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Executive Summary

This deliverable defines the specifications to be demonstrated in the three pilot clusters in three European countries, Greece, Slovenia and Finland during Phase 2. Phase 1 of the pilots concluded in M14, served as a starting point where a pre-pilot with the Minimum Viable Product (MVP) of the iFLEX Framework and Assistants was demonstrated with a small number of users. Each pilot cluster defined a set of inclusion and exclusion criteria that were applied in the selection and recruitment procedure of users for their pilot. In addition, each pilot has identified some concrete activities that were carried out to inform and encourage users to participate in their pilot. Only existing customers (Greek and Slovenian pilot) and building residents (Finnish pilot) were eligible for participation in the pre-pilots. They were primarily contacted via telephone and email and were provided with a link to more online information and registration. The same process is carried out for Phase 2 pilots with users informed of the data that will be collected and processed in each pilot through pilot-specific informed consent. The user engagement and the informed consent was managed in accordance with the framework defined in D2.2-User engagement and co-creation framework and plan [1] as well as in accordance with our ethical guidelines D10.1 H – Requirement No. 1 [2] iFLEX deliverables respectively.

Pre-pilot mainly focused on the available technologies, and infrastructure as well as on the functional requirements that were demonstrated on top of selected users. Phase 2 aims to bring new functionalities and expand the user base; ultimately building upon the findings of the collected user feedback from Phase 1, to improve iFLEX Framework with new functionality and better user experience. By the end of Phase 2, the improved iFLEX Framework and Assistants developed on top of the pre-pilot framework will be validated with small-scale fully featured and fully functional pilots whose scope, objectives and related KPIs are described in detail in this Deliverable.

The overall scope of each of the pilots for Phase 2 can be summarised as follows:

Greek Pilot

Phase 2 pilot expands the initial pool of 10 residential customers to at least 15 households consisting of up to 40 participants based on the 2011 Greek Census[1]. The owners of the electricity supply (electricity bill payers irrespective of home ownership) sign an updated consent form following feedback from the Pre-pilot which identified an issue with some prospective participants (i.e. the electricity supply was in a family members' name such as partner or parent, hence they had no legal basis to give their consent). During this phase, all technical aspects of the pilot will be deployed, validated and fully tested. Further feedback will fine-tune the services and identify improvements before deploying to the pilot's full membership.

Slovenian Pilot

Phase 2 pilot expands results of the first phase in several ways. In technical, i.e. functional terms, the focus is on exploiting the HEMS system functionalities not just for energy data monitoring but also for appliance control for flexibility management. In piloting terms, user base will be expanded to approximately 20 pilot users and merits of price signals and incentives for flexibility engagement will be evaluated. Initial activities are also planned on self-consumption for optimisation of renewable energy use. Last but not least, more focus will be put on testing advanced iFlex security features.

Finnish Pilot

Phase 2 pilot expands existing pilot environment with following improvements. First, iFlex assistant deployed in the apartment building will be used to reduce the peaks in the district heating consumptions and optimize the energy consumption. Heatpump control will also be integrated in iFlex assistant. Second, phase 2 pilot will also focus on displaying the benefits of iFlex system for the apartment residents with advanced user interface. UI will particularly focus on demonstrating the benefits of cutting peaks in district heating and electricity demand and therefore empower consumers to participate. Third aspect of the phase 2 pilot is enabling the aggregation of multiple building.

[1] ELSTAT (2014). Hellenic demographic census 2011, accessed from https://www.statistics.gr/documents/20181/1210503/A1602_SAM01_DT_DC_00_2011_03_F_GR.pdf/e1ac0b1c-8372-4886-acb8-d00a5a68aabe

1 Introduction

1.1 iFLEX Project

The iFLEX project is an EU-funded project under the H2020 program and its aim is to empower energy consumers to participate in DR programs by adjusting their energy consumption in response to the demand response signals or incentives, such as price signals. In order to support the consumers in managing their flexibility potential, the project will develop an intelligent personal assistant, called the iFLEX Assistant for optimising the comfort, energy usage and cost on behalf of the consumers while respecting their preferences.

The various application-specific modules developed by the technology providers which are involved in the project will be integrated into a holistic software framework for flexibility and energy management, namely the iFLEX Framework. The iFLEX framework and the corresponding iFLEX Assistant prototypes as well as associated services will be demonstrated in three European countries, namely Greece, Slovenia, and Finland each one with different focus area. More than 600 consumers will be part of the pilots, mainly comprising residential buildings but also small industries and a supermarket.

In addition, the validation in the three pilots will mainly focus on the following areas:

1. To demonstrate the applicability of the iFLEX Assistant prototypes for minimizing the imbalances and harnessing the flexibility of smart homes in Southern European climate.
2. To demonstrate the iFLEX Assistants in efficient operation of the electricity grid with high share of RES in Central European climate.
3. To demonstrate the iFLEX Assistants in the context of holistic flexibility management services in Nordic climate.
4. To design and execute common validation for iFLEX Assistants demonstrated in the three pilot clusters.

1.2 Scope of the report

This report is the second of the three revisions (D7.1, D7.2 and D7.3) of the pilot specifications plan per pilot cluster and mainly describes the available technologies, and infrastructure as well as the functional requirements to be demonstrated on top of selected users for this phase. D7.1 served as a starting point where a pre-pilot with the MVP of the iFLEX Framework and Assistants was deployed with a least number of users contacted and primarily engaged [3]. This deliverable utilises the feedback gained through questionnaires, communication and the preparation of informed consent forms as part of Pilot recruitment and builds upon the experience gained from the initial technical deployment. In addition, updated pilot specifications per pilot cluster will be described and evaluated based on the use cases having already defined a set of core requirements to be demonstrated as Pre-pilot phase concluded.

1.3 Pilots Context

The iFLEX Framework will be demonstrated and validated in all three pilot clusters with their own focus areas. In this context, application-specific iFLEX Assistants will be developed by using the iFLEX Framework modules and, then integrated to the DR and holistic energy management services provided by project industrial partners. These services include a) flexibility aggregation services for energy markets operated by ECE and HERON, b) RES aggregation services operated by OPTIMUS, c) technical DRM services provided by ICOM and SCOM, d) distribution management system operated by ELE, e) ESCO-type services provided by CAVERION, and f) flexibility market platform for utilities and retailers provided by ENERIM.

A summary of the pilot clusters to be deployed over the three phases foreseen until the end of the project is presented in the following table (Table 1).

Table 1: Summary of pilot clusters

Cluster Type	Focus	Energy Vectors	Type of Loads	Production & Storage	Consumer Types	Building Types
Greek	Integration of smart homes into the grid. RES and DSF aggregation (VPP) for energy market operation.	Electricity, heat	smart devices, water heaters	PVs	Residential	Subset of 200 households
Slovenian	Integration of high share of RES; efficient operation of the power grid. Aggregation of flexibility for peak reduction and RES integration.	Electricity	home appliances, industrial loads	PVs, small HPP	Residential Industrial	100 homes & small enterprises
Finnish	Holistic energy mngt; Local aggregation at apartment building and district levels. Link with INTERRFACE and OneNet for DSO/TSO DR markets.	Electricity, district heating, waste heat	heat pumps, lighting, freezers & coolers, appliances	Thermal mass of the building as heat storage	Residential Commercial	Block of apartments & supermarket

A detailed analysis of Task 7.1-Initial Pilot Specifications for each cluster is presented in sections 3.1-3.3 respectively. The results of this Task are used as an input to Tasks 7.2 and 7.3.

1.4 Structure of the report

This document is structured as follows:

i. In this chapter, Chapter 1 a general introduction of the iFLEX project as well as of this report is made.

ii. Chapter 2 outlines the user engagement approach and co-creation activities during the second phase of the pilots' execution. In addition, the recruitment procedure per pilot cluster is presented in detail.

iii. Chapter 3 describes Phase 2 specifications per pilot cluster as well as the technical requirements to be deployed during the second phase of the pilots' demonstrations, including the engagement of different end-users, gathering their requirements and preferences.

iv. Chapter 4 provides the main conclusions of this report.

1.5 Abbreviation Terms

Table 2: List of Abbreviations

Term	Definition
BC	Business Case
BMS	Building Management System
DR	Demand Response
DRM	Demand Response Management
DSO	Distribution System Operator
ESCO	Energy Service Company
EV	Electric Vehicle
HEMS	Home Energy Management System
HPP	Hybrid Power Plants
KPIs	Key Performance Indicators
MVP	Minimum Viable Product
TSO	Transmission System Operator
UC	Use Case
VPP	Virtual Power Plant

2 User Engagement Activities

2.1 Introduction

In piloting phases and in its associated tasks, user engagement is divided into three phases, each consisting of several agile co-creation iterations. The goal of the first phase (Phase 1) of the pilots' execution was to co-create an MVP of the iFLEX Framework and application-specific iFLEX Assistants (M 14) as well as to deploy these into a pre-pilot consisting of few selected users in order to collect feedback and validate against certain functional requirements.

In the second phase (Phase 2), the feedback from Phase 1 is utilized to improve the iFLEX Framework with new functionalities and enhanced user experience. At the end of this phase (M 25), the improved iFLEX Framework and Assistants developed on top of the framework will be validated with small-scale pilots. In the third phase (Phase 3), any missing functionality is added, and the focus will be on fine-tuning the quality of service (QoS) and user experiences based on the Phase 2 feedback. At this phase, the pilots are also scaled up to include more engaged end-users and technical functionalities in order to collect feedback and validate the final iFLEX Assistants at a larger scale (M 36).

This section outlines the different actors and their roles in the iFLEX project, pilot-specific information on the user inclusion/exclusion criteria as well as the recruitment and informed consent procedure followed by each pilot cluster. The methods and tools used to engage users during the pre-pilot phase is also described per pilot.

2.2 Types of actors participating in the user engagement process

The target for one of the iFLEX key performance indicators (KPIs) is to include up to 6 different actors, including consumers, prosumers, DSOs, retailers, aggregators, technology providers, who will contribute to the co-design of iFLEX Assistant concept. The user engagement activities along with the actors participating in these actions will be tackled according to the procedure followed in the iFLEX project deliverable D2.2-User engagement and co-creation framework and plan [1].

The following table (Table 3) illustrates the different types of actors and their representation in the iFLEX project originally included in [1].

Table 3: Types of actors in the iFlex project

Actors	General description	Representation in iFLEX
Consumers	A party that consumes electricity.	Consumer representatives *(from non-energy – consumer's rights protection, legal and other socio-economic perspectives)*: • In-JeT APS (IN-JET) • Zveza potrošnikov Slovenije Društvo (ZPS) The iFLEX pilot clusters involve two types of participants (end-users): • Residential consumers / prosumers • Small commercial consumers / prosumers All participants are existing customers of one or more of the project partners in the pilot clusters: Greek cluster • Residential customers. Slovenian cluster • 100 households and small enterprises Finnish cluster • Apartment buildings, supermarket
Prosumers	Prosumers are generally defined as electricity consumers that produce part of their electricity needs from their own power plant and use the distribution network to inject excess production and to withdraw electricity when self-production is not sufficient to meet own needs.	

Distribution System Operator (DSO)	A party responsible for operating, ensuring the maintenance of and, if necessary, developing the system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.	• Elektro Celje d.d. (ELE)
Retailers	Electricity retailers (sometimes referred to as power companies) purchase electricity from the wholesale market to sell it to residential and business consumers.	• ECE d.o.o. (ECE) • HERON
Aggregators	As an electricity grid participant, the aggregator tracks companies' consumption and TSO/DSO as well as Market Operators' requirements in real time. The aggregator provides uninterrupted grid balancing to optimise energy use and pays its customers for making their consumption flexibility available.	• Optimus Energy S.A. (OPTIMUS)
Technology providers	Technology providers, represented and contributing to the co-design of iFLEX Assistant concept	• Smart Com d.o.o. (SCOM) • EMPOWER IM Oy (ENERIM) • Institut "Jožef Stefan" (JSI) • Athens University of Economics and Business (AUEB) • Intracom Telecom (ICOM) • Caverion Suomi Oy (CAVERION)

2.3 User Engagement and Co-Creation Activities

The table below describes a general overview of the different user engagement and co-creation activities that will be used by the pilot clusters during the first phase of the pilots' execution. A more detailed description of the method and tools used by each pilot cluster during the first phase is provided in the pilots' sepecification section.

Table 4: Overview of user engagement & co-creation activities

Appoach	Input	Output
Energy metering platform customization for real-time data visualization.	Elaborate the necessary customizations and extensions of the energy metering platform.	Secure the smooth integration of individual components and communication with the iFLEX Assistant.
Assess prototype design of natural user interfaces for customer participation in DR actions.	Feedback will be requested with regards to users' preferable ways to provide their constraints and preferences when participating in a DR program, as well as the desired level of autonomy (e.g. manual feedback or automatic actuations).	In-app analytics for user journey and navigation through different functionalities and features. Define the level of autonomy in users' descision making versus delegation of the decision to the iFLEX Assistant.

Assess iFLEX Assistant end-user interface, namely the developed (mobile or web) app, through one-on-one interviews and/or usability tests with end-users participating in the second piloting phase, in order to receive feedback on their experience with the iFLEX app.	With a given consent, iFLEX Assistant can report back through a web-portal how it is being used, end-users' expectations and upon analysis provide a significant potential for improvements.	Interacting with end-users to gain their feedback and suggestions for potential improvements on designing and developing the iFLEX Assistant interfaces.
Evaluate the technical and behavioural possibilities and limitations of using iFLEX Assistant, which are needed in the modelling and the development of a digital twin of the prosumer/consumer.	With a given consent, iFLEX Assistant can report back through a web-portal how it is being used, end-users' satisfaction on the provided services and upon analysis provide a significant potential for improvements.	Interacting with end-users to gain their feedback and suggestions for potential improvements.
Demonstrate and test feedback mechanisms of the iFLEX Assistant.	Include residential end-user feedback and preferences on thermal comfort at the building level (average of the apartment temperature and humidity measurements).	Interacting with end-users to gain their feedback and suggestions for potential improvements on designing and developing the iFLEX Assistant interfaces.
Develop visualizations for building-level energy consumption (electricity and district heating), and CO_2 carbon footprint.	Include residential end-user feedback and preferences.	Interacting with end-users to gain their feedback and suggestions for potential improvements on designing and developing the iFLEX Assistant interfaces.

2.4 Recruitment of Participants and Informed Consent

2.4.1 Greek Pilot

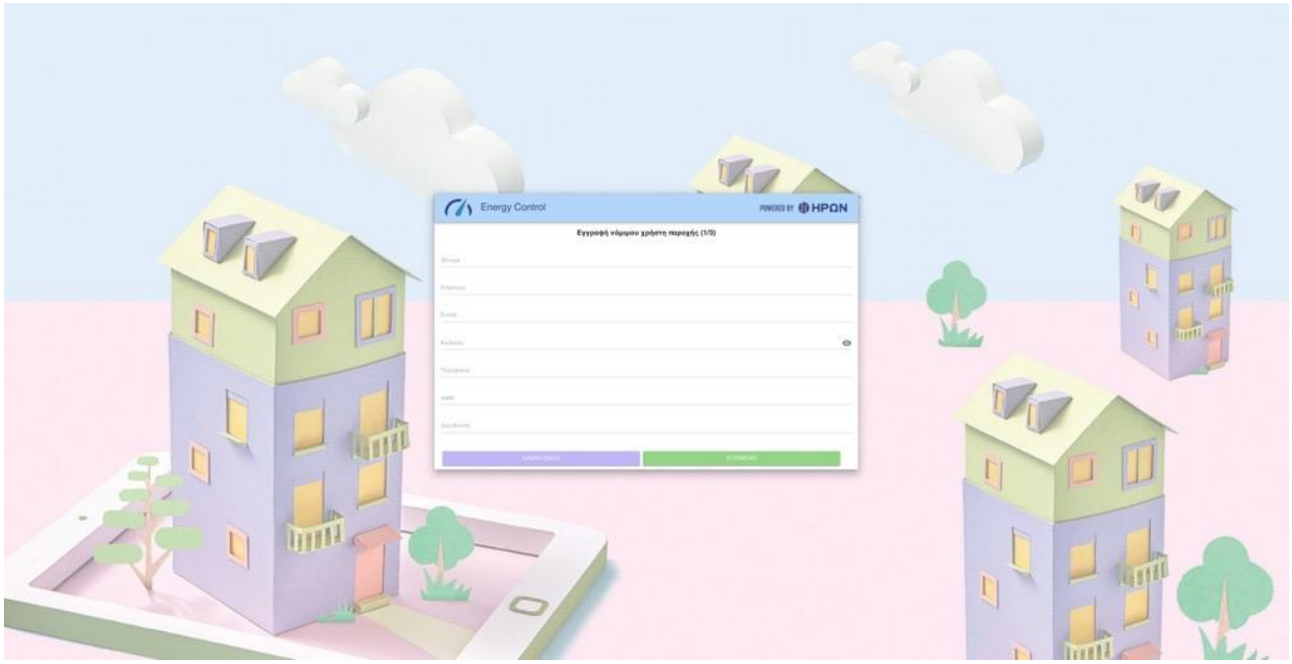
2.4.1.1 Recruitment Procedure

In the context of the iFLEX project, residential consumers, clientsof HERON, were invited to participate in the pilot execution which foresaw, amongst others, the installation of additional smart meters, smart sensors as well as IoT sensors for real-time monitoring of energy and non-energy data. HERON's communication plan was to address the target group of its own clients in order to achieve best results possible for each pilot phase, stressing however that participation is completely voluntary.

Initially, employees of HERON and their family members with already installed smart meters in their households were contacted. Registration occurs through a link that will give them access to a dashboard which contains relevant consumption analytics from the webview of HERON's "Energy Control" app. The registration is successfully accomplished only when the consumer has acknowledged that s/he has read the privacy notice and has accepted the relevant terms and conditions for participating along with the provision of his/her consent online at the time of registration to participate in the pilot. The privacy notice and terms and conditions cover all HERON's platform users whose data is handled for all HERON's Horizon 2020 and Horizon Europe projects.

Upon registration, users are given a survey that aims to provide information on the energy consuming devices in their households. Specifically:

- Identify energyclass and weekly usage patterns of energy consuming appliances such as washing machine, dryer, dish washer, A/C, electric water boiler etc
- Identify heating source (Natural Gas / Oil or electricity through A/C, heat pump etc)



Specifically, users that will test iFLEX solutions are given additional terms and conditions and are presented witha data usage consent that will enable the use of iFLEX assistant features, integrated in HERON's Energy Control app. This two-step process is necessary given that iFLEX participants will gain access to HERON's app with the additional iFLEX features. The registration as well as the informed consent statement will cover all remaining phases of the pilot execution, thus consumers will have to follow only once the relevant acceptance procedure.

In addition, information about the iFLEX project in general and the Greek pilot in particular was published on HERON's Social Media accounts (LinkedIn) as well as on the iFLEX project website and newsletters.

During the second phase of the Greek pilot execution, the following residential consumers are anticipated to be engaged:

1. At least 15 households consisting of ca up to 40 participants will be equipped with real-time smart meters.
2. A subset 15 households to be equipped with remotely controlled relays to manage the operation of heavy consuming appliances (such as water heaters).
3. A subset of 15 households to be equipped with two-sets of smart plugs. A 16A smart plug to monitor heavy loads such as washing machines and a 12A smart plug to monitor lighter loads such as electronic devices.

The inclusion and exclusion criteria for participation in the Greek pilot identified in D7.1 S2.4.1.2 [3] remain unchanged for Phase 2. Furthermore, the Greek pilot builds upon the informed consent procedure described in the iFLEX project deliverable D10.1-H Requirement No.1 [2] with some modifications. As consumers were approached and asked to register in HERON's platform, several legal complexities identified were identified. Most notably, HERON's legal team realised that some of the prospective iFLEX users were not the legal owners of the electricity supply, that is, they were not the bill payers. This relates to a common approach in many Greek families in which the parent or one partner pays the bill for their child or for the couple respectively. The legal challenge here was that in the pre-pilot phase, it was implicitly assumed that the user was the legal owner, without being specified in the consent process. An additional issue was that there were not clauses regarding fair usage of the smart metering equipment, prohibiting unauthorised users from tampering with the installed equipment.

Addressing these issues, proved challenging and lead to an overhaul of both HERON's Energy Control app and iFLEX specific consent forms after consultations with HERON's DPO and the organisation's legal team.

2.4.1.2 Ethics

Ethics checklist was completed prior to Phase 1 start and thus prior to the collection or processing of personal data. In addition, the informed consent form, the DPIA template as well as the ethics checklist was provided to iFLEX Ethics Advisory Board for review and was included in deliverable D1.10-Annual Compliance Monitoring Report 1 [D1.10]. All ethics issues that have arisen since, will be documented and reported in the forthcoming deliverable D1.11 Annual Compliance Monitoring Report 2 (expected to be published as MX at the end of Month/Year). The procedures regarding the management, access, storage and deletion of data upon request that were specified in the previous version of this deliverable [3] have not been modified and therefore still apply.

2.4.2 Slovenian Pilot

2.4.2.1 Recruitment Procedures

In the first iteration of the Slovenian pilot, five end-users were invited to join the project voluntarily. We will also looked for potential participants among ECE and ELE employees who already have a smart electricity meter, a solar power plant and a heat pump installed in their houses. HEMSs also is expected to be installed in their households before implementation. The plan of the Slovenian cluster is to test the registration procedure, to test the new equipment (HEMS) and to get feedback from the users, which would be useful in further pilot executions.

Potential users have been approached in person. Initially they received the link via email to the registration web page through which then accessed to apply for the project. The users that registered to the pilot accepted the relevant terms and conditions for participating. All service information for the end-users will be available through telephone communication.

The inclusion and exclusion criteria for participation in the Slovenian pilot identified in D7.1 S2.4.2.2 [3] remain unchanged for Phase 2. Similarly, there have been no changes in the Informed Consent Procedure outlined in D7,1 S2.4.2.3.

2.4.2.2 Ethics

Ethics and privacy issues have been tackled according to the procedures specified in the iFLEX deliverable D10.2 [4]. Prior to collection of personal data an ethic checklist and DPIA as are described in this deliverable will be prepared and provided to the iFLEX Ethics Advisory Board.

2.4.3 Finnish Pilot

2.4.3.1 Recruitment Procedures

In the first phase, the end-users of the Finnish pilot included the building's facility manager (i.e., Caverion) and the ~140 residents of the pilot building. All of the residents have access to the End-user interface tailored for the apartment building. Additionally, the residents had the option to 1) order apartment specific thermal comfort sensors and 2) provide apartment specific feedback about the thermal comfort by registering to the iFLEX Assistant via the end-user interface. In the phase one four residents registered to the pilot and ordered the sensors. In the second phase, we aim to motivate more residents to order the sensors and register to the iFLEX Assistant. The residents will be recruited by approaching the residents of the apartment building by e-mail. The residents will be informed about the piloting activities and provided with a link to a web page that can be used to register to the pilot. All residents are provided with a possibility to access the building-level end-user interfaces. This interface can be used to monitor building related data (electricity consumption, district heating consumption, CO_2 footprint, and average thermal comfort), as well as, to provide anonymous feedback. In addition, the registered residents are provided with means to monitor their own apartment's thermal comfort and provide feedback.

The registration occurs through the user interface where the resident enters his/her name and apartment number. The resident has to accept the informed consents for participating to the research and for allowing the data collection.

After a few months of data collection period, a survey is implemented for the registered residents. The survey includes questions about the following topics:

- Residents background and awareness of consumption and consumption habits
- Flexibility: residents' willingness and incentives
- Feedback about user interface and iFLEX project
- Needs for data visualization
- Possible changes in consumption habits due to data visualization

To motivate the residents to register, a lottery will be held among the registered residents after few months data collection period.

Inclusion and exclusion criteria and the Informed Consent Procedure described in S2.4.3.2 and S2.4.3.3 in D7.1 [3] remain unchanged.

2.4.3.2 Ethics

Ethics and privacy issues will be tackled according to the procedures specified in the iFLEX deliverable D10.2 [4]. Prior to collection of personal data an ethic checklist and DPIA as are described in the deliverable will be prepared and provided to the iFLEX Ethics Advisory Board.

3 Phase 2 Pilot Specifications

The section describes the specifications for phase 2 pilots. Phase 2 pilots are built on top of a pre-pilot with the Minimum Viable Product (MVP) of the iFLEX Framework and Assistants was demonstrated with a small number of users. Focus of this section is specifically to describe how phase 2 pilots extends the first phase pilots.

3.1 Greek pilot

3.1.1 General Overview

Second phase pilot builds upon the experience accumulated through first phase trials in which HERON's energy monitoring infrastructure was deployed and tested. In the first phase, a number of selected users had a smart meter installed in their home and could access their electricity consumption, active power and power factor calculations. Furthermore, through an API, HERON's platform was integrated into iFLEX framework allowing data crucial for the under development iFLEX assistant to be harvested. Moreover, the initial version of the iFA web app was developed and has been validated by potential end users through a usability test. Finally, Optimus Energy has provided to ICOM an API to monitor real-time imbalances of the 500 KWp PV plant that is dedicated to iFLEX.

3.1.2 Phase 2 Scope

During the second phase, HERON's contribution will be mainly focused on the deployment of the following use cases from D2.1-Use Cases and Requirements [5]: BUC-5 concerning customer's load profile analysis/overview, the deployment of HLUC-1 concerning energy management in an optimal way as well as HLCU-2: Manage flexibility requests or price signals at individual premise level. The contribution of Optimus Energy will be mainly focused on the deployment of HLUC-1 concerning energy management in an optimal way and HLUC-2: Manage flexibility requests or price signals at individual premise level. The use cases mentioned above are also available in Annex A.

In phase 2, sufficient consumption data will be provided from HERON's customers who will be asked to offer balancing services to Optimus Energy based on:

1. the scheduled use of their water boiler for those who will have a smart relay installed
2. real-time advice for those who will have a smart plug installed to monitor the usage of their washing machines or A/C units

Building on existing communication channels with iFLEX Assistant users, information on their consumption habits, preferences and constraints in participating in a DR program will be provided.).

In addition, HERON's pre-pilot setup will be extended to include more residential customers that will accept to participate by installing smart meters, remotely controlled relays for managing the operation of electric boilers and smart plugs that monitor heavy consuming appliances providing valuable data for the iFLEX Assistant to learn the behaviour of the consumers and their environment.

Finally, besides the 500-kW ground-mounted PV plant that has already been involved in Phase 1 and still continues to be monitored by iFLEX, additional medium-size ground-mounted PV plants currently represented in the Greek wholesale electricity market by Optimus Energy are candidate to be added in Phase 2 setup to form an augmented RES portfolio whose operation will be coordinated with the extended end-user DR portfolio. In this context, the end-user DR households' portfolio will be regularly called on to internally address and mitigate RES generation imbalances before the RES aggregator needs to perform balancing through third parties in the relevant markets. This will be enabled via the operation of ICOM's Demand Response Management System (DRMS). The DRMS will receive requests for flexibility by the RES Aggregator's (Optimus) system, dispatch appropriate DR events to the iFA end users to fulfil the request, and report back to the RES Aggregator on the aggregated flexibility. The exact number and maximum capacity of the additional PV plants that will be involved in the augmented RES portfolio will be indirectly determined by the attained number of end-user households that will be actively engaged during Phase 2. This serves the need to obtain comparable RES and end-user DR portfolios in terms of aggregated capacity, so that more realistic and concrete conclusions are derived from their coordinated operation.

3.1.3 Description of Phase 2 Technical Assets

Table 5: Summary of the Greek pilot technical assets

Name of the pilot:	*Demand side flexibility of smart homes in southern Europe distribution grid-Greek Cluster*
Pilot Location	Greece
Partners	● HERON - Electricity generator and Supplier ● Optimus Energy-RES aggregator ● ICOM – Solution Provider (Demand Response platform –outcome of T4.3- and mobile app with natural user interface features – outcome of T3.3)
Type of consumers	Residential
Number of sites	Up to three sites (Athens, Thessaloniki & Volos)
Number of buildings	Corresponding number of residential apartments in blocks of houses or detached houses: at least 15 households, with a subset of ca 40 users
Infrastructure to be used in Phase 2 pilot	- **HERON infrastructure assets**: 1. At least 15 households with real-time smart meters (sampling @ 30 sec). 2. A subset 10 households to be equipped with remotely controlled relays to manage the activation (ON/OFF) of heavy consuming appliances (such as water heaters, electric space heaters). 3. A subset of 10 households to be equipped with smart plugs to monitor heavy loads 4. Extend HERON's energy metering and actuation platform to enable remote device control and DR communication with the iFLEX Assistant. **-Optimus Energy asset:** 1. A single 500 kW ground-mounted PV plant with available generation forecasts and real-time measurements (sampling ∀5 min – 15 min). 2. Additional geographically dispersed PV plants may be employed to provide flexibility for iFLEX users, if needed. **- ICOM assets**: 1. The iFA web app, integrated into HERON's mobile app, which enables the interaction of pilot users with their iFAs. 2. The DRMS, which receives flexibility requests and dispatches appropriate DR events to the iFAs in order to aggregate the needed flexibility from the pilot users.
Extend pilot setups with more assets	During Phase 3 the pilot setup will be extended to include additional: ● IoT sensors able to characterize climate conditions (e.g., temperature, humidity, light) and home usage patterns (door contacts, human presence) in real-time as well as controllers to monitor and control home appliances (Target up to 20 households). ● Smart plugs to monitor specific loads (Target at least 40 households). ● Wi-Fi electricity smart meters (Target up to 70 households, ca 200 users). ● Medium-size ground-mounted PV plants to form an augmented RES portfolio whose operation will be coordinated with the extended end-user DR portfolio to internally address and mitigate uncontrollable RES generation imbalances. The exact number and maximum capacity of the additional PV plants that will be involved in the augmented RES portfolio will be indirectly determined by the attained number of end-user households that will be actively engaged during Phase 3. ● Dispatchable distributed biomass unit that will form a common portfolio with the extended end-user DR resources and, therefore, leverage the provision of flexibility services especially during periods when end-user response is below the expected levels.
Demonstration Topic	● Consumer-centred energy management

3.1.4 Phase 2 Anticipated Objectives

The main goal of second phase pilot is to implement and fully demonstrate advanced demand side flexibility scenarios that require the interaction between a DR and a RES Aggregator with end-consumers offering balancing services, bringing complex procedures from trading and operation rooms to end-users' mobile devices.

The detailed objectives of Phase 2 pilot are:

1. Contact a sufficient number of residential customers and try to engage up to 40 residential customers to participate in this phase.
2. Install at least 15 smart meters, providing a pool of up to 40 residential customers to interact with iFLEX assistant.
3. Provide phase 2 piloting end-users with real-time and historical data visualization:
   - Consumption at phase and/or smart plug, relay level,
   - Total consumption
4. Install relays for water heaters and smart plugs for specific loads in a subset of 40 residential customers to control and /or monitor their operation.
5. Enable participating users to setup time schedules through a user interface (mobile app) to be used for automated activation and control their flexible devices in the next pilot phases.
6. Identify the flexibility potential of participating users by analysing their flexibility preferences as specified from the user interface (mobile app).
7. Detect in real-time the status of connected appliances by monitoring their resulting consumption.
8. Validate user acceptance and understanding of consumer behaviour through a user interface.
9. Showcase synergies and coordinated operation of residential assets (e.g., home appliances) and enrolled RES unit(s) for minimizing unavoidable RES generation imbalances.
10. Elaborate the necessary customizations and extensions of HERON's platform to secure the smooth integration of individual components and communication with the iFLEX Assistant.
11. Develop a DRMS which orchestrates the dispatch of DR events to iFAs based on the flexibility requests of the RES Aggregator for mitigating its imbalances, as well as the A&M Interface component of the iFA to enable the interaction with the DRMS.
12. Assess prototype design of natural user interfaces for customer participation in DR actions (e.g., comfort preferences, personalised notifications, DR event participation).

3.1.5 Phase 2 Activities

This paragraph summarizes the main activities that will be implemented during the second phase of the Greek pilot to meet the objectives described above.

1. Communication of residential users belonging to HERON's clientele to inform them on the pilot activities and ask them to participate in the second phase of the pilot execution in a continuous recruitment effort.
2. Experiment with residential end-users interacting with the electricity grid under real-life conditions.
3. Collect, harmonise, and store data from various data types and sources such as, historical and real-time energy consumption collected from individual smart meters, electricity tariffs, generation forecasts, real-time production measurements of Optimus Energy RES units and weather and grid CO_2 data.
4. Data will be analysed and will be made available to residential end-users, while load patterns will be identified considering electricity consumption per device and/or total consumption on a daily and/or monthly basis to make customers aware of their energy wastages.
5. Provide RES unit forecasting and real-time generation data for monitoring purposes for all RES units that formulate the augmented RES portfolio in Phase 2.

6. Calculate RES generation imbalances at unit and aggregator level on the basis of the above generation forecasts and respective real-time measurements. These data will serve as an input for subsequently triggering end-user households' assets to properly respond and mitigate RES generation imbalances.
7. Based on the RES Aggregator's input, dispatch appropriate DR events to the pilot users in order to aggregate the requested flexibility.

In addition, the following activities relate to the development of HERON's Energy Control App and integrated iFLEX assistant which will be tested by up to 40 iFLEX users:

1. Feedback will be requested with regards to their preferable ways for them to provide constraints and preferences when participating in a DR program, as well as the desired level of autonomy (e.g. manual feedback vs delegation of the decision to the iFLEX Assistant.
2. Identify consumer preferences based on the usage of specific home appliances, such as water heaters and appliances monitored by the smart plugs, as well as consumer comfort limits.
3. Perform first level API customizations and extend HERON's metering platform to support advanced control and DR communication with the iFLEX Assistant.
4. Provide data to the end-users regarding their consumption (aggregated and asset specific) so that they can make informed decisions regarding their participation in DR events.
5. Support consumers in their participation in DR events through appropriate incentives that translate into monetary or other (real-life) rewards.

3.1.6 Phase 2 Associated KPIs

1. ***KPI6a****: Number of consumers in the pilots*
   Target*: at least 40 consumers in up to 15 households*
   Validation Measures: *Total number of consumers/prosumers in the Greek pilot.*

2. ***KPI6b:*** *Number of consumer groups targeted with novel demand response services*
   Target*: Up to 10 households with smart relays and up to 10 with smart plugs*
   Validation Measures: *Total number of different consumer segments that will be engaged with demand response through second phase phase will be residential consumers.*

3.2 Slovenian Pilot

3.2.1 General Overview

The second phase piloting builds on results of the first phase. In the first phase network grid segments for piloting were selected and an initial set of piloting end users contacted. The requirements for the HEMS system have been clearly defined and installed at selected end users. The HEMS systems have been fine tuned for the end user's environment. APIs and services have been defined to integrate the HEMSes into iFLEX framework. The iFA mobile app's first version has been developed, which enables the interaction of pilot participants with their personal iFAs. End user engagement is on-going, the project tries to involve the users often and deep.

3.2.2 Phase 2 Piloting Scope

The second phase will tackle the following challenges:

1. Recruitment of the second phase group of pilot users and setting a base for the third phase recruitment round
2. Deployment of HEMS systems to pilot users and their smooth integration with the iFLEX framework
3. Continuous improvement, testing, maintenance and operation of iFLEX framework background

components: RAI, Digital Twin, Automated Flexibility Management

4. Integration with background components and testing of EUI solution with the end users
5. Development of external DR management system, which will distribute DR events to the pilot users, as well as iFA's A&M Interface component to interact with this system
6. Implementation and evaluation of a number of use cases planned in the project: PUC-1 Manage my preferences, PUC-4 View reports on participation or engagement, PUC-7 Monitor my energy in real time, PUC-8 Offer flexibility, PUC-9 Optimize schedule considering prices and/or incentives and PUC-10 Increase self-balancing through forecasting and automation
7. Engage with the end users and enable co-creation: collect feedback, consult during deployment, evaluation and testing and provide third phase inputs to design and technical WPs

3.2.3 Description of Second Phase piloting Technical Assets

Table 6: Summary of the Slovenian pilot technical assets

Name of the pilot	*Flexibility pilot for efficient operation of the electricity grid with high share of RES in Central European climate (Kozjansko and Savinjska dolina, Slovenia)*
Pilot location	Slovenia
Partners	ECE - Electricity supplier ELE – DSO IJS – Scientific institute SCOM - ICT solutions company
Type of consumers	Residential consumers/prosumers, industrial consumers/prosumers
Number of sites	Two sites (Kozjansko and Savinjska dolina)
Number of clients	20 residential users
Number of buildings	5
Available infrastructure	1. **ELE**: o Data from 10.000 households and small industrial users equipped with smart electricity meters (sampling ∀15 min.) o Local Data from 200 local substations equipped with smart electricity meters (sampling ∀15 min.) o Application "MojElektro" for consumption and production data visualization 2. **ECE**: o 20 households and industrial users equipped with HEMS o Application "Moj ECE" for consumption and production data visualization **3. JSI:** o Resource Abstraction Interface (RAI): a cloud instance for collection of data from external data sources like HEMS and AMI systems and for offering the data resources in a unified way to other system components o Data analytic pipeline for network load, generation and household occupancy forecasting o Machine learning and cloud infrastructure, HW and SW o Security and privacy services as were presented in D4.7 **4. SCOM:** o Smart metering data ingestion system o Secure end user piloting engagement system **5. ICOM:** o iFA mobile app, which enables the interaction of pilot users with their iFAs
Extend pilot setups with more assets	N/A
Demonstration Topic	PUC-1, PUC-4, PUC-7, PUC-8, PUC-9 and PUC-10 demonstration activities

ELE will provide GIS data for testing areas and electricity consumption and production data for a subset of 100 residential and industrial users for at least one-year period.

An indicative list of the readings that will be made available are the following:

- Active Power (P),
- Active Energy (E),
- Reactive Power (Q),
- Current (I),
- Voltage (V).

ELE will also provide climate data:

- Average temperature
- Average sunlight
- Rainfall.

ECE will provide for the 20 users of pilot phase 2 data from HEMSs and in case of prosumers also data about production of electricity from PV.

JSI will provide a cloud platform with HW and SW needed to serve the smart metering data ingestion system, weather data ingestion system, prosumer backend systems and ML data analytics.

3.2.4 Phase 2 Piloting Objectives

1. Continuously improve awareness about potential pilot users and acquire user base for second phase piloting
2. Continuous integration of the smart metering data into the iFLEX framework
3. Installation of HEMS systems at acquired pilot users
4. Continuous integration of installed HEMS systems with the iFLEX framework, further validate PUC-1 and PUC-7 use cases
5. Test improved Digital Twin capabilities on broader range of users and data, validate PUC-4 and PUC-8 use cases
6. Test Automated Flexibility Management in relation to PUC-9 and PUC-10 use cases
7. Test external DR management system and A&M component within the context of PUC-4 and PUC-9 use cases
8. Testing of advanced security features
9. Continuous assessment of the data and data flows for fulfilment of Data Management Plan
10. Get feedback from second pilot phase end-user and evaluate iFLEX Assistant as a service,
11. Critically assess reached objectives and sketch the third phase piloting plan,
12. Provide feedback to technical work packages and include awaited iFLEX Assistant and tools improvements in the third phase piloting plan.

3.2.5 Phase 2 Piloting Activities

1. Initially selected network segments are continuously monitored for changes in network conditions to be able to adapt the selection according to the number of acquired pilot users. Potential pilot users consumption is studied and most promising users, based on their thermal characteristics and location, are invited in the project. Acquiring of the user base continue both through the direct communication with candidates, mouth to mouth, and through invitation campaigns, if needed,
2. The process of ingest of smart metering data is on-going activity. According to adaptation and updates of network segments and acquired pilot users the process needs to be updated and extended,
3. The HEMSes will be installed at acquired pilot users. Different setups are foreseen with different equipment. The primary target are users with strong thermal characteristics, preferably both in winter and summer. PVs are a plus,

4. The HEMSes will be further integrated in the iFLEX framework, in particular in terms of control capabilities and extended data from the pilot users equipment. The EUI will be designed and integrated with the RAI to answer the needs to implement PUC-1 Manage my preferences and PUC-7 Monitor my energy in real time use cases,
5. The Digital Twin (DT) will be tested regarding needed capabilities for implementation of PUC-4 View reports on participation or engagement and PUC-8 Offer flexibility use cases. The data collected in the pilot will be used to build models needed to provide information on participation in DR events and available pilot user household flexibility,
6. The core of the piloting activities will be oriented towards implementation of the PUC-9 Optimize schedule considering prices and/or incentives and PUC-10 Increase self-balancing through forecasting and automation use cases. The extended DT models (5) will be used to plan for optimized end user household response implemented through HEMS integration (4),
7. While for the pilot user enrolment still updated baseline security features are used in the second phase it will be experimented with advanced security features developed in WP4, based on Self Sovereign Identity principles,
8. The pilot will actively follow the process of acquiring of new users (1) and HEMS installations (3) to detect possible now data sets or flows within the project. The updates will be recorded in the DMP,
9. Through the pilot activities the pilot users' feedback will be actively looked for to be able to improve the end users experience according to the provided comments and suggestions. Besides the technical feedback also end user feedback will be passed back to technical work packages,
10. User integration system and tools for development and deployment/update of an iFLEX Assistant evaluation instances into the pilot. The tools have been established and teste dint he first pilot phase.
11. The final effort of the second piloting phase will be an evaluation of achieved objectives and associated KPIs and a sketch of a plan for second piloting phase. The evaluation will include clear feedbacks to the involved technical work packages WP3, WP4 and WP6, as well work packages WP2 and WP5.

3.2.6 Phase 2 Associated KPIs

1. ***KPI6a: Number of consumers in the pilots***
   Target: *20*
   Validation Measures: *Total number of consumers/prosumers in the iFLEX pilots*.

2. ***KPI6b: Number of consumer groups targeted with novel demand response services***
   Target: 2 (i.e., households and small industrial units)
   Validation Measures: *Total number of different consumer segments that have been engaged with demand response through the pilots.*

3. ***KPI6c: Increased consumer flexibility for grid stability and RES integration***
   Target: 15%
   Validation Measures: The average flexibility. Accuracy of pilot participants that is validated in grid stability/RES integration cases is compared to relevant results reported in the literature. Load forecasting model.

3.3 Finnish Pilot

3.3.1 General Overview

Second phase pilot extends and improves the first phase pilot, where an iFLEX Assistant provided flexibility management at an apartment building level. A typical situation in Finland is that the majority of the energy costs in an apartment building, including heating (apartments and common areas), warm water, sauna, and common area lighting is paid by the building community (also known as housing cooperative).

In the first phase pilot, district heating control has been integrated into iFLEX Assistant and has been used as a main source of flexibility. iFLEX Assistant provides means to a forecast of the electricity and district heating demand with configurable forecasting length. In this phase, demand response could be activated with

developed user interface. Second phase of the pilot extends first phase pilot with new functionalities and improvements.

3.3.2 Phase 2 scope

Phase 2 pilot expands existing pilot environment with following improvements. First, iFLEX assistant deployed in the apartment building will be used to reduce the peaks in the district heating consumptions and optimize the energy consumption. Heat pump control will also be integrated in iFLEX assistant. Second, phase 2 pilot will also focus on displaying the benefits of iFLEX Assistant for the apartment residents with advanced user interface. UI will particularly focus on demonstrating the benefits of cutting peaks in district heating and electricity demand and therefore empower consumers to participate. Third aspect of the phase 2 pilot is enabling the aggregation of multiple building.

3.3.3 Description of Pilot Phase 2 Technical Assets

Table 7: Summary of the Finnish pilot technical assets

Name of the pilot	*Holistic flexibility management pilot in Nordic climate*
Pilot location	Finland
Partners	CAVERION - Building automation & facility manager ENERIM - Technology and service provider for Energy Suppliers VTT - AI based modelling and optimization
Type of consumers	Residential, shared infrastructure for heating, warm water and common building infrastructure
Number of sites	1
Number of clients	Apartment building with 90 apartments. Facility manager + up to 5 residents registered to the pilot with their credentials.
Number of buildings	1
Available infrastructure	Building automation system installed in the apartment building. Monitors and controls, heating, ventilation, warm water, lighting, elevator, sauna. Historical data on selected measurement points available, interfaces implemented in the first phase pilot oBix server for storing measurement data and Python API for accessing data Machine learning and physics-based methods for modelling building infrastructure and consumption.
Planned pilot infrastructure improvements for the phase 2	Additional sensors for apartments for environmental monitoring
Demonstration Topic for phase 2	District heating and electricity demand peak cutting, energy optimization, resident empowerment for participating demand response activities, aggregation concepts

The iFLEX Assistant is deployed into an apartment building with 90 apartments. The apartment building is equipped with a Building Management System (BMS). The BMS provides means to monitor and control following assets: district heating substation, radiator-based heating network, heating of domestic hot water, exhaust air heat pump and related ventilation solution, lighting, electric sauna and elevators (only monitoring). BMS also provides an access to monitor temperature and humidity in the corridors and shared spaces of the apartment buildings

Following measurements are currently available from the pilot building:

1. Building level electricity consumption (1-hour time resolution including several years history, new data with 1-minute resolution).
2. District heating energy consumption (1-hour time resolution including several years history, new data with 1-minute resolution).
3. Local weather data including outside air temperature, relative humidity, and optionally solar radiation (1-hour time resolution including several years history).
4. Building level electricity consumption by network analyser (phase level voltage, current, power and frequency at 1–5 s time resolution).
5. Ventilation units' return air temperature and optionally return air relative humidity and CO_2.
6. Indoor air temperature, relative humidity, and CO_2 of selected apartments on different parts of the building.
7. District heating, heating network, domestic hot water and exhaust air heat pump supply and return water temperature and related setpoint values.
8. Status information (percentage or on/off) on water pumps', fans', control valves' and heat pump compressor status.
9. Extract air temperature of the exhaust air heat pump.

The following measurements are planned for the phase 2 to extend the pilot infrastructure:

- Sigfox-based sensors for monitoring the living conditions in the selected apartments, GDPR-related issues need to be resolved
- Thermostat control for setting the apartment temperature level more fine-grained
- Apartment level electricity monitoring, GDPR-related issues need to be resolved

The Finnish pilot will use an existing platform for storing measurement data for ML data analytics (Machine learning and physics-based methods for modelling building infrastructure and consumption).

3.3.4 Phase 2 Anticipated Objectives

The main goal of the second phase pilot is to integrate the iFLEX Assistant with Enerim's Aggregation Platform and to continue investigating the benefits obtained for deterministic flexibility management. The detailed objectives of the second phase pilot are:

1. Utilizing iFLEX assistant to optimize energy efficiency of the apartment building.
2. To systemically evaluate and compare time periods with and without iFLEX assistant reducing district heating demand peaks in order to analyze potential savings generated by iFLEX Assistant
3. To utilize fully ML-based solution to forecast buildings's electricity and district heating and compare it with hybrid (ML and physics based) solution developed in phase 1
4. To define a means for concretizing the benefits of the demand response actions in apartment buildings
5. To demonstrate the updated user interface for the residents for the apartment building to visualize benefits of the demand response and energy optimization
6. To integrate pilot site in to ENERIM's Virtual Power Plant platform to enable aggregation and market integration in the phase 3.

3.3.5 Phase 2 Activities

Following activities are planned to be executed in the second phase of the project:

1. Study the possibility for utilizing the iFLEX Assistant to provide benefits by reducing district heating peak loads and overall energy efficiency of the building (DH and electricity). Following activities are required
    a. Integrate heat pump control to the iFLEX assistant to provide bigger capacity to cut electricity peaks during the peak hours. In the first phase of the pilot, heatpump control has been tested manually in pilot site and phase 2 pilot will integrate heat pump control into iFLEX assistant

   b. Design and implement optimal control method for cutting district heating and electricity peaks and integrate the functionalities into iFLEX assistant.

   c. Plan and implement test campaign, where systematic comparison of the benefits provided by iFLEX system are done. During the campaign, days when iFLEX assistant is controlling the apartment building are compared with days when control is not present.

   d. Design and implement building twin simulation environment. Building model created with hybrid modelling (ML and physics combination) or pure ML-based methods will be tested with historical data from pilot sites

2. User interfaces for residents

   a. Resident feedback mechanism developed in phase 1 is used to collect feedback on their thermal comfort. Special attention to the feedback is paid during the iFLEX assistant demand response test campaign described in activity 1.C in addition to measured living conditions in the apartment building.

   b. Define means to concretize benefits gained from participating demand side flexibility actions. In phase 2 we study existing methods to visually concretize benefits of participate demand flexibility actions in residential building

   c. Desing and implement selected methods for visualizing demand response actions and benefits of demand flexibility in both district heating and electicity

3. iFLEX assistant will be integrated into ENERIM demand response aggregation platform. Aggregation will be demonstrated also in phase 2

3.3.6 Phase 2 Associated KPIs

1. ***KPI6a:*** *Number of consumers in the pilots*
   Target: *93 apartments and 140 residents. All the residents are given access to the apartment building level end-user interface. The aim is to increase the number of users equipped with sensors from 5 to 10-15.*
   Validation Measures: *Total number of consumers/prosumers in the iFLEX pilots.*
2. ***KPI6b: Number of consumer groups targeted with novel demand response services***
   Target: *2*
   Validation Measures: *Total number of different consumer segments that have been engaged with demand response through the pilots*.
3. ***KPI5a:*** *Technology readiness of the iFLEX Framework and iFLEX Assistant prototypes*
   Target: 7
   Validation Measures: *The full iFLEX Assistants demonstrated in operational environment.*
4. ***KPI3a:*** *Level of interoperability (coverage of common standards)*
   Target: *100%*
5. ***KPI3b*** *Compliance with relevant EU privacy and data management regulation and standards*
   Target: *YES*
6. ***KPI2a:*** *Increased accuracy of consumer load forecasting compared to state-of-the-art methods*
   Target: *10% for this phase (20% by the end of the project)*
   Validation Measures: *The results are compared to the state-of-the-art consumer load forecasting models and percentage decrease of forecasting error is calculated.*
7. ***KPI2b:*** *Increased accuracy of flexibility modelling compared to state-of-the-art methods.*
   Target: *8% for this phase (15% by the end of the project)*
   Validation Measures: *The results are compared to the state-of-the-art consumer load forecasting models and percentage decrease of forecasting error is calculated.*
8. ***KPI2c:*** *Increased effectiveness of automated flexibility management compared to standard methods*
   Target: *6% for this phase (10% by the end of the project)*

Validation Measures: *The results obtained by the iFLEX Assistant is compared to the current algorithms used for energy management in the building. The iFLEX Assistant is optimization is run every other day to have as similar conditions for the baseline and the iFA. Percentage improvement in energy-efficiency and peak load reduction (at the building level) is calculated by comparing the to the current baseline.*

4 Conclusions

The document describes Phase 2 pilot specifications as well as the technical requirements to be deployed during the second phase of the pilots' demonstrations, including the engagement procedure of selected end-users, gathering their requirements and preferences, as well as their feedback. This document is the second version of all three revisions to follow and expands and elaborates the initial set of the available technologies, and infrastructure per pilot cluster as well as the co-creation activities to be demonstrated on top of selected users for this phase.

The main objective of this report is to set the requirements and the various application-specific modules for the iFLEX Framework in the second phase starting from M15 until M25, the second instalment in the iterative approach that has been followed in the project in the three pilot countries, namely Greece, Slovenia and Finland, each one with different focus area. In this context, the updating and assessment of the iFLEX Assistant users' interface will be performed in each pilot site with a number of selected users to be contacted and primarily engaged.

Another key objective of this report is to collect in all three pilot the users' feedback on the iFLEX Assistant which will be used for potential improvements as well as to enhance and refine user requirements for the iFLEX Assistant that will be deployed in Phase 3. User engagement and co-creation activities will be pilot-specific thus it is important to finalize technical details and functionalities to be developed individually under the same umbrella of the iFLEX Framework and Assistants.

5 List of figures and tables

5.1 Tables

5.2 Figures

6 References

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