Intelligent Assistants for Flexibility Management (Grant Agreement No. 957670)

D6.5 Initial application-specific iFLEX Assistant prototype

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1 Executive summary

The results from task 6.5 Initial Application-specific iFLEX Assistant prototypes are used to create a baseline of software framework for modelling and optimization of consumer flexibility management that leads in more efficient system which can manage demand and production flexibility for consumers and prosumers and is based on the data that is provided by Home Energy Management System (HEMS), Building Energy Management System (BMES), Distributor System Operator (DSO) and energy supplier. In sector of residential and small commercial customers the RES and consuming appliances can also be controlled behind the meter with HEMS or BEMS. Most of current solutions installed on the market is using manual or local control of appliances. Task 6.5. is responsible for testing of those components, analyse their functionalities and limitations and describe interfaces between hardware and software functional components. The task provides analyse which is used as baseline for initial design to integrate the connection between the HEMS, BEMS into the common iFLEX software framework.

In the pre-pilot phase, the focus of pilots is testing the existing equipment that will be connected to the iFLEX Assistant in order to determine limits, obstacles and of experimenting and evaluating the technical functionality of the iFLEX Assistant, mainly related to checking the possibilities of installation devices in the end-user environment, data collection, ability of services to access data collected by the smart meter, HEMS, BEMS, devices, forecasts, flexibility control and user interfaces.

The pre-pilot version of the iFLEX Assistant consists out of different functional components (Resident interface, Facility manager interface, Resource abstraction interface (RAI), Automated flexibility management (AFM), Digital twin repository (DTR), Weather service interface (WSI), Aggregator & Market Interface Module, Demand Response Management Systems (DRMS), Real-time Energy Metering & Actuation Platform (REMAP), Enrolment module, Home Energy Management System (HEMS), Resource Abstraction Interface (RAI), Smart metering and weather data ingest module.

The development of the common iFLEX framework is a continuous and iterative process executed with collaboration of pilot users in all phases. In this pre-pilot phase initial user engagement activities were carried out in workshop activities and their contribution is considered and implemented in mock-ups and user interface design. In Task 6.5 the initial end user interface (EUI) screenshots / mock-ups are created, which were designed in collaboration with some users who participates in 1.st Phase (pre-pilot phase).

2 Introduction

2.1 Purpose, context and scope

This delivery paper focuses primarily on Finnish, Greek and Slovenian pre-pilot experimental testing and implementation of higher-level hardware and software functional components and assessing the technical functionality of the iFLEX assistant (iFA) primarily in relation to data collection, flexibility control, predictions and user web browser or mobile app base interface (for user data visualization and HEMS, BEMS system manipulation). The delivery paper also describes experimental implementation methods, that is capable of monitoring and controlling HEMS and BMES system (built-in apartment building in Finnish pilot and in plastic IP65 electronic box for Slovenian pre-experimentation purpose) related to weather forecasts, emission factor of electricity production, power consumption, electricity price, user comfort, sensor and smart power meter measurement, data visualization, etc.

2.2 Content and structure

This document is structured in 7 sections and the main focus is on section 3 as follow:

- Section 3, iFLEX assistant prototypes for pre-pilots describes how basic functional blocks of iFA relate to each other, how they communicate (internally and externally) and what was the main purpose of individual function set. Basic HEMS functionalities are given with sets of possible external devices that are capable of communication with HEMS and BEMS through different physical communication protocol. High-level communication protocols like REST API and MQTT are tested and collected data was then visualized via a simple web browser interface. Furthermore, the initial EUI was presented, and first functional screenshots / mock-ups are shown and presented on workshop with presence of pre-pilot users.

3 IFLEX Assistant prototypes for pre-pilots

3.1 Finnish iFLEX Assistant prototype

3.1.1 Overview

The Finnish pilot consists of only a single iFA that is responsible for a whole apartment building. Please refer to the *HLUC-3: Manage flexibility at building community level*, documented in D2.1 for further details on the use case. This use case covers an important consumer sector in Finland, because roughly 40% of people[1] live in an apartment building and it is typical that the majority of the energy costs in an apartment building (e.g. heating, warm water, sauna) are shared by the housing cooperative.

In this so called pre-pilot phase, the focus in the Finnish pilot is on experimenting and evaluating the technical functionality of the iFLEX Assistant, mainly related to data collection, forecasts, flexibility control and user interfaces.

The iFA is deployed into an apartment building with 90 apartments. The apartment building has a Building Management System (BMS) that monitors and controls building's heating ventilation and air conditioning (HVAC), as well as, lighting, electric sauna and elevators. Figure 1 presents the stakeholders and external systems of the Finnish pilot iFA.

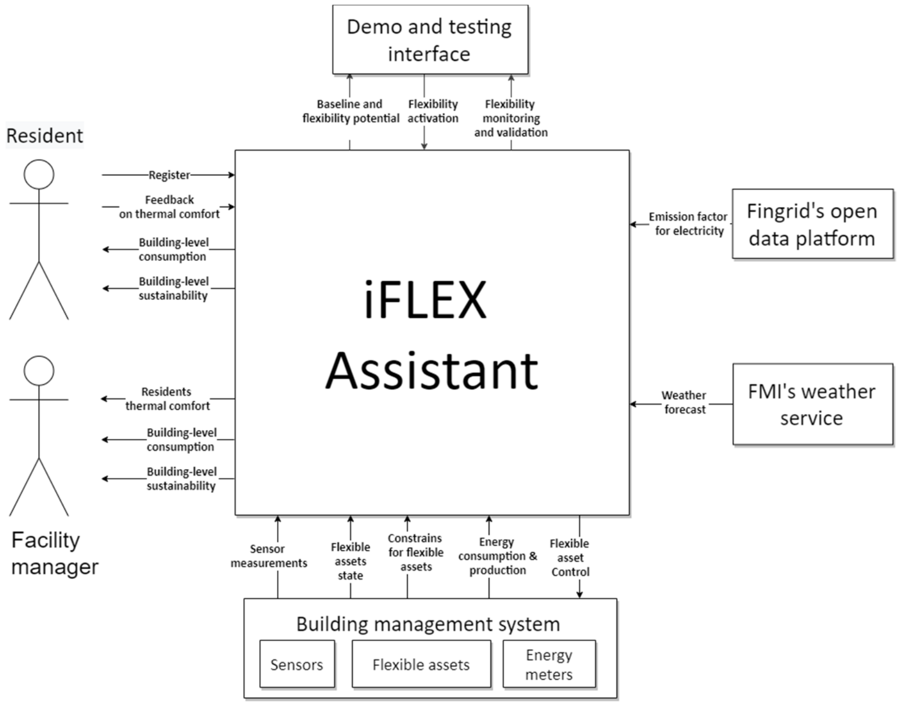

Figure 1: iFLEX Assistant of the Finnish pilot with relevant stakeholders and external systems.

There are two types of end-users: Residents and Facility manager. Please refer to iFLEX deliverables D2.1 [1] and D2.3 [2] for further details on the services provided to these end-users.

The iFA interacts with following several external systems. BMS provides iFA with means to monitor and control building assets. The pilot building had an old BMS system without any external interfaces. For this reason, a JACE-8000 gateway was deployed into the building. The iFA accesses following measurements via the JACE-8000:

1. Building level electricity consumption, power and frequency at 1-minute resolution.
2. District heating energy consumption at 1-minute resolution.
3. Ventilation units' return air temperature and optionally return air relative humidity and CO_2.
4. Average indoor air temperature, relative humidity, and CO_2 of the building.

[1] https://www.stat.fi/til/asas/2017/asas_2017_2018-05-17_tie_001_en.html

5. Various control-related parameters, including set-point and measured values for water temperatures across the system (e.g. space heating, domestic hot water, exhaust air heat pump supply), as well as, status information (on water pumps', fans', control valves and heat pump compressor status).

Fingrid Open Data platform provides the iFA with estimates of CO2 emissions for electricity consumptions. Finnish Meteorological Institute (FMI) provides the weather forecasts utilized by iFA in forecasting the energy consumption and flexibility. In the first phase, there is also no aggregation of buildings, and an external interface is set-up demonstrating and testing flexibility management functionalities of the iFA.

3.1.2 Deployment view

The pre-pilot version of the iFLEX Assistant consists of following functional components: Resident interface, Facility manager interface, Resource abstraction interface (RAI), Automated flexibility management (AFM), Digital twin repository (DTR), and Weather service interface (WSI). These logical components are implemented with concrete software artifacts as follows:

- **Resident interface:** The resident interface consists of Resident frontend, Resident backend and User database (DB) artifacts. The Resident frontend is implemented as web browser application, usable with mobile phones and computers. The Resident backend is responsible for interfacing the with RAI component to fetch relevant data for the Resident interface. It is implemented with Node.js. The User DB is implemented on top of MongoDB. These back-end software artifacts are deployed on a Resident server.
- **Facility manager interface:** The facility manager interface consist of a variety of dashboards to visualize buildings energy parameters. It is implemented on top of Grafana framework[2]. The Grafana back-end is hosted on the same server as the software artifacts of the RAI module.
- **Resource abstraction interface:** The pre-pilot implementation of the RAI components consist of four software artifacts: oBIX database, Building Energy Management System (BEMS) interface, Fingrid integrate, and Client interface. The oBIX database stores all the data collected from BEMS, Fingrid, Finnish Meteorological Institute (FMI). The BEMS interface is implemented with Java and provides mechanism for collecting and controlling building resources. It interfaces with a JACE gateway of the BEMS system with standard oBIX protocol. The Fingrid interface component is implemented with Java and provides means to collect CO2 emission data from Finnish Transmission System Operator (TSO), Fingrid. The Client interface provides other functional components of the iFLEX Assistant access to the data stored in oBIX database. The RAI components are deployed in a single server, called RAI server.
- **Digital twin repository:** In the iFLEX Framework the digital twin repository consist of a variety of digital twins (DTs) for the consumer, including people and buildings they live in. For the Finnish iFLEX Assistant, a digital twin of an apparent building is used from the repository developed for phase one. The Building twin is implemented with Python programming language on top of scipy[3] and tensorflow[4]. It consist of two models for estimating the building's baseline load profiles both for electricity and district heating, as well as, flexibility model, including indoor temperature model, heat pump model and space heating model. The Building twin is implemented as a single software artefact (Python class) that is interfaced by the AFM component.
- **Automated flexibility management:** The AFM component is realized as a single process that import also the Building's twin provided by the DTR component. The AFM is implemented with Python programming language and it provides an MQTT interface for flexibility management. In the pre-pilot the AFM interface will be demonstrated and tested via specific interface. In the second phase, the AFM interface will be integrated to the Aggregator and market interface component.
- **Weather service interface:** The WSI component deployed for the Finnish pilot interfaces with the Finnish Meteorological Institute (FMI) weather forecast service and stores the forecast into the oBIX database. The FMI interface is implemented as a single process that is deployed into the same server as the RAI components.

Figure 2 illustrates the deployment view of the iFLEX Assistant for the Finnish pilot.

[2] https://grafana.com/
[3] https://www.scipy.org/
[4] https://www.tensorflow.org/

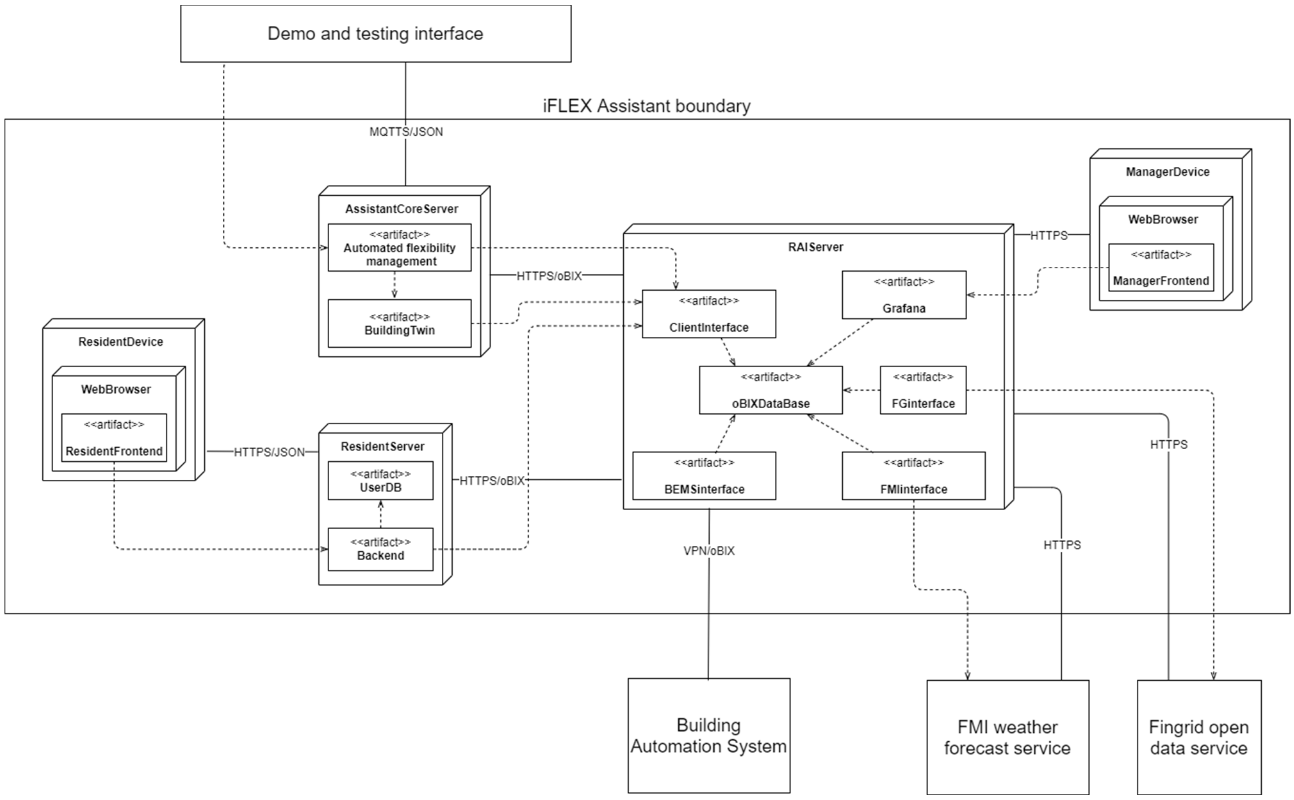

Figure 2: Deployment view of the iFLEX Assistant prototype for the Finnish pre-pilot.

3.2 Greek iFLEX Assistant prototype

3.2.1 Deployment View

The pre-pilot version of the iFLEX Assistant for the Greek case, consists of following functional components of iFA: User Interface Module, Aggregator & Market Interface Module. Furthermore, it consists of the following external components: ICOM’s Demand Response Management Systems (DRMS), HERON’s Real-time Energy Metering & Actuation Platform (REMAP). Finally, it consists of some mocked components that will facilitate later integration with the rest of the solutions developed in the iFlex project.

The following figure presents the deployment diagram of the Greek pilot iFA instantiation, whilst a detailed analysis of the different solutions follows.

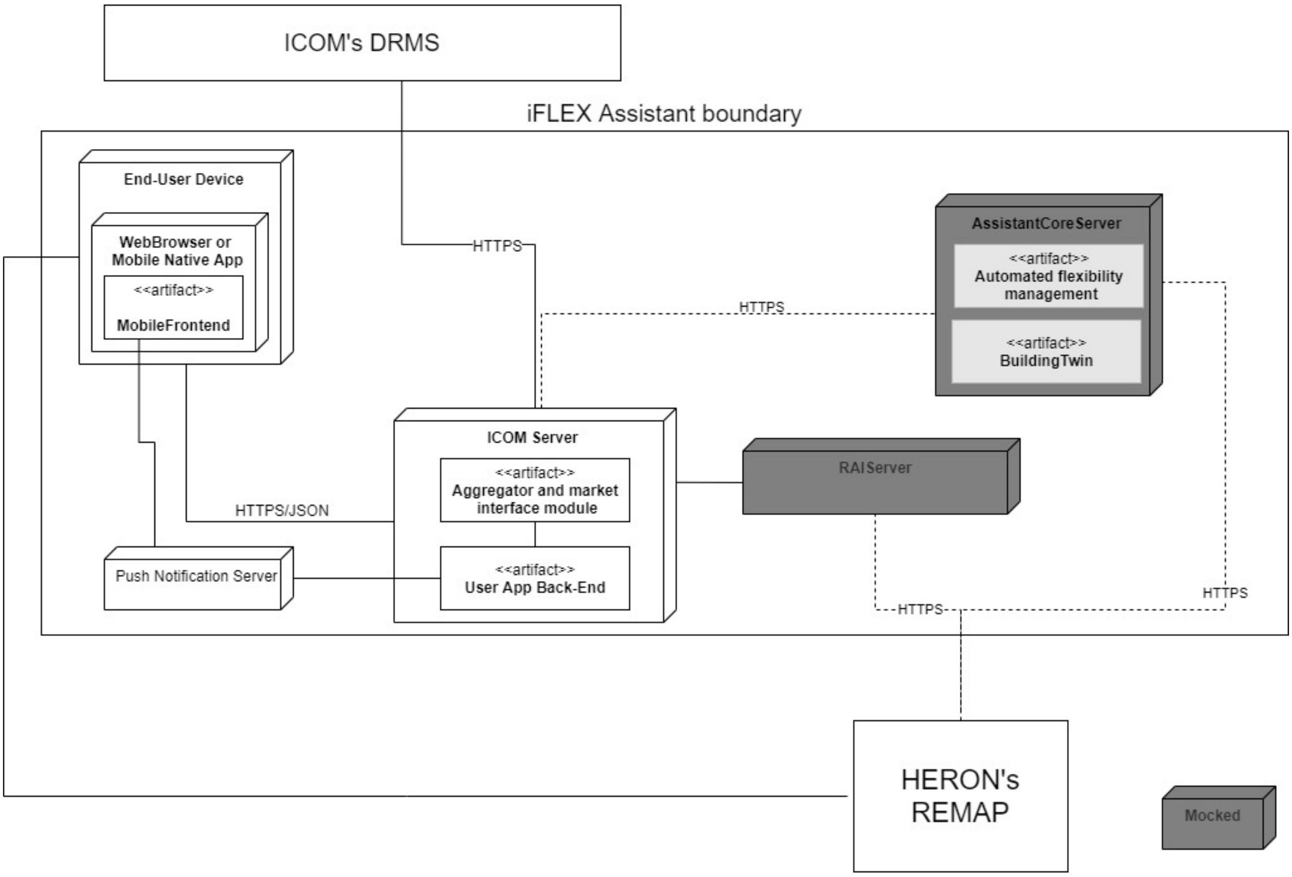

Figure 3: Greek pilot deployment view

3.2.2 User Interface App

The user interface module (MobileFrontEnd component in Figure 3) in the Greek pilot will be instantiated from a collaboration among HERON's baseline native application and iFA specific interfaces developed by ICOM in the project exposed as a web view (through User App Back-End in Figure 3). The former shall provide core operations related to User/ Home/Device management and energy monitoring (specific to customer offering of HERON), as well as communication of push notification and security mechanisms which will be integrated with ICOM's solution. The latter will provide functionalities related to the flexible operation, Demand Response (DR) communications, user policy for optimisation, DR participation and asset scheduling.

More specifically, the following functionalities of iFA's UI will be developed for the Greek pilot during Phase 1 of the project:

- FN-UI-01 - Operation mode customisation
- FN-UI-02 - User-defined time and operational constraints
- FN-UI-05 - Automation level customisation
- FN-UI-08 - Provision of consent for the schedules of dispatchable assets
- FN-UI-09 - DR notification policy
- FN-UI-11 - Real-time energy data
- FN-UI-12 - Past energy data
- FN-UI-21 - DR event notification

During this period, the integration among the HERON's and ICOM's application will be tested. More specifically: Push Notification mechanism, Security Mechanisms, Error Messages to user, Application Deep-linking.

3.2.3 Aggregator & Market Interface Module

The A&M Interface module will exchange signals with ICOM's Demand Response Management System (DRMS) based on OpenADR2.0 protocol [3]. The module is based on the client side (i.e. VEN) of OpenLEADR[5], an open-source implementation in Python[6], compliant with OpenADR. It will also transform these signals to the iFLEX data model, so that they can be communicated to the other components of the iFA. During this phase, the communication of the signals to the user, through the user interfaces will be tested. More specifically, the features below will be supported by the Aggregator & Market (A&M) Interface Module of the Greek pilot in Phase 1 of the iFLEX project:

- FN-AM-04 - Information on participation in explicit DR actions
- FN-AM-08 - Receiving Flexibility Signal
- FN-AM-09 - Communication of Flexibility Signal
- FN-AM-10 - Response to Flexibility Signal (explicit DR)

3.2.4 ICOM Demand Response Management System

A prototype solution of ICOM's DRMS will be deployed during this phase of the project providing the following functionalities:

- FN-DR-03 - Sending Flexibility Signal
- FN-DR-04 - Response to Flexibility Signal (explicit DR)
- FN-DR-05 - Information on participation in explicit DR actions
- FN-DR-08 - Response to flexibility request
- FN-DR-09 - Flexibility dispatch
- FN-DR-10 - Provide activated flexibility report

The solution utilizes OpenADR2.0 protocol to communicate with iFA, whilst flexibility requests are exposed through a REST API, documented via OpenAPI specification[7]. The solution is also based on OpenLEADR implementation, but on the server side (i.e. VTN). A screenshot of the OpenAPI specfciation is presented in the next figure (Figure 4).

[5] https://github.com/openleadr
[6] https://www.python.org/
[7] https://swagger.io/specification/

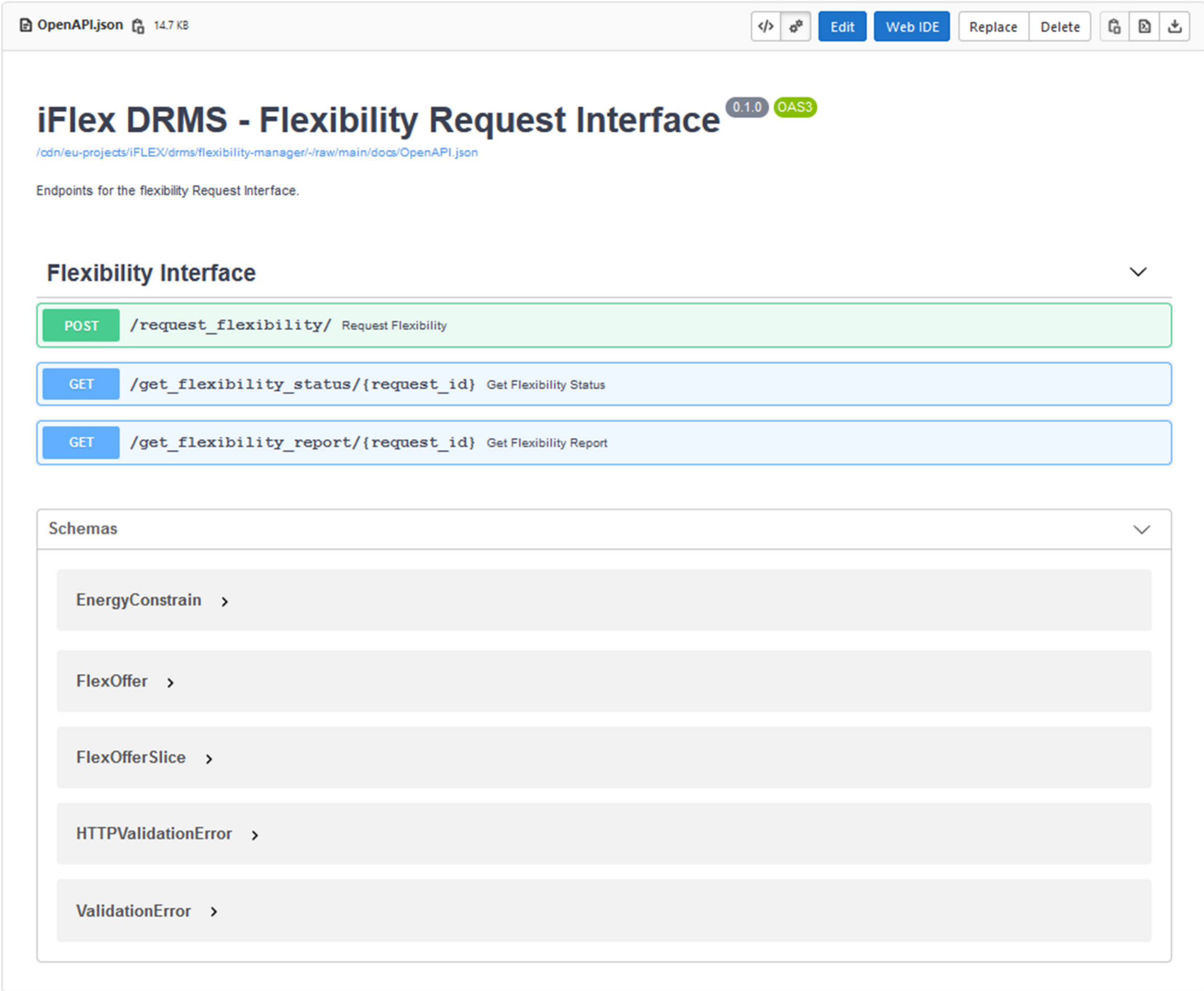

Figure 4: ICOM's DRMS Flexibility Interface

3.2.5 HERON's REMAP

HERON operates an integrated platform consisting of software and hardware systems for energy monitoring and management, the Real-time Energy Metering & Actuation Platform (REMAP). HERON's solution will provide an interface for iFLEX Assistant in order to access energy data, access user schedule provided through manual operation and provide asset control commands to the on-premise assets. The metering infrastructure utilized includes real-time power meters, a back-end system for measurements collection and storage and a remote API to provide access iFA. Heron solution will also support the baseline User Interfaces application.

3.3 Slovenian iFLEX Assistant prototype

The Slovenian iFLEX Assistant framework prototype in the first piloting phase consists of the following functional components: enrolment module, home energy management system (HEMS), resource abstraction interface (RAI), smart metering and weather data ingest module, digital twin, demand response module and end-user interface.

The first Slovenian pilot focus, as has been defined in deliverable D7.1 [4], deployment and integration wise aims at testing of the HEMS in working conditions with the test group of users, activation of available infrastructure and background components, assessment of input sources and their integration with the background system, and providing of an early sketch of the iFLEX Assistant end-user interface. The status of this work is reported in Section 3.3.1 on deployment view.

The actions related to the first piloting phase, defined as well in D7.1 [4], were optimal selection of the network grid segments for piloting, recruitment of a small friendly focus group for piloting and getting an early feedback from the group. The status of this work is reported in Section 0.

3.3.1 Deployment view

The pre-piloting iFLEX Assistant framework consists of a number of components:

- **Enrolment module**: the Enrolment module enables user friendly and privacy compliant enrolment of the end users in the pilots. The users get invited in the project by the pilot host through the module. The module is used to enable pilot users to give consent for data collection and processing and to initialise basic data structures needed for backend system operation. More information on the enrolment procedure is available in the deliverable D4.7 [5]. The enrolment module has been deployed at address *uporabnik.iflex-project.eu*. The name 'uporabnik' stands for the user in Slovenian. The reason for such name is because the module is a frontend for all current and future piloting users activities.
- **HEMS**: the HEMS gets installed and connected with the rest of the framework during the enrolment procedure. It is essential component for sensing, data collection and activation of devices and their flexibility in pilot user's households. HEMS functionality and pre-piloting deployment are further described in Section 3.3.1.1,
- **Resource Abstraction Interface**: the Resource Abstraction Interface (RAI) presents a component that collects the data from HEMS and other external sources, stores the data and provides the data to other iFLEX components, like the Digital Twin or End User Interface. The RAI can provide as well interfaces for actuators available at HEMS. Initial piloting phase RAI has been implemented on a prosumer cloud service (PCS). The following functionality has been deployed:
    - Services for data collection from the HEMS, current implementation is based on HEMS cloud REST API. Future implementation could use MQTT instead. The service periodically, on 1 minute, collects data from the HEMS grid and consumer devices and store it in the PCS storage,
    - Services for data ingest from external services: an interface has been provided for ingest of data from external data sources like smart meter data and weather data. The data is stored in the PCS and is aggregated in other time slices (1h, 2h, 6h, 1d, 1w, etc.),
- **External data ingest module**: The ingest module pushes the data from the data provider towards the PCS module. The ingest module has two parts, the first being the pusher and the second the ingest. The deployment of both modules is as follows:
    - The pusher takes care to push the data from the source towards the ingest module. In the Slovenian pilot case the pusher pushes smart metering data and weather data from Elektro Celje (ELE) data sources towards ingest module. The deployment is based on existing software services available at ELE; the same services are used to provide data to other ELE clients, like transmission operator, retailers, etc.
    - The ingest provides FTP server for receiving the pusher data. The ingest reads the inputs periodically, transforms the inputs according to the ingest specification requirements and pushes the data towards the interface. The interface implementation stores the data in the backend storage.
- **Digital Twin**: the digital twin module implements models as were discussed in the deliverable [6]. The models are implemented in Jupyter notebooks. For the initial piloting phase the notebooks are prepared to test the data as will be received from the RAI layer. Models will be tested and revaluated based on novel data,
- **Demand Response**: the initial Demand Response management solution is based on the combination of the background solution from the Flex4Grid project and open source implementation of OpenADR specification, the OpenLEADR[8]. The prototype Aggregator and Market module developed in iFlex project, also based on the OpenLEADR. The initial pilot implementation is capable of emitting and receiving flexibility events information as well as viewing and managing events via a web interface. Initial piloting evaluation will be detached from the other functionality in this phase. The resulting

[8] See OpenLEADR home page for details: https://www.lfenergy.org/projects/openleadr/

tandem of Demand Response Management System and Marketing & Aggregation module is described in Sections 3.3.1.1.3 and 3.3.1.1.4, respectively. 0

- **End-User Interface**: the End User Interface (EUI) is an important part of the iFLEX Assistant. It should offer as little flexibility as possible to achieve optimal goals of the project. In short, less is better. The interface should hide the functionality from the end user and provide smart solutions based on other iFLEX Assistant components. An initial implementation of the EUI is a mock-up of the interface. The mock-up deployment in the first phase will be a demonstration and evaluation in front of end users. The description of the EUI in this paragraph is a lesson learned from the first meeting with the end users as is described in Section 3.3.2.1. The EUI mock-up is described in Section 3.3.1.1.5.

3.3.1.1 HEMS in Slovenian pilot

In this section an overview of the HEMS functionality will be given together with an example installation at JSI in Section 3.3.1.1.2.

3.3.1.1.1 HEMS functionalities and limitations

In the Slovenian pre piloting phase the following hardware functional components are used:

- HEMS controller,
- Temperature and humidity digital sensors,
- Power sensors (single and/or three phase),
- Power relays,
- Switches and push bottoms,
- Smart plugs etc.

With upper listed functional components, monitoring (power consumption, temperature, humidity) and controlling consumer selected devices (electric water heater, heat pump, air conditioning, PV inverters etc.) is possible. Basic description and limitation in pre pilot used functional components are listed below.

HEMS master controller

The HEMS master controller is hart of the installed embedded system, which can control and monitor consumer selected devices through internally integrated components:

- Serial peripheral communication (main limitation are length of communication lines),
    - RS232 (voltage based serial communication),
    - RS485 (current based insolated serial communication),
    - USB,
    - Ethernet,
    - Wireless EnOcean.
- Digital inputs and output (main limitation was current strength and input/output voltage tolerance):
    - Digital inputs (24 V tolerant) and outputs,
    - Up to 8 A/230 V AC or 8 A/30 V DC relay outputs.
- Analog industrial based standard inputs/outputs (main limitation was voltage and current span),
    - 0-10 V analog DC input and output,
    - 4-20 mA analog DC input,
    - 0-20 mA analog DC input.

The HEMS master controller are fully programmable that opens a possibility to address various smart devices using internal and external digital communication protocols. They have also integrated physical ethernet protocol TCP/IP which provides reliable, robust and safe data transmission link from HEMS controller on to specified data management server or cloud for further data processing.

Temperature and humidity sensors

Temperature and/or humidity sensors can be connected to HEMS controller over wire or via wireless digital link. Wired connection is possible through HEMS analog inputs terminals while wireless connection is done through EnOcean link (wireless communication on RF 868 MHz frequency carrier signal). Wireless temperature and humidity sensor does not need any external power supply or battery, power for operation was harvested via integrated small solar cell.

Power sensors

The measurement of electrical power and energy of all energy sources and main electrical consumers is provided by single-phase and three-phase power sensors (measuring of electric voltage [*U*] and electric current [*I*]) which are connected directly to HEMS (Home Energy Management System). Connection between HEMS and power sensor are established through serial RS485 (half-duplex serial differential current communication or MODBUS RTU) communication bus. Power sensor measures power through current and voltage potential. Electric currents are passively measured (insulated measurements) with induced voltage in current sensing transformer. Electric current measurement accuracy was 0,5 % in maximum measurement range of 50 A per phase. While the electric voltage was directly measured in maximum rang of 500 V with accuracy 0,5 %. Power sensor was also capable of measuring phase angle between voltage and current with accuracy less than 2 °. With electric voltage, current and phase angle we can express active, apparent and reactive power with accuracy ± 1%.

Power relays

Power relays are used to control or managed consumers (home devices which with consume more than 2 kW of power). Power relays are for toggling power supply or enabling signal for the device operation.

Switches and push buttons

Switches and push buttons are used for manual control of managed devices. There are directly wired or paired (via software through RESTful API interface) on to the HEMS controller.

Smart Plugs

For smart plugs two types were be used (1,8 kW and 3 kW rated power), they differ from each other based on controlled power of the consumer device. As well as wireless temperature and humidity sensor the smart plug are using the same wireless EnOcean connectivity to master HEMS controller. Smart plugs also support basic power measurement or power consumption of the connected consumer device. Described smart plugs can be controlled in radius range up to 30 m away from main HEMS controller.

3.3.1.1.2 HEMS deployment illustration

Initial HEMS installations have been done at SCOM, JSI and at some first pilot phase users. In this section initial deployment of HEMS unit at JSI will be presented. The HEMS received at JSI consisted of a master HEMS controller, three phase power sensor and communication gateway. The master controller should be installed near circuit breakers on an electrical panel. At JSI a waterproof portable enclosure has been used to install the HEMS components as is shown in Figure 5. The HEMS master controller can be seen on the right top side of the enclosure, beside the three-phase power sensor (white). The HEMS and sensor are connected to the power supply through one phase circuit breakers. The power supply to the enclosure comes through three phases connection, the power is the connected to three phases circuit breaker and then each phase to one phase circuit breaker. The HEMS and communication gateway are connected to a network switch. The network switch is connected through ethernet cable to Internet.

The enclosure ready for deployment is presented in Figure 6. The enclosure provides three one phase sockets and one three phase socket, all controllable by hardware switches. Two consumers are already connected to the system. The portable enclosure and setup allows to move the system close to the consumers of interest. For example, JSI has few electric cars so the system could be used to control their usage and charging. At the moment for the installation only the network connection and three phase socket is needed.

The data from the HEMS is flowing towards the HEMS provider cloud. The consumption of two consumers for current day is shown in Figure 7. An example of data collected through HEMS provider cloud API is presented in Figure 8.

In current setup switching of the loads is not yet configured. Smaller one phase loads could be switched directly through the HEMS master, three phase loads need a three phase contactor for switching. The setup works only through fixed network connection, a connection through wireless modem is still work in progress.

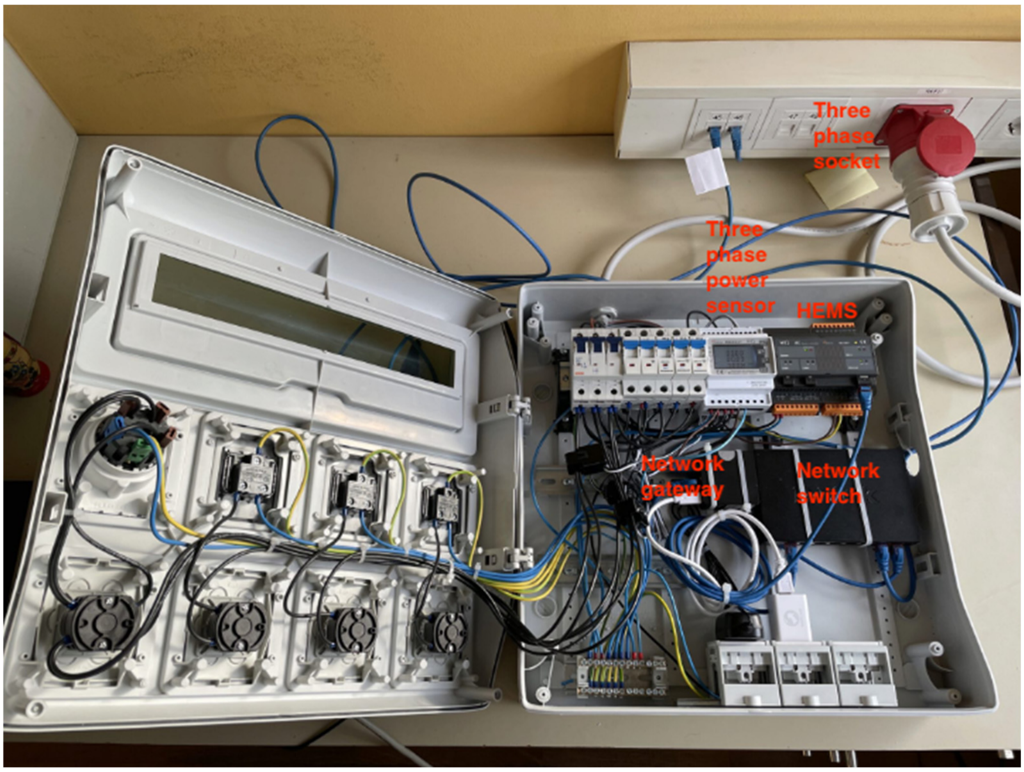

Figure 5: HEMS integration at JSI lab

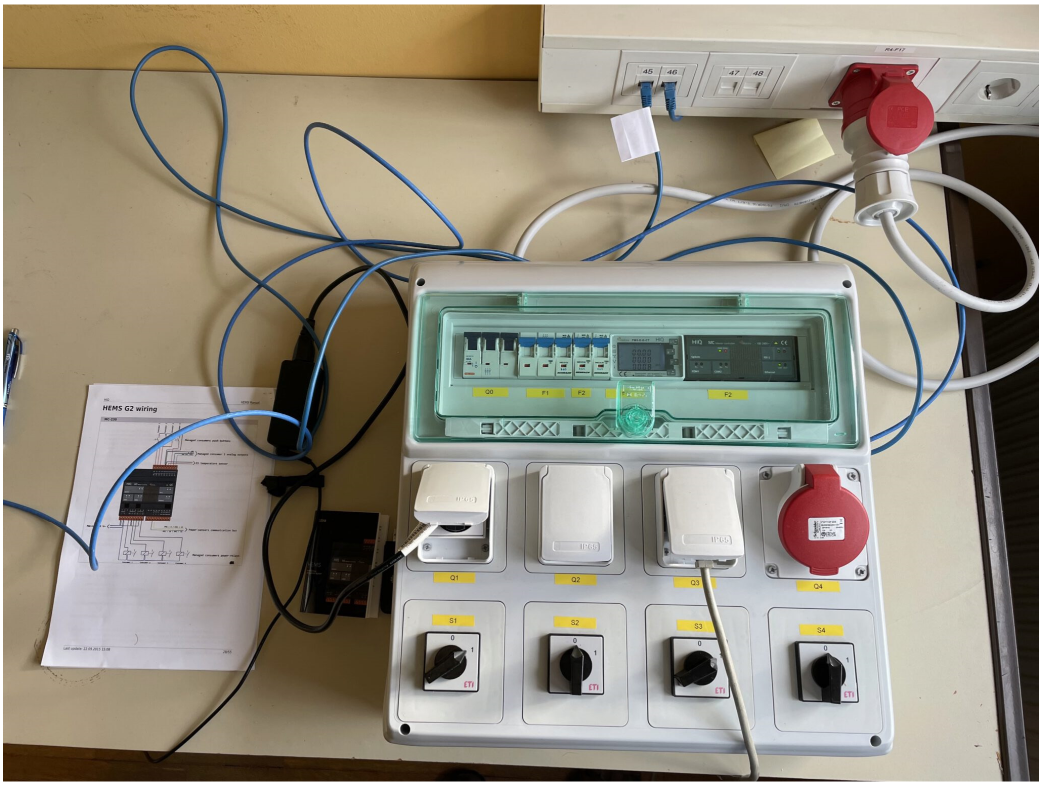
Figure 6: HEMS deployment at JSI lab

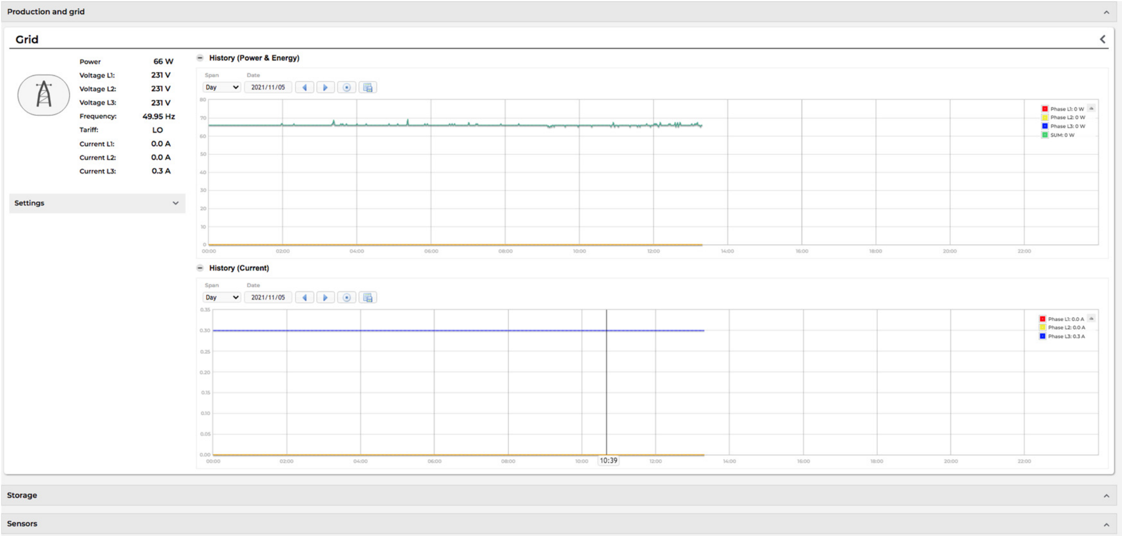

Figure 7: HEMS consumption at HEMS provider's cloud

Consumers:
URL: https://my.hiq-universe.com/rs/data_api/v3_0/instances/by_id/1705/things/by_query/rt_data?nq=consumers


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{
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            }
        }
    ]
}
```


Figure 8: Data collected from HEMS provider cloud

3.3.1.1.3 SCOM Demand Response Management System

SCOM's DRMS prototype will be deployed and the focus of first phase is on piloting the following functionalities:

- FN-DR-03 - Sending Flexibility Signal
- FN-DR-05 - Information on participation in explicit DR actions
- FN-DR-07 - Interface for parameterizing flexibility services

As explained in the project deliverable D4.4, the solution combines the frontend component developed in the Flex4Grid project with the OpenLEADR, an open-source implementation of the OpenADR2.0 protocol to communicate with iFA, The DRMS prototype encompasses the OpenADR server side, which is complemented by its client-side counterpart provided by the Aggregator & Market interface, which is presented next.

3.3.1.1.4 Aggregator & Market Interface Module

The Aggregator and Market Interface module will follow the same implementation as presented in the Greek pilot, supporting communications via OpenADR2.0 protocol from the side of the Aggregator's platform, as well as the interface with the User Interface App. It will also provide an interface, enabling the communication of flexibility service and fixed network tariffs.

The next functionalities shall be supported by the A&M Interface Module in Phase 1 of the Slovenian pilot:

- FN-AM-02 - List of available flexibility services
- FN-DR-03 - Sending Flexibility Signal
- FN-DR-08 - Response to flexibility request
- FN-DR-09 - Flexibility dispatch
- FN-DR-10 - Provide activated flexibility report
- FN-AM-11 - Communication of network tariffs from external system
- FN-AM-12 - Access to network tariffs to end users

3.3.1.1.5 User Interface App

The UI for the Slovenian pilot of iFLEX is being developed as a native mobile app, based on the React Native framework[9]. It will be integrated with the Aggregator and Market Interface module of the Slovenian pilot, enabling the communication of DR events. More specifically, it will support the following features in Phase 1 of the iFLEX project:

- FN-UI-09 - DR notification policy
- FN-UI-12 - Past energy data
- FN-UI-21 - DR event notification

The following figures (Figure 9) present the instantiation of the mock-up in the actual mobile application.

[9] https://reactnative.dev/

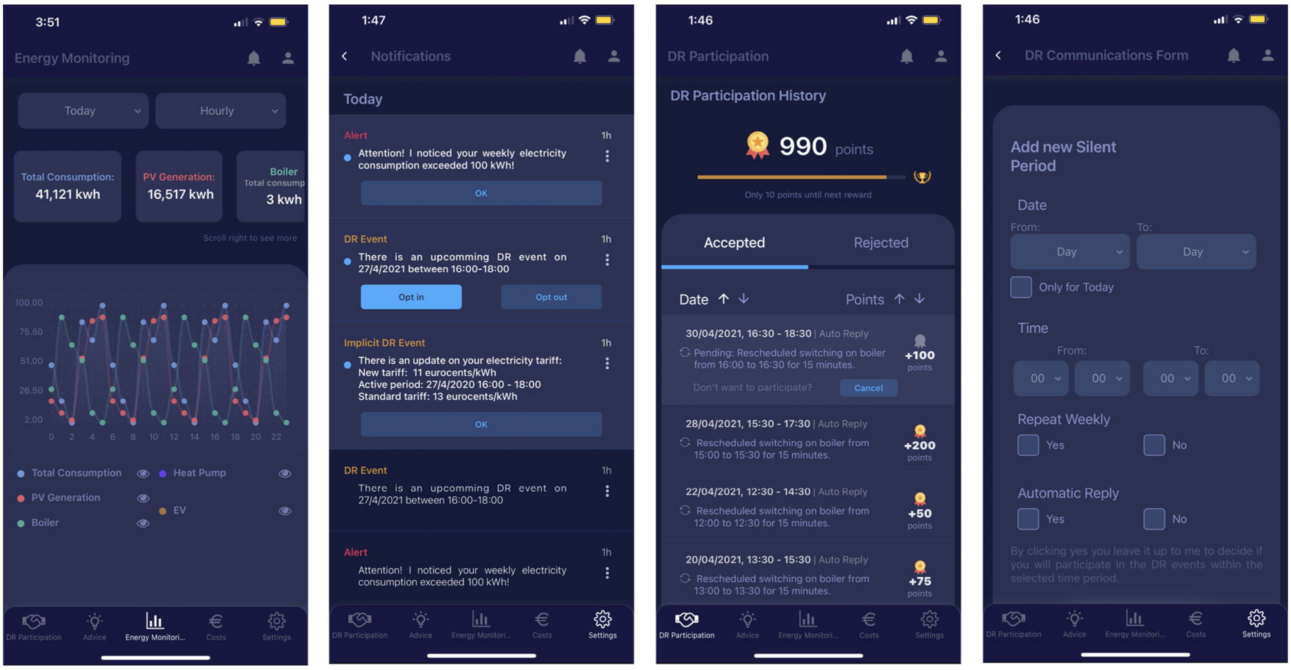

Figure 9: Slovenian iFA prototype Screenshot from User Interface App

3.3.2 Pre-piloting activities

In Slovenian pilot some pre-piloting activities have already started. In Section 3.3.2.1 a report on a workshop with first pilot users is reported.

3.3.2.1 Workshop with pre-pilot users

In early October a workshop was performed (Figure 10Figure 10) with purpose to carry out interview with the first five pre-pilot users. The first pre-pilot users were asked the following personal and technical questions.

1. In what kind of building you live ? Is that house, townhouse, multi family home etc. ?
2. What number of residents live in building you have ?
3. What living size you have ?
4. What is the building electric connection power ?
5. What was the biggest consumers in your building ?
6. Do you have integrated any of smart technologies ?
7. What are the investments in the future that you intend to make in terms of reducing environmental footprint ?
8. What kind of user interface device you prefer the most ?
9. Do you have any concerns about personal data processing and there misuse ?

Figure 10: Slovenian workshop (supported with remote access through MS Teams app)

On upper listed questions the important data was provided and collected in terms of currently used energy consumption and energy generation devices. The description and type of energy devices used by pre-pilot users means a lot, because HEMS integration together with other external electronic will be faster. The answers to the questions are given below (Answer to question number - ATQN).

User ID 1:

- **ATQN 1 –** house,
- **ATQN 2 –** 3,
- **ATQN 3 –** 180 m^2,
- **ATQN 4 –** 3x20 A (power 14 kW),
- **ATQN 5 –** heat pump, fridge, freezer, oven, induction stove and 2x e-bike,
- **ATQN 6 –** home display, lights and sensors, smart plugs,
- **ATQN 7 –** no large consumers,
- **ATQN 8 –** home display,
- **ATQN 9 –** no specific problem.

User ID 2:

- **ATQN 1 –** house,
- **ATQN 2 –** 5,
- **ATQN 3 –** 200 m^2,
- **ATQN 4 –** 3x25 A (power 17 kW),
- **ATQN 5 –** heat pump, fridge, freezer, oven, oven, solar power plant,
- **ATQN 6 –** no smart technologies,
- **ATQN 7 –** e-car,
- **ATQN 8 –** home display,
- **ATQN 9 –** no specific problem.

User ID 3:

- **ATQN 1 –** house (part),
- **ATQN 2 –** 3,
- **ATQN 3 –** 70 m^2,
- **ATQN 4 –** 3x20 A (power 14 kW),
- **ATQN 5 –** heat pump, 2x fridge, freezer, washer, dryer, inductive stove,
- **ATQN 6 –** smart plugs (shading, lights), own open-source user interface (local access, Wi-Fi)
- **ATQN 7 –** no large consumers,
- **ATQN 8 –** mobile app,
- **ATQN 9 –** explicit description of collection, storage and transmission of data.

User ID 4:

- **ATQN 1 –** house,
- **ATQN 2 –** 5,
- **ATQN 3 –** 220 m^2,
- **ATQN 4 –** 3x25 A (power 17 kW),
- **ATQN 5 –** 2x water heater, 2x freezer, 2x fridge, 2x washing machine, solar power plant,
- **ATQN 6 –** Wi-Fi air condition,
- **ATQN 7 –** energy renovation, individual smart devices, e-car, heat pump,
- **ATQN 8 –** home display, mobile app,
- **ATQN 9 –** no specific problem.

User ID 5:

- **ATQN 1 –** house,
- **ATQN 2 –** 4,

- **ATQN 3 –** 250 m^2,
- **ATQN 4 –** 3x25 A (power 17 kW),
- **ATQN 5 –** 3kW water heater, 4x freezer, 4x fridge, 2x e-bike, solar power plant, 2x inductive stroke, 60 m^2 electric underfloor heating,
- **ATQN 6 –** no smart technologies,
- **ATQN 7 –** e-car, e-car charging station,
- **ATQN 8 –** home display, mobile app,
- **ATQN 9 –** no specific problem.

During the workshop a presentation of initial iFLEX Assistant end user interface mock-up has been given by ICOM. Main comments from the end users were that the EUI is too complex and should be simplified. The first simplification should be based on profiling the user first, and then prepare on this profile user preferences. The second simplification should be in a direction of providing a smart interface for flexibility market participation. Too many controls of devices should be omitted and replaced by GUI utilizing the features of the iFLEX Assistant like digital twin and automation, to achieve the goals set in user preferences in an automated way.

4 Conclusion

Deliverable 6.5 is the third commandment document, which is oriented towards prototype implementation in the pre-pilot phase, which includes Finland, Greece and Slovenia partners. It focuses on the practical implementation of the functional components listed in deliverable 7.1 Initial Pilot Specification.

In this document, the Finnish partners focus on the preliminary results of the function blocks (Resident interface, Facility manager interface, RAI, AFM, DTR and WSI), their communication between iFA and BEMS, the way of capturing environmental/physical data (average humidity and temperature, apartment building electric and heating power consumption, CO_2 presence and other control related parameters/signals) and their further processing to ensure optimal iFA flexibility.

Greek partners present their results, which are related to the implementation of the iFA User Interface application , the existing systems and applications that are exteded to support iFA functionalities for the 1st phase and mocked iFA components. The communication channels mechanisms (Push Notification mechanism, Security Mechanisms, Error Messages to user, application deep-linking) that will be used for integration among HERON's and ICOM's applications will be tested during this 1st piloting phase. Furthermore, ICOM’s DRMS will be deployed during 1st phase of the project, supporting a REST API for flexibility requests as well as communication between iFA and DRMS via OpenADR2.

In Slovenian pre-pilot phase, the initial experimental HEMS installation (for HEMS functionality testing purposes) was done as well as the first pre-pilot user was equipped with HEMS controller and external power measurements components. The first test results of high-level REST API communication and JSON response with HEMS cloud controller was shown. Furthermore, the data collected from JSON response from HEMS cloud controller was shown in simple user graphical web application. First iFA framework components for Slovenian pre-pilot phase were presented and described in details.. For the user interaction with iFA, a mobile application with basic DR functionalities, developed in React Native framework will be provided for validation. DR communication will take place via OpenADR2 protocol, supported from OpenLEADR opensource implementation. The main information obtained in workshop with pre-pilot users was presented as well.

5 List of figures and tables

5.1 Figures

6 References

[1] "D2.1 - Use cases and Requirements," 2021.
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[4] "Initial Pilot Specifications. The iFLEX deliverable D7.1.," 2021.
[5] "Secure prosumer data management module. The iFLEX project deliverable D4.7.," 2021.
[6] "Initial Hybrid-modelling Module. The iFLEX project deliverable D3.1.," 2021.