GOFLEX Direct Control gateway (Hardware FOA). The old receiver is left in place, ensuring that everything can be set back to its original state at the end of the project.

Loads used for heating purposes are interesting as they present a natural storage, with the volume of thermal inertia of buildings. Such heating loads can be interrupted momentarily without impact on the end user. He will not even notice any change in temperature before a certain time.

Representative site in WUNWohn laboratory, Wunsiedel (owned by SWW)

The **Home Energy Management System (HEMS)**, provided by Robotina, will be supplied to 22 prosumers. All of the selected prosumers own rooftop PV installations, while 1 of them also owns a Battery Storage System. A HEMS with HW FOA approach will be implemented in the case of 22 prosumers for their flexibility provision. The goal is to manage the energy behaviour of the prosumers, control flexible loads and effectively activate DR potential by monitoring the households' local production, consumption and several other environmental parameters. Through the HEMS, the prosumers will have the opportunity to control their loads by using the web-based application, as well as being able to provide the required flexibility to the DSO.

The HEMS system consists of the following components:

- Meters and actuators
- Power supply
- Cybro controller
- IoT Linker for communication
- Smart socket
- Temperature sensor
- Cloud GUI

The M24 version of HEMS prototype is upgraded with a new controller named Cybro 3. The rest of the system remained the same. The logic for flexibility extraction was implemented on the IoT

Linker and in the Cloud system. The flexibility is extracted using the scheduler component on the HEMS, through which users can set their constraints – operation of specific loads, generators. There is local GUI available for configuration; the monitoring GUI is available through the WEB cloud GUI. Once user allows the trading, flexibilities are communicated to FOA and further to flexibility market.

For each HEMS partner a HEMS/CDEMS Commissioning protocol is filled. The HEMS/CDEMS Commissioning protocol you can see in the appendix.

Representative site for the HEMS solution is the house of Markus Hausmann (Technical director of SWW and co-author of this document)

2.3 Smart Plugs

170 Non-EMS customers (consumers only) will be integrated with their consumption patterns through installation of smart plugs, which will be connected through FMAN to the GOFLEX platform.

The residential consumers have been selected and recruited to demonstrate the AAU Smart plug solution. Smart plugs, which are able to communicate wirelessly with the central GOFLEX platform, are used to control various flexible loads of the apartments. Typically, 3-4 energy-consuming appliances per household are selected as controllable/flexible loads. The controllable loads that will provide flexibility via the smart plugs will be the following appliances:

- Washing Machines
- Clothing Dryers
- Dishwashers
- Freezers

Customers will be provided with a mobile application to configure their appliances' flexibility, operate the smart plugs and offer their flexibility for DR exploitation. The offered flexibility will be characterized by: i) amount of deferrable load, ii) time of availability and iii) deadline to exploit. The implemented solution will evaluate customer responsiveness in DR requests and investigate the flexibility potential of residential households without the use of an EMS.

Representative site is with one of SWWs employees.

2.4 Charging Stations

In the SWW demo case, five charging stations are implemented.

In the region supplied by SWW not one existing charging station was Etre compatible. The selected charging stations must be Etre compatible since Etre's dashboard will be used for their monitoring and control. Therefore, all five locations were equipped with charging systems from Etre.



Figure 12: Reference site is the "House of Energy Future"

Reference site is the "House of Energy Future" where 2 charging stations are installed and operated separately since February 2018 and were demonstrated during the opening event. The other three charging stations are installed on the SWW storage building, inside one of the FEMS premises and with one private operator.

3 Prototype Installation

The integrated GOFLEX System for SWW consists of the following prototypes:

- xEMS (x Energy Management System)
 - FEMS (Factory EMS)
 - CEMS (Charging EMS)
 - HEMS (Home EMS)
- FOA (Flex Offer Agent)
 - Direct trading FOA (for xEMS systems)
 - Delegated trading FOA

- FMAN (Flex Offer Manager)
- FMAR (Flex Offer Market)
- DOMS (Distribution Observability Management System)
- SP (Service Platform)
- Interfaces to the physical world
 - Metering data ingestion
 - Outside service data ingestion

3.1 Automatic Trading Platform

The local platform server was set up in July 2018. In August and September all necessary virtual machines (VM) were installed and are ready by now for any partners' remote access.

1 ATP Hosting Server

GOFLEX project includes budget for purchase of a server that will host ATP platform. ATP consists of the following components:

- FMAR
- FMAN
- FOA

Each instance of the above components should be considered as a separate Virtual Machine. Certain degree of optimization is possible on FOA, since the number of deployed FOAs will be great. This only goes for Virtual FOAs – hardware versions have own execution HW.

AAU prefers to run in the Cloud @ university. If needed we deploy on demand.

1.1 Hardware

For hosting, we propose a server with these minimal characteristics:

- 2x Intel Xeon 4th Generation CPU, each with minimal 12 physical cores *E5-2697 v3*
- 128GB RAM ✓
- 3TB of Full-SSD storage in RAID5 configuration

Server should be backed-up using existing backup system, based on best backup practices.

1.2 Software

1.2.1 Hypervisor

Server will be hosting several Virtual Machines, therefore it requires Hypervisor software. We propose using the following free Hypervisor:

VMWare vSphere ESXi 6.5 or later

1.2.2 VM for FMAR

OS: CentOS Linux 7 x64

vCPU: 12 cores

RAM: 16GB

DISK: 1TB

1.2.3 VM for FMAN (AAU)

OS: Linux x64

Figure 13: Server Config Part I

vCPU: 8 cores

RAM: 16 GB

DISK: 200 GB

1.2.4 VM for AAU FOA (one for all FOAs)

OS: Linux x64

vCPU: 8 cores

RAM: 16 GB

DISK: 1TB

1.2.5 VM for INEA FOA (1 per FOA)

OS: CentOS Linux 7 x64

vCPU: 1 core

RAM: 0,5GB

DISK: 1,5GB

1.2.6 VM for cloudIO (AAU) - Swiss

OS: Linux x64

vCPU: 8 cores

RAM: 16 GB

DISK: 100GB

1.2.7 VM for cloudIO (INEA) - Swiss

OS: Linux x64

vCPU: 8 cores

RAM: 16 GB

DISK: 100GB

Figure 14: Server Config Part II

3.1.1 Flexibility Manager FMAN

In August the VM for FMAN was ready and AAU could access remotely.

3.1.2 Flexibility Market FMAR

In August the VM for FMAR was ready and AAU could access remotely.

3.2 Energy Management Systems

3.2.1 Factories FEMS

As already discussed in section 2.1, a list of all participating factories is shown below. Factories were divided into three categories in order to ensure anonymity.

Table 1: Representative prosumers - installation project documentation

Subproject	Prosumer	Type
Sub prj 1	Water storage, Representative Site	A
Sub prj 2	Breitenbrunn, Representative Site	B
Sub prj 3	combined case Breitenbrunn & Schoenbrunn	B
Sub prj 4	Trading Company	B
Sub prj 5	Medical spa, semi public house (spa installations)	A
Sub prj 6	Waste water treatment plant (2 CHPs,...), Representative Site	C
Sub prj 7	CHP and heating plant in Neusorg is similar to that in Schoenbrunn	B
Sub prj 8	SWW headquarters building (PV on the roof)	C
Sub prj 9	SWW wood chips	C
Sub prj 10	SWW pellets production	A
Sub prj 11	Waterstorage Neighbourhood 1	A
Sub prj 12	Waterstorage Neighbourhood 2	A
Sub prj 13	Public Services HQ Building Wunsiedel	C
Sub prj 14	Electrical installation company HQ	C
Sub prj 15	House of energy future	C
Sub prj 16	bioenergy Sickersreuth	C
Sub prj 17	brewery	C
Sub prj 18	carpenter (PC, drying chamber)	C
Sub prj 19	Bio-gas production plant (energy flexibility producer) (farmer)	C

Sub prj 20	Fichtelgebirgshalle (CHP, hotel, concert hall, county government)	C
Sub prj 21	school (CHP, inside pool)	C
Sub prj 22	quarry	A
Sub prj 23	cloth colouring Monitoring only	CM
Sub prj 24	flex discs production Monitoring only	AM
Sub prj 25	Residence for elderly people Monitoring only	CM

The Factory Management System is composed of the following equipment:

1. Electrical cabinet provided by INEA,
2. Electrical meter on the general introduction of the site (in parallel of ESR meter),
3. Electrical meters on each controlled appliance.

Added electrical meters are connected to the existing control system. This data is supplemented by data of the site (e.g. outside/inside temperature, temperature of storages, and status of the heaters...) and pushed to GOFLEX system through the FEMS cabinet. An exchange table is defined for each site.

Documentations on the 3 SWW FEMS Representative Sites:

GOFLEX: 9-PIE-001 water pumping and storage site “Denglerquelle+HB2”

Introduction

The water pumping and storage site “Denglerquelle+HB2” will participate in the GOFLEX project with the desire to participate after the project as well, as consumer. The storage site “Denglerquelle+HB2” then has the ability to adapt to the demand of electrical energy usage. It can adapt the demand of electrical energy by controlling pumps.

The water pumping and storage site “Denglerquelle+HB2” will install GOFLEX FEMS (Factory Energy Management System) and FOA (Flex-Offer agent) systems.

- The systems will communicate with the GOFLEX control centre.
- The existing control system of “Denglerquelle+HB2+HB3” will make flexible offers:
simplified
 - prediction about adaptation of electrical energy in certain time period combined with adaptation prices.
- Adaptation of electrical energy when flex offers will be accepted.

Sector coupling water and electricity supply

The supply area of SWW Wunsiedel GmbH includes the city of Wunsiedel itself and most of its neighbourhoods. The main focus of supply is the urban area, with a medium-sized share of industry and small businesses. These will be supplied with drinking water with 2.149 additional house connections for 8.776 residents and provision of firefighting water via a 70 km long local network and 23 km long pipeline. The recoveries are spread over five units. Where the main pillar is the source of “Luisenburgquelle” and “Denglerquelle”.

The mixture of drinking water takes place in the elevated tank (ET) “Bibersbach”. This container is a central hub of the supply system Wunsiedel. From here, the drinking water is pumped into the elevated tank “Kappel” to provide the northern part of Wunsiedel and the district “Holenbrunn” with sufficient pressure. When the grid is saturated, the elevated tank “Katharinenberg” and the elevated tank “Bibersbach” balance out according the principle of communicating pipes. Both tanks are located at 588m above sea level.

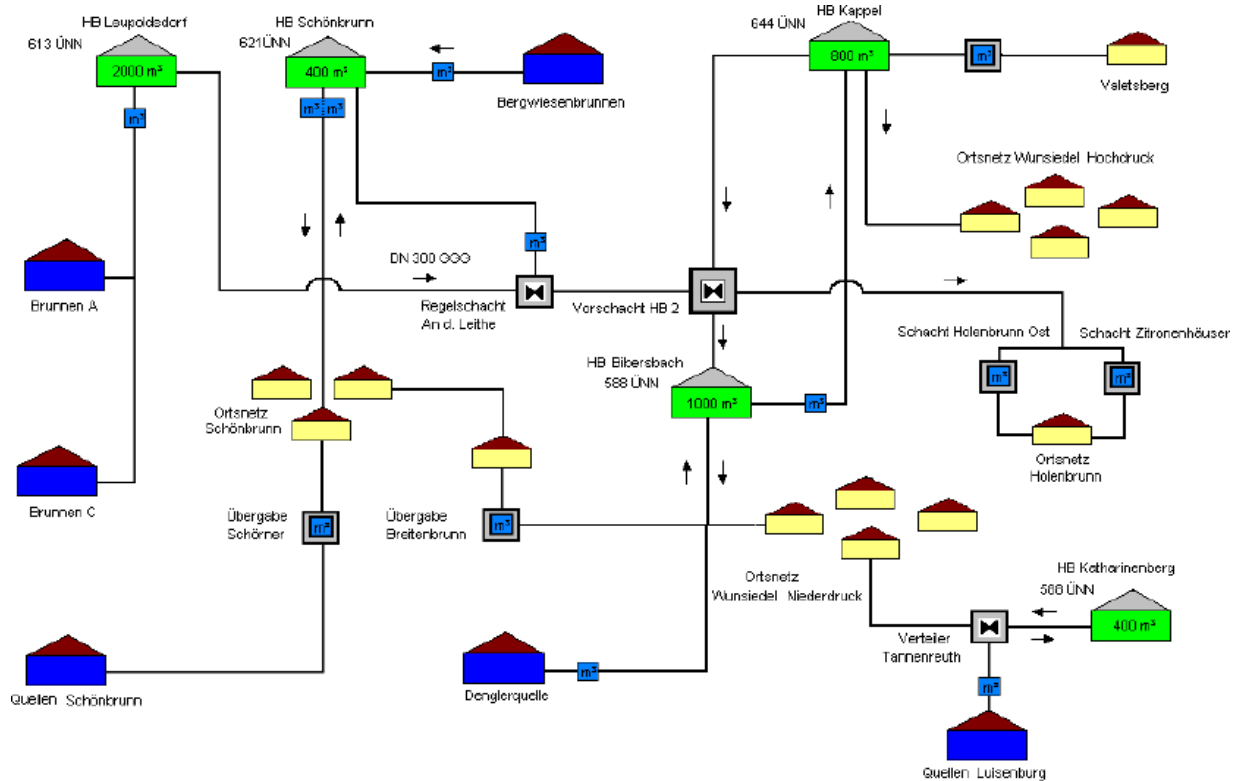


Figure 15: schema WVA Wunsiedel

Filling principle „ET Kappl“ and „ET Bibersbacher Strasse“

In order to fill the elevated tank „Kappl“ with water, the tank level is automatically controlled by a soil penetrometer. Through freely selectable switch-on and switch-off points, a digital output of the programmable logic control (PLC) is switched. Via a control cable, the command is given to the elevated tank „Bibersbacher“ street. There, the controller accepts the command at the entrance, compares the water level in the ET „Bibersbacher“ street and switches a pump to the ET „Kappl“. The pumps, which pump the water from the ET „Bibersbacher“ street to the ET „Kappl“, have a performance of 15 l/s and a power of 15 kW (according to rating plate).

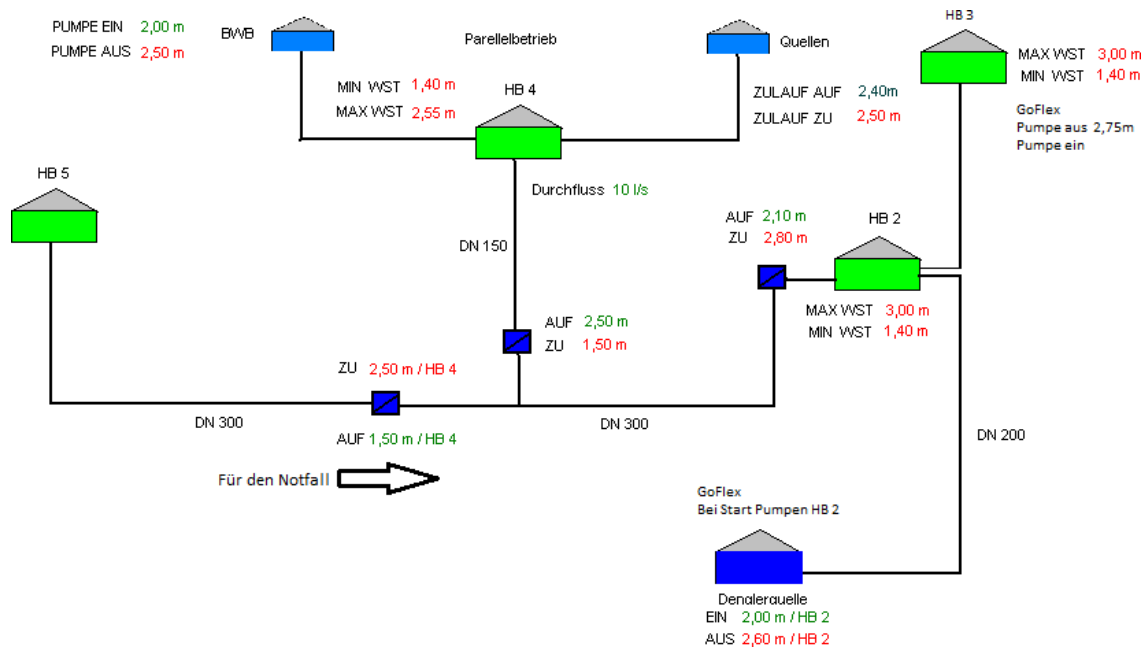


Figure 16: Realization GOFLEX - sector coupling electricity and water supply

At this ET, the implementation of the energetic control could be realized in this way that the ET “Kappl” in normal operation is only partially filled and provided in this case reserves for the absorption of power.

Problems with the energetic control: The water supply of the city Wunsiedel with extinguishing water should not be endangered also in the lowered ET. Therefore, only small switching margins are possible. The ET “Bibersbacher” street must be filled to fulfill the requirement. Therefore, the pumping station “Denglerquelle” is switch on with 20L / S at each pumping operation. The communication for this takes over the existing GPRS technology. At the same time a distress signal must be present if one of the ET drops too much. This fast filling then takes place through the deep wells A and C by ET 5 (Schema: HB 5). This rules out that switching operations during the project cause supply interruptions.

Solution of the energetic control

The control of the FEMS project must be switched in parallel to the existing control of the water supply. The control of the FEMS project and the control of the water supply must be able to turn on the pumps, but the control of the water supply must still be able to interrupt the command of the FEMS control to prevent overfilling and to avoid the ET at »Bibersbacher«

street is pumped out.

The container level is recorded in the ET »Bibersbacher« street via a pressure transducer, evaluated and passed as an analog signal to the control of the ET. If an adjustable minimum or maximum is reached, the fault message is sent via GPRS to the control center and informed by SMS to the appropriate technician.

The tank level is transferred via control cable (analogue signal) to the control unit of the pumping station »Denglerquelle«, where the switch-on and switch-off points are entered and evaluated via a touch panel. Depending on the tank level, one of the three pumps is switched on alternately.

FEMS configuration

1. Hardware configuration:
 - a. Industrial grade PC
 - b. Industrial switch
 - c. Electrical cabinet
2. Software configuration:
 - a. FOA
 - b. FEMS
 - c. Optional: INEA analytics server hosted on a customer server as a virtual machine.

FEMS preferred communications

FEMS preferred following communication from top down to bottom up:

1. http: JSON protocol.
2. Modbus TCP.
3. Modbus RTU.

4. OPC UA.

The existing control system configuration

Description and specifications:

The existing control system from ET “Bibersbacher” street and from the pump station “Denglerquelle” is connected with the Scada system by GPRS through a protocol from Panasonic and Flowchief. This is not a specified protocol. In all stations, the same communication protocol exists. All the components are working with digital and analogue in- and output-signals. The Panasonic PLC was initially intended only for water regulation, not for electrical control. Therefore, no electrical parameters are connected to the PLC.



Figure 17: The switch cabinet of pump station Denglerquelle

The existing control system preferred communications

Description and specifications:

The communication protocol with the least effort is the MODBUS RTU protocol.

Technical specifications of site for flexibility availability and the algorithm of electrical energy adaptation

Water storage:

Table 2: technical specifications_waterstorage

Total volume [m ³] or dimensions (l x h x w) [m]	1000 m ³
Lowest acceptable level [m ³] or height [m]	650 m ³
Highest acceptable level [m ³] or height [m]	900 m ³
Existing level measurement/sensor [yes/no?]	Yes. Pressure sensor – continuous level measurement
Water storage reserve (minute)	300 minutes

The “water storage reserve” is the time interval in which the water level falls from the highest level to the lowest level.

Pumps:

Table 3: technical specifications_pumps

Number of pumps	
Electric power of each pump [kW]	<div>1 30</div> <div>.</div> <div>2 30</div> <div>.</div> <div>3 25</div> <div>.</div> <div>...</div>
Pump water flow rate [m ³ /h]	<div>1 20</div> <div>.</div> <div>2 20</div> <div>.</div>

	3 23
Pumps control system [ON-OFF, VFD,...]	1. ON-OFF 2. ON-OFF 3. ...

User interface of the existing control system

The adaptation of electrical energy should be fully automatic. An operator must have:

1. An emergency button: it should only be used in the case of emergency. This button cancels the adaptation of electrical energy.
2. Adaptation of energy in progress status: a rectangle is used as indicator for the adaptation of energy. The colour green indicates the progress of adaptation, whereas the colour of the background indicates no adaptation of energy.

Further Questions

Table 4: further questions 1

Number of pumps?	3
The power of the pumps is listed individually in kW?	30, 30, 25
Running time of the pumps per day in hours?	8-10
Delivery volume per day in m³?	750
Flow rate in m³ per hour?	72
Volume of the water tank in m³?	1000
Minimum level of the water tank in m³?	600
Minimum running time of the pumps in hours, if relevant in normal operation?	8-10
Are there any external locks or requirements besides the level?	

Table 5: further questions 2

Pump controls type (PC, PLC, ..?) With number of available I / Os	SPS, Panasonic
Communication interface and protocol?	Panasonic - Flowchief
Sensor signals (e.g., levels, current pump operating status, ...) and sampling rate?	Level, sampling rate: 1 sec
Control signals, actuators (eg on / off pumps, normally open, normally closed, etc.)?	
Installation requirements for hardware installation (spatial installation specifications, climatic conditions, etc.)?	
HMI / GUI for operation, maintenance, update, upgrade services?	Panasonic GT32

Status: ready data available at project server

GOFLEX: 9-PIE-002 Cogeneration plant “Breitenbrunn”

Introduction

Cogeneration plant “Breitenbrunn” will participate in the GOFLEX project as well, with hopes to continue to participate after the termination of the project as prosumer, which gives them the ability to adapt the demand of electrical energy usage and production. The control system of the plant can adapt the demand of electrical energy by changing operation of systems (CHP, pellet boiler, PV).

At Cogeneration plant “Breitenbrunn”, GOFLEX FEMS (Factory Energy Management System) and FOA (Flex-Offer agent) systems will be installed. Systems will:

- communicate with:
 - GOFLEX control centre.
 - Existing Control system of “Breitenbrunn”.
- make:
 - Flex offers: simplified – prediction about adaptation of electrical energy in certain time period combined with adaptation prices.
 - Adaptation of electrical energy when flex offers will be accepted.

FEMS configuration

1. Hardware configuration:
 - a. Industrial grade PC
 - b. Industrial switch
 - c. Electrical cabinet
2. Software configuration:
 - a. FOA
 - b. FEMS
 - c. Optional: INEA analytics server hosted on a customer server as a virtual machine.

FEMS preferred communications

FEMS preferred following communication from top to bottom:

1. http: JSON protocol.
2. Modbus TCP.
3. Modbus RTU.
4. OPC UA.

The existing control system configuration

- The existing control system from plant Breitenbrunn is connected with the Scada system by GPRS with a protocol from Panasonic and Flowchief. This is not a specified protocol. All other components are working with digital and analogue in- und outputs. There is a Panasonic control system for the whole plant, there is no communication protocol, no individual control system for boiler and CHP, only digital and analogue in- and outputs, no protocol,

measurements for temperature forward-backward, CHP, pelletboiler, pelletfill, power output CHP.

The existing control system preferred communications

The communication protocol with the least effort is the MODBUS RTU protocol.

Technical specifications of site for flexibility availability and the algorithm of electrical energy adaptation

Please insert description and specifications/technical data.

Table 6: description and specifications/ technical data

CHP electrical and thermal power [kW]	Electrical power: 48 Thermal power: 80
Pellets boiler thermal power [kW]	400; only peak boiler
Hot water storage volume [m ³]	80
Electric power of heater to be installed in hot water tank [kW]	2 x 24; 3-steps control
Maximal and minimal temperature in water storage [°C]	Maximal: 85°C Minimal: 65°C
Communication with existing central control system or sensors? [4-20 mA, communication protocols,...]	4-20mA, PT 100
Temperature levels/regimes of district heating system maximal/minimal [°C]	Forward normal operation: 80 °C Backward normal operation: _60°C Forward max. operation: 90 °C Backward min. operation: 55°C

PV electric power [kWp]	9,6 – EEG scheme (directly to grid), connected in 2011 → measurements will be integrated in the GOFLEX to simulate after out of EEG scheme
-------------------------	--

Please provide operation manual of the whole Plant:

- Description of operating regimes of each system – CHP, pellet boiler, PV...
- pellet boiler is stired by temperature level of buffer
- CHP too
- CHP is prioritized to buffer

User interface of the existing control system

The adaptation of electrical energy should be fully automatic.

An operator must have:

1. An emergency button: it should only be used in the case of emergency. This button cancels the adaptation of electrical energy.
2. Adaptation of energy in progress status: a rectangle is used as indicator for the adaptation of energy. The colour green indicates the progress of adaptation, whereas the colour of the background indicates no adaptation of energy.



Figure 18: Breitenbrunn CHP INEA unit

Status: ready – data available at project server

GOFLEX: 9-PIE-004 Waste water treatment plant

Introduction

The wastewater treatment plant will also participate in the GOFLEX project, with a wish to also be integrated as prosumer after the project. This will give them the ability to adapt consumption and production of the electrical energy. It can adapt to the demand of electrical energy with 2 CHPs and PV. The electric power generating section of the wastewater treatment plant is controlled by the existing control system (several Panasonic PLCs).

Biogas is produced in the digester and transported to 2 biogas storages. The capacity of biogas storages is 500 m³, which, when used on full power, is enough to last up to 8 hours of CHP operation. The low volume limit is 300 m³. CHP can also operate on natural gas.

CHPs nominal power are 60 kW each and minimal operating power 30 kW each. PV station nominal power is 80 kW and when is cloudy approximately 16 kW. Because of the small capacity

of the main cable from the public grid, electric energy flow from/to wastewater treatment plant is limited to 100 kW.

At the Klaeranlage, GOFLEX FEMS (Factory Energy Management System) and FOA (Flex-Offer agent) systems will be installed.

Systems will:

- communicate with:
 - GOFLEX control centre.
 - On-site control system – Panasonic PLC.
- make:
 - Flex offers: simplified – prediction about adaptation of electrical energy in certain time period combined with adaptation prices.
 - Adaptation of electrical energy when flex offers will be accepted.

FEMS configuration

1. Hardware configuration:
 - a. Industrial grade PC
 - b. Industrial switch
 - c. AC/DC transformer
 - d. Electrical cabinet
2. Software configuration:
 - a. FOA
 - b. FEMS
 - c. Optional: INEA analytics server hosted on a customer server as a virtual machine.

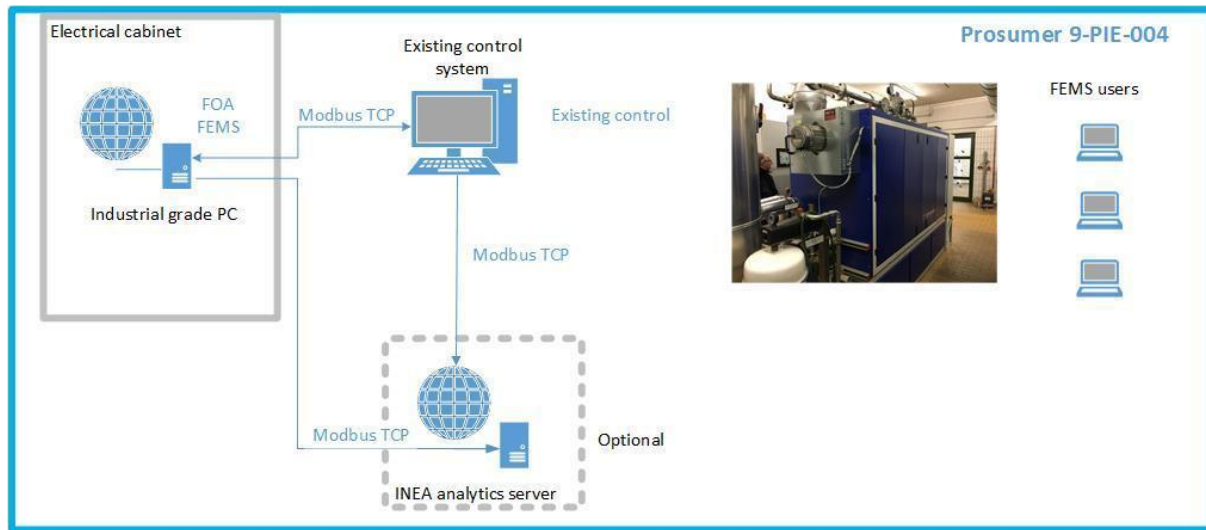


Figure 19: FEMS configuration

FEMS preferred communications

FEMS prefers the following communication from top to bottom:

1. http: JSON protocol.
2. Modbus TCP.
3. Modbus RTU.
4. OPC UA.

By mutual agreement the selected communication protocol between Panasonic PLC and FEMS will be Modbus TCP, FEMS will be the master system.

Existing control system configuration

The PC and 2 CHPs have their own control systems, which are connected to a main controller (Panasonic FP2SH PLC). The XENON SCADA is installed on the supervisory level.

In order to preserve electric power flowing through the cable, a special control algorithm was made, which tries to keep electric power through the main (grid connection) cable at 0kW. Control is being maintained by switching ON/OFF and changing the power of CHPs.

Control parameters are shown on the figure Picture 10.

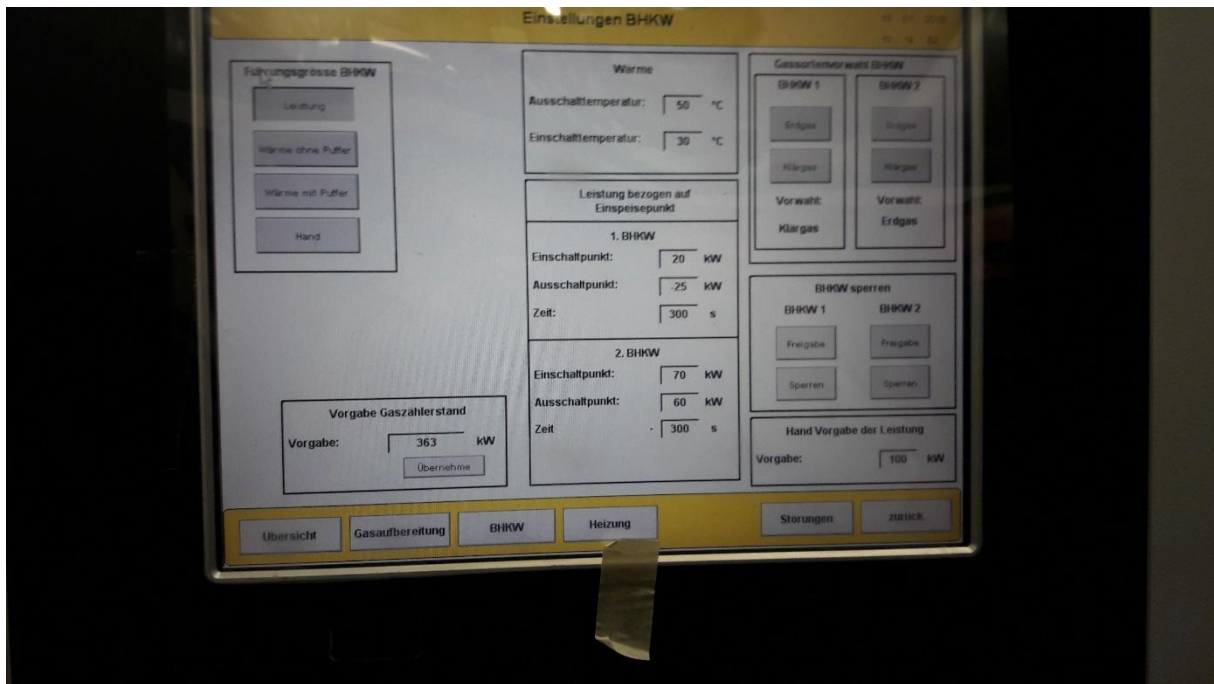


Figure 20: control parameters of the control algorithm

The control algorithm switches on the 1st CHP when imported electric power from the grid to the plant reaches 20 kW. If electric power import increases to 70 kW, the 2nd CHP is switched on. The measurement filter is set to 300 seconds. When electric power import, decreases to 60 kW, the 2nd CHP is switched off. When electric power export to the grid reaches 25 kW, the 1st CHP is switched off. Usually CHPs work on approximately 80 % of their nominal power.

Algorithm of electric energy adaptation

The interaction between the existing control system and the FEMS must meet the following criteria:

- The existing control system is functional regardless of what comes from the GOFLEX system.
- Safe operation is guaranteed, even in the case of failure or outliers, which may be transmitted by the GOFLEX system.
- Modbus TCP protocol will be used.

The existing control algorithm tries to preserve electric power, which flows through the main (grid connection) cable equal to 0 kW. For electric energy adaptation this reference value will be

changed. We assumed that reference values, which keep operating on the safe side are ± 30 kW. Where +30 kW means electric energy import and -30 kW means electric energy export. The reference values will be generated from the existing control system and will be used in the FEMS for making a prediction.

The predictions will be made on the basis of reference values of the existing control system and real-time values from main electric meter. In order to make offers, it is also necessary to know, if CHPs work on natural gas or biogas.

At the beginning of the adaptation process of electric energy, the FEMS will send the new reference value to the existing control system. The existing control system will then check if the reference value is ok and then start the adaptation with the new reference value.

Table 7: exchange table waste water treatment plant

Register	Address		R/W	Range	Unit	Multiplier	Format
Global values:							
Type of gas			R	1: biogas 2: natural 3: mixed			integer
Main counter energy			R		kWh		integer
Main counter power			R		kW		float
Authorization to change electric power			R	1: no 2: yes: increase and decrease 3: yes: only decrease 4: yes: only increase			integer
Reference value for increasing flow-in from grid			R		kW		float
Reference value for increasing flow-out to grid			R		kW		float
Power demand			W	1: no 2: yes			integer
Power reference command			W		kW		float
CHP 1:							
Electric power			R		kW		float
Electric power 15 min			R		kW		float
CHP gas consumption *			R		m ³ /h		float
CHP 2:							
Electric power			R		kW		float
Electric power 15 min			R		kW		float
CHP gas consumption *			R		m ³ /h		float
PV							
Electric power			R		kW		float
Electric power 15 min			R		kW		float

Exchange table

This table contains all values that would be exchanged between the FEMS and the Panasonic PLC through Modbus TCP protocol.

READ: Panasonic PLC → FEMS

WRITE: FEMS → Panasonic PLC

Data timestamp is 20 seconds.

Data timestamp is 15 minutes for data with 15 min mark.

Remarks: * optional

User interface of the existing control system

The adaptation of electrical energy should be fully automatic. We propose to add two pieces of information for the operator to the supervision level:

1. An “enable” button: it should only be used when the operator wants to disable the automatic adaptation and switch back to normal use.

Adaptation of energy in progress status: an icon that displays energy adaptation in progress or not



Figure 21: Waste-Water-Treatment INEA unit

Status: ready – data available at project server

3.2.2 Homes No HEMS

GOFLEX: 9-PRD-001-to-005 at WunWohnlaboratory (NoEMS Representative)

Introduction

The building WunWohnlaboratory, located on Dr.-Schmidt Strasse 7, encompasses six apartments and two offices, which are all equipped with an electric boiler for sanitary water, as well as an electric heater with thermal accumulation.

Electric boilers and heaters are controlled by a ripple control.

In the building WunWohnlaboratory GOFLEX Direct control will be installed, further in document called no-HEMS.

No-HEMS configuration

Hardware configuration:

- d. Industrial grade PC
- e. Siemens PLC S7-1212C.
- f. Industrial switch
- g. Power analyzer
- h. AC/DC transformer
- i. Electric cabinet

Software configuration:

- j. no-HEMS
-
1. Communication between the no-HEMS and the GOFLEX control centre will be through a public internet network, which is already on the location and should be available to use.

2. Each electric power line will be controlled by one no-HEMS. Each no-HEMS must have a power analyser connected to its power line. Outputs from several no-HEMS will be integrated in one Siemens PLC.
3. After the installation of no-HEMS, signals which currently go from the ripple controller to the relays, will then go to the Siemens PLC and continue on to relays.

No-HEMS preferred communications with the existing control system

No-HEMS preferred communication protocols listed from top to bottom (top=highest preference):

1. http: JSON protocol.
2. Modbus TCP.
3. Modbus RTU.
4. OPC UA.

No-HEMS will not engage in any communication with the existing control system.

Existing control system configuration

Electric boilers and heaters are controlled by a ripple control. The signal comes from the SWW central control system and enables the electric power supply to reach the electric boilers and heaters. The power supply is enabled daily from 22:00 to 6:00 o'clock.

The water temperatures in the boilers are controlled through local thermostats. Each electric heater has its own switching clock. Owners can choose different time intervals throughout the given time period, in which the power supply is enabled.

Algorithm of electrical energy adaptation

Any existing switching clocks, which control the ON/OFF switches of the heaters should be disabled.

Predictions for adaptation of an electric energy consumption will be made regarding the power measurements from the power analyser for each power line. Predictions for increasing electric energy consumption will need nominal power of each power line.

When the no-HEMS gets a command to decrease the electric energy consumption, it will switch OFF the power line to its consumers (loads). However, when there is no need to decrease electric energy consumption, the power line will be switched ON.

When the no-HEMS gets a command to increase the electric energy consumption, it will switch ON the power line regardless of the ripple controller (current periods from 22:00 to 6:00 o'clock). When there is no need for increasing electric energy consumption, the power line will be switched OFF.

Exchange table:

Not required.

User interface of the existing control system:

Not required.



Figure 22: Picture of Controller Cabinet WunWohnlabor for ripple controller

Status: ready – data available at project server

GOFLEX: 9-PRE-001-HEMS Representative

Introduction

Through the various questionnaires and events, we received an accurate picture of the prosumers regarding their equipment, interests and motivations to participate in the project. Each prosumer was given its own code number (HEMS number), which can be assigned with the initials uniquely to the addresses. In addition, there are special remarks that you should pay attention to when you visit the house and install our hardware, as you can see in table 8.

Table 8: remarks

Lf d.	already own:					interested in:					Remarks	Reply to the letter of 14.02. 2018	particip ation on 16.03.2 018	Agreem ent appoint ment	Specific ation of appoint ment	HEM S- Num ber
	PV system	battery storage	e-car or hybrid	charging station	Smartmeter	PV system	battery storage	e-car or hybrid	charging station	Smartmeter						
1						x	x	x	x	x		x	x	/		1
2							x			x	CHP	x	x	x		2
3	x						x			x		x	x	/		3
4	x									x						4
5	x	x										x	x	x		5
6	x	x			x							x	x	x		6
7																7
8						x	x									8
9	x	x						x	x							9
10																10
11	x						x	x	x	x						11
12	x						x	x	x	x						12
13	x						x		x		heat pum p					13
14						x	x	x	x	x						14
15						x	x	x	x	x	Dem osid e	x	x	x		15
16						x										16
17						x	x	x	x	x						17
18	x						x	x	x			x	x	x		18

19	x						x	x								19
20	x															20
21	x				x		x		x							21
22	x						x					x	x	/	/	22
23	x						x	x	x			x	x	x		23
24	x						x	x	x			x	x	x		24
25	x									x		x		x		25
26	x						x					x	x	x		26
27	x															27
28						x	x		x	x		x	x	x		28
29	x						x					x	x	x		29
30						x	x									30
31	x					x	x	x				x	x	x		31
32	x						x	x	x	x						32
33	x						x					x	x	/	/	33
34	x						x									34
35	x						x			x		x	x	x		35
36	x						x			x						36
37	x						x					x	x	x		37
38	x								x			x	x			38
39												x	x	x		39
40	x						x	x	x	x	Pelle ts CHP	x	x	x		40
41	x						x	x	x	x		x	x	x		41
42	✖	-	✖	-	-	-	-	-	-	-	-	✖	✖	✖	-	42
43																43
44																44
45																45
46																46
47																47
48																48
49	x				x							x	x			49
50																50
51																51
52	x	x										x	x			52

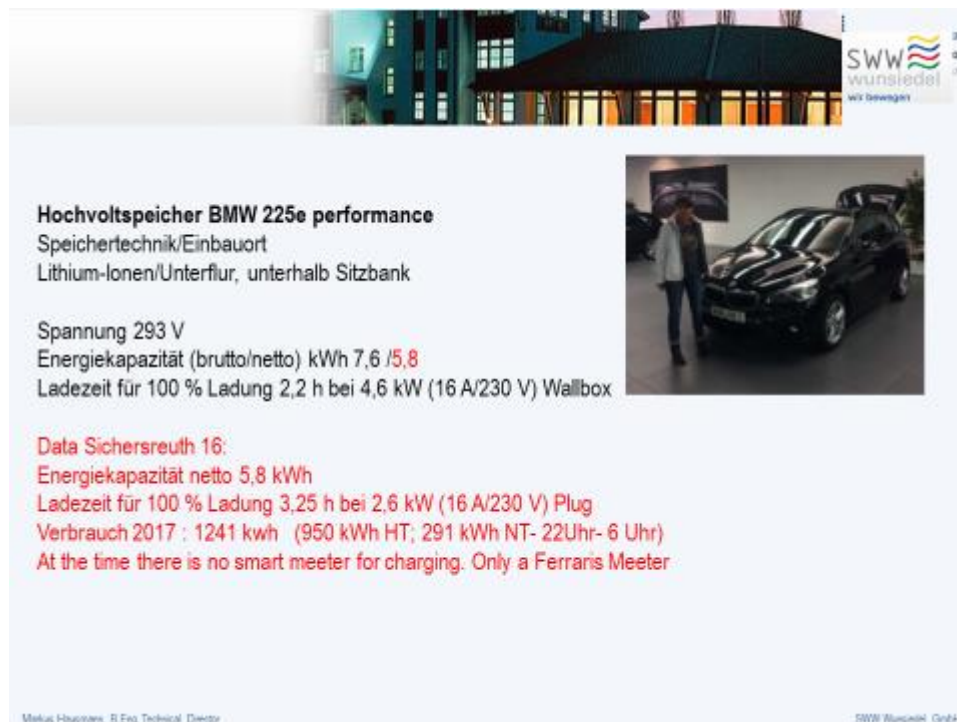
Our demosite is a detached house near Wunsiedel.

The building is located in Alexandersbad, equipped with pv, battery, a charging box for an e-car and a boiler with an additional heater. It is used by one 3-person family.



Figure 23: Electrical consumer

The annual demand for electricity for the household amounts 3500 kWh. The electrical vehicle needs circa 1200 kWh per year.



Hochvoltpeicher BMW 225e performance
Speichertechnik/Einbauort
Lithium-Ionen/Unterflur, unterhalb Sitzbank

Spannung 293 V
Energiekapazität (brutto/netto) kWh 7,6 /5,8
Ladezeit für 100 % Ladung 2,2 h bei 4,6 kW (16 A/230 V) Wallbox

Data Sichersreuth 16:
Energiekapazität netto 5,8 kWh
Ladezeit für 100 % Ladung 3,25 h bei 2,6 kW (16 A/230 V) Plug
Verbrauch 2017 : 1241 kWh (950 kWh HT; 291 kWh NT- 22Uhr- 6 Uhr)
At the time there is no smart meter for charging. Only a Ferraris Meeter

Marius Haasemann, B.Eng. Technical Director
SWW Wunsiedel GmbH

Figure 24: Hochvoltpeicher BMW 225e performance

In this building GOFLEX Direct control for an electrical heater on the boiler by INEA and a Robotina HEMS for the PV, battery, charging installation and household consumers will be installed.

HEMS configuration

Hardware configuration:

- Meters and actuators
- Power supply
- Cybro controller
- IoT Linker for communication
- Smart socket
- Temperature sensor
- Cloud GUI

The “HEMS wiring” document can be seen in the docu wiki.

Software configuration:

- a. HEMS

Any communication between the HEMS and the GOFLEX control centre will be made possible through a public internet network located on the site, which will be available to use.

Components list:

Table 9: Components list

S/N	Material / Device	Number of units	Provider
1	HEMS controller (CI-IQ-HEMS) with Zig-Bee gateway (GW-WN-W), power 24V supply (PS-IQ), IoT Linker (Cybro-Pi3), RS485 module and auxiliary parts/cables.	1	Robotina
2	INEA HW FOA IFB122 with WiFi module and auxiliary parts/cables	1	INEA
3	Bidirectional grid power consumption 1PH or 3PH wired meter (Model/Part Number: PM1-E-D or PM3-I-D)	1 x PM3-I-D	Robotina

4	Bidirectional PV power production 1PH or 3PH wired meter (Model/Part Number: PM1-E-D or PM3-I-D)	1 x PM1-I-D	Robotina
5	Bidirectional grid power consumption 1PH meter with ZigBee and optional CT or cables (Model/Part Number: PM1-WN-D or W)	0	
6	Bidirectional PV power production 1PH meter with ZigBee and optional CT or cables (Model/Part Number: PM1-WN-D or W)		
7	Wireless Bridge used for connecting power meter to wireless network (Model/Part Number: BR-WN-W)	0	
8	Smart Wireless Type G Plugs (Model/Part Number: SC1-WN-F)	1	Robotina
9	Smart Wireless Relay with cables (Model/Part Number: RL1-WN-W)	1	Robotina
10	Wireless (ZigBee) room temperature sensors (Model/Part Number: TSH-WN-W)	1	Robotina
11	INEA's prototype cabinet with IFB controller, relay, power supply, meter and other auxiliary parts/cables.	0	INEA
12	Wireless TP-LINK type-G smart plugs	0	AAU

13	PLC adapters	2	
14	4-port Ethernet Switch	1	

Wiring plan meters

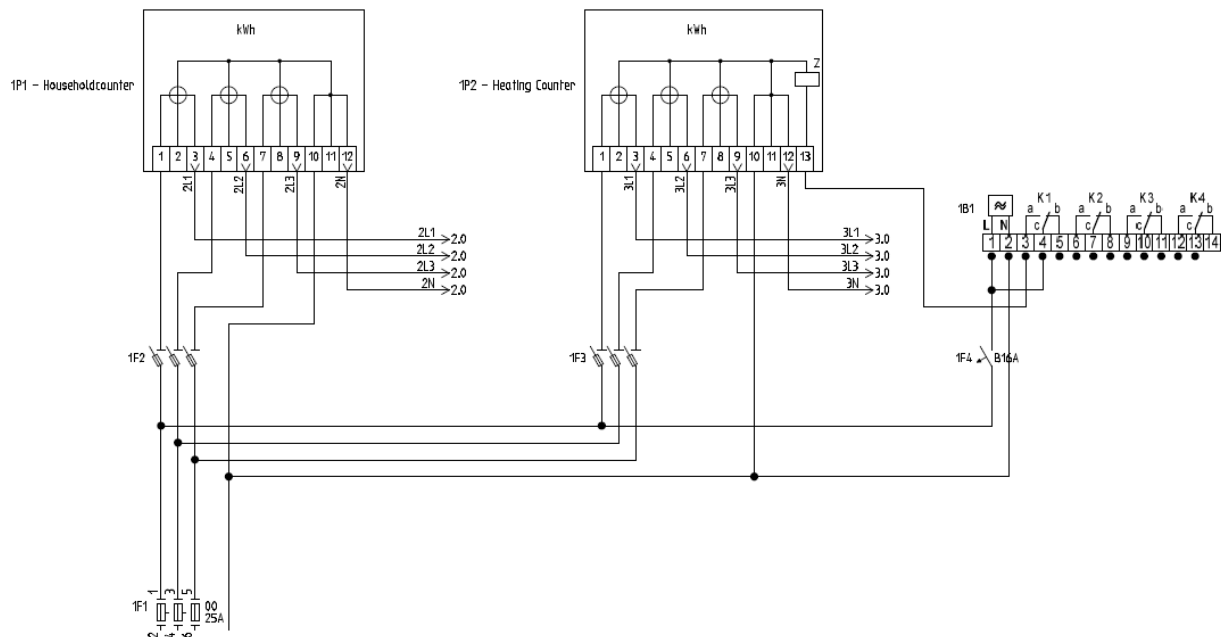


Figure 25: Wiring plan meters

Installationplan house:

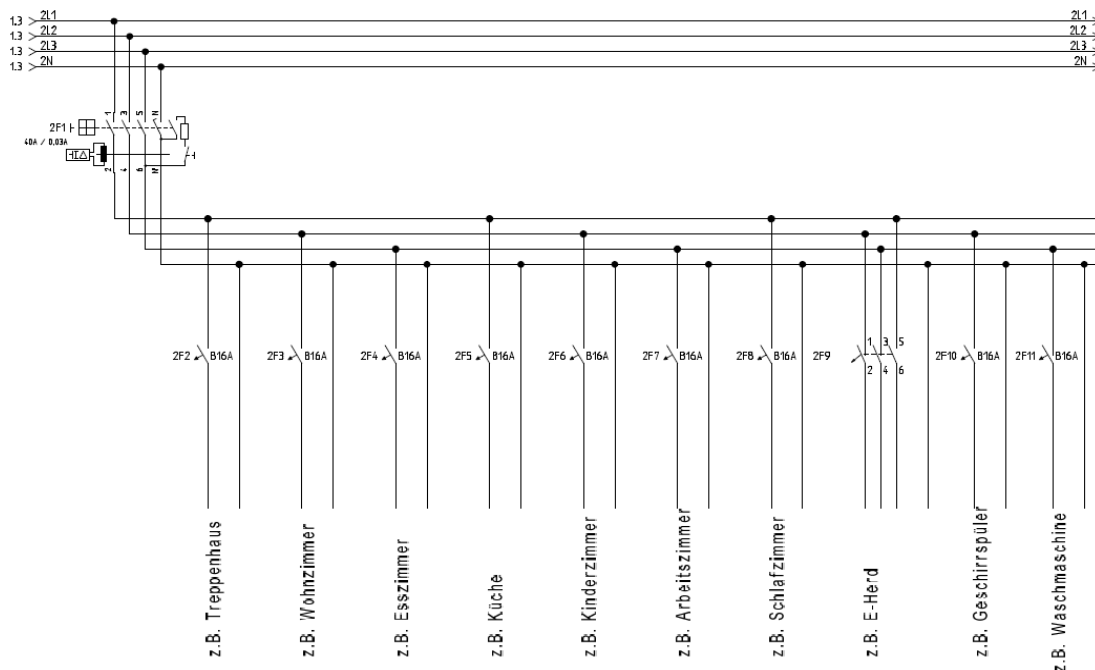


Figure 26: installationplan house

Status: ready – data available at project server

3.2.3 Smart Plugs WP-PRD-001 Non-EMS (AAU), Representative Site

Introduction

The apartment flat of the representative site is 100m², in which 4 Power Plugs from TP-Link were installed. These Power Plugs, with the model number HS110, became a smart plug through the smart grid project.

HEMS configuration

Technical data of smart plugs:

Device Type:

TP-Link HS100 WiFi Smart Plug



Figure 27: Smart Plug

The figure below shows the plugs are located in the kitchen, the laundry room and the office. The three different rooms are connected via wireless WLAN from a single repeater called TP-Link TL-WA901ND.

The repeater extends the range of an existing WI-FI network from a Fritz!Box 7362. Both devices have the same SSID and use the WPA2-PSK authentication-mode.

The Repeater is necessary to ensure good signal strength for the smart plugs.



Figure 28: Ground plan flat with smart plugs and loads

Two smart plugs are currently installed in the kitchen, one on a fridge-freezer combination and the other on the water boiler.



Figure 29: Fridge

The fridge has a daily electricity consumption of 0,88 kWh.



Figure 30: Therflow device

The non-pressure 5-litre Therflow device has a daily electricity consumption of 0,197 kWh.

In the office, the Smart plug is connected to a power supply that loads a pedelec battery of the company Tri. When the battery needs to be charged, it runs continuously for 4 hours and has an average consumption of 0,23kWh.



Figure 31: Pedelec Akku



Figure 32: Washing machine

In the laundry room, the washing machine of the company Gorenje is connected to a power plug.

Depending on the program setting, the washing machine has a consumption rate between 0, 50kWh and 0.95 kwh.

Before the GUI can be used by GOFLEX, all devices must be logged in and set up in a mobile phone app called CASA. Below, Figure 9 shows the registered devices on the account, which have previously been set up.

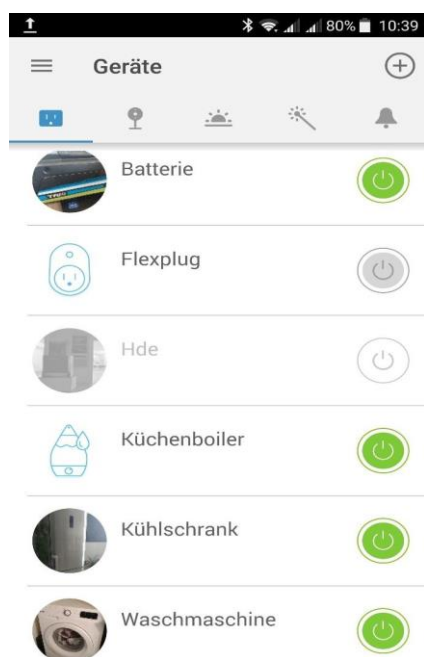


Figure 33: CASA app for the smart plugs

If the account of the app is connected to the account of GOFLEX, consumers have the ability to log on to the FOA server and participate in the project.

Exchange table:

Not required.

User interface of the existing control system:

Not required.

Status: ready – data available at project server

3.2.4 WP-PPE-001 Charging Stations CEMS

In August the ocean-cloud application was installed and ETREL could approach the charging station.

3.3 Distribution Observability and Management System DOMS

GOFLEX will help SWW to achieve the main goals out of the existing roadmap (D9.1):

- migrate into new business models
 - enter reserve market
 - enter flexibility trading
- enabling islanding mode, segmentation of grid operation and black start capability
- establish sector coupling for all segments in SWW supply region

For achieving all this goals SWW SCADA is now connected to DOMS and the description of the SWW goals for operation and support, with and through DOMS, that were defined by the SWW business cases (as described in report D9.2), is implemented.

The vision is not only to shape load profiles and balance energy consumption or supply locally but also to provide a bandwidth of power source or drain capacity to the external energy market. The following figure shows the concept of load balancing and the related IT architecture for monitoring and control of distributed energy systems, where smart xEMS technologies play a key role in the smart grid of the future.

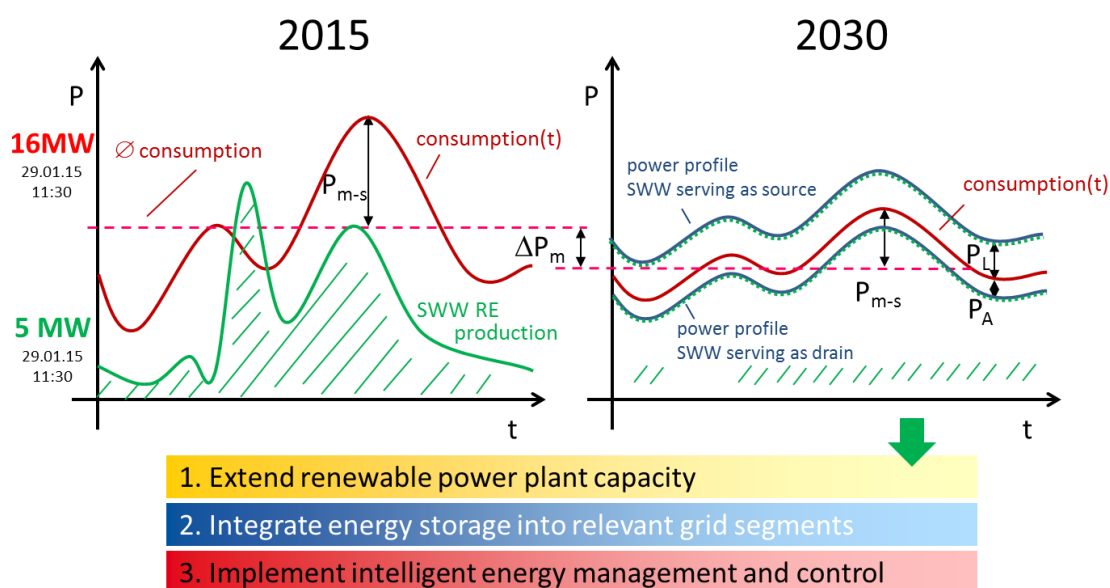


Figure 34: Reliable load profiles and a bandwidth of power source or drain capacity will provide our region prosperity and independence

Additionally to the actions SWW is going to establish in load shifting directly, dynamic pricing or other kind of contracts to get flexible consumers will help to shape their load in accordance to SWW needs, for both reducing the intra-day corrections costs and reducing the upgrading investments in the distribution grid. Moreover, maximizing self-consumption will also be investigated with private and public customers. Another business model that will be investigated is to sell the aggregated flexibility to TSO for tertiary reserves (ancillary services for TSO).

Load and Injection SWW – TSO (now)

2017	Load	Injection
January	2.728.544 kWh	- 252.132 kWh
February	2.160.796 kWh	- 437.452 kWh
March	1.632.258 kWh	- 633.182 kWh
April	1.496.418 kWh	- 530.146 kWh
May	1.870.768 kWh	- 176.360 kWh
June	1.307.690 kWh	- 563.214 kWh
July	1.497.644 kWh	- 531.158 kWh
August	1.785.766 kWh	- 201.106 kWh
September	2.002.366 kWh	- 294.548 kWh
October	1.465.322 kWh	- 728.278 kWh
November	2.029.296 kWh	- 476.664 kWh
December	1.457.842 kWh	- 854.856 kWh
Total:	21.494.710 kWh	5.679.096 kWh

Flexibility nowadays
only upstream!

Table 10: First estimation of flexibility generated out of grid operations by SWW in 2017

A first complete and overall estimation of flexibilities out of change of business models (D9.2) and future operative flexibility will be prepared for D9.4.

DOMS specifications

Tasks for DOMS:

1. Use the transmitted load forecast
2. Construct the best possible load estimation with available data and some predictions of unavailable load live data:)
 1. The production not in SWW balance group:
 1. All Customers not supplied by SWW
 2. Large PV plants

3. Wind plants
4. CHP
5. Biomass plants
 1. With live data if available, or schedules
 2. With day after data
3. Compare the day ahead forecast and the actual load estimation to construct the balance error at this moment.
4. Build an intraday forecast of the load to estimate the error in the short-term future.
5. Calculate the errors in the future.
6. Try to minimize the penalty caused by the error over a given horizon with load displacement
 - a) It needs the imbalance energy price to be optimized economically
 - b) A simulation of load displacement is necessary

DOMS setup at SWW

The software used in SWW for Energy Data Management (EDM) is Elipse E3. The necessary time series were prepared and sent to IBM with a MQTT client.

Data are collected on meters and sensors all over the grid. Time series with a resolution of 15 minutes steps are generally available from the electricity meters. All energy exchanges are accounted on the 15 minutes basis.

For the main grid loads there are two connecting points to be measured at, “Schalthaus” and “Übergabe Neusorg”. The monitoring of data is done with a 5 minutes sampling time. This allows us to assess if during the present quarter hour, there is a prediction error and how much must be corrected with the flexibility. Official data are only available the day after.

In September the VM for IBM direct approach was ready and operable.

3.4 Cloud Service Platform

The cloud service platform is applied in SWW. In September the VM for IBM direct approach was ready and operable.

4 Conclusions

We are ready to commence demonstrations!

This document has described how each GOFLEX system will be transitioned into a specific operational system. In the case of SWW, the document contains an overview of the implemented solutions in Wunsiedel and provides the current state of electrical and communication installation.

The recruitment and installation period has been quite challenging for the demo sites of SWW. However, representative prosumers of CEMS, FEMS, HEMS and delegated control (direct control) were recruited and installed. The different solutions were installed in the field and even if all participants are not yet installed, the pilot phase can start, as the whole chain is installed for each type of technical solution. Thus, the pilot phase and the trial operation of each particular GOFLEX solution is ready to be initiated, while any pending installation is expected to be completed by M26.

5 APPENDICES

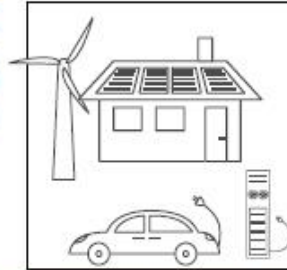
The following pages are used to demonstrate any documents and presentations which were being used or sent out in order to recruit participants, such as user questionnaires and data privacy statements. Furthermore, tables enabling data collection are illustrated.

***Project Title: Generalized Operational FLEXibility for
Integrating Renewables in the Distribution Grid
(GOFLEX)***

Appendix 1: Invitation “Wunsiedler Immobilientage”:



Adressfeld



**Neugierig auf ...
... Technik aus unserer Region
... Leben von morgen
... das neuste aus Ihren SWW?!**

**Wir laden ein zur öffentlichen Ausstellung mit Vorträgen
innerhalb der Messe WUN-Immobilien in der Fichtelgebirgshalle
in Wunsiedel**

- Es geht um die **Bürger-Teilnahme** an einem zukunftsfähigen regionalen Energiesystem nach dem Energieeinspeisegesetz (EEG). Die SWW kümmert sich darum und hat dafür sogar über das **GOFLEX-Projekt** EU-Mittel akquiriert.
- **Gemeinsam** mit einer Gruppe innovativer mutiger „Prosumer“ (die heute EEG-Anlagen betreiben oder neu anfangen wollen), entwickeln **SWW und Bürger** gemeinsam im Projekt ein Prosumer-Geschäftsmodell.
- Das wird für die Industriekunden und die Privatkunden in zwei verschiedenen Workshops (Design-Thinking) entwickelt und dann gemeinsam ausprobiert.
 - Als Belohnung wird der Einstieg in die **Prosumer-Welt** für die mutigen Bürger **günstiger**.



Unsere Info-Stände bieten Einblicke in die Funktionen eines modernen „Prosumer-Haushalts“ mit intelligenter Steuerungstechnik.

Außerdem gibt es viele interessante Einblicke in die **aktuelle Forschung**. Es wird die **E-Mobilität** von morgen mit Speicher, Ladesäulen und E-Autos ausgestellt.

Wun-Connect bietet zudem die Möglichkeit einer Live-Suche von Glasfaseranschlüssen im Stadtgebiet der SWW.

Programm von 14. – 15. Oktober 2017

Sa., 14. Okt. 10.00Uhr – 18.00Uhr:

11.30 Uhr – 12.45 Uhr

Der Wunsiedler Weg (Marco Krasser, Geschäftsführer SWW Wunsiedel GmbH -15Min.)

„GOFLEX“ – EU fördert regionalen Energiehandel (Dr. Gerhard Kleineidam, SWW Forschungsbeauftragter -15Min.-)

Was nützt GOFLEX mir als Bürger (Alexander von Jagwitz, B.A.U.M. Consulting München -15 Min.)

Wie läuft's am Energiemarkt (Benedikt Wagner, SWW -15 Min.)

Fragen und Antworten (alle, 15 Min.)

14.00 Uhr – 15.00 Uhr

„GOFLEX“ – EU fördert regionalen Energiehandel (Gerhard Meindl, SWW Forschungsbeauftragter -15Min.-)



Was nützt GOFLEX mir als Bürger (Alexander von Jagwitz, B.A.U.M. Consulting München -15 Min.-)

Wie läuft's am Energiemarkt (Benedikt Wagner, SWW -15 Min.-)

Fragen und Antworten (alle, 15 Min.)

So., 15. Okt. 10.00Uhr – 17.00Uhr:

11.30 Uhr – 12.45 Uhr

Der Wunsiedler Weg (Markus Hausmann, Prokurist SWW Wunsiedel GmbH -15Min.-)

„GOFLEX“ – EU fördert regionalen Energiehandel (Dr. Gerhard Kleineidam, SWW Forschungsbeauftragter -15Min.-)

Was nützt GOFLEX mir als Bürger (Alexander von Jagwitz, B.A.U.M. Consulting München -15 Min.-)

Wie läuft's am Energiemarkt (Matthias Wagner, SWW -15 Min.-)

Fragen und Antworten (alle -15 Min.-)

14.00 Uhr – 15.00 Uhr

„GOFLEX“ – EU fördert regionalen Energiehandel (Gerhard Meindl, SWW Forschungsbeauftragter -15Min.-)

Was nützt GOFLEX mir als Bürger (Alexander von Jagwitz, B.A.U.M. Consulting München -15 Min.-)

Wie läuft's am Energiemarkt (Matthias Wagner, SWW -15 Min.-)

Fragen und Antworten (alle -15 Min.-)



GOFLEX-Fragebogen :

Ja, ich habe Interesse an dem Thema Go-Flex und/oder einem Prosumerhaushalt

Ich besitze bereits:

Ich interessiere mich für:

☐

Eine PV-Anlage

☐☐

Einen Batteriespeicher

☐☐

Ein E-Auto oder Hybrid

☐☐

Eine Ladesäule

☐☐

Einen Smartmeter

☐

Name:

Anschrift:

Wie dürfen wir Sie erreichen?

Telefonnummer:

Email-Adresse:

Verzehrgutschein im Wert von 5.-€

Bei der Abgabe unseres Go-Flex Fragebogens oder eines Vertragsabschlusses mit Wun-Connect



Appendix 2: Questionary for Visitors WunWohn trade fair:

Fragebogen-GOFLEX-15./16.Okttober-2017

1

Name: → → → → → Gutschein

2

Anschrift:

.....

3

Warum:

4

Bisherige-Ausstattung: + → → → → → Interesse an:

5

PV → → → → → seit:

Batterie

Wärmepumpe

BHKW

Ladesäule

Elektromobil

Speicherheizung

Energiemanagement

Eigenstromnutzung

Energiehandel

Flextarif

SmartHome

Fichtelgebirgsstrom

6

Lässt-Datennutzung- zu:

7

Bemerkungen:

Appendix 3: Data privacy statement:

Datenschutz-GOFLEX

Einwilligungserklärung

zur Erhebung, Verarbeitung und Nutzung personenbezogener Daten
zu Forschungszwecken

¶

Die SWW Wunsiedel GmbH (im Folgenden: **SWW**) ist an einem Konsortium (bestehend aus: IBM-IRELAND LIMITED, Irland; INEA-INFORMATIZACIJA-ENERGETIKA-AVTOMATIZACIJA-DOO, Slowenien; AALBORG-UNIVERSITET, Dänemark; TECHNISCHE UNIVERSITÄT DRESDEN, Deutschland; ETREL-SVETOVANJE-IN-DRUGE-STORITVE-DOO, Slowenien; ROBOTINA-D.O.O., PODJETJE ZA INŽENIERING, MARKETING, TRGOVINO-IN-PROIZVODNJO, Slowenien; B.A.U.M.-CONSULT GmbH, Deutschland; UNIVERSITY OF CYPRUS, Zypern; ARCHI-ILEKTRISMOU-KYPROU, Zypern; HAUTE-ECOLE-SPECIALISEE-DE-SUISSE-OCCIDENTALE, Schweiz; L'ENERGIE-DE-SION-REGION-SA, ESR, Schweiz) beteiligt, welches mit der Durchführung eines europaweiten Forschungsprojekts betraut worden ist und durch die Europäische Union gefördert wird. Das Projekt trägt den Titel H2020 – Generalized Operational FLEXibility for Integrating Renewables in the Distribution Grid (Kurzbezeichnung: GOFLEX) und befasst sich mit der Entwicklung und Erprobung einer flexiblen Handelsplattform für Verteilnetzbetreiber und Prosumer (im Folgenden: Projekt). ¶

¶

Im Rahmen des Projekts werden zum Zweck des „Handels mit Flexibilität“ (positive/negative Last) meine nachstehenden Daten genutzt: ¶

Name, Vorname, Anschrift, Zählerdaten (Last) ¶

¶

Ich bin damit einverstanden, dass durch die SWW meine oben genannten Daten im Zusammenhang mit dem Projekt erhoben, verarbeitet und genutzt werden. ¶

Soweit für die Durchführung des Projekts eine zweckgebundene Weitergabe / Übermittlung der Daten an das am Projekt beteiligte Konsortium erforderlich ist, willige ich in diese zweckgebundene Übermittlung hiermit ebenfalls ein. Für Veröffentlichungen kann ich die Anonymisierung meiner Daten verlangen. ¶

Ich bin zudem darauf hingewiesen worden, dass die Erhebung, Verarbeitung und Nutzung meiner Daten auf freiwilliger Basis erfolgt. Ferner, dass ich mein Einverständnis ohne für mich nachteilige Folgen jederzeit gegenüber der SWW Wunsiedel GmbH, Rot-Kreuz-Straße 6, 95632 Wunsiedel mit Wirkung für die Zukunft widerrufen kann. ¶

¶

_____ [Ort / Datum] → _____ ¶

Name: ¶

Appendix 4: Prosumer profile_general information:

HEMS - Prosumer Profile						
Short questionnaire						
General information						
Name	GM					
Address	Eichenstrasse 48, 84066 Mallersdorf					
Type of a building	EFH					
Number of household members	3					
Electrical energy consumption						
Installed capacity (kW)	Max measured consumption (kW)	Average daily consumption (kWh)	Average monthly consumption - summer (kWh)	Average monthly consumption - winter (kWh)	Average yearly consumption (kWh)	Comment
6					3500	
Heat energy consumption						
Average daily consumption (kWh)		Average monthly consumption – winter kWh		Average yearly consumption (kWh)	Comment	
					Wood based	
Energy storage						
Type of unit (Batteries, PV..)	Present (Yes / No)	Available for energy management (Yes / No)	Storage capacity (kWh, L)	Max charging / discharging Power (kW)	Comment	
Batteries	No				wish	
Water tank	Yes			/	Heated from wood	

--	--	--	--	--	--

Prosumer profile_electricity production unit:

Electricity production unit							
Type of unit (PV, Heat pump..)	Installed capacity (kW)	Max peak power (kW)	Average daily production (kWh)	Average monthly production – summer (kWh)	Average monthly production – winter (kWh)	Average yearly production (kWh)	Comment
PV	6						

Prosumer profile_household loads-general overview 1:

Household loads - General overview										
Prosumers		Present (Yes / No)	Available for energy management (Yes / No)	Shifting possibilities (allowed / not allowed)	Operating interruption (possible / not possible)	Power [kW]	Average operating cycle time (hours)	Estimated consumed energy per cycle/day (kWh)	Estimated consumed energy per year	Comments
Electric Vehicle	Electric car	No								
Heating & Cooling	Heat pump - Room heating	No								
	Electric Heater - Domestic water	No								
	Heat pump - Domestic water	No								
	Air Conditioner - Heating	No								
	Air Conditioner - Cooling	No								
White Appliances	Dishwasher	Yes	Yes	Yes	Yes		1,5			
	Clothes dryer	Yes	Yes	Yes	Yes		1,5			
	Washing machine	Yes	Yes	Yes	Yes		1,5			
Other specific household	Miscellaneous									
	Steam iron									

s loads (>1kW)	Hair dryer									
	(air ventilatio n, electric stove, hob, electric motors..)									
Household loads - General overview										
Prosumers	Present (Yes / No)	Available for energy managem ent (Yes / No)	Shifting possibiliti es (allowed / not allowed)	Operating interrupti on (possible / not possible)	Pow er [kW]	Averag e operati ng cycle time (hours)	Estimat ed consum ed energy per cycle/da y (kWh)	Estimat ed consum ed energy per year	Comme nt	
Other specific househol ds loads (>1kW)										

Appendix 5: Presentation “Goflex for prosumer”:



Time's up! Let's shape the
Market for Flexibility
together!

Was machen Wir eigentlich?!



 The project Generalized Operational FLEXibility for Integrating Renewables in the Distribution Grid (GOFLEX) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731232.

Inhalt

- Um was geht es überhaupt?
- Eckdaten des Projekts
- Unsere Partner
- Neue Energiewelt
- Was erforschen wir bei der SWW?
- Unser Prosumerhaushalt
- Die Komponenten
- Weiteres Vorgehen
- Die Ansprechpartner



Um was geht es überhaupt?

- Bei diesem EU-weiten Projekt für mehr Flexibilität im Stromsektor stellen wir (SWW) unser Know-how namhaften Unternehmen wie IBM Irland zur Verfügung.
- Ziel der Forschungen des GOFLEX-Projektes ist nichts weniger als die Gestaltung einer neuen Energiewelt sowohl für den Stromnetzbetreiber als auch für die Abnehmer. Dazu gehört auch die Mobilität.



GOFLEX Partner

Handelsplattform



Energiemanagementsysteme

Testpartner



Überwachung und Prognose



Geschäftsmodelle



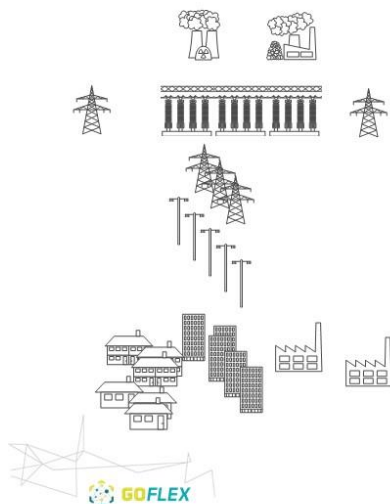
B.A.U.M.

Die Eckdaten

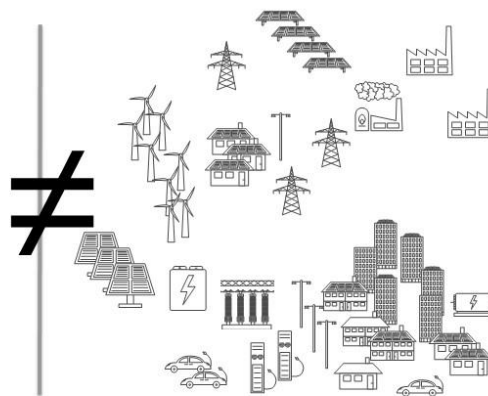
Koordinator	IBM IRELAND LIMITED
Koordinator-Land	Irland
Budget	11.234.125 €
Maximale EU-Förderung	6.826.393 € (61%)
Programm	H2020-EU.3.3.4 (A single, smart European electricity grid)
Code für Call	H2020-LCE-2016-SGS
Startjahr	2016
Dauer (Jahr-Monat-Tag)	von 2016-11-01 bis 2019-10-31



Links, das Netz von
Früher!



Rechts, das Netz
von heute!



Was wollen wir bei SWW erforschen?

- Ziel des Projektes ist es herauszufinden, wie Privathaushalte zur Stabilisierung des Stromnetzes beitragen können. Im Experten-Deutsch werden so aus Kunden „Prosumer“. Dies bedeutet, dass Haushalte nicht nur Energieabnehmer sind, sondern auch Produzenten.
- Das bedeutet:
 - Dynamische (lastvariable) Preisbildung und automatisierter Handel mit den Prosumern
 - Intelligentes Energiemanagement – Speichermanagement
 - Prognosen als Regelgröße zur Netzstabilisierung



Übergang in ein neues Energiesystem

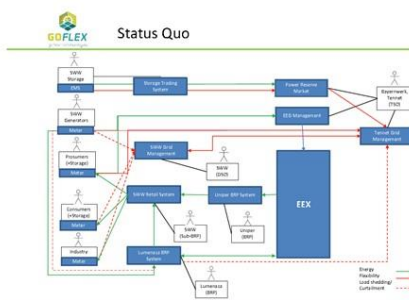


Figure 1: UML Diagram for scenario "SWW as service provider for Prosumers and flexible industry"

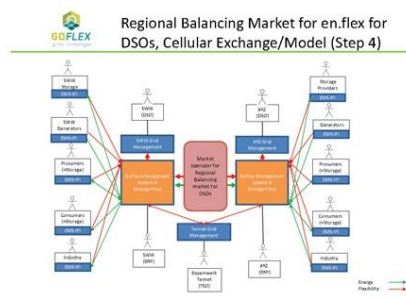
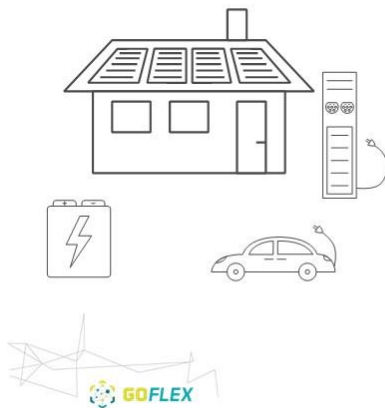


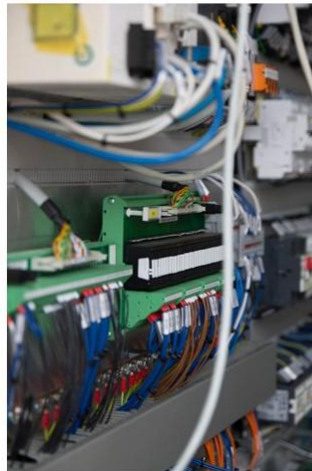
Figure 7: UML Diagram for scenario "Regional Balancing Market for energy flexibility for DSOs, Cellular Exchange/Model (Step 4)"



„Prosumer- haushalt“



...und die Technik von unseren
Partnern, die alles steuert...



Heimenergiemanagementsystem (HEMS)

- Der jährliche Verbrauch liegt hier im Durchschnitt bei 3500 kWh
- Ein elektrisches Fahrzeug benötigt ca. 1200 kWh im Jahr

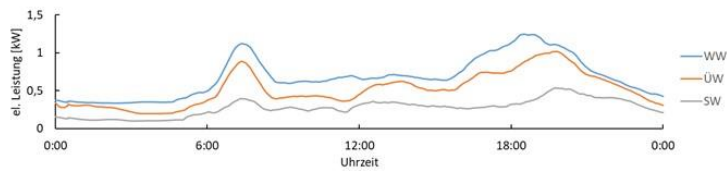


Sichersreuth 16, 95680 Bad Alexandersbad

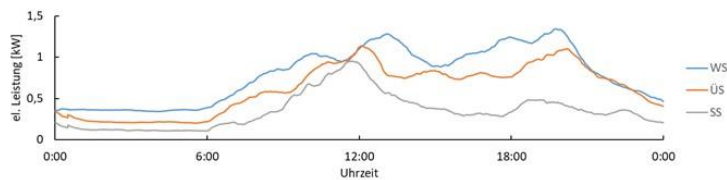




Tagesverlauf Strom



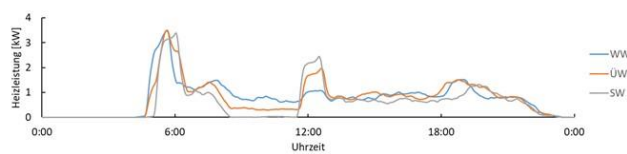
Tagesverlauf Montag - Freitag



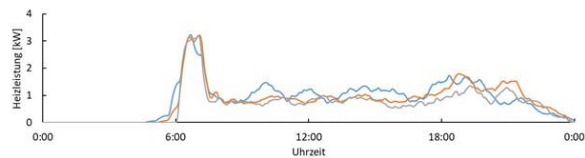
Tagesverlauf Samstag - Sonntag



Tagesverlauf Warmwasser



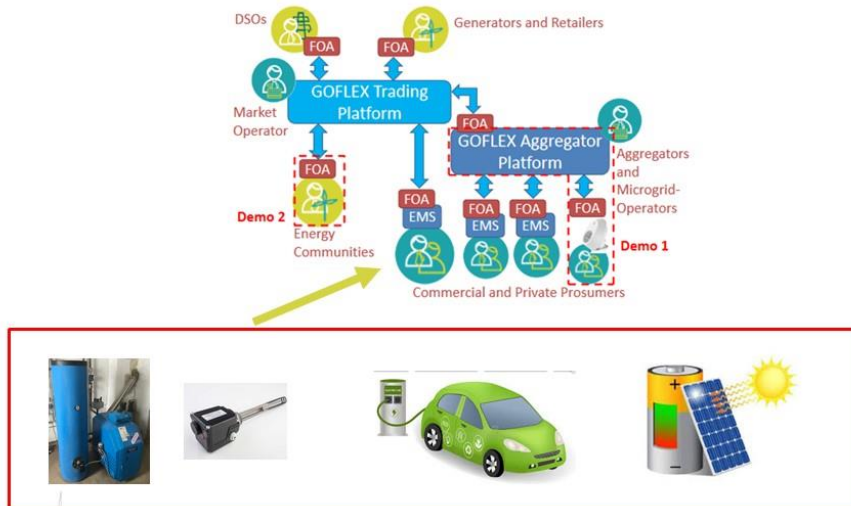
Tagesverlauf Montag - Freitag



Tagesverlauf Samstag - Sonntag



HEMS



13

Die Komponenten

- Hausbatteriespeicher
- Powerplug



Die Komponenten

- PV-Anlage



- ETREL-Ladestation



Die Komponenten

- Steuerungs- und Messtechnik

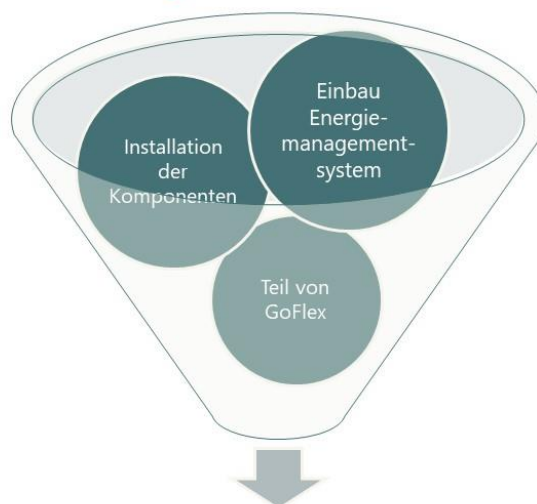


Weiteres Vorgehen...

- Bei Invest über SWW 500,00 € "Zuschuß/Nachlass"
 - ✓ Invest muss so groß sein, dass darüber hinaus mehr Erzeugung bereit gehalten werden kann, um somit Flexibilitäten für das Forschungsprogramm zu haben
 - ✓ Evt. Einzelfallprüfungen z.B. Leasing Hybridauto
- Einrüstung bis September 2018
 - Einzelterminabsprache ab 25.06.2018 (Wunschtermine in Anwesenheitsliste eintragen)
- Bei vorhandener EEG-Einspeisevergütung
 - Vorerst Daten aufnehmen und erst danach auf Eigenbedarf aufrüsten
 - Vom neuen Post-EEG Flexibilitätsmodell profitieren
 - ...oder gemischtes AuslaufszENARIO wählen (noch in Entwicklung)



Weiteres Vorgehen...



Zukünftiges profitieren von
neuem Flexibilitätsboni :o)

Konkret:



Die Ansprechpartner



Sebastian Auer M.A.
Erco AG

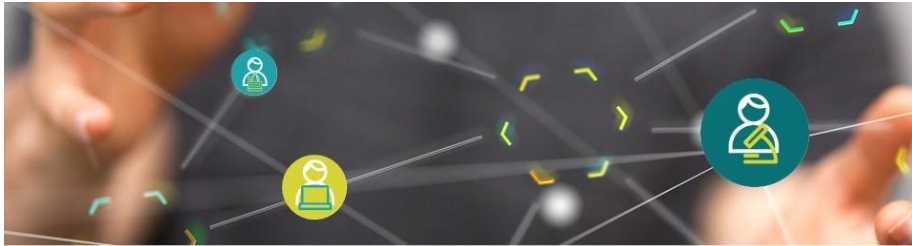


Gerhard Meindl
Dipl.-Ing.

- Vertrieb des gesamten Leistungsportfolios
- Projektmanagement Blackout Simulator und GoFlex
- Netzwerkarbeit

- Freier MA der SWW für GOFLEX





Bei Fragen können Sie sich jederzeit an mich wenden:

Sebastian Auer
Sebastian.auer@ercn.de
Tel.: 0151/10021317



Appendix 6: HEMS/CDEMS Commissioning protocol



HEMS/CDEMS Commissioning protocol



PROSUMER	EQUIPMENT
Name and surname: _____	HEMS (Cybro-3) S/N: _____
Email address: _____	Home Linker S/N: _____
	CDEMS S/N: _____

1. Equipment validation

No.	Objective	Test procedure	Acceptance Criteria	Test equipment	Test result
1	HEMS Equipment validation	HEMS is connected as specified in electrical diagram provided by Robotina.	Power light on power supply module is ON	Visual check	
2			Power light on HEMS Controller is ON	Visual check	
3			Power light on Home Linker is ON	Visual check	
4			Power light on Power meter is ON	Visual check	
5			Power light on ZigBee Gateway is ON	Visual check	
6			Power light on Smart socket is ON	Visual check	
7			Power light on Temperature sensor is ON	Visual check	
8	CDEMS Equipment validation	Turn CDEMS main switch ON	Power light on CDEMS controller is ON	Visual check	
9		Push button on the battery front	Power light on CDEMS battery is ON	Visual check	
10		Manual charge / discharge of battery	Battery charges/discharges	CDEMS CONFIGURATOR	

Appendix 7: Households loads guide

Impact of household loads on energy management possibilities



Household loads - General overview										
	Prosumers	Shifting possibilities	Cycle Interruption	Power	Cycle time	Energy per cycle	Cost per cycle (Price 0,20 €/kWh)	Energy per year	Cost per year (Price 0,20 €/kWh)	Comment
PV	Photovoltaic inverter	Depends on daily weather	Possible	-10 kW	Depends on daily weather	Depends on daily weather	Depends on daily weather	-10000 kWh	-2000 €	Direct consumption, storing in batteries or feeding.
Batteries	Electric storage	0-24 h	Possible	+10 kW	2 hours	+ 20 kWh*	+ 4 €	365 cycles, 7300 kWh**	→ 1460 €**	* Depends on battery capacity ** Depends on number of cycles
Electric Vehicle	Electric car 3,3 kW	0-12	Possible	3,3 kW	6 hours	20 kWh	4 €	365 cycles, 7300 kWh	1460 €	Average 100 km range charge is around 20 kWh. So far electric cars don't allow to discharge. ** Depends on number of cycles
Heating & Cooling	Heat pump 18 kW - Room heating	0-24 h	Possible	4,5 kW	4 hours	17,5 kWh	3,5 €	6135 kWh	1230 €	
	Water boiler	0-24 h	Possible	2 kW	3,5 hours	7 kWh	1,4 €	2529 kWh	505 €	
	Heat pump - Domestic water	0-24 h	Possible	1,2 kW	3 hours	4 kWh	0,8 €	1468 kWh	294 €	
	Air Conditioner - Heating	0-24 h	Possible	1 kW	2,5 hours	2,5 kWh	0,5 €	845 kWh	169 €	
White Appliances	Air Conditioner - Cooling	0-24 h	Possible	0,4 kW	1,5 hour	0,6 kWh	0,12 €	180 kWh	36 €	
	Dishwasher	0-24 h	Not possible	0,6 kW	1,5 hour	0,92 kWh	0,18 €	258 kWh	52 €	
	Clothes dryer	0-24 h**	Not possible	0,7 kW	1,5 hour	1,24 kWh	0,25 €	199 kWh	39 €	
	Washing machine	0-24 h**	Not possible	0,5 kW	1,5 hour	0,68 kWh	0,13 €	150 kWh	30 €	
Other households Loads	LED TV	/	/	0,2 kW	/	/	/	/	/	
	LED lights (15x)	/	/	0,07 kW	/	/	/	/	/	
	Steam Iron	/	/	2,3 kW	/	/	/	/	/	
	Other kitchen gadget	/	/	1 kW	/	/	/	/	/	
	...	/	/	/	/	/	/	/	/	

Appendix 8: Meters & Sensors

Meters & Sensors									
Type of meter (electrical power meter, calorimeter, sensors..)	Present (Yes / No)	Available for energy management (Yes / No)	Measuring (EE, Heat, Temperature..)	Allow external communication (Yes / No)	Output pulse communication (Yes / No)	Communication interface (RS - 485, M-Bus..)	Communication protocol (Modbus, M-bus..)	Model	Comment
Grid power meter	Yes	No	EE	No	No	No		Ferraris	
PV power meter	Yes	No	EE	No	No	No		Ferraris	
Calorimeter			Heat flowing						
Temperature sensor - Air			Air temperature						
Temperature sensor - Water			Water temperature						
Movement sensor			Movement						