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

## D2.1 Use cases and requirements

## Date: 2021-02-19

## Version 1.0

**Published by the iFLEX Consortium**

**Dissemination Level: PU - Public**

**Co-funded by the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement No 957670**

# Document control page

**Document file:** iFLEX D2.1 - Use Cases and Requirements v1.0.docx
**Document version:** 1.0
Document owner: ICOM

**Work package:** WP2 User-centric service and system design
**Deliverable type:** R - Document, report

**Document status:** ☒ Approved by the document owner for internal review
☒ Approved for submission to the EC

# Document history:

| Version | Author(s) | Date | Summary of changes made |
|---|---|---|---|
| 0.1 | Isidoros Kokos (ICOM), Nikos Charitos (ICOM) | 2020-12-08 | Initial ToC. |
| 0.2 | Isidoros Kokos (ICOM), Nikos Charitos (ICOM) | 2021-01-11 | Initial version describing methodology, iFLEX concepts and business requirements (1st version). |
| 0.3 | Isidoros Kokos (ICOM), Nikos Charitos (ICOM), Louise B. Riley (IN-JET), Jussi Kiljander (VTT), Dušan Gabrijelčič (JSI), Konstantina Mentesidi (HERON), Costas Kalogiros (AUEB), Thanasis Papaioannou (AUEB), Gregor Laura (ZPS), Gašper Ravnak (ECE), Anton Kos (ELE) | 2021-02-03 | Draft version of the document for review by task participants. |
| 0.4 | Isidoros Kokos (ICOM), Nikos Charitos (ICOM), Louise B. Riley (IN-JET), Jussi Kiljander (VTT), Dušan Gabrijelčič (JSI), Costas Kalogiros (AUEB), Thanasis Papaioannou (AUEB), Gregor Laura (ZPS) | 2021-02-10 | Requirements refinement and final polishing for providing draft for review by assigned peers. |
| 0.5 | Arso Savanović (SCOM) Gašper Ravnak (ECE) | 2021-02-16 | Reviewed document. |
| 0.6 | Ilias Lamprinos (ICOM), Nikos Ioannidis (ICOM) | 2021-02-18 | Second review and finalization of the document. |
| 1.0 | Isidoros Kokos (ICOM) | 2021-02-19 | Final version submitted to the European Commission. |

## Internal review history:

| Reviewed by | Date | Summary of comments |
|---|---|---|
| Arso Savanović (SCOM) | 2021-02-16 | Accepted with minor comments. |
| Gašper Ravnak (ECE) | 2021-02-15 | Accepted with minor comments. |

# Table of Contents

## Executive summary

The main objective of this report is to describe an initial set of requirements of the framework of iFLEX project. The work focuses on different types of requirements: those describing the functions or tasks to be performed by the system, business activities supported by the iFLEX solution, usability aspects and motivation of the end user, as well as those related to security, privacy and socioeconomic context.

The iFLEX solution aims at enabling Consumers and/or Prosumers at the level of individual premises, or at the level of a community to improve the energy and sustainability performance of their premises and enter the energy and flexibility markets by offering demand side flexibility services to relevant market actors. On the other hand, various Flexibility Procurers from the market e.g. System Operators (SOs), Balance Responsible Parties (BRPs), can leverage flexibility from the end users of the power system.

The established paradigm of analysing business and functional requirements with the Use Cases methodology in the Smart Grids domain was followed, adopting an iterative and recursive approach. Use Cases were analysed for possible conflicts (e.g. overlaps), missing functions of the iFLEX Assistant and overall the level of detail provided by the UC model. In case any of the above checks provided a non-acceptable result, the Use Cases model was refined (e.g. scope refinement, UC merging, introduction of new UC) and a new iteration cycle of the analysis began. An adapted template of the IEC 62559-2 standard was utilised for documenting the use cases.

Initially, a list of business actors benefiting from the iFLEX Assistant was analysed in the context of Business Use Cases, capturing the requirements at the business domain. The following cases were modelled:

- BUC1: Optimise BRP operation by leveraging flexibility from consumer/prosumer through DR;
- BUC2: Optimise grid operation by leveraging flexibility from consumer/prosumer through DR;
- BUC 3: Offer the flexibility of a multi-vector energy system (building community) to the energy markets;
- BUC 4: Optimal energy consumption for multi-vector energy system (building community) based on the behaviour of consumers and market price signals;
- BUC 5: Added value services: Customer load profile analysis and overview;
- BUC6: Increase self-balancing through advanced monitoring and automation;
- BUC7: Optimise end-user's energy consumption based on own preferences and market price signals;
- BUC8: Offer flexibility through participation in explicit demand response programmes.

The operations offered by the iFLEX Assistant to the end user as well as its main interactions with external systems were analysed in the form of (technical) High Level Use Cases (HLUC) and Primary Use Cases (PUC), aiming to document the systemic requirements of the solution. This work outlined the boundaries of the iFLEX Assistant as well as the respective preconditions/assumptions towards their realisation. Three high-level functions were identified, tackling energy management as well as flexibility management at the level of individual premises and at the level of a (building) community:

- HLUC-1: Manage energy of the premises in an optimal way;
- HLUC-2: Manage flexibility requests or price signals at individual premises level;
- HLUC-3: Manage flexibility requests or price signals at building level.

The following main operations of the iFLEX Assistant were modelled:

- PUC-1: Manage my preferences;
- PUC-2: Integrate iFLEX Assistant;
- PUC-3: Monitor my sustainability metrics;
- PUC-4: View reports for participation or engagement;
- PUC-5: View energy advice;
- PUC-6: Register for a new flexibility service;
- PUC-7: Monitor my energy in real-time;

- PUC-8: Offer flexibility;
- PUC- 9: Optimise schedule considering prices and/or incentives;
- PUC-10: Increase self-balancing through forecasting and automation;

On the other hand, the end-user perspective was driven by a user experience design approach, which entails identifying the why, what and how of iFLEX use. Apart from usability aspects (how the product is used), the motivations and needs behind the interaction (why the product is wanted and what it helps solve) were also analysed. The requirements related to what the user would like the system to do are documented through user stories, whilst the context and basic principles of the user interfaces were also analysed.

To address security and privacy of the project in a practical manner, a number of general level security and privacy requirements has been gathered and exposed, re-using existing knowledge in the domain, as established via recommendations from various organisations such as NIST, CEN-CENELEC-ETSI, ENISA and USEF.

To address socio-economic aspects of the solution, requirements were documented tackling privacy protection, flexibility contract offering, as well as contract termination and switching. Furthermore, requirements on the automated decision making, based on consumer data, were captured focusing on protecting the consumer/prosumer from various risks – including discrimination, loss of privacy, loss of autonomy, and lack of transparency.

This document provided an initial set of requirements for the iFLEX project, capturing the business and technical context, the scope of the project's solutions and acting as a basis for the iterative design approach followed in the project. Since it has been developed at an early stage of the project, the main sources of eliciting the requirements were project (internal) expert workshops, existing research and domain knowledge as well as the iFLEX concept vision. In subsequent activities of the project, these requirements will be further analysed and refactored using the feedback of actual end users in iFLEX (through co-creation activities) and further research on their needs and the context of use.

# 1 Introduction

The iFLEX project is a response to the call LC-SC3-EC-3-2020, entitled “Intelligent Assistants for Flexibility Management”, of the Horizon 2020 program. Key objectives of the iFLEX project are:

- To develop AI-enabled modelling, optimisation and user interface methods for consumer flexibility management and load forecasting;
- To design and develop modular, secure and interoperable interfaces and data management services for consumer flexibility management;
- To design and implement novel user engagement, incentives, and market mechanisms for consumer-centric demand response, whilst respecting consumer rights.

The various modules developed by the solution providers who are involved in the project, will be integrated into a holistic software framework for flexibility and energy management, namely the iFLEX Framework. Based on this framework, application-specific iFLEX Assistant prototypes, customised for services provided by the industrial partners of the project, will be deployed and tested through pilots in three different countries, namely Finland, Greece and Slovenia. The agile methodology will be implemented in the iFLEX project, so that co-creation with end users can be facilitated. Hence, their feedback will be considered in the following iterations of the project to enhance the user-centric solutions.

## 1.1 Report Objectives

The objective of this report is the documentation of a first set of requirements for the iFLEX project solution, in the form of requirement aggregates (in the form of use cases), individual functional requirement (in the form of user stories) and non-functional requirements (in natural language form`). The report aims on one hand to provide a high-level description of the business cases that drove the requirement analysis process and the relevant functions that will facilitate their realisation; on the other hand to provide a set of requirements that will enable the design of a solution with emphasis on user experience and respect to security, privacy and comfort of the end user.

## 1.2 Report Outline

Addressing the main objectives of the project’s tasks contributing to this report and its audience, this document is structured as follows:

- Chapter 1 (the present section) is an introductory chapter for the report;
- Chapter 2 describes the methodology followed to capture and document the requirements within the activities reported in this work;
- Chapter 3 presents a high-level view of the iFLEX Assistant, documenting its business and systemic context;
- Chapter 4 presents how different stakeholders of the energy market can interact and benefit via the iFLEX Assistant, in the form of Business Use Cases and business requirements.
- Chapter 5 documents the end-user perspective, covering user experience aspects of the iFLEX Assistant;
- Chapter 6 documents the systemic requirements of the solution in the form of use cases, following the established paradigm of analysis in the domain;
- Chapter 7 presents security and privacy related requirements that should be fulfilled by the iFLEX Assistant;
- Chapter 8 presents socio-economic related requirements, particularly with respect to legal and policy guidelines, with which the operation of the iFLEX Assistant should comply;
- Chapter 9 summarises the main conclusions of this work.

## 1.3 How to Read this Document

This report provides a first snapshot of the functional and non-functional requirements of iFLEX Assistant and the different business cases it aims to facilitate. The content is of interest to both technical staff (e.g. software architects, requirements engineers) and non-technical staff (e.g. analysts) who want to understand the solution offered by iFLEX Assistant. Being one of the first deliverables of the project, there is no prerequisite for any other report of the project for understanding it.

Readers familiar with Use Case methodology and in general Requirement Engineering can skip chapter 2, which presents the methodology. Chapter 3 is a must read, since it provides a conceptual analysis of iFLEX Assistant, whilst the reader can then focus on the rest of the chapters depending on the requirement type of interest.

# 2 Methodology

This chapter documents the methodology utilised in the phase of requirement elicitation and elaboration, introducing the basics, terminology, techniques and means of documentation.

## 2.1 Requirements Analysis

The emergent functionalities in the domain of electric power systems, involving intense incorporation of information and communication technologies (ICT) necessitates novel analysis and definition methodology in order to enable the successful identification and understanding of their technical requirements. For capturing the requirements of novel Smart Grid functionalities - combining software and hardware based advances - the Use Case (UC) approach has assumed very central role, having been used in numerous projects over the past years.

Several standardisation activities contributed to providing the fundamental guidelines for analysing requirements in the context of Smart Grid. CEN/CENELEC/ETSI Smart Grid Coordination Group documented the Smart Grid Architecture Model (SGAM) [1], a framework for capturing requirements – in the form of Use Cases - and documenting the design of smart grid solutions. Furthermore, the IEC 62559 standard series defines a methodology for determining and describing user requirements following the “Use case approach”.

A Use Case (UC) defines the necessary actions performed by a system that will provide an impact. The impacts should be of interest for certain stakeholders (meaning that they are in line with their business goals) and should be measurable through specific metrics that are formulated in conjunction with the UC analysis and development procedure. A UC should describe in a practical but precise manner the interactions amongst the various actors of the system that will facilitate the accomplishment of the objectives of the relevant functionalities which are going to be deployed in the system.

In the iFLEX project, the Use Case methodology was utilised to document systemic requirements, following the principles presented in IEC 62559-2:2015 standard “Use case methodology - Part 2: Definition of the templates for use cases, actor list and requirements list” [2]. The template of the standard was adjusted to the scope of the project, and is presented in the Appendix. The template provides several sections for capturing both functional requirements of the respective process or function, as well as other related non-functional requirements (e.g. performance, security and interoperability), common terms, performance metrics and other information that facilitate collaboration, coordination and common understanding.

Furthermore, the User Stories approach was utilised for capturing end-user requirements in an agile manner. User Stories are short natural language sentences using a specific template, describing the role of the stakeholder the intended functionality of a software system and the respective goal achieved by this functionality. User stories can be developed through discussion with stakeholders or simply made up. User stories differ from use cases in the sense that the latter have a formal structure and cover significantly more details, such as preconditions, detailed steps of scenarios, multiple actors.

Other types of requirements (e.g. non-functional), were documented using natural language form, whilst considering best practices (e.g. establishing a common glossary) to avoid ambiguity or inconsistencies.

## 2.2 Basic Terms

The basic UC-related terminology that is used throughout this document is as follows [3] [4]:

- **Use Case:** According to ISO/IEC 19505-2:2012– which defines the Unified Modelling Language (UML) - it is “the specification of a set of actions performed by a system, which yields an observable result that is, typically, of value for one or more actors or other stakeholders of the system”.
- **Actor:** According to the same standard, an actor specifies a role played by an external entity that interacts with the subject (i.e., a system). This entity can be a human user of the designed system, or another system, application or device.
- **Party**: Legal entities, i.e., either natural persons (a person) or judicial persons (organisations) that can bundle different roles according to their business model.
- **Role**: Represents the intended external behaviour (i.e., responsibility) of a party. Parties cannot share a role. Parties carry out their activities by assuming roles, e.g., system operator, trader. Roles describe external business interactions with other parties in relation to the goal of a given business transaction e.g., Balance Responsible Party, Grid Operator, Market Operator.

- **Requirement:** A statement which translates or expresses a need and its associated constraints and conditions.

### 2.2.1 Use Case Classification

One of the basic classifications of use cases is based on the design scope and the level of abstraction [3]:

- The design scope defines the boundary box of the use case i.e., “what is in?”, “what is out?” for the system under design.
- The level of abstraction refers to the details in describing the objective of the use case.

We can see different classifications in the literature for use cases [3]:

- Use case concepts (or High Level Use Cases - HLUC) describe a general idea by defining the roles (generic actors) involved and sketching their responsibilities, but not the underlying business models or processes. The target audience is system engineers, business developers, regulators and key experts in standardisation having a very good overview on the whole Smart Grid landscape.
- Conceptual business requirements are refined in one or several business use cases written by business architects or regulators which describe them within an enterprise scope (i.e., the operation of businesses) and the interaction between different roles, e.g., to contract or negotiate services.
- Refinement of the technical view is added by specifying one or multiple device/system use cases to realise the goal of a business use case. For these technical use cases we can define the device/system boundaries and interactions between the system(s) and external actors to fulfil a goal for the actor(s). The target audience is mostly HW/SW engineers.

A device/system use case can take the form of a:

- Primary Use Case: A primary use case (PUC) is a use case implemented in a specific system characterised by a defined boundary.
- Secondary Use Case: A secondary use case is used to describe core functionalities that are used by multiple PUCs.

Use Case scenarios define different routes within one UC according to different trigger signals. The previously described classification of use cases is summarised in Figure 1.

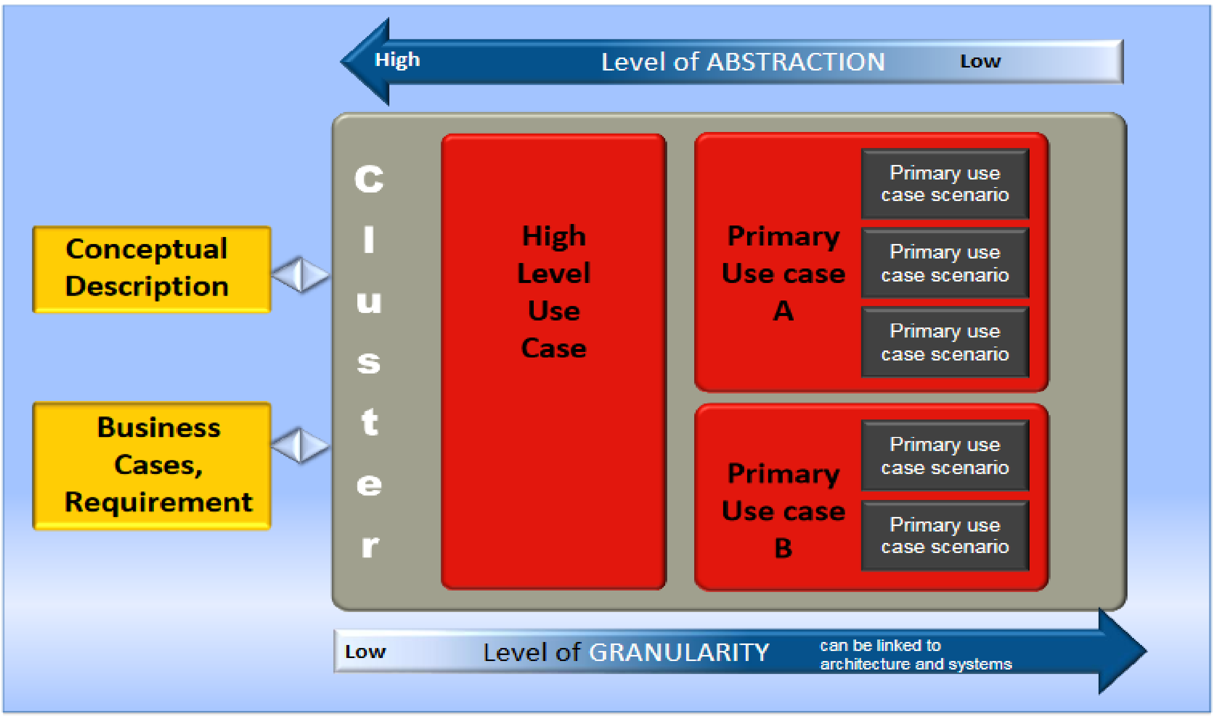



Figure 1 Use case structure based on Smart Metering Coordination Group [5]

### 2.2.2 Use Case Actors

Different types of actors can be identified based on the use case perspective:

- Business actors - representing a party that participates in a business transaction whilst performing tasks in a specific role or a set of roles;
- Technical actors - an entity (someone or something) that communicates and interacts with the system under design causing it to respond to events.

Furthermore, different types of actors can be identified, with regards to their role in the realisation of a use case:

- Primary actor - having a goal with respect to the system, which can be satisfied by its operation, initiates the interaction with the system under design by triggering a scenario (triggering event);
- Supporting actor - an external actor that facilitates the system under design to perform its operation (e.g. by providing a service);
- Internal Actor - a component of the system under design.

For a business use case, actors are specified as roles, as opposed to a technical use case where actors are humans, devices and/or systems.

## 2.3 Requirements Classification

Requirements can be categorised to:

- **Functional**: Describes what a system “must do” (behavioural attributes), detailing the functionality that is supposed to accomplish;
- **Non - functional**: Impose constraints on the design or implementation focusing on the operational criteria (quality attributes) e.g. performance, security, scalability, reliability, maintainability, standards compliance.

With respect to their intent, requirements analysed in the context of iFLEX project, are classified as:

- **Business Requirements:** Provide the description of the business goals, objectives and needs of an organization that shall be achieved by employing a system.
    - Why is the system needed, what should it support and in which context?
- **User Requirements:** Capture the desires and needs of the users of a system. Elaborate user/operator characteristics and usability of the system.
    - What do end users need the system to do?
- **System Requirements:** Concern the requirements of the system from a technical perspective. Following the elicitation of the business requirements, the technical requirements for the selected systems of interest are identified, transforming the stakeholders’ requirements into a technical view required for documenting the systems, defining the boundaries of the system/subsystem in terms of the behaviour and properties to be provided.
    - What does the system need to do?

## 2.4 Scope and boundaries

The task of requirement analysis necessitates a common understanding of the application domain and the environment that the system will be developed/operating. An analysis of the main concepts considered in requirement engineering are presented in the following list and in Figure 2:

- **Domain**: The general field of business or technology in which the system under design will be used;
- **Context**: The part of a system’s environment being relevant for understanding the system and its requirements;
- **System**: A combination of interacting elements organised to achieve one or more stated purposes;
- **System Boundary**: The boundary between a system and its surrounding Context;

- **Scope**: The range of things that can be shaped and designed when developing a system.

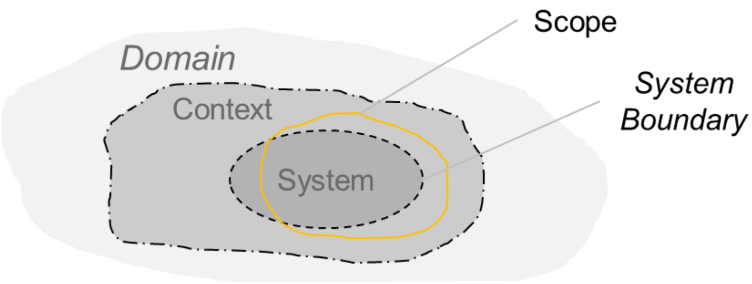



Figure 2 Scope and Boundaries

The requirements work - in the context of this report - considers both the requirements inside the system boundary, but also the business constraints and assumptions that exist in the context of the system, as defined by the project's pilot areas and business context analysis performed.

## 2.5 Use Case Analysis Methodology

The use cases definition process is described in the following steps and illustrated in Figure 3:

1. The Business Context was analysed through interactive workshops with the pilots, where the objectives of different domain stakeholders were analysed (e.g., System Operators, Energy Suppliers, Consumers, Prosumers);
2. A list of business use cases was formulated describing how the iFLEX Assistant would enable the realisation of the business objectives. On top of these business cases, some initial high-level functions of the iFLEX Assistant were devised;
3. An analysis of the System Context followed, identifying the initial list of technical actors that might interact with the iFLEX Assistant;
4. The High-Level Use case list was devised;
5. An iterative process was initiated, where each UC was analysed, refining the scope, objective, actors and documenting the narrative. The UC was decomposed to Primary Use Cases (PUCs);
6. Upon completing the iteration of the whole Use Case list, the UCs were analysed for possible conflicts (e.g. overlaps), missing functions of the iFLEX Assistant and overall the level of detail provided by the UC model;
7. In case any of the above checks provided a non-acceptable result, the Use Cases model was refined (e.g. scope refinement, UC merging, new UC introduction) and a new iteration cycle of the analysis began;

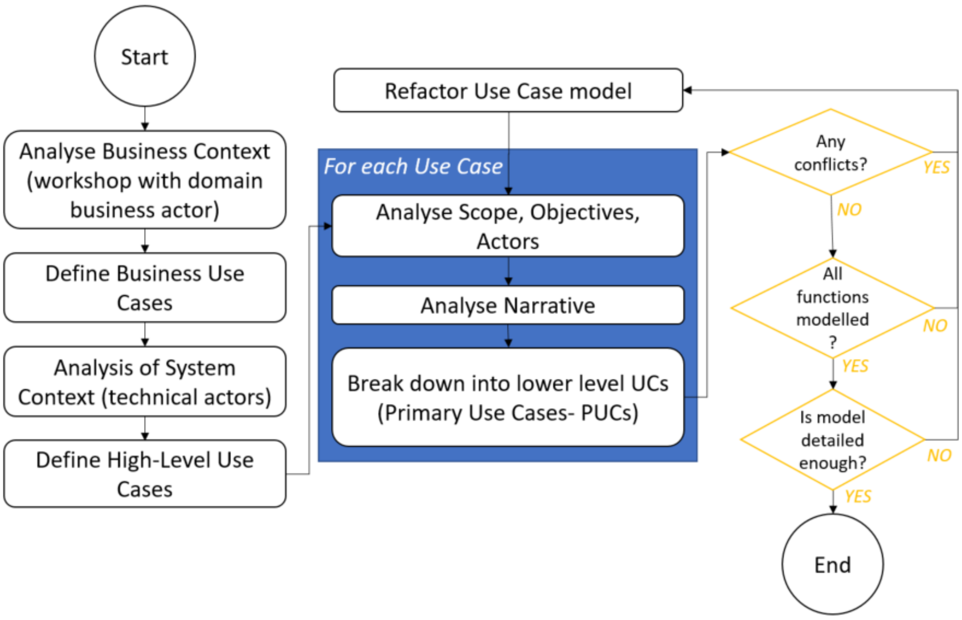



Figure 3 iFLEX Use Case Analysis Methodology

# 3 iFLEX concepts

## 3.1 Empowering end user of energy system through flexibility

The energy system has been undergoing major changes in recent years on the basis of three axes: decarbonisation, decentralisation and digitalisation. The first two are related to the fact that a continuously increasing percent of the generated power is produced from Renewable Energy Sources (RES), thus the generation is becoming more decentralised. Hence, controlling the intermittent and distributed generation becomes more complicated, as opposed to the case of centrally produced power via large power plants. As regards the aspect of grid digitalisation, this stems from the need to better monitor and control the energy flow within the power system and subsequently facilitate the necessary energy transition. In this changing landscape, where coupling generation and demand becomes more difficult, the importance of flexibility highly increases.

The primary goal of the iFLEX Assistant is to empower end users by making it as easy as possible for them to offer flexibility services. Thus, on the basis of the holistic energy management approach of the common iFLEX Framework, customised iFLEX Assistants will enhance the level of automation and personalisation in local energy management and flexibility services, while improving user experience. The AI-based optimisation of energy scheduling can result in mutual benefits for both the beneficiaries of the assistant, namely consumers, prosumers and energy communities, and various energy stakeholders which are active in energy and flexibility markets, such as Energy Suppliers, System Operators or independent Aggregators. The end users of the iFLEX Assistant will be able to maintain their comfort level and also access a new remuneration source by offering their flexibility to interested actors in the market at various timeframes and through different means, such as shifting their consumption according to time-varying electricity price signals or explicit flexibility requests.

## 3.2 Challenges engaging end users

The iFLEX project aspires to develop a user-centric solution with respect to flexibility management in coordination with end users. Various challenges might be faced in this attempt, as it is highlighted by previous research on the field [6] [7]:

- Clearly understanding the needs and desires of different target groups. Although diverse barriers and success factors have been documented in the literature, their importance and prioritisation to different target groups remain rather unclear;
- Developing appealing products and services for the end users. The development of added values services is highly significant for the project, as complying with flexibility requests or price signals might contradict with the daily habits of the users;
- Evaluation of different incentives and pricing schemes. As previous experience is not thorough yet, the impact of different electricity pricing schemes and incentives – either monetary or not – on end-users' engagement has to be evaluated within the project;
- Exploiting end-users' feedback. The iFLEX project is particularly interested in the feedback of the end users. Hence, it aims to exploit this feedback by adjusting accordingly the system design at the following iterations of the project's development.

## 3.3 iFLEX Ecosystem

The iFLEX project aims to empower end users by facilitating their participation in flexibility services. Thus, the base of the project is the iFLEX Framework, a common software framework for development of intelligent assistants for flexibility and holistic energy management. While the focus of the project lies within the power sector, cross-sector energy optimisation, as in the case of electricity and district heat, will be explored. This framework shall comply with all the requirements elicited throughout the project design phase.

Upon the iFLEX Framework, application specific instances of intelligent assistants, the iFLEX Assistants, will be developed. These customised assistants shall provide their end users with novel flexibility and energy management services. Hence, prosumers and consumers will be able to improve the energy and sustainability performance of their premises and enter the energy and flexibility markets by offering demand side flexibility services to relevant market actors. On the other hand, these actors will be equipped with the capability to leverage flexibility from the end users of the power system, a potential which has not been exploited so far. Within the scope of the project, both individual consumers and prosumers as well as building communities will be examined as potential beneficiaries of the iFLEX Assistant. Figure 4 presents key points for the iFLEX project.

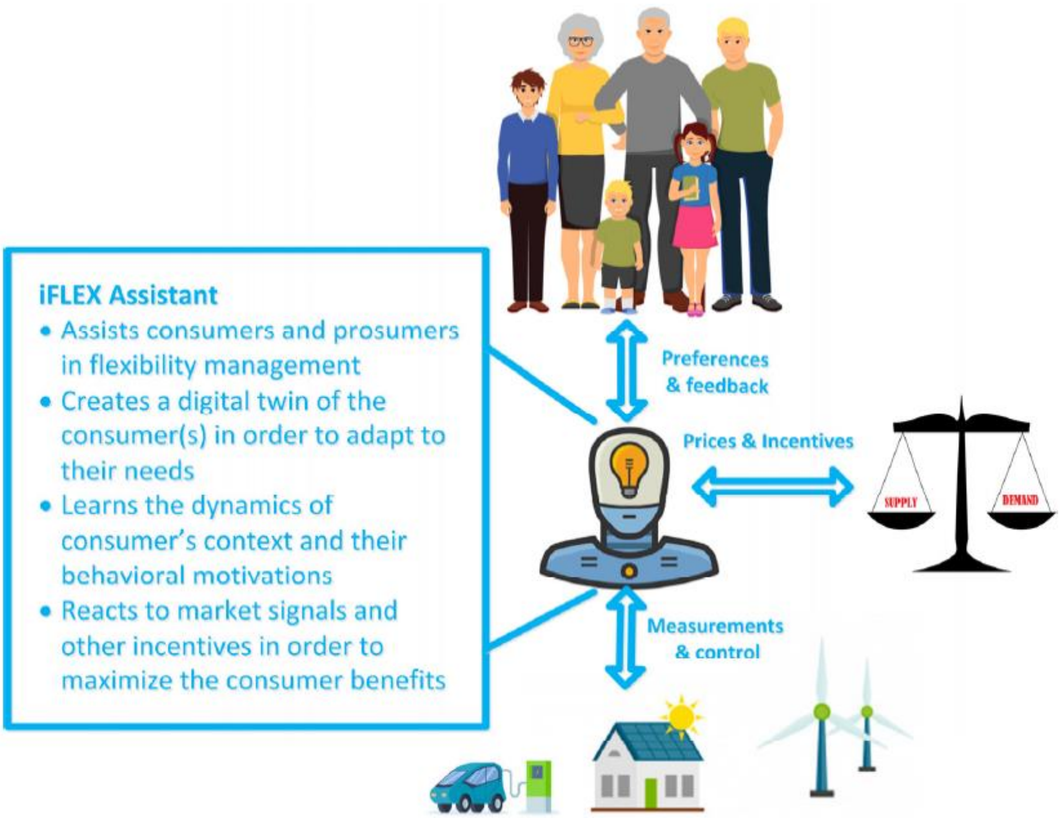



Figure 4 Basic iFLEX concepts

The iFLEX Assistant shall possess a set of functionalities that enable it to offer advanced energy management solutions to consumers and prosumers. Through the Resource Abstraction Interface, which will enable the communication with the Energy Management System (EMS), sensors and metering devices and systems, the assistant will be able to monitor energy in real-time, as well as other important variables for the operation of the system, e.g., the room temperature. The end users will be able to provide the iFLEX Assistant with their preferences, including comfort levels, operational boundaries for in-premise appliances and assets or simply their communication preferences with the assistant. Based on the user's prioritisation of motives (e.g., economic, sustainability, etc.) and past behaviour, the iFLEX Assistant will be able to devise an optimal schedule for dispatchable devices and assets. Furthermore, the end users will have access to their sustainability metrics and tailored energy advice, in case they want to further improve their energy efficiency or sustainability performance.

In addition to these functionalities, the iFLEX Assistant shall provide its users with advanced flexibility management services. Hence, AI-based methods will be implemented in order to optimise energy scheduling, while offering flexibility to interested market actors via the Market and Aggregation Interface. Moreover, reports on the participation of the end users in flexibility offering will be provided to them with the goal to foster their engagement in these services.

## 3.4 Business Context

Table 1 provides the analysis of the main stakeholders that were considered in the analysis of the domain and the business cases that drove the requirements analysis. The description of stakeholders was based on the Harmonised European Electricity Market Role Model (HEEMRM) [8], whilst additional ones were identified, covering in some occasions similar roles in the market. In addition to that, the main roles of the various actors in the context of the requirements analysis of iFLEX project is highlighted and overlapping terminology is also elaborated.

Table 1 iFLEX Business Actors

| Actor Name | Acronym | Description | Role in project |
|---|---|---|---|
| **(Resource/Flexibility) Aggregator** | - | A party that aggregates resources for usage by a Balancing Service Provider for energy market services. | A BSP acting as Flexibility Provider by aggregating flexibility from prosumers. |
| **Balance Responsible Party** | BRP | A Balance Responsible Party is responsible for its imbalances, meaning the difference between the energy volume physically injected to or withdrawn from the system and the final nominated energy volume, including any imbalance adjustment within a given imbalance settlement period. | Flexibility Procurer |
| **Balance Service Provider** | BSP | A party with reserve-providing units or reserve-providing groups able to provide balancing services. | Flexibility Services Provider |
| **Building Community** | - | A party which consists of multiple Consumers. Aims to offer the building-level aggregated flexibility of shared and private resources to the energy market. | Beneficiary of iFLEX Assistant |
| **Consumer** | - | A party that consumes electricity. This is a Type of Party Connected to the Grid. | iFLEX Assistant' end user |
| **Distribution System Operator** | DSO | A party responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution 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. | Flexibility Procurer |
| **District Heating Company** | - | A party that produces and distributes district heating. It provides district heating tariffs and can act as an Aggregator. | Flexibility Procurer |
| **Energy Service Company** | ESCO | A party offering energy-related services to the Party Connected to Grid, but not directly active in the energy value chain or the physical infrastructure itself. The ESCO may provide insight services as well as energy management services. | iFLEX Assistant' end user in the case of solutions at the level of apartment buildings. |
| **Energy Supplier** | - | An Energy Supplier supplies electricity to or takes electricity from a Party Connected to the Grid at an Accounting Point. | Flexibility Procurer<br><br>Note: Within the iFLEX context, the term refers to Energy Suppliers in the retail energy market. Hence, the term Energy Supplier is used interchangeably throughout the |

| | | | |
|---|---|---|---|
| | | | document with the term Retailer. |
| **Generator** | - | A party that generates electricity. This is a Type of Party Connected to the Grid. | Generators are involved indirectly, in the case of vertically integrated energy companies (e.g., an integrated Retailer, BRP and Generator).<br><br>Note: The term Generator may be used interchangeably with the term Producer. |
| **Meter Data Administrator** | - | A party that receives smart meter data from various external systems (e.g., Distribution Management System, Data Hub[1], etc.) and sends relevant data to the end users. | Represents the business entity providing access to smart meter data to iFLEX Assistant. |
| **Party Connected to the Grid** | - | A party that contracts for the right to consume or produce electricity at an Accounting Point. | iFLEX Assistant end user (depending on the specific type of party). |
| **Producer** | - | A party that generates electricity. This is a Type of Party Connected to the Grid. | Producers are involved indirectly, in the case of vertically integrated energy companies (e.g., an integrated Retailer, BRP and Producer).<br><br>Note: The term Producer may be used interchangeably with the term Generator. |
| **Prosumer** | - | A party that both consumes and generates electricity. This is a Type of Party Connected to the Grid. | iFLEX Assistant end user |
| **Retailer** | - | A party that supplies electricity to or takes electricity from its customers in the retail energy market. | Flexibility Procurer<br><br>Note: The term Retailer is used interchangeably throughout the document with the term Energy Supplier, which refers within the iFLEX context to Energy Suppliers in the retail energy market. |
| **Transmission System Operator** | TSO | A party responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission 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 transmission of electricity. | Flexibility Procurer |

[1] https://www.fingrid.fi/en/electricity-market/datahub/

### 3.5 System Context

As briefly analysed above (Section 3.3) the iFLEX Assistant will need to interact with various systems. Table 2 provides the analysis of the main technical actors (systems, applications, devices, etc.) involved in the requirements analysis and in general relevant to the scope of the iFLEX solution.

Table 2 iFLEX Technical Actors

| Actor Name | Acronym | Actor Type | Description |
|---|---|---|---|
| **Data Hub** | - | System | System that centralises a collection of data from multiple sources, which can be shared between various endpoints. Provides Smart Meter data to the iFLEX Assistant. |
| **Dispatchable Distributed Energy Resource** | Dispatchable DER | Device | Dispatchable device (e.g. small-scale PV system, controllable home appliance, energy storage, EV). |
| **Distribution Management System** | DMS | System | DSO's system, which monitors and controls the electricity distribution grid with the aim to maintain the efficient, reliable and secure operation of the grid. Provides information to the iFLEX Assistant via the Meter Data Access Interface. |
| **Demand Response Management System** | DRMS | System | A system enabling to manage a number of Demand Response resources, optimally allocating dispatch actions (price or control signals). |
| **Energy Management System** | EMS | System | System that enables monitoring metering and sensor data, and controlling the available energy resources (devices, distributed energy resources, storage systems) within the premises. Depending on the occasion, it can be either a Home EMS (HEMS) or a Building EMS (BEMS). |
| **Market Interface** | - | System Interface | Interface representing systems of market actors (e.g. DSO, Aggregator) that interact with iFLEX Assistant for communicating energy tariffs and flexibility requests, or for providing the end users with energy advice and feedback on their participation in flexibility services. |
| **Meter Data Access Interface** | - | System Interface | Interface providing access to smart metering data. May represent different external systems and devices (e.g. Smart Meter, MDMS, DMS). |
| **Meter Data Management System** | MDMS | System | System responsible for storing and managing data delivered by smart meters. Provides smart meter data to the iFLEX Assistant. |
| **Sensor** | - | Device | Device that measures certain variables within the end-user's premises, e.g. room temperature. Provides information to the iFLEX Assistant either directly or via the EMS. |
| **Smart Meter** | SM | Device | Device that provides real-time metering data (e.g. energy consumption, energy generation). Provides smart meter data to the iFLEX Assistant. |
| **Weather Service** | - | Application | Application that provides access to weather data (historic, forecast). |

# 4 Business Requirements

An analysis of the business requirements of iFLEX Assistant project is presented in this chapter, in the form of business use cases – identifying actors, scope, assumptions and use case description; as well as in the form of individual requirements, documenting domain related needs for the various stakeholders.

First, we give an overview of the most relevant stakeholders.

## 4.1 Relevant Business Stakeholders

**Energy Supplier and Balance Responsible Party** Energy Suppliers or Retailers participate in day-ahead wholesale electricity markets and purchase power to meet expected load in the next day based on demand forecasts. Any inaccuracies in demand forecasting (and in power procurement) may create imbalances between supply and demand at the grid access point(s) of a retailer. For each grid access point, there must be a designated Balance Responsible Party (BRP). The BRP may be a producer, major customer, energy supplier or trader, and therefore it can be the retailer itself or an external business entity. BRPs have to settle imbalances through power exchanges in the real-time wholesale market or other power exchange at – most probably - expensive imbalance tariffs or employ of demand-side management techniques, so that the power balance is met by means of flexibility on behalf of their consumers and prosumers. BRP also face imbalance penalties should the imbalance violate certain bounds on power frequency or duration. Moreover, retailers can participate in the real-time wholesale power exchanges as flexibility providers, selling flexibility services to BRPs that need it.

**Resource Aggregators**[2] Resource Aggregators must be able to procure flexibility services for all market roles (mainly DSO, TSO, BRP, generator) in order to be viable and maximise their return on investment. A level-playing field suggests that flexibility activation should span all timescales (from long-term contracts up to real-time), thus support for both automated and manual demand response campaigns should be supported. Furthermore, an Aggregator should be allowed to serve multiple flexibility purchasers at the same time (unless contradicting) by selecting the most appropriate flexibility sources from his portfolio. In an extreme scenario this means that x% of a member's flexibility at a certain period is used for helping BRP A and the rest, (i.e., (1-x)%) for BRP B.

For a sustainable business case, the Resource Aggregator's portfolio should be**:**

- large enough in absolute numbers which means that supporting systems should be scalable;
- diverse by securing high accuracy for profiles referring to a wide set of member types (e.g., residential consumers with smart devices, residential consumers without smart devices, community buildings, residential prosumers, energy communities, commercial customers, etc.), or even individual assets (PV plant, fixed storage system, EV, etc.), as well as widely distributed in space.

To attract more members, Aggregators need to provide incentives that are carefully designed to cater for the needs of different types of members and which may involve financial compensations, rewards, equipment, etc. Any penalties for failing to deliver the promised flexibility over a certain period should be also clearly communicated to its members and agreed upon. Thus, various contract types should be designed and offered to its members with clear terms and conditions.

For each member, baseline and flexibility profiles are needed. For example, based on the former profiles an Aggregator could announce (if needed) a baseline forecast for its portfolio to a market facilitator, who could later compute the actual flexibility delivered by comparing the forecasted energy to actual smart-meter measurements. Any of these profiles may be created, and regularly updated, by an external entity or compiled by the Aggregator itself by feeding relevant models with historical smart-meter data (or sub-meter measurements) that it is granted access to.

Additional pieces of information for each member, apart from baseline and flexibility profiles, that should be available to Aggregators include:

[2] ENTSO-E. Harmonised Role Model. Available at: Harmonised_Role_Model_2020-01.pdf (entsoe.eu) Accessed: January 29, 2021.

- geographical location (or serving substation and feeder of access point) for being able to address congestion incidents in distribution (or transmission) network, to forecast weather conditions, etc.
- details on the BRP associated to that member's supplier or producer (e.g., virtual power plant) so that BRP can be informed about any pending flexibility activations triggered by the Aggregator. After receiving such notifications, the BRP could make any adjustments to the balance schedule that it had already announced in order to avoid imbalance charges attributed to flexibility activations.

Given that an Aggregator's portfolio will need to interact with several external systems, such as iFLEX assistant, standardised interfaces are preferred.

**System Operators** TSOs and DSOs are regulated entities responsible for ensuring system stability, quality of service and security of supply in the most cost-effective way. Thus, it is important that they can use flexibility when the total expected costs to the overall market from employing demand-side management techniques are less than traditional network expansion costs (laying down more electricity feeders, upgrading transformers, etc.) over a long-term period (e.g., 10-15 years). This paradigm shift from high, yet known, upfront capital-intensive investments to recurring operating expenditures of potentially high variation, requires approval from regulatory authorities so that flexibility costs are part of the "normal" regulated cost-base of system operators. Even if traditional approaches are found to maximise social welfare in the long-run, flexibility provisioning can act as a short-term remedy while network upgrades are planned, approved, deployed, tested and delivered. Thus, DSOs and TSOs should be allowed to procure system flexibility services in all timescales and to recover their costs in an appropriate manner [9].

Furthermore, system operators should have visibility over flexibility needs that could affect their networks and, if needed, they should be able to able to control and jointly coordinate flexibility activations. For example, they may need to assess the impact of planned flexibility activations on the future voltage levels so that they can refuse those if system stability, security or quality is jeopardised.

**Prosumers & Energy Communities** Prosumers and Energy Communities want to be able to install distributed generation technologies in their premises or a near-by location, but a DSO needs to approve their deployment by considering network constraints.

As soon as Prosumers and Energy Communities commence their activities, they are interested in maximising local production so that they reduce energy bills, increase revenues, reduce carbon footprint and/or secure electricity supply in case of power outage. Aggregators can help in this direction by managing consumption and production according to the predicted or actual system/market/environmental conditions. Prosumers and Energy Community members expect to be able to override Aggregator's decisions/actions according to their present needs and preferences.
Furthermore, Demand-Side Flexibility can be beneficial for prosumers by reducing curtailment of distributed generation, as well as outage times (that usually require distributed generation units to be disconnected for safety reasons).

## 4.2 Business Use Cases

### 4.2.1 BUC-1: Optimise BRP operation by leveraging flexibility from consumer/prosumer through DR

**Stakeholder Perspective:** Balance Responsible Party (BRP), Integrated retailer (retailer and BRP), Integrated "gentailer" (retailer & BRP & generator)
**Other Stakeholders**: Consumer, Prosumer, Independent Aggregator
**Scope**
According to current market structures, all market entities active in the wholesale electricity markets, such as Retailers and Generators, have to comply with certain requirements regarding their balance in day-ahead and intra-day wholesale markets. In order to facilitate balancing their portfolio, Balance Responsible Parties of Retailers (and Generators), and Retailers choosing to be responsible for their imbalances could make use of demand-side management techniques so that their Consumers and Prosumers are incentivised to adjust their demand and/or production decisions when instructed to do so.
**Objectives**

- BRPs to increase profitability and competitiveness by reducing imbalance charges (self-balancing and passive balancing) [10]
- Integrated suppliers and Integrated “gentailers” to increase profitability and competitiveness by [10]:
    - reducing of an integrated supplier's (retailer & BRP) imbalance charges (self-balancing and passive balancing)
    - reducing overall electricity purchase costs (e.g., shift loads from a high to a low-price time interval on a day-ahead basis, or closer to real-time)
    - reducing overshoot or undershoot in production output compared to promised one
    - providing attractive tariff schemes to a wide range of customers.

**Description**

Towards achieving better balancing and avoiding increased costs from balancing market (i.e., imbalance penalties) and/or increased costs for electricity purchase costs in wholesale markets (e.g., closer to real-time), BRPs, Integrated Retailers and Integrated “Gentailers” can reduce their operational costs and/or expand their customer base by leveraging flexibility services from consumers and prosumers. Demand-side flexibility can be obtained by several means:

- Explicit Demand-Response campaigns, where an Aggregator that can be an independent service provider or a Retailer, trades/dispatches the flexibility of its user group on different energy markets (wholesale, balancing and reserves markets). End users may be offered various types of incentives for providing their flexibility:
    - Financial compensation, e.g., a certain remuneration per KWh or KW
    - Prizes and rewards, e.g., cinema tickets, vouchers, etc.
    - Social recognition, e.g., leaderboards, etc.
- Implicit Demand-Response, where consumers react to competitive tariffs announced by Retailers (reflecting variability on the condition of its balance or the wholesale market) or regulated tariffs set by network operators (DSOs and TSOs). Such implicit demand response schemes can help consumers (e.g., especially those having a consumption profile that is flexible enough to take advantage of low-priced periods) to lower their energy bills. Dynamic pricing schemes include:
    - fixed Time-of-Use (ToU) rates, which specify different fixed energy prices for specific times of day (or week).
    - Critical Peak Pricing (CPP) that aim to reduce consumers’ load during the relatively few very expensive periods every year (e.g., 20) by following the electricity costs at the wholesale level. Time-of-Use prices or uniform prices that are lower compared to standard ones apply during the rest periods.
    - Dynamic prices that are established a day in advance, on a daily or hourly basis, or even in real-time (RTP). Furthermore, these prices can widely vary resulting in consumers being compensated for their consumption (i.e., negative prices) or paying extremely high charges. Current experience has showcased that providing access to dynamic price contracts empowers consumers and can in many cases significantly reduce the energy supply component of the electricity bill. For example, the annual savings of consumers with annual consumption below 1000 KWh can be in the range of 15 –80 EUR per year [11].

Both explicit and implicit campaigns can be realised via direct load control and manual flexibility activation by consumers.
The iFLEX Assistant will enable the realisation of this business case by implementing automated control strategies based on the price signals of the BRP/Retailer with respect to the preferences of the end user (i.e. Consumer, Prosumer), at the level of the facility.

**Assumptions**

- The market enables the ability to offer implicit or explicit DR schemes.
- Smart meters provide regular measurements.
- Explicit Demand Side Management techniques (and direct load control programmes especially) are treated on par with Supply Side flexibility.
- In case of direct control, the Consumer/Prosumer has provided the needed consent.

### 4.2.2 BUC-2: Optimise grid operation by leveraging flexibility from consumer/prosumer through DR

**Stakeholder Perspective:** Distribution System Operator (DSO), Transmission System Operator (TSO)
**Other Stakeholders:** Aggregator, Consumer, Prosumer

**Scope**

The Distribution System Operator (DSO) is responsible for maintaining the Low/Medium Voltage distribution grid in a cost-effective way and providing secure and high-quality power to end users in terms of service continuity and stability of electrical parameters (namely voltage and frequency within the limit). Similarly, the Transmission System Operator (TSO) is responsible for installation and maintenance of the High-voltage transmission grid and for system stability. Furthermore, they are responsible for approving the deployment of a new generation plant (distributed or not) by considering network constraints.

**Objectives**

- Cost-effective management of distribution and transmission network so that capacity upgrades are avoided, deferred or ensuring high-quality power supply until network reinforcements are completed.
- Penalties (e.g., for frequent outages) are avoided.
- Cost-effective frequency regulation in transmission network (e.g., Frequency Containment Reserve, Automatic Frequency Restoration Reserve, Manual Frequency Restoration Reserve)

**Description**

The rise of renewables, general shift towards electrification (e.g., mobility and heating/cooling) and gradual phase-out of centralised generation units for ensuring climate sustainability are driving the need for demand-side flexibility by DSOs and TSOs [10].

In particular, DSOs may purchase flexibility for:

- Voltage control, as increased/decreased voltage levels can occur in the (local) grid when renewable systems generate significant reverse power flows, or respectively when local consumption exceeds production.
- Congestion control, as further increase/decrease of voltage over the limit (normally ±10% of the rated voltage) in case of high production or consumption may lead to a power outage. Furthermore, by reducing peak loads, the lifetime of grid component can be extended.
- Reducing technical network losses by reducing peak loads (since the energy lost during transportation is physically proportional to the square of the transported energy).
- Smoother black out management, as demand is usually increased after a power outage event and restoration procedures may be significantly challenged.

Furthermore, demand-side flexibility can be used by TSOs for:

1. Congestion control.
2. Balancing services so that system frequency is restored to its nominal frequency of 50 Hz. These services include Frequency Containment Reserve (FCR), Automatic Frequency Restoration Reserve (aFRR), Manual Frequency Restoration Reserve (mFRR) and Replacement Reserve (RR).
3. Strategic reserves so that generation capacity and demand flexibility can be activated by the TSO in case of black-out.

The iFLEX Assistant will enable the realisation of this business case by implementing automated control strategies based on DSO, TSO requests for flexibility, or the dynamic network tariffs set by the System Operators, with respect to the preferences of the end user (i.e. Consumer, Prosumer), as well as at the level of the facility/building.

**Assumptions**

- The market enables the ability to offer implicit DR schemes for network tariffs.

### 4.2.3 BUC-3: Offer the flexibility of a multi-vector energy system (building community) to the energy markets

**Stakeholder Perspective:** Building Community

**Other Stakeholders:** Consumer, ESCO, Retailer, Aggregator, District Heating Company

**Scope**

The Building Community aims to take advantage of new revenue streams in order to compensate for part of the building energy costs. This objective can be achieved by leveraging flexibility from shared assets, individual residents and common areas, and offering the aggregated building flexibility to the relevant energy markets and/or district heating provider.

**Objectives**

Economic benefits from offering flexibility to the electricity market and/or district heating network.

**Description**

The Building Community wants to benefit from a new revenue stream, which will be derived from offering the aggregated building flexibility to the electricity market and/or to the district heating network. This will be subsequently beneficial for individual Consumers, since they are members of the Building Community.

This business case can be facilitated by the adoption of the iFLEX Assistant from the Building Community, as the assistant can manage the flexibility of the building via either automated or manual control, taking also into consideration the preferences of the Community and leveraging the modelling of the dynamic behaviour of the building to calculate the optimum control scenarios. Furthermore, the iFLEX Assistant will be able to learn the behaviour of the end users at the building level and adapt its control strategy accordingly. Hence, its operation will not hinder the comfort levels of the Building Community members.

**Assumptions**

- An Energy Service Company (ESCO) manages the facility of the Community and facilitates achieving the objective of offering the aggregated flexibility to the electricity market and/or for district heating network.
- The members of the Building Community provide the ESCO with their consent to implement flexibility control strategies with the aim to offer their aggregated flexibility to the relevant markets.
- The Building Community can participate in DR schemes offered by the market (e.g. via the Retailer or independent Aggregators).

### 4.2.4 BUC-4: Optimal energy consumption for multi-vector energy system (building community) based on the behaviour of consumers and market price signals

**Stakeholder Perspective:** Building Community

**Other Stakeholders:** Consumer, ESCO, Retailer, District Heating Company

**Scope**

The Building Community wants to decrease the heating and electricity costs of the facility. This objective can be enabled via the execution of energy consumption optimisation strategies, which will be based on market price signals (for both electricity and district heating) and the consumption behaviour of the residents.

**Objectives**

Reduce heating and electricity costs.

**Description**

The Building Community aims to reduce heating and electricity costs by optimising the operation schedule of the aggregated multi-vector building energy system. This goal will be facilitated by predicting the behaviour of Consumers and taking advantage of market price signals provided by the Retailer and/or the District Heating Company. This will be subsequently beneficial for individual Consumers, since they are members of the Building Community.

An ESCO, that wants to provide advanced energy services at building level in order to attract new customers, manages the facility of the Community and facilitates the energy consumption optimisation of the multi-vector building energy system. Retailers will offer dynamic energy pricing schemes to the Consumers, so that they can implicitly leverage flexibility from them, with the aim to decrease their imbalances and increase their competitiveness.

The iFLEX Assistant can facilitate the execution of the proposed business case by optimising the aggregated energy consumption of the building facility based on market price signals. This optimisation will be implemented considering also the consumption behaviour of the Building Community, which will be learned by the iFLEX Assistant. Thus, the desired goal will be achieved without affecting the comfort levels of the residents.

**Assumptions**

- An ESCO manages the facility of the Community
- The Building Community receives dynamic market price signals.

### 4.2.5 BUC-5: Added value services: Customer load profile analysis and overview

**Stakeholder Perspective:** Consumer
**Other Stakeholders:** Retailer

**Scope**

The consumer is offered with load profile analysis for its consumption. The electricity consumption is summarised per hour/day/week/month, per device and/or per activity domain, so that the consumer can observe any wastages of energy or home network leaks. This service could be offered by a retailer to its customers as an add-on service.

**Objectives**
To present to the consumer a detailed analysis of its electricity consumption.

**Description**
As a competitive advantage or as an extra service, a retailer can provide its customers a detailed analysis of their consumption profiles. The consumption information can be provided in various levels of detail, on a temporal basis hourly/daily/weekly/monthly, on a device basis, or on the basis of activity category. Consumption will be monitored on a power (KW) / energy (KWh) basis, and will be presented in comparative/illustrative manner to the user (e.g., in pie charts, bar charts etc.), so that the main drivers of consumption are revealed. This information can be derived based on the analysis of the metered electricity consumption, based on clustering of energy data and with the combination of sensor readings, such as temperature, humidity, motion, etc. Importantly, the analysis of consumption data can be kept local at customer premises, if needed.

**Assumptions**
- The Consumer has expressed interest for detailed energy-consumption data analysis.
- Smart meters provide regular measurements.
- Sensor readings are available (through EMS or directly).
- The Consumer has provided consent to process its energy consumption data.

### 4.2.6 BUC-6: Increase self-balancing through advanced monitoring and automation

**Stakeholder Perspective:** Prosumer
**Other Stakeholders:** ESCO

**Scope**
The Prosumers want to make the most out of their investments on residential DER assets (e.g. PV plant). In parallel, they aim to increase their sustainability by maximising absorption of on-site generated energy. These objectives can be facilitated by exploiting energy generation and consumption forecasting, as well as operation optimisation of the end-user's energy system.

**Objectives**
- Increase self-balancing
- Improve sustainability performance

**Description**
The Prosumers pursue reducing their energy costs and/or increasing their sustainability. These goals can be enabled via leveraging energy forecasting and subsequently optimising the operation of the Prosumer's energy assets and devices.

This potential can be fulfilled through several functionalities of the iFLEX Assistant. First, it can facilitate the energy monitoring of the household and provide the Prosumer with relevant alerts (e.g. when exceeding certain thresholds). On top of that, the Prosumer can also have access to a set of sustainability metrics. Moreover, consumption and generation forecasting, as well as scheduling optimisation are among the core functionalities of the iFLEX Assistant. Furthermore, the automated operation of the system can be personalised according to the preferences of each end user. Finally, the Prosumer can opt for receiving tailor-made energy advice.

An ESCO that offers to its customers services related to design, installation and maintenance of residential PV systems can benefit from the adoption of a system, such as the iFLEX Assistant, which has the potential to automatically optimise the operation of the end-user's energy system.

**Assumptions**

- Smart meters provide regular measurements
- Information of DER capacity is available

### 4.2.7 BUC-7: Optimise end-user's energy consumption based on own preferences and market price signals

**Stakeholder Perspective:** Consumer/Prosumer
**Other Stakeholders:** Retailer, Aggregator, DSO

**Scope**
Consumers and Prosumers are interested in decreasing their electricity costs. This pursuit can be enabled by shifting their energy consumption in accordance with the electricity market price signals.

**Objectives**

- Lower energy costs
- Increase utilisation of DER investments

**Description**
Thanks to the digitalisation of the energy system, new opportunities arise for residential and small commercial end users. Using the capabilities of digital assistants, they can leverage flexible pricing schemes (static or dynamic), optimally adapting their consumption schedule to reduce their energy costs.

Current experience has showcased that providing access to dynamic price contracts empowers consumers and can in many cases reduce the energy supply component of the electricity bill [12]. On the other hand, Prosumers can better exploit their production/investment by consuming their PV-generated power when the electricity consumption price is high or exporting their excess energy to the grid at times when they can achieve higher remuneration.

The Flexibility Procurer on the other hand, can make use of such schemes in order to motivate its customers to adapt their profile, towards improving its operation which can concern balancing of portfolio in the case of BRPs, or the operation of the system in the case of DSOs.

The iFLEX Assistant can facilitate the execution of this business case by managing the end-user's energy system based on the electricity price signals and the preferences of the end user. This process is supported by the energy forecasting and operation optimisation functionalities of the iFLEX Assistant. The end user will be also equipped with the capability to view the gained rewards for shifting his/her electricity consumption based on the market price signals and register – if interested – for a new flexibility service among a list of adequate programmes.

**Assumptions**
The Consumers/Prosumers are able to subscribe to flexible price scheme contracts.

### 4.2.8 BUC-8: Offer flexibility through participation in explicit demand response programmes

**Stakeholder Perspective:** Consumer/Prosumer
**Other Stakeholders:** BRP, Retailer, Aggregator

**Scope**
Consumers and Prosumers can offer their flexibility to BRPs by enrolling in explicit demand response programmes. Hence, they can take advantage of this new revenue stream and decrease their electricity costs.

**Objectives**
Lower energy costs

**Description**

Thanks to the digitalisation of the energy system, new opportunities arise for residential and small commercial end users. Using the capabilities of digital assistants, they can benefit from offering their flexibility to a BRP (directly or through an Aggregator), receiving remuneration in various forms (e.g. bill reduction, non-monetary rewards).
As regards the BRP, it can improve its balancing by leveraging flexibility through explicit demand response actions from Consumers and Prosumers, who will be incentivised to modify their energy profile according to the BRP's needs.

This business case can be enabled via the iFLEX Assistant through its functionality of managing flexibility requests, optimising the end-user's energy system based on selected preferences. Such operations of iFLEX Assistant are enabled through forecasting of baseline consumption and calculation of flexibility offerings. Moreover, the end user can view his/her benefits for participating in demand response actions and opt for a different flexibility program among several which are appropriate for his/her available energy assets and devices.

**Assumptions**

The Consumers/Prosumers is able to subscribe in explicit demand response programmes.

# 5 End-user Requirements

This chapter is concerned with the perspective of the end users and their desired functionalities of the iFLEX Framework. Since in iFLEX project the primary end users are the energy consumers and prosumers at individual (e.g., household, small-scale business) or community level, focus is mainly on this end-user group.

## 5.1 A holistic approach to user experience

The design of the iFLEX Assistant is driven by a user experience design approach, which entails identifying the why, what and how of iFLEX use. Design should therefore not only cover aspects related to the use of the product (the "what" and "how") but also consider the motivations and needs behind the interaction (the why).

When designing experiences in the interaction with digital products, it is necessary to go beyond the product use itself as suggested by the model by Hassenzahl [13] shown in Figure 5. The model depicts a hierarchical structure of how we are driven by different goals in the interaction with the world. The 'be goals' at the top represent the needs and emotions that motivate interaction (why we interact). Do-goals reflect the action i.e., what we choose to interact with and 'motor goals' specify how the interaction is happening. So, in the case of the iFLEX Assistant, the feeling of 'being in control and competent' are examples of 'be goals' that can be the underlying reasons for interaction. A 'do goal' can be 'see my energy consumption' and a motor goal could be 'touching the View-icon on the screen'. As shown on the right side of the model, the 'do goals' and 'motor goals' are related to the product use. However, when designing experience, it is not enough to look at these. One has also to consider the 'be goals' which are placed at the top of the hierarchy, because they motivate the interaction in the levels below and give it meaning ( [13], p.13).

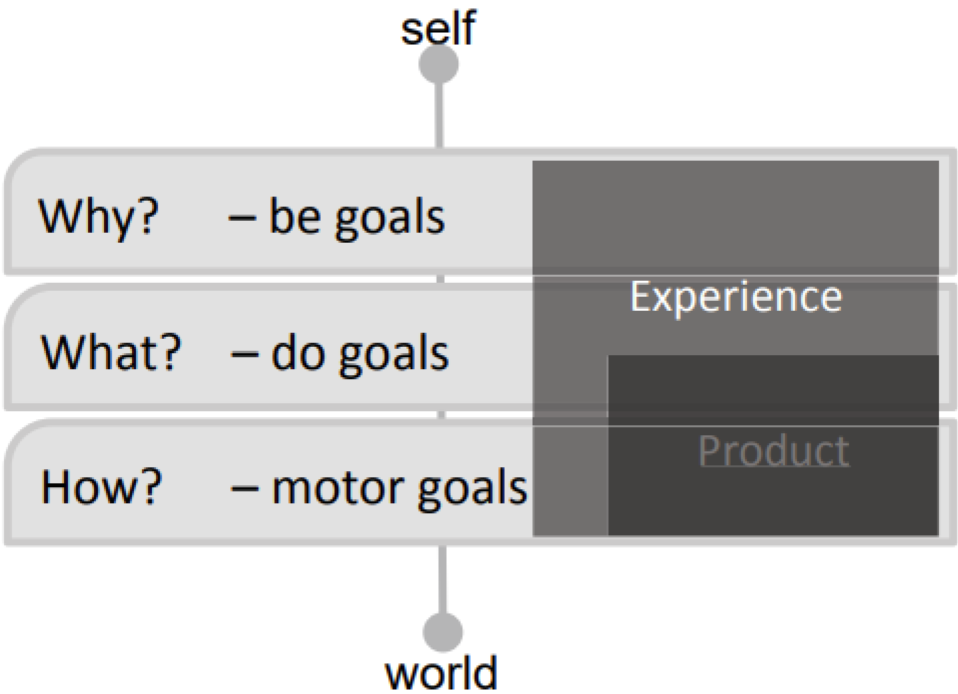


Figure 5 Three level hierarchy of goals [13]

The position indicates that 'be goals' are a central starting point for experience design since they are close to the user's motives and feelings which are 'integral to experiences (maybe even its core), inextricably intertwined with our action' [13]. Considering the user motivation and 'be goals' in the design of the iFLEX Assistant and focusing on the fulfilment of these needs can thus help enhance existing service offerings and create new services that can drive user participation in demand response.

The following section highlights the design principles in relation to the motivational aspects (the "why") before moving onto requirements concerned with the usage of the system (the "what") and design principles for the user interface (the "how").

Since this document has been developed at an early stage of the project, the principles and requirements have been elicited from internal expert workshops, existing research and domain knowledge as well as the iFLEX concept vision and are thus subject to revision and alteration in the engagement of the actual end users in iFLEX and the research of their needs and the context of use.

### 5.1.1 User motivation

The user motivation and needs behind the use of a product can vary and co-exist depending on the situation.

Table 3 depicts 10 universal psychological needs ( [14], adapted from [15]) which can be seen as categories of experiences and a source of 'be goals' [13]. The degree of fulfilment of a particular need behind the interaction determines the value of the experience.

Table 3 Ten central psychological needs [11] adapted from [12]

| | |
|---|---|
| **Autonomy** | Feeling independent and self-decided |
| **Competence** | Feeling capable and effective |
| **Relatedness** | Feeling a sense of belongingness and closeness |
| **Self-Actualisation** | Feeling meaningful in life and capable to progress toward the highest potentials |
| **Security** | Feeling safe and in control |
| **Money-luxury** | Feeling sufficiently rich and able to purchase most of the desirable things |
| **Popularity-influence** | Feeling popular and influential |
| **Physical thriving** | Feeling healthy and well taken care of |
| **Self-Esteem** | Feeling respected and worthy |
| **Pleasure-stimulation** | Feeling enjoyed and pleased |

Key needs or 'be-goals' identified in iFLEX are related to autonomy, competence and security but also self-actualisation, relatedness and pleasure are at play. They all indicate what needs iFLEX design should focus on to achieve a positive user experience. Which of these needs is the most prominent depends on the individual and the situation and are thus dynamic sizes. The following statements indicate the positive experiences that the design of iFLEX should frame:

Experience of being competent, independent and in control (personal aspect):

- The service is beneficial since it enables me to gain economic benefits;
- The service is smart since it helps me to optimise my energy without losing comfort.

Experience of being meaningful, respected and belonging (social and societal aspect):

- The service is meaningful since it helps to conserve energy and thereby reduce my environmental footprint.

## 5.2 User interaction

The interaction between the user and the iFLEX Assistant concerns the 'do goals' and 'motor goals' layers presented by Figure 5, i.e., what the user would like the system to do and how the interaction takes place. As mentioned, these two aspects 'what' and 'how' should relate to the 'why' in Figure 5.

Whereas Section 5.1.1 looks upon the hedonic quality of interaction i.e., the 'product's perceived ability to support the achievement of be-goals' ( [13], p. 49), this section deals with the pragmatic quality i.e., 'the product's perceived ability to support the achievement of do-goals' ( [13], p. 49) and is thus more product-oriented, dealing with a product's  functionality, content, presentation and interaction [13] and related aspects of usefulness (does it solve my need and will I use it), usability (is it an effective and efficient tool) and attractiveness (does it provide pleasure and is it desirable) which collectively influence the user experience of the interaction.

Several principles exist for (product-oriented) user experience and common to them all is the focus on involvement of the user (designing for the user through user research, prototyping and user testing) and the identification of needs together with a focus on the entire experience before, during and after the interaction (looking at it as a journey).

### 5.2.1 User stories

The requirements related to what the user would like the system to do are documented through the following user stories which follow the sentence structure: 'As a …(stakeholder), I want to…(goal/task) so that (desired outcome). User stories help depict how iFLEX can provide value i.e., be useful seen from the user's perspective. The following user stories focus on the main user in iFLEX which is the consumer/prosumer.

**As a consumer/prosumer…**

| Story Narration | Title | Story ID | Source | Related use case(s) |
|---|---|---|---|---|
| I want to see my energy consumption/production in a detailed, real-time and historic manner so that I can understand my energy system and trends more clearly and make timely decisions | Improved visibility into energy consumption and/or production | US-01 | Pilot workshop | PUC-7 Monitor my energy in real time<br><br>PUC-3 Monitor my sustainability metrics |
| I would like to have the option to choose and change the level of automation, ranging from automatic energy optimisation to manual optimisation through advice on reaching targets so that I have the freedom of choice | Choice of control | US-02 | DoA | PUC-1 Manage my preferences<br><br>PUC-5 View energy advice |
| I want to view information on and see the results of my participation in demand response so that I can evaluate the status and effect | View information on and results of demand response participation | US-03 | Pilot workshop | PUC-4 View metrics for participation/engagement |
| I would like the system to consider and adapt to my personal preferences and needs so that it is always relevant to my situation | Adapt to personal preferences and needs | US-04 | DoA | PUC-1 Manage my preferences |
| I would like any communication with the service to happen as seamless and natural as possible so that it makes operation easy and convenient for me | Seamless and natural communication | US-05 | DoA | PUC-1 Manage my preferences |

#### 5.2.1.1 Usability

How well the design helps the user to achieve the above 'do' goals determines the level of usability. The International Organisation for Standardisation (ISO) defines usability as: 'the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness (accurate), efficiency (quick) and satisfaction in a specified context of use' [16]. Understanding the specific user and context is hence central to usability. The following list some of the central design principles for usability as defined by [17]:

- Work with a clear understanding of users' goals and show it in your design;
- Mimic the real world regarding concepts, icons and language;
- Present instantly understandable, jargon-free messages and actions users can take—one chief action per screen;
- Limit options to give a strong information scent on an uncluttered display—show essential information for completing tasks;
- Keep content consistent;
- Follow established norms regarding function and layout (e.g., logo positioning, tappable buttons);
- Use proper font size, colour, contrast, whitespace, etc. to:
    - combine aesthetic appeal with scanning readability,
    - present a clear, logical information hierarchy,
    - design for accessibility;
- Use chunking (group information into smaller memorable chunks);
- Offer informative feedback about system status;
- Include helpful navigation systems and search functionality;
- Allow for customizable controls, including shortcuts;
- Avoid disruptions – e.g., forced logins/pop-ups;
- Make forms easy to complete;
- Include warnings and autocorrect features to minimise errors;
- Make errors easy to diagnose;
- Offer easy-to-understand help documentation and show clear contact options;
- Provide a back button to undo actions;
- Consider server abilities regarding page-loading time and downtime;
- Beware of in-app browsers and restrictions (e.g., scrolling) in mobile design;
- Make links active and describe them accurately.

### 5.2.2 User interfaces

User interfaces provide the access point between consumers/prosumers and the iFLEX Assistant and deal with the achievement of 'do' goals through 'motor' goals, specifying the visual and interactive elements.

In IFLEX, the user interface is planned to be implemented as a mobile and web application with support for natural user interaction to support the aim of making participation in demand response as easy as possible.

<u>Natural user interfaces</u>

The aim of a natural user interface is to make the interaction with and guidance by the iFLEX Assistant as natural, simple and direct as possible, allowing for a broad range of usage skills such as voice, gesture and/or touch which increase accessibility. The aim is to leave most of the work to the iFLEX Assistant so that the user does not get overloaded or overly distracted.

However, to feel natural, the design needs to be appropriate to the context of use and skill level of the user (motor-sensory, cognitive, social) [18]. The following general design principles for natural user interfaces based on [19] and [18] are:

- Reuse existing skills or use simple skills, mirroring the natural interactions with the real world, so the user doesn't have to learn them or use too much time learning them. The aim is to minimise the cognitive load and hence distraction;

- Provide a smooth learning path from basic tasks to advanced tasks so that the user gets acquainted with how to do things before moving on. Limiting the number of tasks which can be done at any one time enables an easier decision-making;
- Design for direct interaction so that user action constantly correlates with the interface reaction. This can take different forms (touching it, real-time action-reaction, motion-sensing). Only provide information that is relevant to the current interaction to avoid choice overload.

Web and mobile interfaces

iFLEX considers both web and mobile applications for the iFLEX Assistant, integrating with existing customer energy management solutions and energy management systems. Often web interfaces allow for a more content-rich, in-depth engagement than the mobile application which is often linked to a minimal design approach for immediate access and action. The following are key guidelines for design of user interfaces as presented by [17]:

- Make buttons and other common elements perform predictably so users can unconsciously use them everywhere. Form should follow function;
- Maintain high discoverability. Clearly label icons and include well-indicated affordances: e.g., shadows for buttons;
- Keep interfaces simple (with only elements that help serve users' purposes) and create an "invisible" feel;
- Respect the user's eye and attention regarding layout. Focus on hierarchy and readability:
    - Use proper alignment. Typically choose edge (over centre) alignment;
    - Draw attention to key features using:
        - Colour, brightness and contrast. Avoid including colours or buttons excessively,
        - Text via font sizes, bold type/weighting, italics, capitals and distance between letters. Users should pick up meanings just by scanning;
- Minimise the number of actions for performing tasks but focus on one chief function per page. Guide users by indicating preferred actions. Ease complex tasks by using progressive disclosure;
- Put controls near objects that users want to control. For example, a button to submit a form should be near the form;
- Keep users informed regarding system responses/actions with feedback;
- Use appropriate UI design patterns to help guide users and reduce burdens (e.g., pre-fill forms). Beware of using dark patterns, which include hard-to-see prefilled opt-in/opt-out checkboxes;
- Maintain brand consistency;
- Always provide next steps which users can deduce naturally, whatever their context.

### 5.2.3 The energy perspective

Plenty of user research exists on the needs, motivations and barriers when it comes to energy consumption and change of behaviour through interaction with energy management solutions. Less user research has been done in terms of the prosumer role and participation in demand response.

The following list presents some common user perceptions which influence the consumer behaviour and motivation in the management of energy and consumption flexibility. They are extracted from a user study on energy consumption and visualisation by the MCHA project [20] and from an end-user validation report on flexibility services by the Flex4-Grid project [21].

Energy consumption is always mediated through our use of devices in different situations and is thus hidden to most of us [20]. Energy consumption is therefore linked to several factors listed below which can co-exist and sometimes conflict [20] as also mentioned in Section 5.1. Albeit they reflect perceptions in the design of an energy control unit, the factors are also relevant to the design and functionalities of a personal flexibility assistant dealing with energy consumption, offering key design considerations relevant to iFLEX.

The following list present the common perceptions and barriers together with associated design principles, relevant to iFLEX:

- Convenience/comfort is a high priority that people are willing to pay extra for. To 'act green' can be perceived as inconvenient.
    - The system should increase comfort through control of consumption that is adapted to the needs of each individual and preferences and automated so that they user does not have to be actively involved. (US-04: adapt to personal preferences and needs)
- Safety and security are basic needs.
    - The system should offer transparency and autonomy through collection and visualisation of consumption, communication of consumption alerts and automatic switch on/off functions. Meanwhile, the user should have the feeling that it is easy to use and control the system. (US-01: improved visibility, US-02: choice of control, US-05: Seamless and natural communication)
- Economy can be perceived both as a motivator (energy savings) and barrier (need of investment) for sustainable consumption.
    - Energy consumption and savings translated into money can help the users understand their consumption and gains and thereby experience a return on investment (US-01: improved visibility, US-03: View result of demand response)
- Technology can to some be a motivating factor and to some a source of insecurity.
    - The system should be accessible and easy to use for all. One way to achieve this, is to have different levels of user access based on the experience level. (US-05: Seamless and natural communication)
- Play and social interaction can motivate consumption change so that it becomes a fun and joint project.
    - It should be possible to benchmark consumption with that of others (US-01: improved visibility)
- Time can become a barrier to sustainable consumption if it is not considered quality time. And to be 'green' is often considered time consuming.
    - The system should help save time and make the green choice the easy choice. (US-05: Seamless and natural communication, US-02: choice of control)
- Aesthetics and design matter and design often determines the choice between products.
    - Aesthetic qualities and latent needs to send certain social signals must be met in the appearance of the product. (US-01: improved visibility)
- Social identity touches upon self-perception and the presentation towards others.
    - Visualisation of energy consumption (and participation in demand response programmes) can help promote the user as a green conscientious citizen and the system must support this. (US-01: improved visibility)
- Assumptive knowledge about doing the right (sustainable) thing steers consumption and might not be true.
    - The system should support giving advice on how to optimise consumption, supplemented by a simplification of consumption so that the user can be guided to correct behaviour. (US-01: improved visibility, US-02: choice of control)
- Environmental impact has become a central point of focus in how we consume energy and is a motivating factor. People would like to be able to position themselves within the ideal of environmental consciousness.
    - The system should provide this information through easy-to-use visualisation of consumption and the relation to environmental savings/impact and benchmarking own consumption. The system must give the users a clear conscience or give advice on how to improve. (US-01: improved visibility, US-02: choice of control)

The introduction of demand response programmes yields additional barriers since they call upon a more dynamic behaviour through introduction of external signals/requests and thus more potential 'disruptions'. Results from the Flex4-Grid project [21] present a central barrier related to attitude vs action. A significant gap appeared between users' positive attitude towards shifting energy usage and their actual behaviour. The more their lives were affected by energy shifting, the less they did it in practice. One of the reasons was related to convenience and comfort: Shifting consumption should not impact on comfort and time but be easy and convenient. Also, the user was more inclined to adapt consumption, the less requests there were.

Another reason was the reluctance to allow remote control of devices. The majority of users would not allow a delayed start of devices of more than 30 minutes, and one-third would not allow any delay (Flex4-Grid, 2018, p. 75). This finding illustrates the importance of the be-goal 'Autonomy' and the feeling of being in control and independent which the system must support. The majority of users indicate this self-reliance and that 'they would adapt their consumption because they think it is necessary' ( [21], p. 64). This need comes before a willingness to 'adjust if the distributor asked them' ( [21], p. 64).

However, the level of acceptance to change behaviour also depends on the constraints of the system and the cost of electricity. Energy consumers who are used to time-varying tariffs or consumption restrictions are more accustomed to shifting energy consumption than consumers with an unchanging tariff. Behaviour is also affected by electricity prices which vary across Europe, making consumers who pay a low rate less susceptible to change their energy practice.

The following design principles can be extracted:

- Shifting energy consumption continuously is inconvenient
    - The system should allow for automation so demand response does not impact too much on comfort and time. (US-04: Adapt to personal preferences and needs, US-05: Seamless and natural communication)
- Remote control conflicts with self-autonomy
    - The system should respect user preferences, allow transparency of operation and user control and provide feedback on events performed. (US-04: Adapt to personal preferences and needs, US-02: choice of control, US-03: View result of demand response).

# 6 System Requirements

This section presents the system perspective of iFLEX's requirements, documenting the functional requirements. This analysis is based on the use case analysis methodology. The system context was defined subsequent to the analysis of the business context and use cases. First, the technical actors involved in the iFLEX project were identified. Then, the definition and analysis of the High-Level Use Cases (HLUCs) followed. As lower-level functions of the system were distinguished, Primary Use Cases were described. In the following subsections, the final result of the iterative refinement of the technical use cases is presented, including both High-Level and Primary Use Cases.

## 6.1 High Level Use Cases

In this section, the HLUCs of the iFLEX project are described. The distinction between the HLUCs is based on their scope, as well as the involved actors. Hence, HLUC-1 concerns the functionalities of the iFLEX Assistant, which ensure the provision of advanced energy management services to its users. HLUC-2 extends the previous one by exposing the features of the assistant which will enable end users to offer flexibility management services to interested energy and flexibility market actors. As regards HLUC-3, it differs from HLUC-2 on the basis of the actors involved. Namely, this use case addresses the iFLEX solution at a building level, so both a building facility manager and individuals (residents of the building) might be users of iFLEX Assistant. Furthermore, within the scope of HLUC-3, exploitation of the assistant with respect to holistic energy and flexibility management will be investigated, by considering both electricity and district heat vectors.

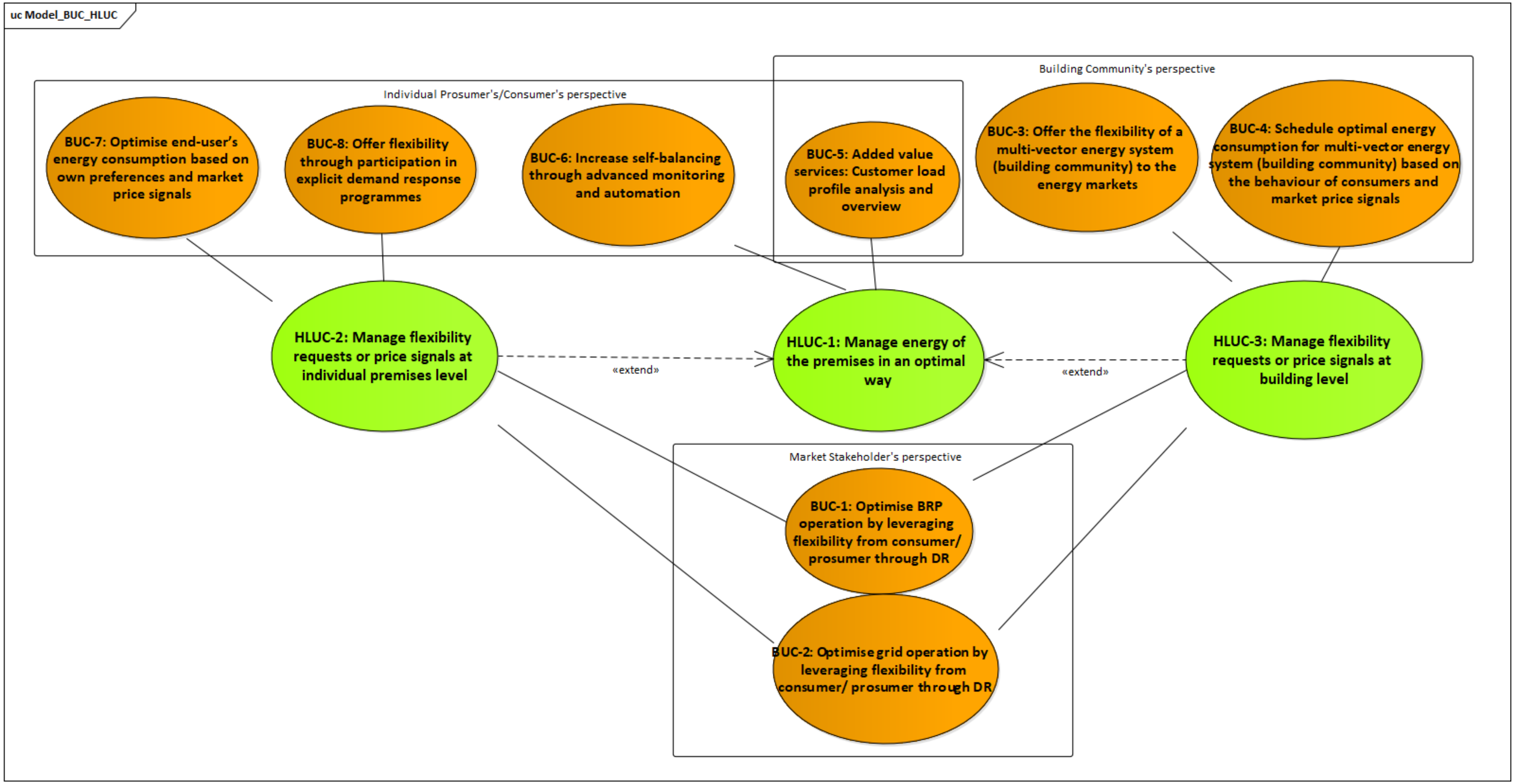



Figure 6 High Level UCs and relation to Business UCs

### 6.1.1 HLUC-1: Manage energy of the premises in an optimal way

#### 6.1.1.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | Describes the process followed by iFLEX Assistant for optimally managing the energy of a premise, pursuing different objectives e.g. lowering energy costs, increasing sustainability. |
| **Objectives** | 1. Monitor in real-time the energy flow within the premises.<br>2. Increase self-balancing through advanced monitoring and personalised automation.<br>3. Monitor sustainability performance.<br>4. Receive customised energy advice. |
| **Related business case(s)** | • BUC-5 Added value services: Customer load profile analysis and overview<br>• BUC-6 Increase self-balancing through advanced monitoring and automation |
| **Related user experience goal(s)** | To be competent, independent and in control |
| **Name of author(s)** | ICOM |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI4a_DoA | Return on Investment for prosumers in the base scenarios | Calculation of Return on Investment through a Cost Benefit Analysis (CBA)-based technoeconomic evaluation under various business modelling scenarios. A sensitivity analysis will also be performed for alternative settings, e.g. changes to electricity tariffs. | Increase self-balancing through advanced monitoring and personalised automation (PUC-10).<br>Monitor in real-time the energy flow within the premises (PUC-7). |
| KPI4c_DoA | Monetary benefits to the consumer in the base scenarios | Decrease of costs for the consumer compared to current situation. | Increase self-balancing through advanced monitoring and personalised automation (PUC-10).<br>Monitor in real-time the energy flow within the premises (PUC-7). |
| KPI10a | Increase self-consumption ratio | Increase self-consumption ratio of own PV-generated energy by scheduling accordingly the operation of dispatchable devices and assets. | Increase self-balancing through advanced monitoring and personalised automation (PUC-10). |
| KPI10b | Reduction in curtailed PV-generated energy [%] | Reduce the curtailment of PV-generated energy, in cases this is imposed by relevant DSO's rules. This goal is enabled via scheduling accordingly the operation of dispatchable devices and assets. Compare with the current state. | Increase self-balancing through advanced monitoring and personalised automation (PUC-10). |
| KPI3a | Environmental sustainability metrics | Define at least three sustainability metrics to be presented as a goal, measured and followed. | Monitor sustainability performance (PUC-3). |

| | | | |
|---|---|---|---|
| KPI3b | Improve progress | Improve engagement and progress of following the metrics by 10%. | Monitor sustainability performance (PUC-3). |
| KPI5a | Engage end users | Engage a number of end users in energy advice use case (more the 50). | Receive customised energy advice (PUC-5). |
| KPI5b | Advice applied | Estimated number of end users apply the advice successfully (30%). | Receive customised energy advice (PUC-5). |

| **Classification information** |
|---|
| **Relation to other use cases** |
| • HLUC-2 Manage flexibility requests or price signals at individual premises level (extended by)<br>• HLUC-3 Manage flexibility requests or price signals at building level (extended by)<br>• PUC-1 Manage my preferences (includes)<br>• PUC-2 Integrate iFLEX Assistant (includes)<br>• PUC-3 Monitor my sustainability metrics (includes)<br>• PUC-5 View energy advice (includes)<br>• PUC-7 Monitor my energy in real-time (includes)<br>• PUC-10 Increase self-balancing through forecasting and automation (includes) |
| **Level of Depth** |
| High |
| **Prioritisation** |
| High |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| Energy management, energy monitoring, energy advice, energy efficiency, sustainability |

#### 6.1.1.2 High-Level Analysis

| **Narrative of use case** |
|---|
| **Short description** |
| The iFLEX Assistant is charged with the task of optimally managing energy scheduling within the end-user's premises based on the economic and/or sustainability motives of its user. It also equips the user with the ability to monitor energy flow and performance metrics as well as receive advice aiming to drive the user towards a more sustainable behaviour. |
| **Complete description** |
| The iFLEX Assistant will enable the realisation of advanced energy management and monitoring of the end-user's premises. To accomplish this target, it has to exploit the locally installed EMS and make use of a set of diverse functionalities.<br><br><u>Real time energy monitoring</u><br>By exposing power generation and consumption in real time and providing an alert mechanism, the iFLEX Assistant can facilitate improving the energy performance of the premises and directing the end user towards sustainable and energy efficient behaviour.<br><br><u>Self-balancing enhancement</u><br>Especially in the case of prosumers, the iFLEX Assistant can utilise its advanced monitoring and automation features in order to improve their self-balancing. The automation goal can be tailored to the preferences of the end user. Namely, it can be influenced by economic reasons and aim at reducing energy costs by considering the electricity tariffs - provided by the Energy Supplier - or ecologically driven and pursue maximising self-consumption of own PV-generated energy. Weather data are taken into consideration in order to improve the automation schedule. |

| |
|---|
| Sustainability performance monitoring<br>The iFLEX Assistant will enable the user to set environmental sustainability goals as well as keep track of progress towards achieving them and sustainability performance in general. Key metrics will be visualised and presented to the end user assisting into gaining deeper insights on sustainability.<br><br>Energy advice provision<br>The end user will be offered the ability to opt for and follow tailored energy advice based on own personal motives. Possible objectives of the advice are cost reduction, improvement of energy efficiency or sustainability. |

| **Use case conditions** |
|---|
| **Assumption(s)** |
| • An Energy Management System (EMS) is installed and provides the status of local assets and relays the control commands of controllable ones.<br>• A Weather Service is integrated and able to provide weather data<br>• A Meter Data Administrator provides smart meter data to the iFLEX Assistant<br>• A Market Interface enables communication of energy market data (energy tariffs). |
| **Precondition(s)** |
| • The iFLEX Assistant is parameterised and fully operational.<br>• The iFLEX Assistant is able to communicate with EMS, Weather Service, Market Interface and Meter Data Interface<br>• The end user has provided consent to share certain energy metrics in order to receive tailored alerts and energy advice.<br>• The end user has provided consent to receiving alerts and energy advice. |

| **Actors** | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **Consumer/Prosumer** | Person | Wants to reduce energy costs and/or increase sustainability. |
| **Energy Supplier** | Business entity | Wants to foster the engagement of its customers. |
| **Meter Data Administrator** | Business entity | Provides smart meter data measurements to iFLEX Assistant. |
| **Energy Management System** | System | Assists the iFLEX Assistant in improving energy management through monitoring and control of devices. |
| **Weather Service** | Application | Weather forecasts can be exploited in order to improve the energy scheduling. |

| Diagram(s) of use case |
|---|

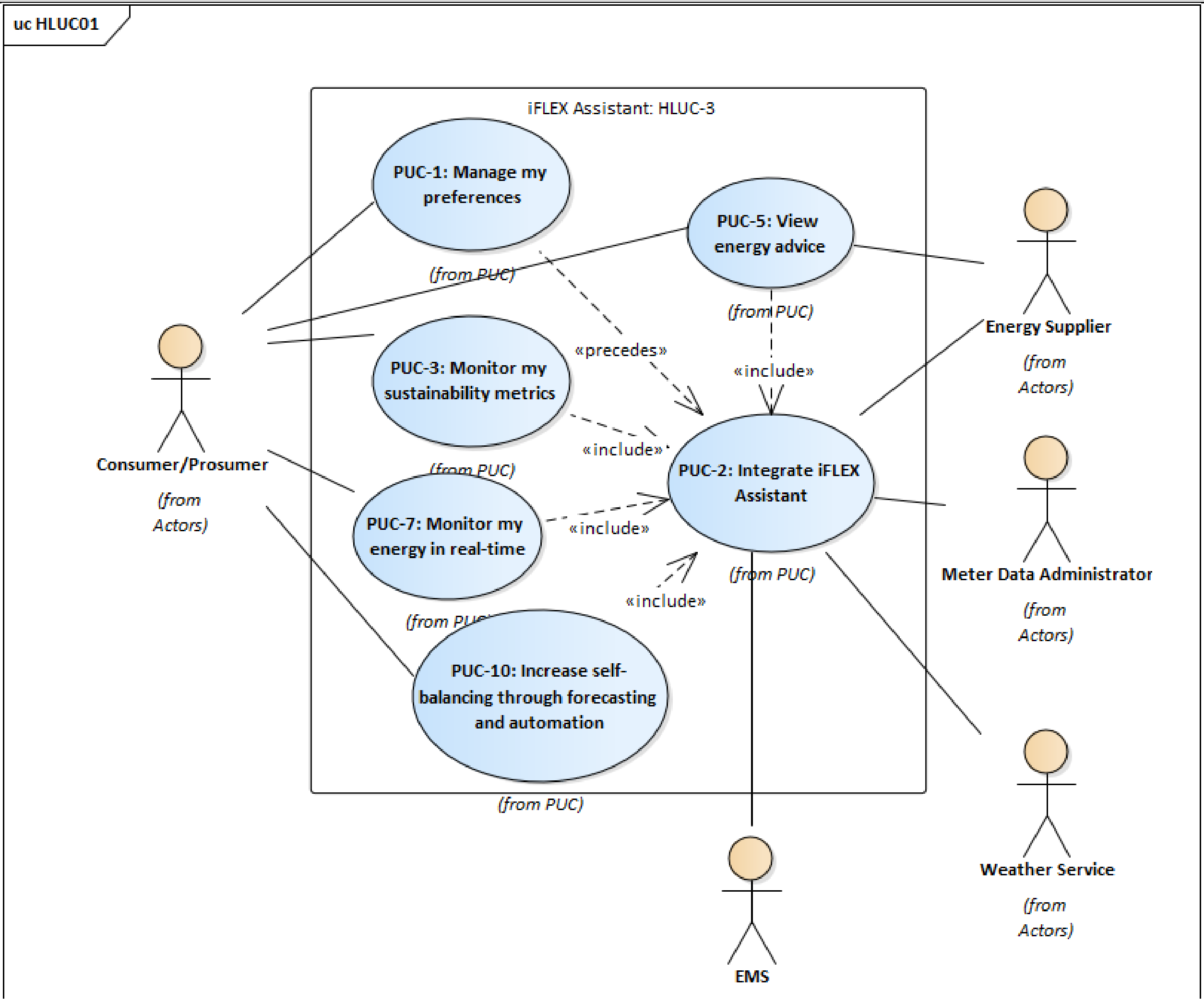



Figure 7 HLUC-1 UC Diagram

### 6.1.2 HLUC-2: Manage flexibility requests or price signals at individual premise level

#### 6.1.2.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | Describes the process followed by the iFLEX Assistant for managing external flexibility requests or price signals at individual premises level (e.g. household), ensuring optimal operation of the end-user's energy system. |
| **Objectives** | 1. Offer flexibility<br>2. Optimise schedule considering prices and/or incentives<br>3. View metrics on participation/engagement<br>4. Register for a new flexibility service |
| **Related business case(s)** | • BUC-1 Optimise operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-2 Optimise grid operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-7 Optimise end-user's energy consumption based on own preferences and market price signals<br>• BUC-8 Offer flexibility through participation in explicit demand response programmes |
| **Related user experience goal(s)** | To be smart, cost-efficient and meaningful |
| **Name of author(s)** | IN-JET |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI2a_DoA | Increased accuracy of consumer load forecasting compared to state-of-the-art methods | The results are compared to the state-of-the-art consumer load forecasting models and percentage decrease of forecasting error is calculated. Evaluation is performed using a variety of data sets (collected in the project), data amounts and load forecasting lengths and average performance of the approaches is calculated. | Offer flexibility (PUC-8). |
| KPI2b_DoA | Increased accuracy of flexibility modelling compared to state-of-the-art methods | The results are compared to the state-of-the-art flexibility modelling results and percentage decrease of forecasting error is calculated. Evaluation is performed using a variety of data sets (collected in the project), data amounts and flexibility forecasting lengths and average performance of the approaches is calculated. | Offer flexibility (PUC-8). |
| KPI6c _DoA | Increased consumer flexibility for grid stability and RES integration | The average flexibility of pilot participants that is validated in grid stability/RES integration cases is compared to relevant results reported in the literature. | Offer flexibility (PUC-8). |
| KPI2c_DoA | Increased effectiveness of automated | The results are compared to typical flexibility management algorithms in a wide variety of DR optimisation | Optimise schedule considering prices and/or incentives (PUC-9). |

| | | | |
|---|---|---|---|
| | flexibility management compared to standard methods | targets and incentives. Percentage improvement of rewards (incentive-specific) is calculated. Evaluation is performed using a variety of data sets (collected in the project), and incentives, and an average performance of the approaches is calculated. | |
| KPI4a_DoA | Return on Investment for prosumers in the base scenarios | Calculation of Return on Investment through a Cost Benefit Analysis (CBA)-based technoeconomic evaluation under various business modelling scenarios. A sensitivity analysis will also be performed for alternative settings, e.g. changes to electricity tariffs. | Optimise schedule considering prices and/or incentives (PUC-9). |
| KPI4c_DoA | Monetary benefits to the consumer in the base scenarios | Decrease of costs for the consumer compared to current situation. | Optimise schedule considering prices and/or incentives (PUC-9). |
| KPI4a | Effective engagement and participation reporting | Being able to report on engagement and participation in short, timely and effective manner. Measured by a number of reports read and reacted to in mid-term period. | View metrics on participation/engagement (PUC-4). |
| KPI4b | Engagement impact of reporting | Being able to engage the end user notably better than without reporting. | View metrics on participation/engagement (PUC-4). |
| KPI6a | Percentage of the end users that asked for a new flexibility service | Percentage of the eligible pilot end users that asked for a new flexibility service using the relevant feature of the iFLEX Assistant. | Register for a new flexibility service (PUC-6). |

| **Classification information** |
|---|
| **Relation to other use cases** |
| • HLUC-1 Manage energy of the premises in an optimal way (extends)<br>• PUC-1 Manage my preferences (includes)<br>• PUC-2 Integrate iFLEX Assistant (includes)<br>• PUC-4 View reports for participation/engagement (includes)<br>• PUC-6 Register for a new flexibility service (includes)<br>• PUC-8 Offer flexibility (includes)<br>• PUC-9 Optimise schedule considering prices and/or incentives (includes) |
| **Level of Depth** |
| High |
| **Prioritisation** |
| High |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| Demand side flexibility, implicit demand response, explicit demand response |

#### 6.1.2.2 High-Level Analysis

| Narrative of use case |
|---|
| **Short description** |
| Consumers and Prosumers of individual premises (e.g. households) would like to benefit by providing flexibility to the electricity system. The iFLEX Assistant is assigned with the task of managing participation in flexibility programmes, scheduling the operation of the end-user's energy system in the most optimal way either based on price signals or flexibility requests – respecting the preferences of the end user. |
| **Complete description** |
| The end user would like to provide flexibility to the electricity system whereby the user's electricity consumption/load shifts in reaction to price signals or to specific flexibility requests in an easy, simple and 'quiet' manner. To realise this operation, the iFLEX Assistant incorporates several functionalities.<br><br>Energy Management<br>A basic functionality of the iFLEX Assistant (see HLUC-1) is managing energy scheduling within the end-user's premises based on the economic and/or sustainability motives of its user. It also equips the user with the ability to monitor energy flow and performance metrics as well as receive advice aiming to drive the user towards a more sustainable behaviour.<br><br>Offer flexibility to the relevant market actors<br>By learning the consumption behaviour of the user and relevant energy systems, the iFLEX Assistant exposes the available flexibility and baseline profile to the relevant market actors (e.g. Aggregator) to enable the realisation of explicit demand response.<br><br>Optimise energy schedule considering prices and/or incentives<br>Based on the characteristics of the demand response program enrolled and the user preferences, the iFLEX Assistant calculates and devises an optimal energy scheduling of the premises' dispatchable devices and assets.<br><br>View reports for participation/engagement<br>To help the user understand and follow the results of demand response participation and the associated rewards, the iFLEX Assistant provides analysis and visualisation of the outcome. The report is parameterised by the Flexibility Procurer (e.g. Aggregator, Energy Supplier) who provides the DR program.<br><br>Register for a new flexibility service<br>The iFLEX Assistant showcases the demand response programmes that are relevant to the end user based on household characteristics and user preferences and enables the end user to expose interest in these flexibility services. |

| Use case conditions |
|---|
| **Assumption(s)** |
| • The end user is registered to a demand response program.<br>• An Energy Management System (EMS) is installed and provides the status of local assets and relays the control commands of controllable ones.<br>• A Weather Service is integrated and able to provide weather data.<br>• A Meter Data Administrator provides smart meter data to the iFLEX Assistant.<br>• A Market Interface enables communication of market data (energy tariffs and flexibility requests). |
| **Precondition(s)** |
| • The iFLEX Assistant is parameterised and fully operational.<br>• The iFLEX Assistant is connected to the EMS.<br>• The iFLEX Assistant communicates with the Weather Service.<br>• The EMS has access to smart meter, sensors and dispatchable devices and assets<br>• The end user has provided consent on sharing baseline load and flexibility information with the Flexibility Procurer and has signed an agreement detailing power and compensation aspects. |

| Actors | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **Consumer/Prosumer** | Person | Motivated by economic, environmental and personal reasons. |
| **Energy Management System** | System | Manages the energy operation of the household, communicates control signals from iFLEX Assistant, provides sensing data to iFLEX Assistant. |
| **Energy Supplier** | Business Entity | Leads and coordinates the reporting on flexibility services participation. |
| **Aggregator** | Business Entity | Aggregates several consumers and/or prosumers for flexibility market services. |
| **Meter Data Administrator** | Business Entity | Provides smart meter data measurements to iFLEX Assistant. |
| **Weather Service** | Application | Provides weather forecasts, which can be considered in the optimisation of the energy scheduling. |

| Diagram(s) of use case |
|---|

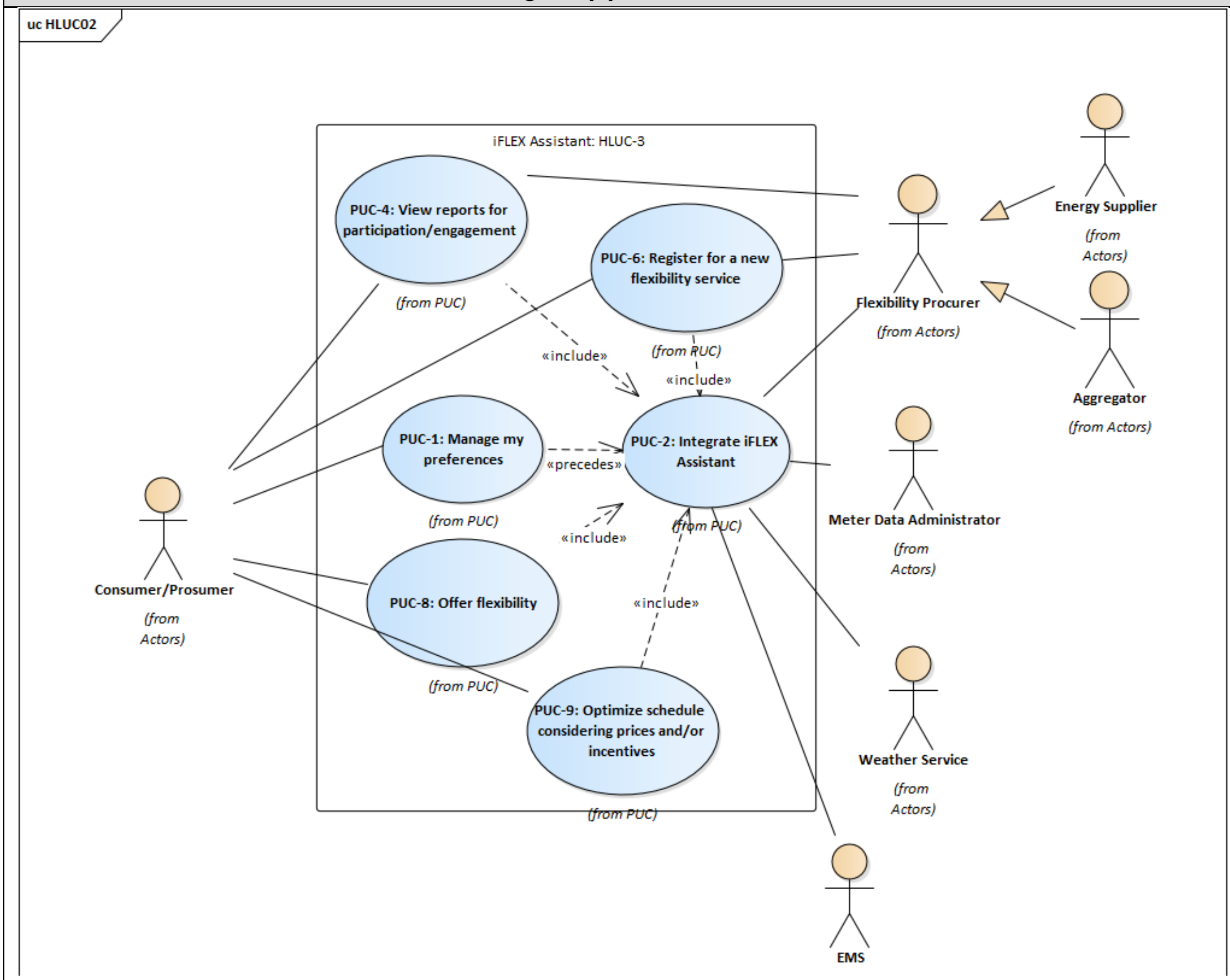



Figure 8 HLUC-2 UC Diagram

### 6.1.3 HLUC-3: Manage flexibility requests or price signals at building level

#### 6.1.3.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | Describes the process of managing flexibility in context of apartment buildings. This use case covers both implicit demand response (i.e., flexibility management with respect to external price signals) and explicit demand response. It also covers flexibility management across heat and electricity vectors. |
| **Objectives** | The main objective is to maximise consumer benefits by managing flexible resources within a building. Consists of following sub-objectives, which are represented as individual Primary Use Cases (PUC):<br>1. Offer the building's flexibility for aggregators (PUC-8).<br>2. Optimise schedule of flexible resources considering prices and/or incentives (PUC-9).<br>3. Provide end user with means to view reports on participation/engagement (PUC-4). |
| **Related business case(s)** | • BUC 1 Optimise operation by leveraging flexibility from consumer/prosumer through DR.<br>• BUC 2 Optimise grid operation by leveraging flexibility from consumer/prosumer through DR.<br>• BUC 3 Offer flexibility of a multi-vector energy system (building community) to the energy market.<br>• BUC 4 Optimal energy consumption for multi-vector energy system (building community) based on the behaviour of consumers and market signals. |
| **Related user experience goal(s)** | To be smart, cost-efficient and meaningful |
| **Name of author(s)** | VTT |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI2a_DoA | Increased accuracy of consumer load forecasting compared to state-of-the-art methods | The results are compared to the state-of-the-art consumer load forecasting models and percentage decrease of forecasting error is calculated. Evaluation is performed using a variety of data sets (collected in the project), data amounts and load forecasting lengths and average performance of the approaches is calculated. | Offer flexibility (PUC-8). |
| KPI2b_DoA | Increased accuracy of flexibility modelling compared to state-of-the-art methods | The results are compared to the state-of-the-art flexibility modelling results and percentage decrease of forecasting error is calculated. Evaluation is performed using a variety of data sets (collected in the project), data amounts and flexibility forecasting lengths and average performance of the approaches is calculated. | Offer flexibility (PUC-8). |
| KPI6c _DoA | Increased consumer flexibility for grid stability and RES integration | The average flexibility of pilot participants that is validated in grid stability/RES integration cases is compared to relevant results reported in the literature. | Offer flexibility (PUC-8). |

| | | | |
|---|---|---|---|
| KPI2c_DoA | Increased effectiveness of automated flexibility management compared to standard methods | The results are compared to typical flexibility management algorithms in a wide variety of DR optimisation targets and incentives. Percentage improvement of rewards (incentive-specific) is calculated. Evaluation is performed using a variety of data sets (collected in the project), and incentives, and an average performance of the approaches is calculated. | Optimise schedule considering prices and/or incentives (PUC-9). |
| KPI4a_DoA | Return on Investment for prosumers in the base scenarios | Calculation of Return on Investment through a Cost Benefit Analysis (CBA)-based technoeconomic evaluation under various business modelling scenarios. A sensitivity analysis will also be performed for alternative settings, e.g. changes to electricity tariffs. | Optimise schedule considering prices and/or incentives (PUC-9). |
| KPI4c_DoA | Monetary benefits to the consumer in the base scenarios | Decrease of costs for the consumer compared to current situation. | Optimise schedule considering prices and/or incentives (PUC-9). |
| KPI4a | Effective engagement and participation reporting | Being able to report on engagement and participation in short, timely and effective manner. Measured by a number of reports read and reacted to in mid-term period. | View metrics on participation/engagement (PUC-4). |
| KPI4b | Engagement impact of reporting | Being able to engage the end user notably better than without reporting. | View metrics on participation/engagement (PUC-4). |

| Classification information |
|---|
| **Relation to other use cases** |
| • HLUC-1 Manage energy of the premises in an optimal way (extends)<br>• PUC-1 Manage my preferences (includes)<br>• PUC-2 Integrate iFLEX Assistant (includes)<br>• PUC-4 View reports for participation/engagement (includes)<br>• PUC-8 Offer flexibility (includes)<br>• PUC-9 Optimise schedule considering prices and/or incentives (includes) |
| **Level of Depth** |
| High |
| **Prioritisation** |
| High |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| Demand side flexibility, implicit demand response, explicit demand response, building community, flexibility management |

#### 6.1.3.2 High-Level Analysis

| Narrative of use case |
|---|
| **Short description** |
| A building community would like to gain benefits by providing flexibility to the electricity system and/or district heating system. The iFLEX Assistant manages the flexible resources (e.g. building's heating, and warm water) in order to maximise the consumer benefits. When necessary, control actions and/or new schedules are approved either by a resident (apartment level actions) or facility manager (building level control). |
| **Complete description** |
| The iFLEX Assistant's end users are the facility manager and potentially the residents of a building community who would like to provide flexibility to the electricity and/or district heating system whereby the building's load is shifted in reaction to price signals (e.g. optimisation across electricity and district heating prices) or to specific external requests in an easy, simple and 'quiet' manner.<br><br>Offer flexibility to the relevant market actors<br>The iFLEX Assistant will learn the normal consumption behaviour and flexibility at the building level in order to provide aggregators (Energy Suppliers and/or District Heating Companies) with flexibility offers.<br><br>The flexibility at the building-level is mainly based on the thermal mass of a building. The facility manager and/or residents will specify the limits for their flexibility (e.g. minimum and maximum temperatures in apartments).<br><br>Optimise energy schedule considering prices and/or incentives<br>The iFLEX Assistant aims to minimise the costs and maximise the rewards of a building community by searching optimal control policies for flexible resources such as heating, ventilation, air conditioning, and warm water. In the optimisation the iFLEX Assistant may utilise models for flexible resources, load (and generation) forecasts, weather forecasts, the current status of the controllable assets and the user's preferences (automatic vs manual control actions). The UC covers also scenarios where costs are optimised across different energy vectors. In practice, this can include e.g. optimisation of HVAC costs across electricity (heat pump) and district heating vectors with different pricing schemes.<br><br>Depending on the user's preferred configuration for different flexible resources and the prices/incentives in general (defined in PUC-01) the iFLEX Assistant will either automatically control the devices or propose DR actions that need to be accepted by the end user (i.e., facility manager in the case of building-level control and residents in the case of apartment-level flexibility management). In the case the end user wants to accept the flexibility management actions manually, the user receives a notification of the DR event in the chosen interaction form of the iFLEX Assistant, including information about time, (price) and duration. The notification also consists of a suggestion of the optimal control actions calculated by the iFLEX Assistant.<br><br>Upon approval of a schedule, the iFLEX Assistant shall communicate the control scheme to the controllable devices through the Building Energy Management System.<br><br>View reports for participation/engagement<br>The end user can follow the premise status during the flexibility management and receive notifications if action is required to fulfil the target – compliance in the case of explicit DR, optimal costs in case of implicit. After the event, the user accesses the user interface to view the related cost and the savings. If the flexibility service is an example of explicit demand response, the percentage and cost of non-compliance is also shown (if applicable).<br><br>The report is parameterised by the Flexibility Procurer (e.g. Aggregator, Energy Supplier) who provides the DR program. |

| Use case conditions |
|---|
| **Assumption(s)** |
| • User is registered to a DR program and/or has a contract with dynamic electricity and/or district heating prices<br>• A Building Energy Management System (BEMS) provides the status of local assets and relays the control commands of controllable ones.<br>• A Weather Service is providing weather data.<br>• A Meter Data Administrator provides smart meter data to the iFLEX Assistant.<br>• A Market Interface enables communication of energy and flexibility market data. |
| **Precondition(s)** |
| • The iFLEX Assistant is parameterised and fully operational.<br>• The iFLEX Assistant is connected to the BEMS.<br>• The iFLEX Assistant communicates with the Weather Service.<br>• The BEMS has access to smart meter, sensors and dispatchable devices and assets.<br>• The iFLEX Assistant has access to the end-user's electricity price scheme.<br>• The end user has provided consent to receiving alerts and energy advice.<br>• The end user has provided consent on sharing baseline load and flexibility information with the Aggregator and has signed an agreement detailing power and compensation aspects |

| Actors | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **Resident** | Person | End user of the iFLEX Assistant, who is motivated by economic, environmental and personal reasons. |
| **Facility manager** | Person | End user of the iFLEX Assistant in the case of apartment and commercial buildings, who is motivated by economic reasons. |
| **Building Energy Management System** | System | Manages the energy operation of the building, communicates control signals from iFLEX Assistant, provides sensing data to iFLEX Assistant. |
| **Energy Supplier** | Business Entity | Supplies electricity to the building and residents. Residents and the building can have different electricity suppliers. Can act as an aggregator. Would like to achieve optimal balancing and benefits from electricity market trading. |
| **District Heating Company** | Business Entity | Produces and distributes district heating. Provides district heating tariffs. Can act as an aggregator. Would like to optimise district heating production and benefit from optimal electricity trading (CHP plant). |
| **Aggregator** | Business Entity | Aggregates several consumers and/or prosumers for flexibility market services. |
| **Meter Data Administrator** | Business Entity | Provides smart meter data measurements to iFLEX Assistant. |
| **Weather Service** | Application | Provides weather forecast used in flexibility management. This information is important for heating/cooling related flexibility. |

| Diagram(s) of use case |
|---|

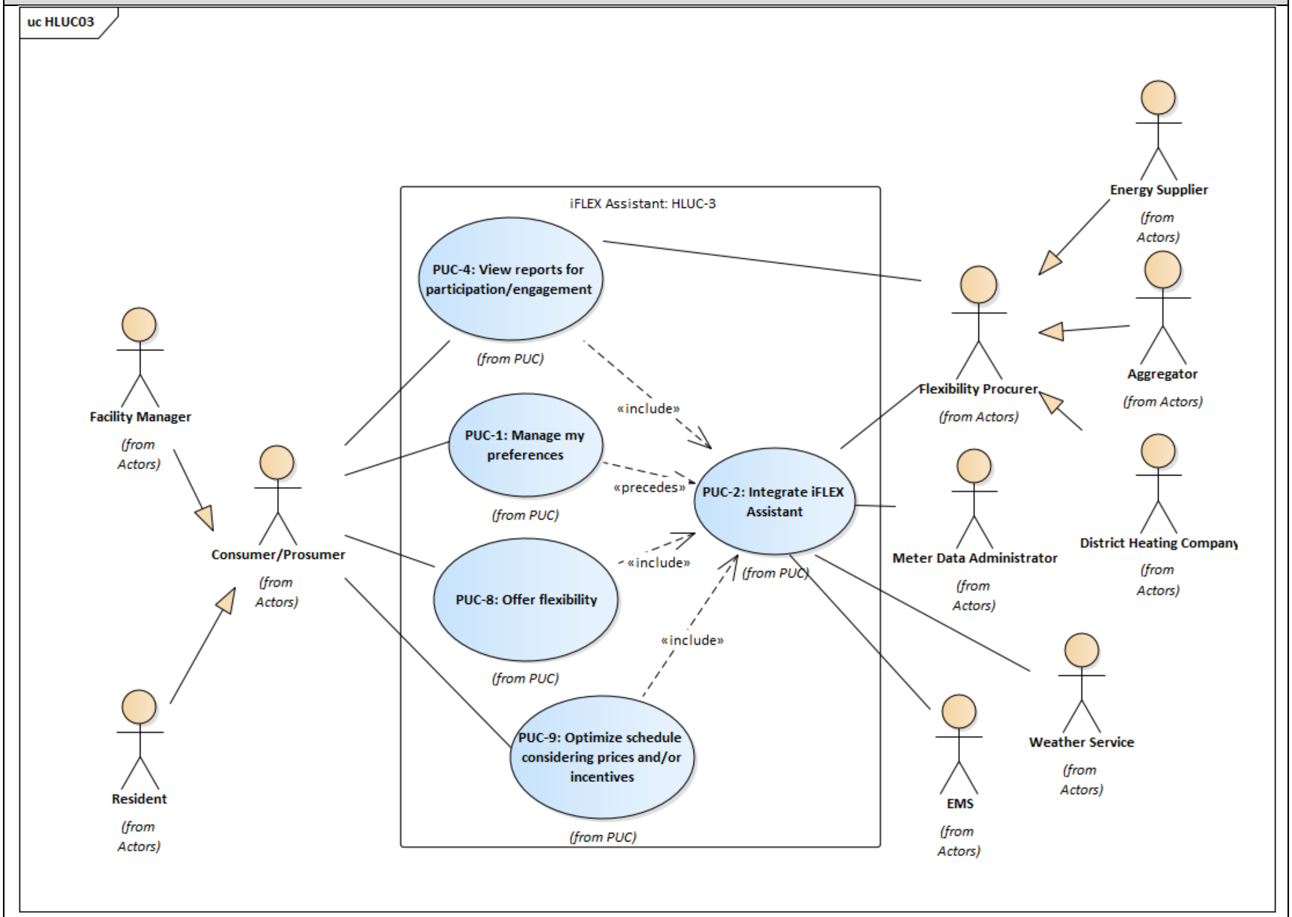



Figure 9 HLUC-3 UC Diagram

## 6.2 Primary Use Cases

This section provides a documentation of the Primary Use Cases (PUCs), decomposing the high-level functions of the iFLEX Assistant operation. These PUCs might be included in more than one HLUCs. In fact, certain PUCs concern basic features of the iFLEX Assistant, which enable managing the preferences of the end users and communicating with external devices and systems. These functionalities are essential for the exploitation of the assistant's full potential and consist part of all the HLUCs.

Other PUCs describe features, which facilitate the provision of advanced energy management services to the users. For example, the assistant shall devise and execute an optimised energy scheduling of the dispatchable devices and assets within the premises, considering the preferences, motives and past behaviour of the end users. To accomplish this task, the iFLEX Assistant will exploit its monitoring and forecasting capabilities. Furthermore, iFLEX Assistant shall provide the end users with insightful metrics related to energy efficiency or sustainability aspects, as well as energy advice tailored to the needs and goals of the users.

Moreover, a set of PUCs is related to actions, which enable offering flexibility services. Based on AI-methods, iFLEX Assistant will come up with the baseline consumption and flexibility offers of the end users towards relevant stakeholders. Then, the optimised energy scheduling of the premises will be updated by considering also the accepted flexibility offers. In addition to that, the end user will be able to gain deeper insights into offering flexibility to the market by receiving specialised reports, which have the aim to foster the engagement of the end users in such services. Lastly, iFLEX Assistant shall inform the end users about flexibility programmes which are appropriate to them, taking into account the available dispatchable assets of the premises.

### 6.2.1 PUC-1: Manage my preferences

#### 6.2.1.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | Providing different types of end-user preferences to iFLEX Assistant. |
| **Objective** | Define comfort levels, flexibility management policy, and form of communication with end user. |
| **Related business case(s)** | • BUC-1 Optimise operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-2 Optimise grid operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-3 Offer the flexibility of a multi-vector energy system (building community) to the energy markets<br>• BUC-4 Schedule optimal energy consumption for multi-vector energy system (building community) based on the behaviour of consumers and market price signals<br>• BUC-5 Added value services: Customer load profile analysis and overview<br>• BUC-6 Increase self-balancing through advanced monitoring and automation<br>• BUC-7 Optimise end-user's energy consumption based on own preferences and market price signals<br>• BUC-8 Offer flexibility through participation in explicit demand response programmes |
| **Related user experience goal(s)** | To be independent and in control |
| **Name of author(s)** | ICOM |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI1a | Compliance of operation with end-user's preferences | Number of incidents during a time period (e.g. a week, month, etc.) that the operation of the iFLEX Assistant does not comply with the predefined user preferences. | Define comfort levels |

| Classification information |
|---|
| **Relation to other use cases** |
| • HLUC-1 Manage energy of the premises in an optimal way (included in)<br>• HLUC-2 Manage flexibility requests or price signals at individual premises level (included in)<br>• HLUC-3 Manage flexibility requests or price signals at building level (included in)<br>• PUC-2 Integrate iFLEX Assistant (precedes) |
| **Level of Depth** |
| System |
| **Prioritisation** |
| High |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |

| Further keywords for classification |
|---|
| End-user preferences, comfort levels, personalised communication, flexibility management policy |

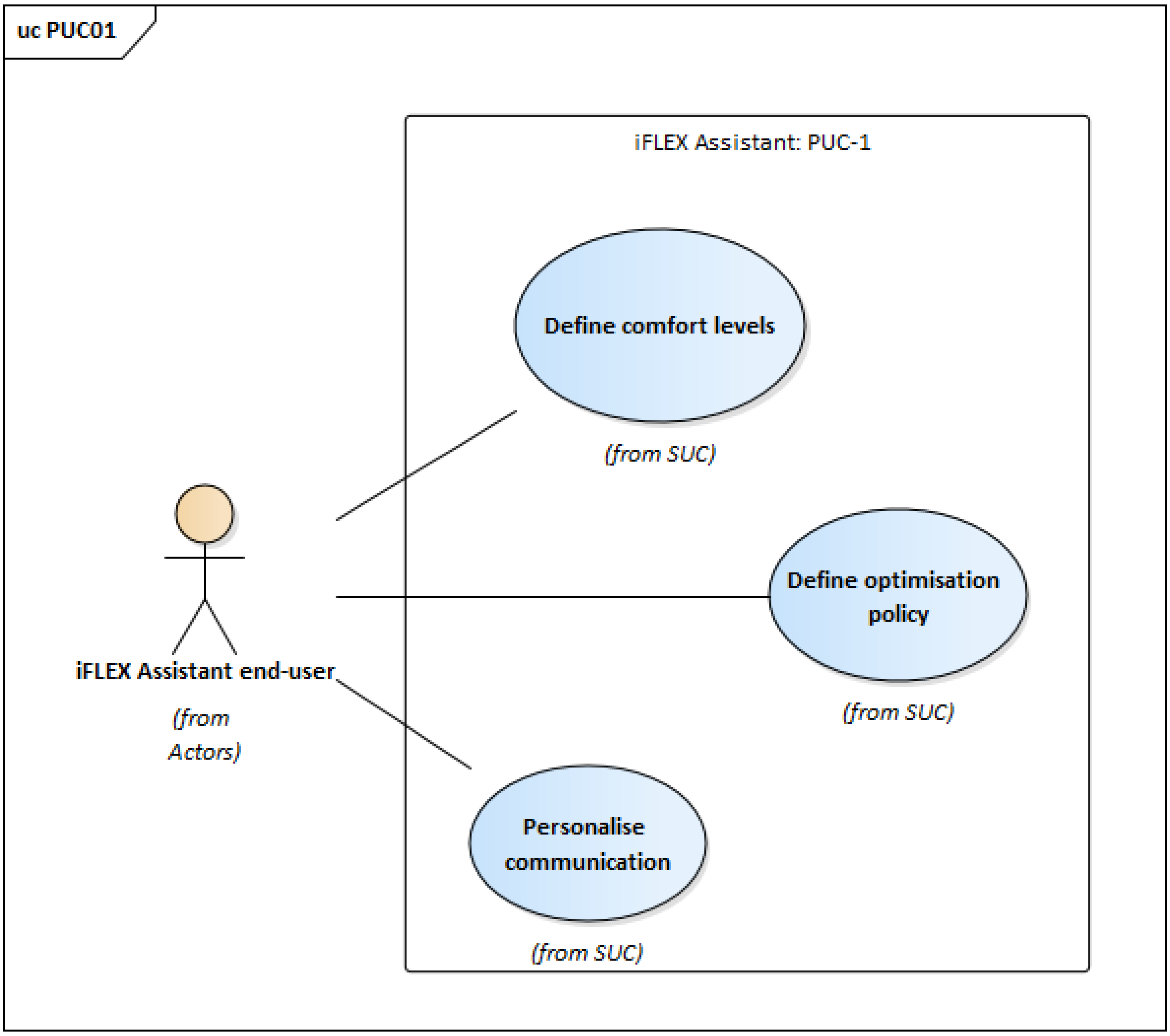
#### 6.2.1.2 High-Level Analysis

| Narrative of use case |
|---|
| **Short description** |
| The iFLEX Assistant aims to leverage flexibility from consumers/prosumers without disturbing their daily needs and habits. Thus, the operation of iFLEX Assistant complies with a set of operational constraints defined by its end users, who can also configure their communication with iFLEX Assistant according to their wishes. |
| **Complete description** |
| In order for the iFLEX Assistant to be appealing to end users, it is vital to avoid conflicts between flexibility offering and satisfaction of their needs. For this reason, the operation of iFLEX Assistant has to comply with a set of constraints defined by the end users.<br><br>**Define comfort levels**<br>An important relevant feature is the selection of operation mode. The end users will be able to select among predefined modes and customise them according to their preferences. The capability of iFLEX Assistant to exploit controllable assets will depend on the chosen mode of operation (e.g. when in "away" mode, the HVAC setpoint can be controlled). Furthermore, the operational boundaries of specific devices may differ depending on the mode. For instance, the lower and upper limits for room temperature can vary, if the selected operation mode is “normal” or “away”. Further operational constraints can be applied to devices depending on the active operation mode e.g. the charging rate of an EV may be limited within a certain power range, if the owner has opted for an “ecological” operation mode. This of course entails the relevant functionality exposed by the respective EMS or device interface.<br><br>Another significant aspect is the user-defined time constraints with respect to the operation of domestic devices and assets. For example, users who own EVs can specify that the battery has to be fully charged by the time they leave for work. Hence, iFLEX Assistant has to strictly comply with this prerequisite while implementing a flexibility management strategy.<br><br>Within the scope of providing its end user with advanced energy and flexibility management services, the iFLEX Assistant will be able to propose alternative time-related or operational constraints for devices and assets. Upon approval of the suggested modifications from the end user, the constraints will be updated.<br><br>The aforementioned set of user-defined choices should result in a seamless and pleasing user experience. Nevertheless, to ensure that the operation of the iFLEX Assistant complies with the end-user's wishes, the user will be able to provide iFLEX Assistant with feedback on its operation. For instance, the user will be able to inform the assistant if the room temperature is not satisfying. Subsequently, the iFLEX Assistant shall take the user’s feedback into account and make necessary adjustments in order to comply with it.<br><br>**Optimisation policy**<br><br>The assistant will offer a prioritisation of end-user motives (i.e. energy/cost/environmental) for proposing the optimal schedule(s) of devices operations. Based on the flexibility management policy selected by the user, the assistant will automatically process the selection/execution of the ‘best’ control action schedule (e.g. shifting laundry time) – by respecting user preferences and user motives. If the user prefers having a better monitoring of control actions – the assistant shall provide capability for end-user selection of the scenario of operation (among multiple) – or provide consent for the applicable scenario.<br><br>**Communication personalisation**<br>End users will be granted the capability to customise their interaction with the iFLEX Assistant according to their preferences, so that its use is adapted to personalised needs and preferences, facilitating its operation.<br><br>The application will provide various types of notifications:<br>• Alerts: For example, in case household power consumption or daily/weekly electricity consumption exceeds a user-defined threshold; |

| |
|---|
| • DR event information: either implicit - notifying the end user of a change in tariff price - or explicit, communicating the activation information;<br>• Notification for providing consent for control actions calculated by iFLEX Assistant;<br>• Advice: Suggestions for sustainability provided by iFLEX Assistant.<br><br>The user might want to set some preferences on the time these notifications are received. For instance, the user might select a 2 hours ahead or day ahead notification time for a DR event or to receive the notification at specific times of day, e.g. only during noon (silent operation).<br><br>An important feature for the wide exploitation of the assistant is the capability to support various languages, giving the end users the freedom to select their favourable one.<br><br>Besides that, end users will be able to opt for their preferred means of interaction with the system, choosing among email, SMS, mobile app, web application and - if possible - the interface of their EMS. The user may select the means of communication in relation to specific form of communications. For example, in cases of alerts, control actions or flexibility signals, where a quick response is necessary, mobile app notifications or SMS might be the preferred means selected by the users. In contrast, a web application may be favourable when notifications concern analytical processes, such as energy monitoring and provision of relevant feedback and advice. A preset for all communications shall be provided to the iFLEX Assistant, whilst the user can customise according to own preferences.<br><br>The end-user's access point to the iFLEX Assistant will support natural user interaction to become more user-friendly and enjoyable. Natural user interfaces allow for a broad range of usage skills which increase accessibility such as voice, gesture and touch, mirroring the natural interactions with the real world. The interaction is designed according to the context of use, the user's skill level and preferences with touch as one of the most likely options. |

| **Use case conditions** |
|---|
| **Assumption(s)** |
| • End users can be contacted by iFLEX Assistant via at least one of the possible means of communication (email, SMS, mobile app, web application, dashboard).<br>• iFLEX Assistant is integrated with the EMS and premise infrastructure |
| **Precondition(s)** |
| • iFLEX Assistant is operational |

| **Actors** | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **iFLEX Assistant end user** | Person | Wants to set own preferences regarding flexibility management and interaction with iFLEX Assistant |

| Diagram(s) of use case |
| --- |
|  <br>Figure 10 PUC-1 UC diagram |

### 6.2.2 PUC-2: Integrate iFLEX Assistant

#### 6.2.2.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | Specification of the data flows required by the iFLEX Assistant to become operational (e.g., market interface(s), EMS/ Smart Meter integration). |
| **Objective** | Make iFLEX Assistant operational. |
| **Related business case(s)** | • BUC-1 Optimise operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-2 Optimise grid operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-3 Offer the flexibility of a multi-vector energy system (building community) to the energy markets<br>• BUC-4 Schedule optimal energy consumption for multi-vector energy system (building community) based on the behaviour of consumers and market price signals<br>• BUC-5 Added value services: Customer load profile analysis and overview<br>• BUC-6 Increase self-balancing through advanced monitoring and automation<br>• BUC-7 Optimise end-user's energy consumption based on own preferences and market price signals<br>• BUC-8 Offer flexibility through participation in explicit demand response programmes |
| **Name of author(s)** | ICOM |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI3a_DoA | Level of interoperability | Compliance of the iFLEX Framework with connectivity, syntactic and semantic interoperability standards. | Make iFLEX Assistant operational. |

| Classification information |
|---|
| **Relation to other use cases** |
| • HLUC-1 Manage energy of the premises in an optimal way (included in)<br>• HLUC-2 Manage flexibility requests or price signals at individual premises level (included in)<br>• HLUC-3 Manage flexibility requests or price signals at building level (included in)<br>• PUC-1 Manage my preferences (preceded by)<br>• PUC-3 Monitor my sustainability metrics (included in)<br>• PUC-4 View repots for participation or engagement (included in)<br>• PUC-5 View energy advice (included in)<br>• PUC-6 Register for a new flexibility service (included in)<br>• PUC-7 Monitor my energy in real-time (included in)<br>• PUC-8 Offer flexibility (included in)<br>• PUC-9 Optimise schedule considering prices and/or incentives (included in)<br>• PUC-10 Increase self-balancing through forecasting and automation (included in) |
| **Level of Depth** |
| System |
| **Prioritisation** |
| High |

| **Generic, regional or national relation** |
|---|
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| System integration |

#### 6.2.2.2 High-Level Analysis

| **Narrative of use case** |
|---|
| **Short description** |
| The iFLEX Assistant aims to facilitate consumers, prosumers and communities in offering flexibility services. In order to exploit its full potential, the iFLEX Assistant has to be equipped with a set of modules, which facilitate the interaction with various external systems. Appropriate integration of these modules is vital, so that seamless operation of the iFLEX Assistant is ensured. |
| **Complete description** |
| The iFLEX Assistant is charged with the task of providing its end users with advanced energy and flexibility management services. To accomplish that, it has to communicate with external systems and devices in order to retrieve or send data that enable its operation at full scale.<br><br>***Resource Abstraction Interface***<br>The Resource Abstraction Interface shall provide iFLEX Assistant with APIs that enable managing dispatchable devices and assets via the Energy Management System (EMS), as well as accessing sensor, metering and weather data.<br><br>As regards to metering devices, the iFLEX Assistant will be able to acquire data from various sources and exploit them to provide its end user with advanced energy and flexibility management services. Receiving smart meter data can be integrated by different systems (e.g. Meter Data Management System (MDMS), Distribution Management System (DMS), Data Hub), which are grouped under Meter Data Access Interface.<br><br>Furthermore, the iFLEX Assistant shall interface an Energy Management System (e.g. BEMS, HEMS), enabling:<br><br>• *fetching data* from sensors (e.g., smart meter, submeter, temperature sensor)<br>• *providing setpoints* of operation to local dispatchable assets (e.g., home appliances, energy storage systems, EVs)<br><br>This functionality will enable the various operations of the iFLEX Assistant as well as the provision of relevant data to end users (through user interfaces) and to third parties, as described below.<br><br>Weather data, which will be provided by an external weather service, can be exploited by the iFLEX Assistant e.g., for improving the energy scheduling of the premises.<br><br>***Market and Aggregation Interface***<br><br>An interface between iFLEX Assistant and systems of the Flexibility Aggregator (e.g. Demand Response Management System – DRMS) shall enable:<br>• *communication of flexibility signals* (incentives) to end users – current and historic<br>• *communication of publicly available market data* to end users<br>• *communication of flexibility remuneration*<br>• *communication of baseline and flexibility offer*<br><br>These functionalities will enable the flexibility market participants to efficiently participate in the underlying energy markets via leveraging flexibility potential of consumers/prosumers. On the other hand, consumers |

| |
|---|
| and prosumers will be able to get remunerated in return for offering flexibility services to interested market actors. |

| Use case conditions |
|---|
| **Assumption(s)** |
| • An Energy Management System (EMS) is installed.<br>• A Weather Service is available and able to provide weather data (incl. Forecasts)<br>• An Energy Management System (EMS) provides the status of local assets and relays the control commands of controllable ones.<br>• Measurement data are available through the Meter Data Access Interface.<br>• A Market Interface enables communication of energy and flexibility market data. |
| **Precondition(s)** |
| • The iFLEX Assistant is parameterised and fully operational.<br>• The iFLEX Assistant is connected to the EMS.<br>• The iFLEX Assistant communicates with the Weather Service.<br>• The EMS has access to and can communicate with smart meter, dispatchable assets, and sensors. |

| Actors | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **Meter Data Access Interface** | System Interface | Provides iFLEX Assistant with metering data. |
| **Market Interface** | System Interface | Enables communication of energy prices and flexibility requests, or provision of energy advice and feedback on participation in flexibility services from the systems of the relevant market actors to the iFLEX Assistant. |
| **Energy Management System (EMS)** | System | Provides iFLEX Assistant with access to metering and sensor data and asset controllability. |
| **Weather Service** | Application | Provides weather information to the iFLEX Assistant. |
| **Sensors** | Device | Provides information to the iFLEX Assistant either directly or via the EMS. |
| **Smart Meter** | Device | Provides information to the iFLEX Assistant. |
| **Meter Data Management System (MDMS)** | System | Provides smart meter data to the iFLEX Assistant |
| **Data Hub** | System | Provides smart meter data to the iFLEX Assistant |
| **Dispatchable Distributed Energy Resources (DERs)** | Device | Can be controlled via the EMS. |
| **Demand Response Management System** | DRMS | Provides flexibility information to the iFLEX Assistant. |

| Diagram(s) of use case |
|---|

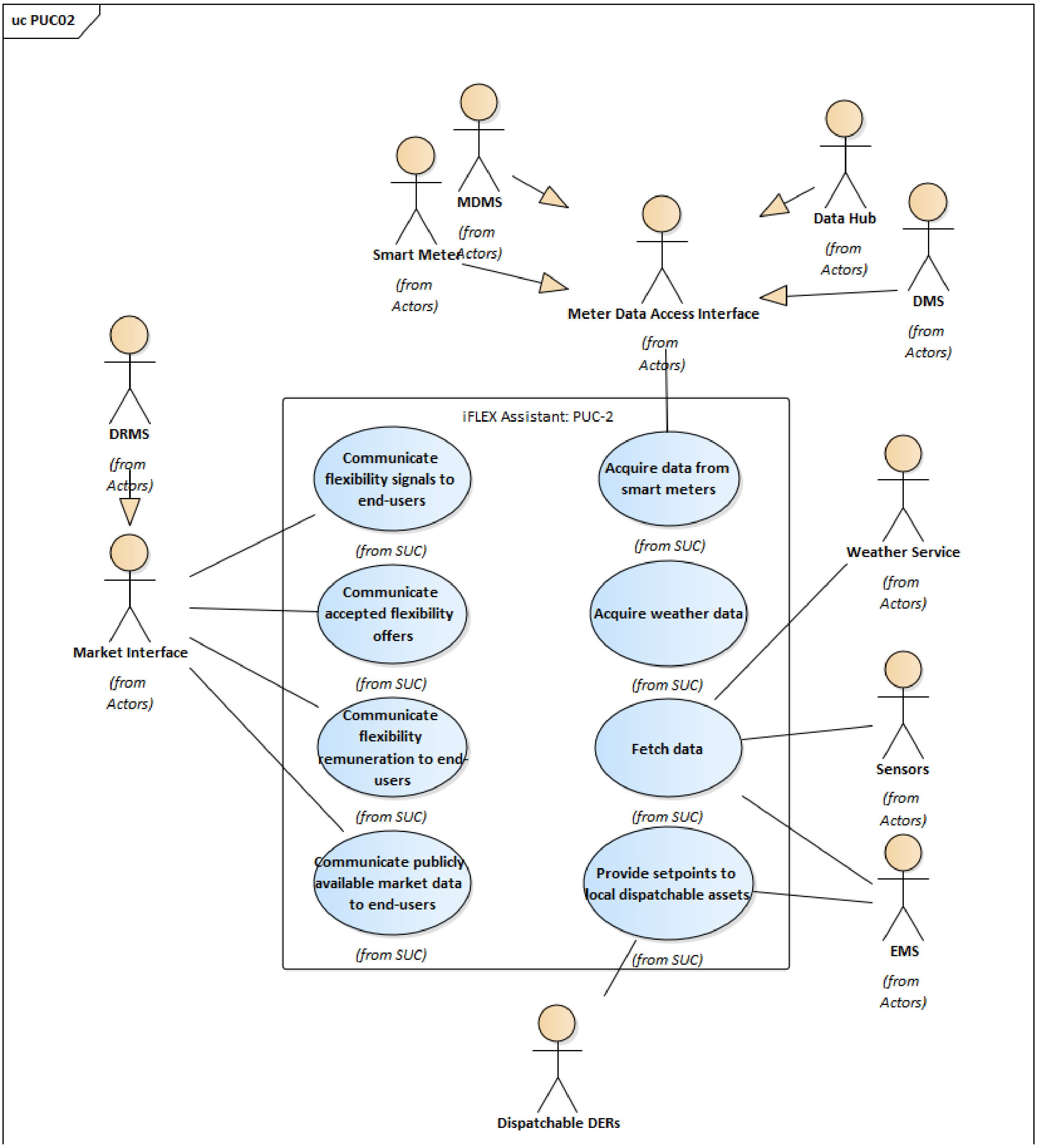



Figure 11 PUC-2 UC Diagram

### 6.2.3 PUC-3: Monitor my sustainability metrics

#### 6.2.3.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | Expose environmental sustainability metrics and use their monitoring and evaluation for stronger engagement of consumers into premises sustainability improvements. |
| **Objective** | • Define environmental sustainability metrics<br>• Gain insights into sustainability status of the premises<br>• Visualise sustainability metrics to the consumer or building manager<br>• Evaluate progress achieved towards sustainability targets |
| **Related business case(s)** | • BUC-5 Added value services: Customer load profile analysis and overview<br>• BUC-6 Increase self-balancing through advanced monitoring and automation |
| **Related user experience goal(s)** | To be smart, meaningful and in-control |
| **Name of the author(s)** | JSI, IN-JET, ICOM |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI3a | Environmental sustainability metrics | Define at least three sustainability metrics to be presented as a goal, measured and followed. | Define environmental sustainability metrics. |
| KPI3b | Improve engagement in sustainability goals | Improve engagement and progress of following the metrics (10%). | Evaluate progress achieved towards sustainability targets. |

| Classification information |
|---|
| **Relation to other use cases** |
| • HLUC-1 Manage energy of the premises in an optimal way (included in)<br>• PUC-2 Integrate iFLEX Assistant (includes) |
| **Level of Depth** |
| System |
| **Prioritisation** |
| Medium |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| Sustainability monitoring, evaluation and visualisation |

#### 6.2.3.2 High-Level Analysis

| Narrative of use case |
|---|
| **Short description** |
| The iFLEX Assistant aims to provide the end users with the ability to visualise environmental sustainability metrics, set personal sustainability goals and monitor how current behaviour can facilitate reaching this goal. |
| **Complete description** |
| The *iFLEX Assistant* aims at improving the sustainability of the end-user's premises by exposing sustainability metrics through monitoring, evaluation and visualisation of the results. The user will be able to select sustainability goals via iFLEX Assistant and follow sustainability efforts achievements through visualisation and notifications.<br><br>**Visualise/Manage 'sustainability' goals**<br>The *iFLEX Assistant* will provide information on personal sustainability goals, which are set by the *end user* and relate to specific metrics e.g. energy consumption in a period of time. The user will be able to select the goal to follow. For example, the end user will be able to set through the application a goal on energy – whilst relevant metrics e.g. eq. CO2 emission will be provided – an active period (e.g. month) and periodicity, as well as one or more benchmarks on when notifications would be issued (e.g. 80% reached). The application will provide visualisation to the user on the current status (e.g. total consumption this month) vs. the sustainability goal(s) in a form of traffic lights. Moreover, the possibility to overview the set goals and achieved milestones towards them will be provided. The goals' visualisation will use the same mechanisms as in PUC-4 - View reports for participation/engagement. Furthermore, upon reaching the benchmark set, a notification will be provided to the end user.<br><br>**Visualise 'sustainability' metrics**<br>Upon accessing the User Interface application of the iFLEX Assistant, the end user will be able to access information on the impact of participation in actions related to sustainability. The end user will be able to visualise:<br>• Metrics of successful self-balancing based on mechanisms and results defined in BUC-6, HLUC-1 and PUC-10.<br>• Energy footprint metrics (e.g. total eq. $CO_2$ emissions)<br>• Correlation of energy footprint metrics with community<br>• Correlation of energy footprint metrics with past performance (e.g. reduction of eq. $CO_2$ emissions) as well as mechanisms defined in BUC-5 on customer load profile analyses and overview<br>The metrics' visualisation will be closely related to the goals' visualisation and will be guided according to the user preferences. By default, the metrics will be hidden behind the goals after setting the goals, but the end user will be able to see the metrics' details together with the goal upon request. On top of this, the end user will be able to opt for periodic notifications on the above metrics – depending on personalised preferences.<br><br>Data flow wise there will be minimal flows between the iFLEX Assistant and the other actors as defined in related use cases. |

| Use case conditions |
|---|
| **Assumption(s)** |
| • EMS or Meter Data Interface provides the energy measurements needed for the calculation of performance metrics<br>• iFLEX Assistant is parameterised with different sustainability goals<br>• Community related metrics are anonymised |
| **Precondition(s)** |
| • iFLEX Assistant is integrated and operational<br>• End-users' consent to share their consumption data for the purpose of metric calculation |

| Actors | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **iFLEX Assistant end user** | Person | Wants to be notified on sustainability |
| **Energy Management System (EMS)** | System | Provides iFLEX Assistant with relevant data for the calculation of sustainability metrics. |
| **Meter Data Access Interface** | System Interface | Provides iFLEX Assistant with metering data. |

**Diagram(s) of use case**

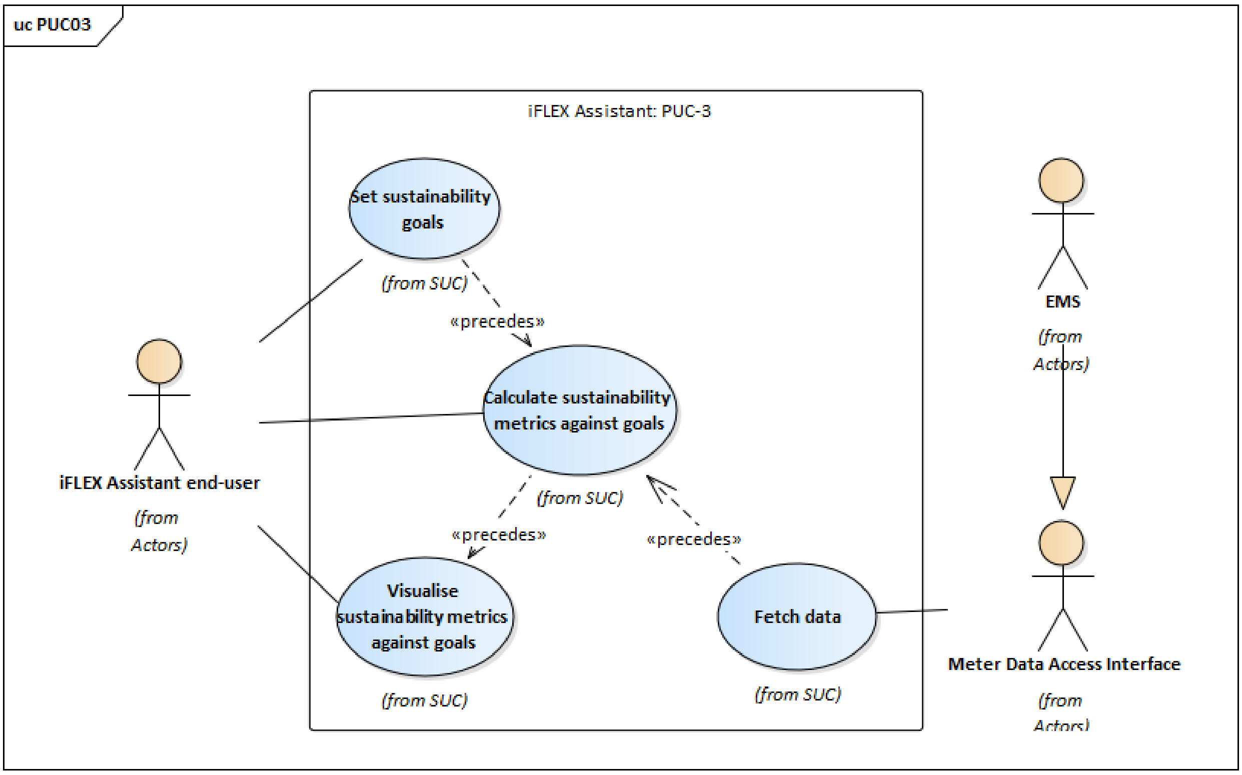



Figure 12 PUC-3 UC Diagram

### 6.2.4 PUC-4: View reports for participation or engagement

#### 6.2.4.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | Presenting the results of participation or engagement in flexibility services. Results are presented with an aim to inform a consumer or prosumer about their participation. The information passed to the consumer should enhance end-user engagement in the service participation. |
| **Objective** | The use case has the following objectives:<br>• Gather and understand possible results of consumer or prosumer participation in flexibility services<br>• Specify ways to quantify end-user flexibility services participation<br>• Specify ways to visualise the results<br>• Specify ways to pass the results information to the end user<br>• Evaluate impact of passed results information on end-users' engagement |
| **Related business case(s)** | • BUC-1 Optimise operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-2 Optimise grid operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-3 Offer the flexibility of a multi-vector energy system (building community) to the energy markets<br>• BUC-4 Schedule optimal energy consumption for multi-vector energy system (building community) based on the behaviour of consumers and market price signals<br>• BUC-7 Optimise end-user's energy consumption based on own preferences and market price signals<br>• BUC-8 Offer flexibility through participation in explicit demand response programmes |
| **Related user experience goal(s)** | To be cost-efficient and in control |
| **Name of author(s)** | JSI |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI4a | Effective engagement and participation reporting | Being able to report on engagement and participation in short, timely and effective manner. Measured by a number of reports read and reacted to in mid-term period. | Gather and understand possible results of consumer or prosumer participation in flexibility services.<br>Specify ways to quantify end-user flexibility services participation.<br>Specify ways to visualise the results.<br>Specify ways to pass the results information to the end user. |
| KPI4b | Engagement impact of reporting | Being able to engage the end user notably better than without reporting. | Evaluate impact of passed results information on end-users' engagement. |

| Classification information |
|---|
| **Relation to other use cases** |
| • HLUC-2 Manage flexibility request or price signals at individual premises level (included in)<br>• HLUC-3 Manage flexibility request or price signals at building community level (included in)<br>• PUC-2 Integrate iFLEX Assistant (includes) |
| **Level of Depth** |
| High |
| **Prioritisation** |
| High |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| Rewards, incentives, participation estimate, communicate participation results, evaluate engagement |

#### 6.2.4.2 High-Level Analysis

| Narrative of use case |
|---|
| **Short description** |
| End-user participation in flexibility services and self-improvement efforts are reported to the end user with an aim to inform the user about results of participation and to enhance future user engagement. The reporting is triggered by a flexibility procurer (energy supplier, aggregator, etc.) who controls when, which information is passed and how the reports are presented to the end user. |
| **Complete description** |
| An end user could participate in a number of flexibility services. The services can be ephemeral or long term, they can invoke changes in self-optimisation preferences or intended changes of the user behaviour. The iFLEX Assistant reporting service helps the end user to understand the results of participation in the services. The results can be related to successful participation in DR programs, for example information on reducing end-users' consumption during the peak reducing events or increased consumption during 'happy hours' periods.<br><br>The reporting is controlled by an energy supplier initiating the flexibility services. The provider decides when the reports are supplied to the end user, which information is passed to the user and how the information is presented/communicated. iFLEX Assistant reporting service, analytic and visualisation capabilities are used to support the energy provider's goals. Main goals are to provide timely, optimal and informative information about end-user participation to the user and to evaluate how the reports improve the end-user engagement in the flexibility service. Differently prepared reports could be sent to the end users of the same flexibility service with an aim of improvement of the reporting service itself.<br><br>iFLEX Assistant uses a number of algorithms to calculate the information to be reported to the end user. The algorithms can calculate, for example, user's response to explicit DR events, price changes, shifts of energy consumption during the day due to flexibility services' requests, etc., and report based on the findings. The history of the calculation is kept by the assistant and used by engagement evaluation algorithms to evaluate the end-user engagement performance. Engagement metrics could be part of the reports provided to the end user as well. |

| Use case conditions |
|---|
| **Assumption(s)** |
| • The Energy Supplier offers a parameterisation of the report through Market Interface<br>• iFLEX Assistant has access to smart meter data through Meter Data Access Interface |
| **Precondition(s)** |
| • End user is enrolled in at least one flexibility service or program<br>• iFLEX Assistant is parameterised and provisioned to the end user |

| |
|---|
| • iFLEX Assistant has access to smart meter data and flexibility related information<br>• End user has provided consent for sharing their consumption data for the purpose of metric calculation |

| General Remarks |
|---|
| Main parts of the calculation are to be performed at iFLEX Assistant, under the end-user control. Information exchange with the energy supplier should be strictly user-controlled and the user's explicit consent should be given to the supplier prior to the exchange. |

| Actors | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **iFLEX Assistant end user** | Person | Calculates and visualise the information about the results and rewards of participation in flexibility services |
| **Meter Data Access Interface** | System Interface | Provides iFLEX Assistant with metering data. |
| **Market Interface** | System Interface | Enables provision of feedback on participation in flexibility services from the systems of the relevant market actors to the iFLEX Assistant. |

**Diagram(s) of use case**

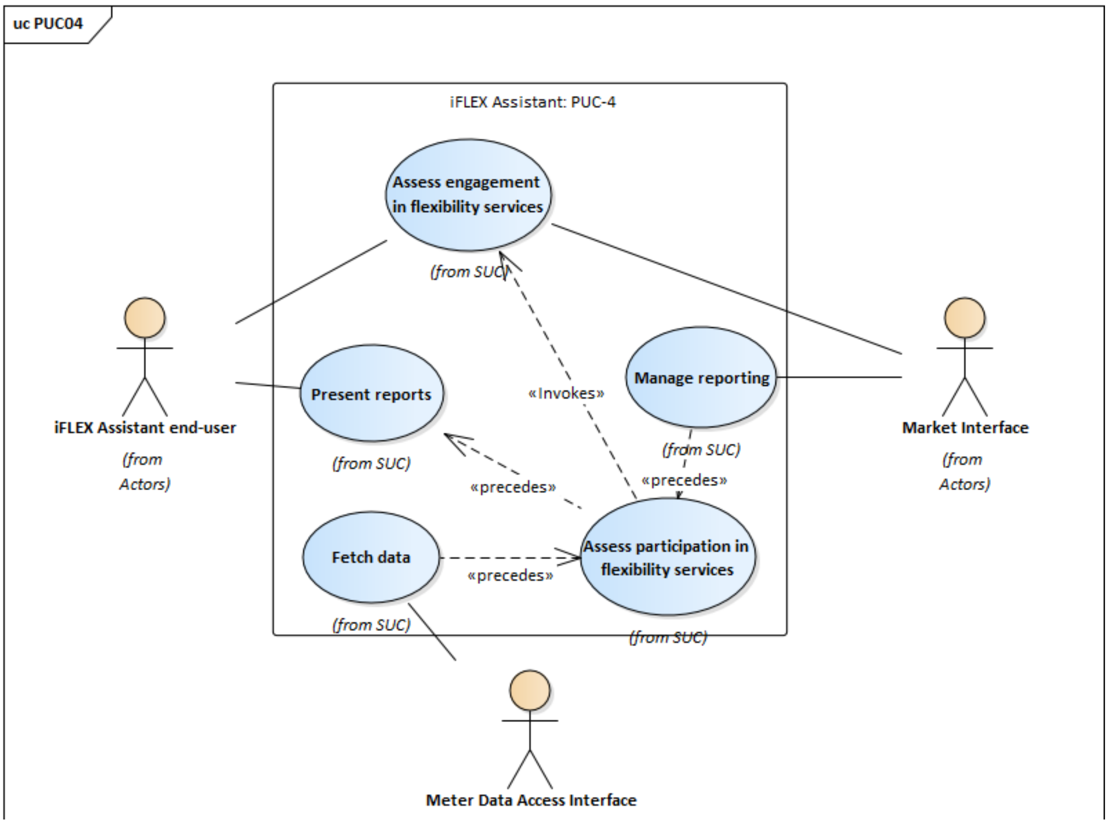



Figure 13 PUC 4 UC Diagram

### 6.2.5 PUC-5: View energy advice

#### 6.2.5.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | Engage the end user through energy advice to lower or shift consumption of a household or building. |
| **Objective** | • Engage the end user through energy advice<br>• Prepare the advice based on historical data (energy, weather), information about the end-user environment<br>• Follow the end-user progress and evaluate the engagement |
| **Related business case(s)** | • BUC-5: Added value services: Customer load profile analysis and overview<br>• BUC-6: Increase self-balancing through advanced monitoring and automation |
| **Related user experience goal(s)** | To be cost-efficient and meaningful |
| **Name of author(s)** | JSI |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI5a | Engage end users | Engaged number of end users in energy advice use case (more the 50). | Engage the end user through energy advice. |
| KPI5b | Advice applied | Estimated number of end users who apply the advice successfully (30%). | Follow the end-user progress and evaluate the engagement. |

| Classification information |
|---|
| **Relation to other use cases** |
| • HLUC-1 Manage energy of the premises in an optimal way (included in)<br>• PUC-2 Integrate iFLEX Assistant (includes) |
| **Level of Depth** |
| System |
| **Prioritisation** |
| High |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| Energy advice, end-user engagement, engagement evaluation |

#### 6.2.5.2 High-Level Analysis

| Narrative of use case |
|---|
| **Short description** |
| The Energy Supplier offers energy advice through a service provided on iFLEX Assistant with an aim to engage end users in activities to lower their energy consumption, reduce cost and achieve other goals like being environmentally friendly. The advice given is adapted to the end-user environment and past behaviour. The user can choose an advice to follow and then the service keeps track of the decision success. Evaluation of the engagement can be reported to the Energy Supplier with end-users' consent. |

| Complete description |
|---|
| The Energy Supplier offers end users a service for energy advice provisioning. An end user enrols for the service and receives advice how to reduce energy consumption, lower energy costs or contribute to other goals like preserving the natural environment and reducing technical constraints. The advice is visualised through the iFLEX Assistant interface. The end user can compare the advice and benefits through simulation of applying the advice to the particular environment. Short and long term consequences of the advice are presented to the end user [22]. A simple example of the use case could be that the energy inspection spots a device with high consumption; the advice could be to replace the device with a new one, the consequences of potential choice are shown to the end user.<br><br>The end user can decide to follow a particular advice. The service helps the end user to keep focus on the advice and its goals' fulfilment. If the goals of the advice can be followed through automated means, for example the EMS, the iFLEX Assistant can be used to fine tune the end-user preferences and enforce newly taken decisions in the future. The results of following the end-user decisions are later reported to the user. Simple means of visualisation could be chosen to report on engagement like the traffic light approach. Evaluation of the engagement can be reported to the Energy Supplier as well, if allowed by the end user.<br><br>The advice proposed by the service can be fine-tuned to the end-user environment based on historical data and information about the end-user environment. If an EMS system is available, the information about the environment can be much more detailed than obtained by, for example, a questionnaire. The iFLEX Assistant can characterise the environment and end-user profile based on historical data as well and propose the advice and its scope in line with the findings. The same data models of the end-user behaviour and consumption patterns can be used to characterise the determination of the end-user engagement and success of the advice given. |

| Use case conditions |
|---|
| **Assumption(s)** |
| - The Energy Supplier offers a service for providing advice through Market Interface<br>- iFLEX Assistant has access to smart meter data through Meter Data Access Interface |
| **Precondition(s)** |
| - Smart metering historic data is available<br>- EMS system and historic data should be available<br>- iFLEX Assistant is parameterised and provisioned to the end user |

| Actors | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **iFLEX Assistant end user** | Person | Visualise the energy advice, engages in a process of lowering/changing energy consumption or costs. |
| **Market Interface** | System Interface | Leads and coordinates the process of engaging the end users through energy advice, evaluates engagement success. |
| **Meter Data Access Interface** | System Interface | Provides iFLEX Assistant with metering data. |

| Diagram(s) of use case |
|---|

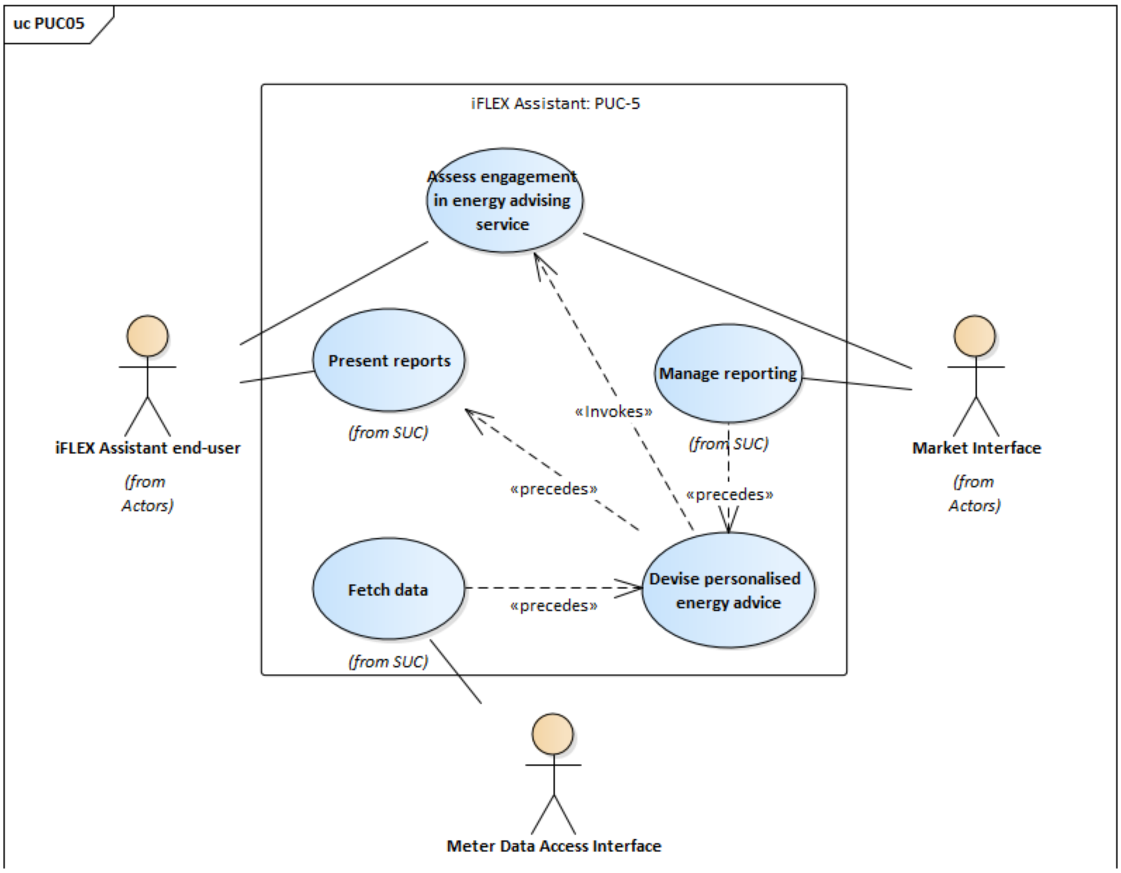



Figure 14 PUC-5 UC Diagram

### 6.2.6 PUC-6: Register for a new flexibility service

#### 6.2.6.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | The scope of the use case is to enable the consumer/prosumer to view the details of the current enrolled flexibility service (if any) and a list of available flexibility services which are compatible with the facility specification as well as to expose interest in registering for a new flexibility service. |
| **Objectives** | • To increase awareness, interest and participation in demand response programmes by knowledge support and access provision.<br>• To achieve personalised/customised decision support. |
| **Related business case(s)** | • BUC-1 Optimise operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-2 Optimise grid operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-7 Optimise end-user's energy consumption based on own preferences and market price signals<br>• BUC-8 Offer flexibility through participation in explicit demand response programmes |
| **Related user experience goal(s)** | To be energy-efficient and effective |
| **Name of author(s)** | IN-JET |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI6a | Percentage of the end users who asked for a new flexibility service | Percentage of the eligible pilot end users who asked for a new flexibility service using the relevant feature of the iFLEX Assistant. | Increase awareness, interest and participation in demand response programmes by knowledge support and access provision. |

| Classification information |
|---|
| **Relation to other use cases** |
| HLUC-2 Manage flexibility requests or price signals at individual premises level (included in)<br>PUC-2 Integrate iFLEX Assistant (includes) |
| **Level of Depth** |
| System |
| **Prioritisation** |
| Medium |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| Personalised/customised Demand Response |

#### 6.2.6.2 High-Level Analysis

| Narrative of use case |
|---|
| **Short description** |
| To make it easier for individual consumers/prosumers to engage in demand response programmes, it is important to personalise and customise the offering and present the flexibility services that are relevant to the particular facility. The iFLEX Assistant enables the end user to make an informed decision based on the facility characteristics and to expose interest in flexibility services. |
| **Complete description** |
| To support the consumer/prosumer in the decision-making, the iFLEX Assistant enables the end user to retrieve the current flexibility service (if any) and a list of available flexibility services compatible with the facility specification. To create the specification, the iFLEX Assistant uses knowledge of the electricity consuming appliances and electricity producing assets in the facility (either provided by the EMS or by smart meter integration), as well as user preferences in terms of comfort and scheduling.<br><br>The list of relevant services is provided by Flexibility Procurers, which can be an Aggregator or Energy Supplier depending on the type of DR program.<br><br>The iFLEX Assistant enables the end user to expose interest in registering for a new flexibility service communicating the interest to the DR program provider. |

| Use case conditions |
|---|
| **Assumption(s)** |
| • The Consumer/Prosumer is able to be offered different DR Program<br>• Only applicable programmes (for the specific type of customer) are communicated to iFLEX Assistant<br>• An Energy Management System (EMS) is installed and provides the status of local assets<br>• A Meter Data Access Interface provides smart meter data to the iFLEX Assistant |
| **Precondition(s)** |
| • The iFLEX Assistant is parameterised and fully operational.<br>• Access to and communication with smart meter, appliances and production assets is possible<br>• iFLEX Assistant is communicated with the specificities of each DR program<br>• IFLEX Assistant can compute the cost benefit analysis based on the detailed of the program and the field data (i.e. from asset, smart meter) |

| Actors | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **iFLEX Assistant end user** | Person | Would like to have the most optimal demand response solution |
| **Energy Management System** | System | Provides smart metering data to the iFLEX Assistant. |
| **Meter Data Access Interface** | System Interface | Provides iFLEX Assistant with status of local devices. |
| **Market Interface** | System Interface | Enables communication of appropriate DR programmes from the systems of the relevant market actors to the iFLEX Assistant. |

| Diagram(s) of use case |
| --- |

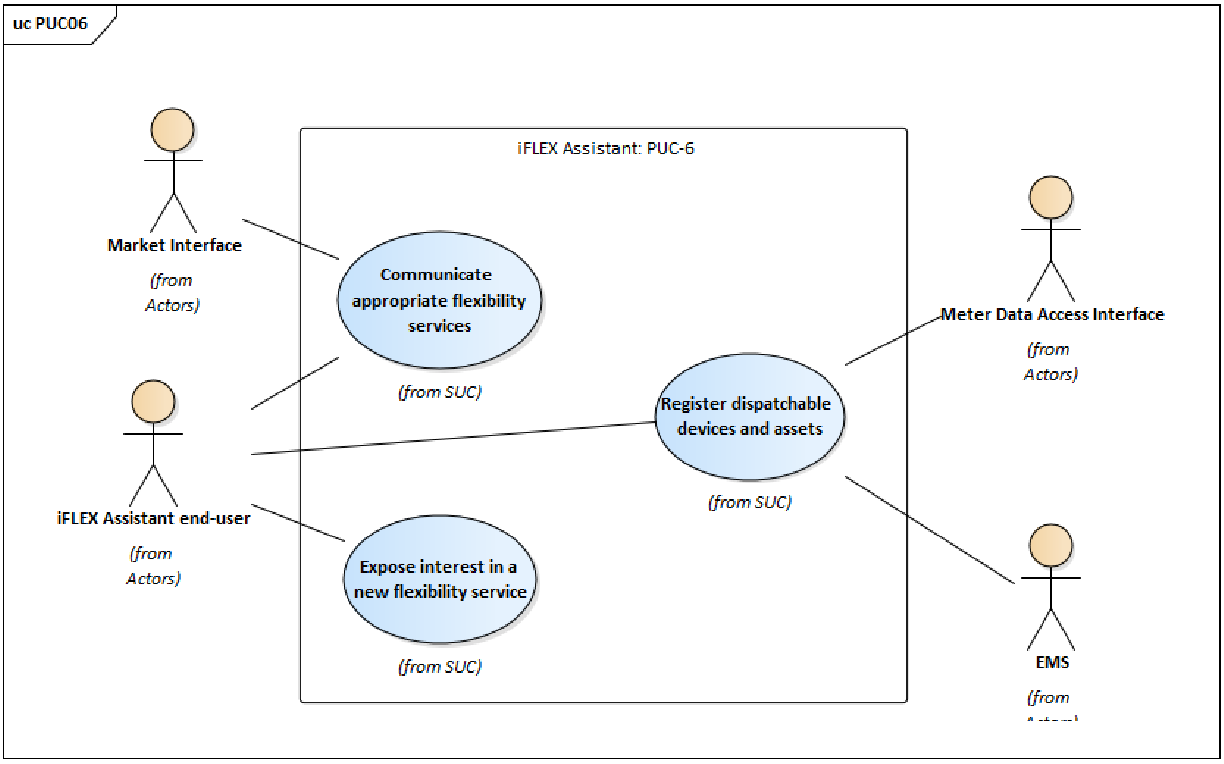



Figure 15 PUC-6 UC Diagram

### 6.2.7 PUC-7: Monitor my energy in real-time

#### 6.2.7.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | Expose real-time monitoring of consumption or/and production and trends. |
| **Objectives** | The objective is to provide insights into consumption/production to motivate change in consumption behaviour, increase actor reaction, improve the energy performance and decrease energy costs. |
| **Related business case(s)** | • BUC-5: Added value services: Customer load profile analysis and overview<br>• BUC-6: Increase self-balancing through advanced monitoring and automation |
| **Related user experience goal(s)** | To be competent, independent and in control |
| **Name of author(s)** | IN-JET |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI4a_DoA | Return on Investment for prosumers in the base scenarios | Calculation of Return on Investment through a Cost Benefit Analysis (CBA)-based technoeconomic evaluation under various business modelling scenarios. A sensitivity analysis will also be performed for alternative settings, e.g. changes to electricity tariffs. | Cost savings |
| KPI4c_DoA | Monetary benefits to the consumer in the base scenarios | Decrease of costs for the consumer compared to current situation. | Cost savings |

| Classification information |
|---|
| **Relation to other use cases** |
| • HLUC-1 Manage energy of the premises in an optimal way (included in)<br>• PUC-2 Integrate iFLEX Assistant (includes) |
| **Level of Depth** |
| System |
| **Prioritisation** |
| High |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| Energy consumption and production monitoring |

#### 6.2.7.2 High-Level Analysis

| Narrative of use case |
|---|
| **Short description** |
| The consumer/prosumer would like to visualise the electricity consumption/production to get a detailed overview of the energy consumption and performance. |
| **Complete description** |
| The aim of the iFLEX Assistant is to facilitate improved visibility into the status of the user's energy system and electricity consumption and trigger a reaction by providing detailed analysis of the electricity consumption and performance.<br><br><u>Visualisation of energy consumption/production</u><br>The user would like to view the electricity consumption/production status of the household in real-time, being able to identify unwanted consumption such as equipment on stand-by or lights not turned off or non-performing assets. The user can also access a detailed analysis of consumption/production, presenting the main drivers of consumption.<br><br>The iFLEX Assistant facilitates improved visibility into the status of the user's energy system (communicated by the SM, the EMS or other means) so that the users have access to power/energy measurements as well as status of their installed devices (on-off, live and historical data) from everywhere, anytime.<br><br>Energy consumption can be summarised according to custom parameters for time (e.g., just now, hourly, daily, monthly), device level (total and breakdown to individual devices), or per activity domain, so that the consumer can observe any wastages of energy. The correlation between kWh consumption and electricity cost can be visualised as well.<br><br>Consumption can be presented in comparative/illustrative manner to the user (e.g., in pie charts, bar charts etc.), so that the main drivers of consumption are revealed. If the user is also a PV owner, consumption and generation forecasting can be visualised to support optimal scheduling and include historical data on consumption powered by PV in percentage, bought and sold solar electricity, correlation between total PV production, total consumed production and surplus production returned to the grid.<br><br>Access to information can happen both through a web interface and a mobile application, depending on the level of detail and functionality. On the mobile application current status and recent trends can be visualised, whereas more in-depth information is accessed through the web-interface providing a status overview of consumption/production together with options to access detailed information and trends.<br><br><u>Performance management</u><br>The iFLEX Assistant supports different types of energy benchmarking. Based on user preferences (PUC-1) the user can choose to set goals on the performance of their installed devices in relation to chosen metrics (PUC-3) such as sustainability, energy consumption and cost savings. Operation can be automated through HEMS based on predefined rules (PUC-1, PUC-10). The user can choose to receive notifications (PUC-1, PUC-5) through the app. Notifications can be sent according to certain (predefined) events e.g., status update of an appliance, or the total (or phase) power consumption exceeds a certain predefined threshold. The user can also receive advice e.g., on reduced performance of appliances that would benefit from replacement. |

| Use case conditions |
|---|
| **Assumption(s)** |
| • Smart meter data are available<br>• Smart devices (sensors/smart plugs etc.) are available<br>• An Energy Management System (EMS) is able to provide monitoring of local assets (e.g. controllable devices/DER) |
| **Precondition(s)** |
| • IFLEX Assistant is parameterised and operational<br>• The HEMS is operational and integrated with iFLEX Assistant<br>• IFLEX Assistant has access to user's electricity costs and feed-in revenue |

| |
|---|
| • The user has provided consent to process its energy consumption/production data |

| Actors | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **iFLEX Assistant end user** | Person | Would like to understand the energy consumption/production to increase performance |
| **Energy Management System** | System | Provides monitoring and automation capabilities |
| **Meter Data Access Interface** | System Interface | Provides iFLEX Assistant with smart meter data |

**Diagram(s) of use case**

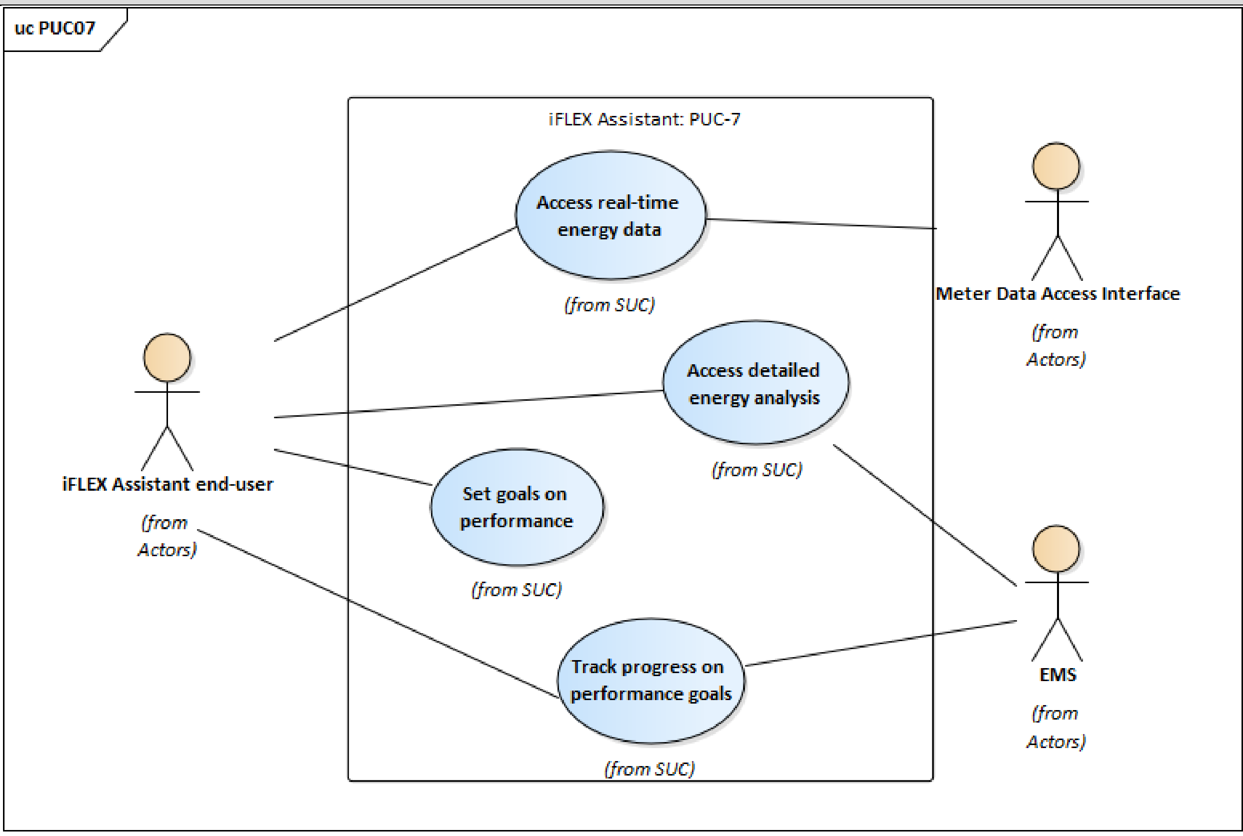



Figure 16 PUC-7 UC Diagram

### 6.2.8 PUC-8: Offer flexibility

#### 6.2.8.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | Describes the process of learning the behaviour of consumers/prosumers and their energy systems in order to offer the available flexibility to a procurer of flexibility (e.g. retailer, independent aggregator). In addition to electricity, this use case covers also the flexibility provided to district heating network. |
| **Objective** | To offer the flexibility at the consumer premises (e.g. household or apartment building) to be used for explicit demand response (e.g. offering the flexibility to markets via aggregation). The aggregator needs to know both the baseline load and available flexibility. To this end, the objective is to:<br>• Forecast the baseline load for electricity and/or district heating in configurable time window.<br>• Forecast and model the flexibility for electricity and/or district heating. |
| **Related business case(s)** | • BUC-1 Optimise operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-2 Optimise grid operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-3 Offer the flexibility of a multi-vector energy system (building community) to the energy markets<br>• BUC-4 Schedule optimal energy consumption for multi-vector energy system (building community) based on the behaviour of consumers and market price signals<br>• BUC-7 Optimise end-user's energy consumption based on own preferences and market price signals<br>• BUC-8 Offer flexibility through participation in explicit demand response programmes |
| **Related user experience goal(s)** | To be smart, competent and cost-efficient |
| **Name of the author(s)** | VTT, ICOM |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI2a_DoA | Increased accuracy of consumer load forecasting compared to state-of-the-art methods | The results are compared to the state-of-the-art consumer load forecasting models and percentage decrease of forecasting error is calculated. Evaluation is performed using a variety of data sets (collected in the project), data amounts and load forecasting lengths and average performance of the approaches is calculated. | Baseline load forecasts for electricity and district heating. |
| KPI2b_DoA | Increased accuracy of flexibility modelling compared to state-of-the-art methods | The results are compared to the state-of-the-art flexibility modelling results and percentage decrease of forecasting error is calculated. Evaluation is performed using a variety of data sets (collected in the project), data amounts and flexibility forecasting lengths and average performance of the approaches is calculated. | Flexibility forecasts for electricity and district heating. |
| KPI6c_DoA | Increased consumer flexibility | The average flexibility of pilot participants that is validated in grid stability/RES integration cases is compared to relevant results reported in the literature. | Flexibility forecasts for electricity and district heating. |

| | | | |
|---|---|---|---|
| | for grid stability and RES integration | | |

| Classification information |
|---|
| **Relation to other use cases** |
| • HLUC-2 Manage flexibility request or price signals at individual premises level (included in)<br>• HLUC-3 Manage flexibility request or price signals at building community level (included in)<br>• PUC-2 Integrate iFLEX Assistant (includes) |
| **Level of Depth** |
| High |
| **Prioritisation** |
| High |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| Flexibility offer, baseline load, modelling |

#### 6.2.8.2 High-Level Analysis

| Narrative of use case |
|---|
| **Short description** |
| The iFLEX Assistant learns the consumption behaviour of the user and the dynamics of relevant energy systems (e.g. buildings thermal mass, local production) in order to expose the available flexibility and baseline load profile at different time periods to market actors (e.g. BRP, Aggregator). This will enable aggregators to execute explicit demand response by activating the flexibility offers via DR signals (HLUC-2 and HLUC-3). The UC covers electricity and district heating energy vectors. |
| **Complete description** |
| The iFLEX Assistant is able to leverage a variety of information available from sensing devices, external services (e.g. weather forecast) and most importantly the preferences and behaviour of the consumer/prosumer in order to forecast the baseline load profile. On top of this, the available flexibility of the user – with respect to user comfort – is devised by the iFLEX Assistant.<br><br>Accurate baseline load profiles and flexibilities are important for a procurer of flexibility because they make it possible to first estimate and then measure the impact of DR events in more precise manner. This is especially important in explicit demand response where e.g. the aggregator is bidding specific quantities to the energy markets. Moreover, the flexibility offers and baseline load profiles are important to quantify the contribution of users in explicit demand response activities.<br><br>To provide this functionality the iFLEX Assistant will learn the user behaviour and the dynamics of relevant energy systems such as the Heating, Ventilation and Air Conditioning (HVAC) of a building to create forecasts on the consumption profile with respect to different inputs (e.g. weather, user preferences, appliances schedules, etc.). Additionally, if there is local production in the consumer premises, the iFLEX Assistant will learn to forecast the local energy production along with baseline load profiles. |

| Use case conditions |
|---|
| **Assumption(s)** |
| • An Energy Management System (EMS) can provide access to energy measurement data.<br>• A Weather Service is available. |
| **Precondition(s)** |
| • The iFLEX Assistant is parameterised and operational |

| |
|---|
| • The iFLEX Assistant is connected to the EMS.<br>• The iFLEX Assistant communicates with the Weather Service.<br>• The iFLEX Assistant is able to communicate with the Flexibility Procurer back-end system<br>• The EMS has access to smart meter, sensors and dispatchable devices and assets.<br>• The end user has provided consent on sharing baseline load and flexibility information with the aggregator. |

| General Remarks |
|---|
| Liability issues for calculated of flexibility models should be considered. |

| Actors | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **Market Interface** | System Interface | Enables communication of flexibility requests from the systems of the relevant market actors to the iFLEX Assistant. |
| **Energy Management System (EMS)** | System | Provide sensing data (energy consumption) |
| **Weather Service** | Application | Weather information is important for heating/cooling related flexibility. |

**Diagram(s) of use case**

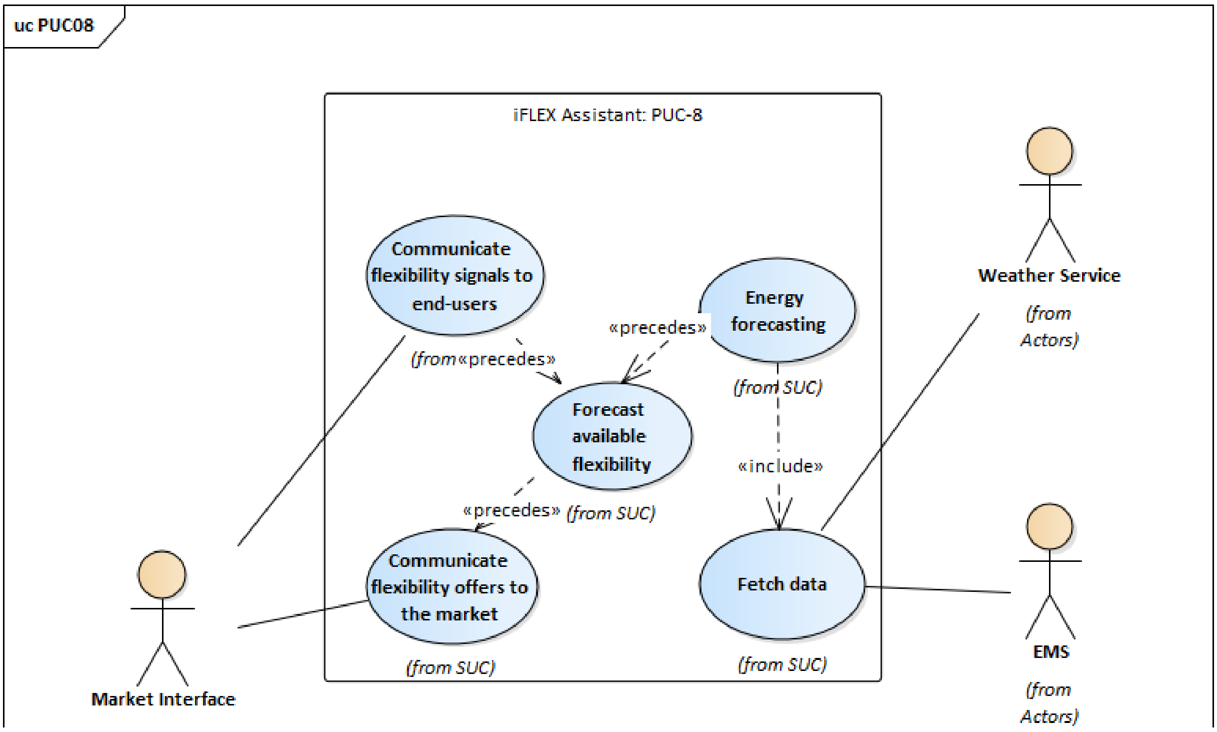



Figure 17 PUC-8 UC Diagram

### 6.2.9 PUC-9: Optimise schedule considering prices and/or incentives

#### 6.2.9.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | The iFLEX Assistant should be able to optimally schedule the operation of the end-user's energy system, taking into account enrolment in demand response (DR) programmes. Both explicit (based on flexibility requests) and implicit (based on price signals) DR programmes are examined in this use case. Also, at least electricity and district heat – when applicable – are among the energy vectors of interest. |
| **Objectives** | The main objective is to achieve optimal operation of the end-user's energy system, while offering flexibility services. This can be broken down to the following sub-objectives:<br>• Plan optimal control schedule for flexible resources within the end-user's premises.<br>• Execute the new control scheme by interacting with the Energy Management System (EMS).<br>• Assess the proposed operation schedule as new data become available and reschedule accordingly – if needed. |
| **Related business case(s)** | • BUC-1 Optimise operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-2 Optimise grid operation by leveraging flexibility from consumer/prosumer through DR<br>• BUC-3 Offer the flexibility of a multi-vector energy system (building community) to the energy markets<br>• BUC-4 Schedule optimal energy consumption for multi-vector energy system (building community) based on the behaviour of consumers and market price signals<br>• BUC-7 Optimise end-user's energy consumption based on own preferences and market price signals<br>• BUC-8 Offer flexibility through participation in explicit demand response programmes |
| **Related user experience goal(s)** | To be smart, competent and cost-efficient. |
| **Name of the author(s)** | ICOM |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI2c_DoA | Increased effectiveness of automated flexibility management compared to standard methods | The results are compared to typical flexibility management algorithms in a wide variety of DR optimisation targets and incentives. Percentage improvement of rewards (incentive-specific) is calculated. Evaluation is performed using a variety of data sets (collected in the project), and incentives, and an average performance of the approaches is calculated. | Achieve optimal operation of the end-user's energy system, while offering flexibility services. |
| KPI4a_DoA | Return on Investment for prosumers in | Calculation of Return on Investment through a Cost Benefit Analysis (CBA)-based technoeconomic evaluation under various business modelling scenarios. A | Achieve optimal operation of the end-user's energy system, while offering flexibility services. |

| | | | |
|---|---|---|---|
| | the base scenarios | sensitivity analysis will also be performed for alternative settings, e.g. changes to electricity tariffs. | |
| KPI4c_DoA | Monetary benefits to the consumer in the base scenarios | Decrease of costs for the consumer compared to current situation. | Achieve optimal operation of the end-user's energy system, while offering flexibility services. |

| Classification information |
|---|
| **Relation to other use cases** |
| • HLUC-2 Manage flexibility requests or price signals at individual premises level (included in)<br>• HLUC-3 Manage flexibility requests or price signals at building level (included in)<br>• PUC-2 Integrate iFLEX Assistant (includes) |
| **Level of Depth** |
| High |
| **Prioritisation** |
| High |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| Demand side flexibility, demand response, energy management, scheduling optimisation. |

#### 6.2.9.2 High-Level Analysis

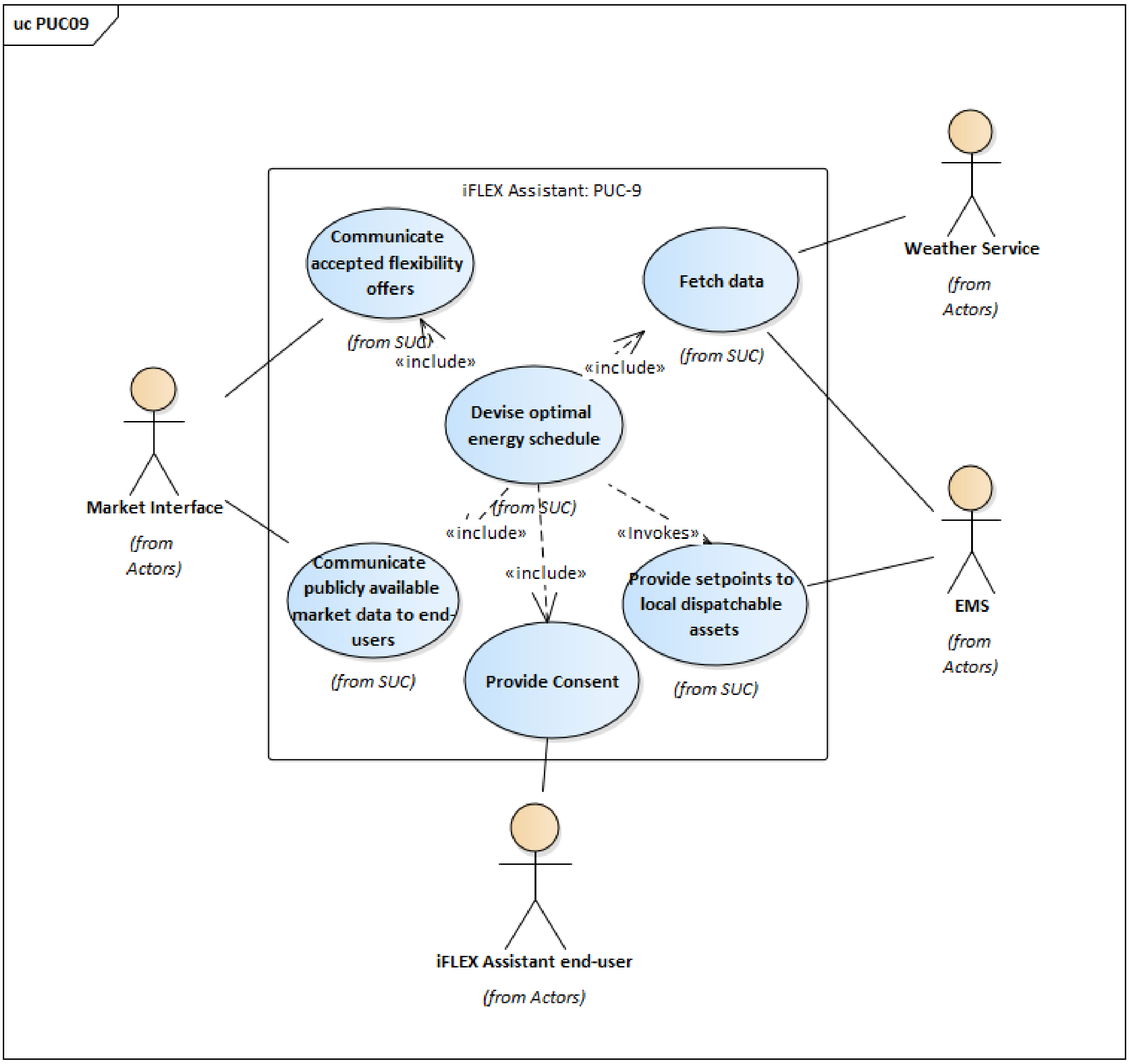
| Narrative of use case |
|---|
| **Short description** |
| The iFLEX Assistant aims to provide the end user with advanced energy and flexibility management services. Thus, following the calculation of the end-user's flexibility offers towards the interested market actor within the context of a DR program, the iFLEX Assistant is charged with planning optimally the schedules of the premises' dispatchable resources. To accomplish this task, it utilises models that learn from past user's behaviour (e.g. AI-based methods). |
| **Complete description** |
| The *iFLEX Assistant* is responsible for providing the *consumer/prosumer* with an optimal energy scheduling, at different levels: individual premises and building (block) level.<br><br>For this reason, various inputs can be assessed to devise the optimal schedule of the premises' dispatchable devices and assets.<br>• In-premise sensing data, such as room and outdoor temperature which are retrieved from the *sensors* of the premises;<br>• Energy metering data from the installed *smart metering devices* (e.g., electricity, heat);<br>• Weather forecast data derived from an external *weather service*;<br>• Energy prices, as communicated through *market interfaces*;<br>• Flexibility requests from the market e.g. aggregator;<br>• Preferences of the end user regarding the operation of dispatchable devices and comfort levels.<br><br>The optimisation shall consider past behaviour of the user (e.g. through machine learning methods); this way, the iFLEX Assistant shall be able to exploit past experience to come up with an optimised energy schedule for the premises.<br><br>The devised schedule(s) might be submitted to the end user for acceptance, depending on preset preferences. Upon calculation/acceptance the schedule(s) are communicated to the *EMS*, which controls the operation of dispatchable devices and assets. |

| |
|---|
| The optimisation operation shall consider data that are regularly updated, in order for the iFLEX Assistant to assess performance and adapt the proposed schedule accordingly – depending on the end-user preferences.<br><br>Different scenarios might be identified, leveraging the different types of input and dispatchable assets/devices:<br>• Optimise building resources at building-level<br>• Optimise resources within individual apartment<br>Scenarios might also differ in terms of business context, including some combination of following:<br>• Implicit DR<br>• Explicit DR<br>• Optimisation across energy vectors (e.g. electricity and district heating)<br>Scenarios might also differ in terms of optimisation goal:<br>• Optimise sustainability<br>• Optimise costs<br><br>In case the end user has selected to provide consent for control actions, an imperative step is to get the feedback of the user on the plan to be dispatched. |

| Use case conditions |
|---|
| **Assumption(s)** |
| • An Energy Management System (EMS) is installed.<br>• A Weather Service is available.<br>• An Energy Management System (EMS) provides the status of local assets and relays the control commands of controllable ones.<br>• Measurement data are available by an EMS or via direct communication with sensing devices, or via direct communication with the Smart Meter.<br>• Weather forecast data are provided via communication with relevant external service.<br>• A market interface enables communication of energy prices/flexibility requests. |
| **Precondition(s)** |
| • The iFLEX Assistant is parameterised and fully operational.<br>• The iFLEX Assistant is connected to the EMS.<br>• The iFLEX Assistant communicates with the Weather Service.<br>• The EMS has access to and can communicate with smart meter, dispatchable assets, and sensors. |

| Actors | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **iFLEX Assistant end user** | Person | Provides preference and consent for schedules calculated by the assistant. Wants his/her energy system to operate optimally, while offering flexibility services. |
| **Energy Management System** | System | Assists the iFLEX Assistant in optimising the energy operation of the premises through monitoring and control of devices and assets. |
| **Weather Service** | Application | Provides weather forecasts which can be utilised to derive the optimised schedule(s) |
| **Market Interface** | System Interface | Enables communication of energy prices and accepted flexibility offers from the |

| | | |
|---|---|---|
| | | systems of the relevant market actors to the iFLEX Assistant. |

| Diagram(s) of use case |
|---|
|  <br>Figure 18 PUC-9 UC Diagram |

### 6.2.10 PUC-10: Increase self-balancing through forecasting and automation

#### 6.2.10.1 General information

| Scope and objectives of the use case | |
|---|---|
| **Scope** | Describes how iFLEX Assistant facilitates the optimal energy management of the facility (household) based on different objectives, such as maximising self-consumption or minimising energy costs. To accomplish this, various factors such as local RES production forecast, electricity cost and user preferences are considered. |
| **Objectives** | The objectives are to<br>1. Achieve automated control of assets based on user preferences<br>2. Optimise energy absorption from production assets (sustainability goal)<br>3. Optimise the operation of the premises from an economic viewpoint |
| **Related business case(s)** | • BUC-5 Added value services: Customer load profile analysis and overview<br>• BUC-6 Increase self-balancing through advanced monitoring and automation |
| **Related user experience goal(s)** | To be independent, competent, meaningful, cost-efficient and in control |
| **Name of the author(s)** | IN-JET, ICOM |

| Key performance indicators | | | |
|---|---|---|---|
| **ID** | **Name** | **Description** | **Reference to mentioned use case objectives** |
| KPI4a_DoA | Return on Investment for prosumers in the base scenarios | Calculation of Return on Investment through a Cost Benefit Analysis (CBA)-based technoeconomic evaluation under various business modelling scenarios. A sensitivity analysis will also be performed for alternative settings, e.g. changes to electricity tariffs. | Optimise operation based on economic motives. |
| KPI4c_DoA | Monetary benefits to the consumer in the base scenarios | Decrease of costs for the consumer compared to current situation. | Optimise operation based on economic motives. |
| KPI10a | Increase self-consumption ratio | Increase self-consumption ratio of own PV-generated energy by scheduling accordingly the operation of dispatchable devices and assets. | Optimise energy absorption from production assets. |
| KPI10b | Reduction in curtailed PV-generated energy [%] | Reduce the curtailment of PV-generated energy, in cases this is imposed by relevant DSO's rules. This goal is enabled via scheduling accordingly the operation of dispatchable devices and assets. Compare with the current state. | Optimise energy absorption from production assets.<br><br>Optimise operation based on economic motives. |

| Classification information |
| --- |
| **Relation to other use cases** |
| • HLUC-1 Manage energy of the premises in an optimal way (included in)<br>• PUC-2 Integrate iFLEX Assistant (includes) |
| **Level of Depth** |
| High |
| **Prioritisation** |
| Medium |
| **Generic, regional or national relation** |
| Generic |
| **Nature of the use case** |
| Technical |
| **Further keywords for classification** |
| Renewable Home Energy Automation, energy management, scheduling optimisation, self-consumption maximisation, PV curtailment, cost optimisation |

#### 6.2.10.2 High-Level Analysis

| Narrative of use case |
| --- |
| **Short description** |
| The iFLEX Assistant aims to provide the end user with advanced energy management services, which can be tailored to the user's preferences. Hence, the scheduling optimisation can be driven by different motives, e.g., sustainability-related, or economic ones. In the first case, iFLEX Assistant will enable the prosumer to utilise the facility's renewable electricity production (i.e., solar) to its fullest, through automated control of assets, respecting the user's preferences. In the second case, the goal of the assistant will be to minimise the energy costs. |
| **Complete description** |
| Based on the monitoring of energy in the household, the iFLEX Assistant shall provide the prosumer with an optimal energy scheduling, which considers his/her preferences.<br>Several inputs shall be considered to come up with the optimal schedule(s) of dispatchable devices and assets.<br>• In-premise metering and sensing data, which are communicated to iFLEX Assistant via the EMS;<br>• Weather forecast data derived from an external weather service;<br>• Electricity tariffs (e.g., electricity consumption and feed-in tariffs) which are communicated via the market interface;<br>• Local generation and consumption forecasts, devised by the iFLEX Assistant itself;<br>• Prosumer's preferences with respect to the operation of dispatchable devices and comfort levels.<br><br>The optimisation shall take into account the prosumer's past behaviour and devise an energy schedule accordingly.<br><br>Depending on the user's preferences, the assistant will notify the user for providing consent for the schedules of controllable assets (or selection among different schedules) or directly proceed with sending the schedules to the EMS in order to perform the appropriate actions (i.e., provide set points to controllable assets).<br><br>The optimisation operation shall consider regularly updated data, so that the iFLEX Assistant can periodically assess performance and adapt – if needed – the proposed schedule for controllable loads accordingly. Furthermore, if the assistant is authorised, it can provide the prosumer with advice for non-controllable loads (e.g., cooking).<br><br>As discussed, different scenarios might be identified with respect to optimisation goal:<br>• Maximise self-consumption<br>• Minimise energy costs |

In the first case, the prosumer wants to consume as much of the generated energy within the premise as possible, by shifting electricity consumption to periods of high PV generation, in order to increase self-consumption. The prosumer aims to increase his/her sustainability performance and avoid curtailing the PV output due to limits concerning the maximum feed-in power to the grid, which can be imposed by the DSO.

In the second case, the prosumer is mainly driven by an economic motive. Thus, the iFLEX Assistant considers also the electricity tariffs while devising the optimal energy scheduling, so that the energy costs can be minimised.

In case the end user has selected to provide consent for control actions, an imperative step is to get the feedback of the user on the plan to be dispatched.

**Use case conditions**

**Assumption(s)**

- An Energy Management System (EMS) is installed.
- A Weather Service is available.
- An Energy Management System (EMS) provides the status of local assets and relays the control commands of controllable ones.
- Measurement data are available by an EMS or via direct communication with sensing devices, or via direct communication with the Smart Meter.
- Weather forecast data are provided via communication with relevant external service.
- A market interface enables communication of energy prices.

**Precondition(s)**

- The iFLEX Assistant is parameterised and fully operational.
- The iFLEX Assistant is connected to the EMS.
- The iFLEX Assistant communicates with the Weather Service.
- The EMS has access to and can communicate with smart meter, dispatchable assets, and sensors.

| **Actors** | | |
|---|---|---|
| **Actor name** | **Actor type** | **Further information** |
| **iFLEX Assistant end user** | Person | Provides preference and consent for schedules calculated by the assistant. Would like to exploit production to the fullest and/or reduce energy costs. |
| **Energy Management System** | System | Assists the iFLEX Assistant in optimising the energy operation of the premises through monitoring and control of devices and assets. |
| **Weather service** | Application | Provides weather forecasts which can be utilised to derive the optimised schedule(s). |
| **Market Interface** | System Interface | Enables communication of energy market data between the systems of the relevant market actors and the iFLEX Assistant. |

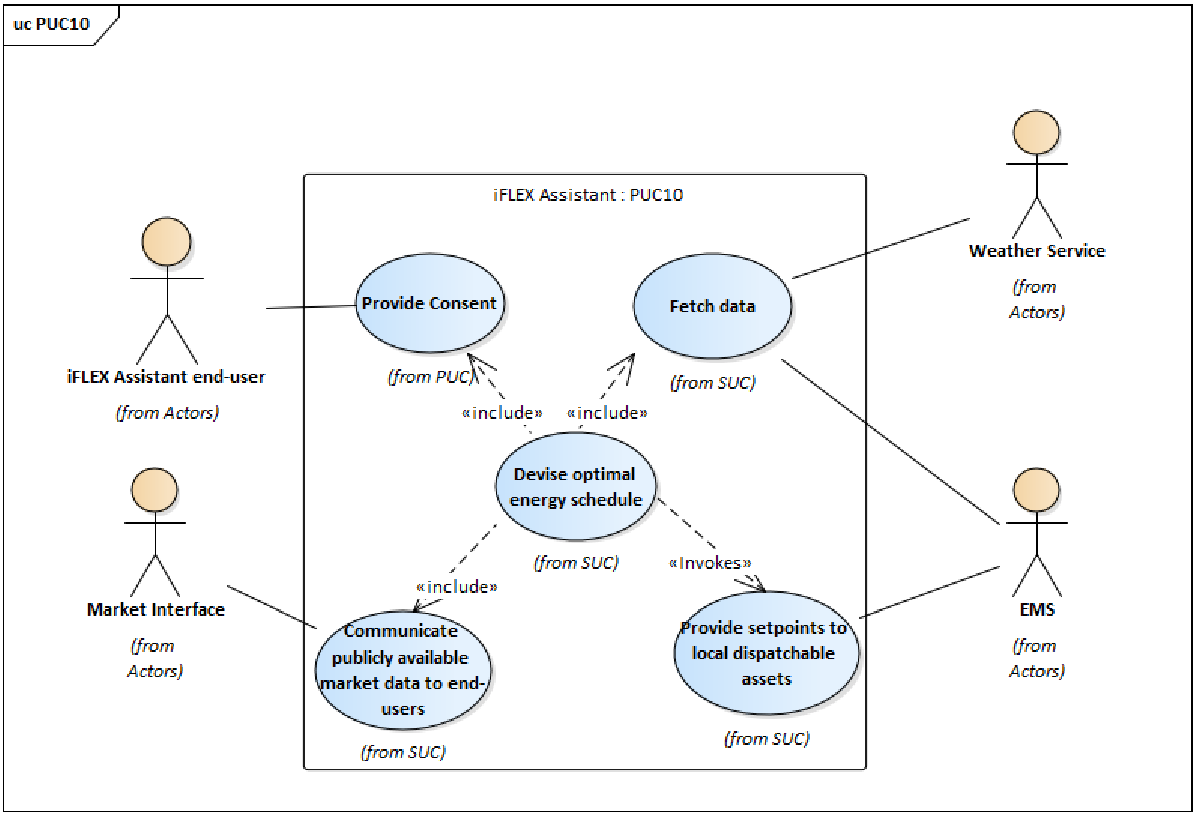
| Diagram(s) of use case |
|---|
|  |



Figure 19 PUC-10 UC Diagram

# 7 Security Requirements

Security and privacy are important aspects of the iFLEX system in development. A number of efforts have addressed the aspects thoroughly in the last decade. Standardisation organisations like NIST [23] [24] [25] and CEN-CENELEC-ETSI [26] have prepared a number of recommendations in the field. Similarly, European Union Agency for Cybersecurity has been active with a number of recommendations addressing various aspects of security and smart grids [27] [28] [29] [30] [31] [32] [33]. Working closely with EU Smart Grid task force[3] USEF foundation[4] has prepared a list of recommendations for security and privacy [34]. Important impact on privacy requirements has the General Data Protection Regulation (GDPR) [35].

To address security and privacy of the project in a practical manner, a number of general level security and privacy requirements has been gathered and exposed, using the smart grid background detailed above. The requirements are listed and explained in the lists below. They are labelled clearly to allow the requirements' direct use in a process of use cases analysis.

Security and privacy requirements are related to an extent. Some of the security requirements help to fulfil the privacy requirements while the later assist to foster the security ones. In the description of the requirements an Internet Security Glossary [36] terminology has been used, if not specified otherwise.

The following security requirements should be considered by the project:

- SEC-01-TRUST: trust needs to be managed between system entities representing various stakeholder roles in the system. The entities belong to different administrative domains and a way (or ways) needs to be provided, so that they can trust each other's claims on identities, capabilities and authorisations,
- SEC-02-AAA: authentication, authorisation and accounting needs to be provided. System-wide authentication of system entities should be possible, access to system and end-user resources should be authorised and spending or provision of user and system resources should be accountable,
- SEC-03-COMSEC: all information exchanged in communication between system entities should be protected. Data integrity and confidentiality services should be provided within the scope of the system that the project controls,
- SEC-04-CIA: confidentiality and integrity of the data stored in the system should be provided, availability properties of the services should be specified and implemented,
- SEC-05-REST: security of the data and service information at rest should be provided,
- SEC-06-ECOSYS: the iFLEX system will interact with a number of other systems, components or devices, like HEMSes, sensors, etc. During the iFLEX Assistant design phase, these external systems should be considered and clear security and privacy recommendations for their interoperability should be provided.

The following privacy requirements should be considered by the project:

- PRI-01-CONSENT: personal data collection requires piloting user's consent, in case the pilot user is not controlling his/her own data,
- PRI-02-DF: data flows in the iFLEX system should be explicit and validated before the parts of the system functionality controlling the flow is being used. Validation should happen early, already during design, but later phases of implementation, deployment and piloting should not be neglected,
- PRI-03-PSDN: pseudonymous end-user identifiers should be used wherever possible instead of directly identifiable personal information like name, surname, email, etc.,
- PRI-04-ANON: the project data flows should be checked, so that all flows without consent emit only anonymised data,
- PRI-05-NTKP: care should be taken that handling of the data complies with need-to-know principle. Only the entity that needs to know the data for providing its role and functionality in the iFLEX system [23] should be able to access the data,
- PRI-06-STORE: storing of the data in the cloud should be compliant with EU and pilot-national directives and policies,
- PRI-07-RTBF: right to be forgotten policy should be considered during the system design and implementation.

[3] See task force home page for details: https://ec.europa.eu/energy/topics/markets-and-consumers/smart-grids-and-meters/smart-grids-task-force_en
[4] Universal Smart Grid Energy Framework foundation, see home page for details: https://www.usef.energy/

# 8 Socio-economic Requirements

This chapter outlines non-functional requirements related to legal and policy realms in the areas of privacy, contract termination, offers and automated decision making based on consumer data.

## 8.1 Privacy

- The solution should be fully compliant with GDPR, in particular [37]:
    - It should be clear what data is collected, who has access to that data, for which purposes it is used, how it is protected and for how long it is stored.
    - Services should be designed following the principle of privacy by design and ensure that no more data than necessary is collected and that it is not kept for longer than needed.
    - Consumers should be able to access their data, request its deletion, correction and their portability.
- Best practices in privacy protection should be followed beyond mere compliance with GDPR, such as [37]:
    - Consent for the use of data should always be requested in case of any marketing related practices, even if they could be considered a legitimate interest under GDPR.
    - Consumers should be able to easily view and directly control which third parties have access to their data.
    - Privacy related information should be easily accessible and gathered in one single place, instead of scattered across the privacy policy, terms and conditions, etc., to make sure the consumer can get a good overview of how his/her data will be used and assess this prior to entering into any contract with the service.

## 8.2 Contract termination

The following requirements with respect to contract termination should be satisfied [37]:

- Consumers should be allowed to easily terminate the contract and switch.
- Termination fees should be limited. Early termination fees for a fixed term contract could be linked to an advantage that was given to the consumer (e.g., a discount, a promotion on the energy price). In such cases, energy companies should be obliged to demonstrate the real cost to be able to charge termination fees. The fee must be reasonable and proportionate to the advantage given to the consumer.
- Duration of the contract and its termination should be clear to consumers. In case of tacit renewal, the consumer should be able to terminate the contract monthly and free of charge after the agreed contract period.

## 8.3 Offers

Furthermore, available offers should comply with the subsequent requirements [37]:

- Marketing and communication materials should provide clear and complete information on offers, including how the tariffs and rewards levels are set. All information should be provided in the same place before the customer commits to the services.
- Consumers should be informed if flexible electricity offers are adequate for their consumption patterns, and look out for any signs of vulnerability.
- Consumers should be informed about the necessary devices or assets (e.g., battery) to benefit from the offer.
- Clear, accessible and up-to-date tariff levels should be provided regularly. The communication should take place using mediums that work and at the moments that are most relevant to consumers.
- Tariffs should be evaluated frequently and consumers should get the tools to save money, and to protect themselves against bill shocks. This should include the provision of additional services that are useful for optimising electricity consumption (e.g., a platform that can be used by consumers to monitor their consumption in real-time).
- Consumers should be able to pay bills by instalments whenever the amount to be paid exceeds the average charged in the past.

## 8.4 Automated decision making based on consumer data

Automated decision making based on consumer data has to be safe and risks – including discrimination, loss of privacy, loss of autonomy, and lack of transparency – should be avoided. The principles listed below should be followed from the design phase of any product that incorporates any aspect of automated decision making based on artificial intelligence (AI) [38]:

- Transparency, Explanation, and Objection
  - Consumers should get a clear picture of how decisions that affect them are made and be able to oppose wrong or unfair decisions and request human intervention.
- Accountability and Control
  - Appropriate technical and organisational systems as well as measures are put in place that ensure legal compliance and regulatory oversight.
- Fairness
  - Algorithmic decision making should be done in a fair and responsible way.
- Non-discrimination
  - Consumers should be protected from illegal discrimination and unfair differentiation.
- Safety and Security
  - AI-powered products should be safe and secure throughout their lifecycle.
- Access to Justice
  - Consumers should be entitled to redress and public enforcement if risks associated with artificial intelligence materialise.
- Reliability and Robustness
  - AI powered products should be technically reliable and robust by design.

# 9 Conclusions

This document aims to identify a set of functional and non-functional requirements for the development of intelligent assistants offering flexibility and holistic energy management. While the focus of the project lies within the power sector, cross-sector energy optimisation, as in the case of electricity and district heat, is explored.

The established paradigm of analysing requirements with the Use Cases methodology in the Smart Grids domain was followed, adopting an iterative and recursive approach. Use Cases were analysed for possible conflicts (e.g. overlaps), missing functions of the iFLEX Assistant and overall the level of detail provided by the UC model. In case any of the above checks provided a non-acceptable result, the Use Cases model was refined (e.g. scope refinement, UC merging, new UC modelling) and a new iteration cycle of the analysis began. Use cases were analysed both in a business and a technical context, with different levels of abstraction.

Furthermore, the end-user perspective was analysed addressing both usability aspects (how the product is used), as well as the motivations and needs behind the interaction. The requirements related to what the user would like the system to do are documented through user stories, whilst the context and the basic principles of the user interfaces were also analysed.

To address security and privacy of the project in a practical manner, a number of general level security and privacy requirements has been gathered and exposed, re-using existing knowledge in the domain, as established via recommendations from various organisations such as NIST, CEN-CENELEC-ETSI, ENISA and USEF.

To address socio-economic aspects of the solution, a number of requirements was documented tackling privacy protection, flexibility contract offering, as well as contract termination and switching. Furthermore, requirements on the automated decision making based on consumer data were captured focusing on protecting the consumer/prosumer from risks – including discrimination, loss of privacy, loss of autonomy, and lack of transparency.

This document provided an initial set of requirements for the iFLEX project, capturing the business and technical context, the scope of the project's solutions and acting as a basis for the iterative design approach followed in the project. Since it has been developed at an early stage of the project, the main sources of eliciting the requirements were project (internal) expert workshops, existing research and domain knowledge as well as the iFLEX concept vision. In subsequent activities of the project, these requirements will be further analysed and refactored using the feedback of actual end users in iFLEX (through co-creation activities) and further research on their needs and the context of use.

# 10 List of figures and tables

## 10.1 Figures



## 10.2 Tables

# 11 List of abbreviations

| Abbreviation | Term |
|---|---|
| aFRR | Automatic Frequency Restoration Reserve |
| AI | Artificial Intelligence |
| BEMS | Building Energy Management System |
| BRP | Balance Responsible Party |
| BSP | Balance Service Provider |
| BUC | Business Use Case |
| CEN | European Committee for Standardisation |
| CENELEC | European Committee for Electrotechnical Standardisation |
| CPP | Critical Peak Pricing |
| DER | Distributed Energy Resource |
| DMS | Distribution Management System |
| DR | Demand Response |
| DRMS | Demand Response Management System |
| DSO | Distribution System Operator |
| EMS | Energy Management System |
| ENISA | European Union Agency for Cybersecurity |
| ESCO | Energy Service Company |
| ETSI | European Telecommunications Standards Institute |
| EV | Electric Vehicle |
| FCR | Frequency Containment Reserve |
| GDPR | General Data Protection Regulation |
| HEEMRM | Harmonised European Electricity Market Role Model |
| HEMS | Home Energy Management System |
| HLUC | High-Level Use Case |
| HW | Hardware |
| ICT | Information and Communications Technology |
| IEC | International Electro-Technical Commission |
| ISO | International Organisation for Standardisation |
| KPI | Key Performance Indicator |
| MDMS | Meter Data Management System |
| mFRR | Manual Frequency Restoration Reserve |
| NIST | National Institute of Standards and Technology |
| PUC | Primary Use Case |
| PV | Photovoltaic |
| RES | Renewable Energy Source |

| | |
|---|---|
| RR | Replacement Reserve |
| RTP | Real-Time Pricing |
| SGAM | Smart Grid Architecture Model |
| SO | System Operator |
| SUC | Secondary Use Case |
| SW | Software |
| ToU | Time-of-Use |
| TSO | Transmission System Operator |
| UC | Use Case |
| UML | Unified Modelling Language |
| US | User Story |
| USEF | Universal Smart Energy Framework |

## 12 References

[1] CEN CENELEC ETSI Smart Grid Coordination Group, ""Smart Grid Reference Architecture - Version 3.0"," 2012.

[2] IEC, "IEC 62559-2:2015 "Use case methodology - Part 2: Definition of the templates for use cases, actor list and requirements list"," IEC, 2015.

[3] CEN-CENELEC-ETSI Smart Grid Coordination Group, "«SGAM User Manual -Applying, testing & refining the Smart Grid Architecture Model - Version 3.0,»," 2014.

[4] ISO/IEC, "ISO/IEC 19505-2:2012 "Information technology — Object Management Group Unified Modeling Language (OMG UML) — Part 2: Superstructure"," ISO/IEC, 2012.

[5] CEN-CENELEC-ETSI , "Smart Grid Coordination Group, «Overview of SG-CG Methodologies,» 2014.".

[6] P. &. L. E. &. K. K. &. U. M. &. S. K. Valkering, "How to engage end-users in smart energy behaviour?," *EPJ Web of Conferences,* no. 79, 2014.

[7] A. R. S. A.Morton, "Empowering and Engaging European building users for energy efficiency," *Energy Research & Social Science,* vol. 70, 2020.

[8] ebIX, EFET, and ENTSO-E, "The Harmonised Electricity Market Role Model, version: 2020-01," 2020.

[9] E. D. S. O. (. f. S. Grids, "Flexibility: The role of DSOs in tomorrow's electric-ity market," 2014. [Online]. Available: https://www.edsoforsmartgrids.eu/wp-content/uploads/public/EDSO-views-on-Flexibility-FINAL-May-5th-2014.pdf.

[10] Universal Smart Energy Framework (USEF), "USEF: The Framework explained," Universal Smart Energy Framework (USEF), 2015.

[11] European Commission, "Energy prices and costs in Europe. Commission staff working document. Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions," European Commission, 2019.

[12] G. M. K. Dutta, "A literature review on dynamic pricing of electricity," *Journal of the Operational Research Society,* vol. 68, no. 10, p. 1131–1145, 2017.

[13] M. Hassenzahl, Experience Design: Technology for All the Right Reasons. Synthesis Lectures on Human-Centered Informatics, 3(1), 1–95, Morgan & Claypool Publishers, 2010.

[14] H. V. A. M. C. L. J. Ridder, "Designing for crowd well-being: Needs and design suggestions," in *International Conference on Planning and Design, 2013, NCKU*, Tainan, Taiwan, 2013.

[15] A. J. E. Y. K. T. K. Kennon M. Sheldon, "What is satisfying about satisfying events? Testing 10 candidate psychological needs.," *Journal of Personality and Social Psychology,* vol. 80, no. 2, pp. 325-339, 2001.

[16] ISO, "ISO 9241-11:2018(en). Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts," ISO, 2018.

[17] Interaction Design Foundation, "Interaction Design Foundation," [Online]. Available: https://www.interaction-design.org/. [Accessed 5 January 2021].

[18] B. Buxton, Interviewee, *CES 2010: NUI with Bill Buxton with Larry Larsen..* [Interview]. 6 January 2010.

[19] B. J., Natural User Interfaces in .Net, Manning Publications, 2011.

[20] Alexandra Institute, "Energy Consumption in the home: An anthropological user study of needs, motivations and barriers to energy consumption in the home. Minimum Configuration Home Automation project (MCHA).," Alexandra Institute, 2009.

[21] A. K. J. K. Arso Savanović, "Flex4Grid, 2018. The Flex4Grid project (2018). D6.6 Validation of second pilot, v.1.1," 2018.

[22] Department for Business, Energy and Industrial Strategy, "Review of Energy Efficiency Advice Best Practice," 2017.

[23] NIST SGIP, "Guidelines for Smart Grid Cyber Security: Vol. 1, Smart Grid Cyber Security Strategy, Architecture, and High-Level Requirements," NIST, 2010.

[24] NIST SGIP, "Guidelines for Smart Grid Cyber Security: Vol. 2, Privacy and the Smart Grid," NIST, 2010.

[25] NIST SGIP, "Guidelines for Smart Grid Cyber Security: Vol. 3, Supportive Analyses and References," NIST, 2013.

[26] CEN-CENELEC-ETSI, "Smart Grid Information Security," 2012.

[27] ENISA, “Appropriate security measures for smart grids: Guidelines to assess the sophistication of security measures implementation,” 2012.

[28] ENISA, “Smart Grid Security: Annex I. General Concepts and Dependencies with ICT,” 2012.

[29] ENISA, “Smart Grid Security: Annex II. Security aspects of the smart grid,” 2012.

[30] ENISA, “Smart Grid Security: Annex III. Survey and interview analysis,” 2012.

[31] ENISA, “Smart Grid Security: Security related standards, guidelines and regulatory documents,” 2012.

[32] ENISA, “ Smart grid security certification in Europe Challenges and recommendations,” 2014.

[33] ENISA, “Communication network interdependencies in smart grids,” 2016.

[34] USEF, “USEF: the Privacy and Security Guideline,” 2016.

[35] European Parliament and Council of the European Union, “General Data Protection Regulation. REGULATION (EU) 2016/679 OF THE EU- ROPEAN PARLIAMENT AND OF THE COUNCIL on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive,” 2016.

[36] R. Shirely, “Internet security glossary version 2,” IETF, 2007.

[37] BEUC, The European Consumer Organisation, “Fit for the consumer? Do's and don'ts of flexible electricity contracts,” BEUC, The European Consumer Organisation, 2019.

[38] BEUC, The European Consumer Organisation, “AI rights for consumers,” BEUC, The European Consumer Organisation, 2019.

# 13 Appendix

## 13.1 Common terms and definitions

Glossary of the terms utilised in the Requirement Analysis.

| Common terms and definitions | |
|---|---|
| Term | Definition |
| Business Use Case | A Use Case describing the interaction between different business actors (market roles) for the realisation of some goal(s). |
| High Level Use Case | Describe a Use Case concept by defining roles (generic actors) involved and sketching their responsibilities. |
| Scenario | In the context of Use Case analysis, a possible flow of the use case. |
| System Under Design | The iFLEX Assistant. |
| iFLEX Assistant | Application specific instances of intelligent assistants developed in iFLEX project. |
| iFLEX Framework | Common project software framework for development of intelligent assistants. |
| Notification | Different types of notifications provided to the end user: alerts, DR event information, notification for providing consent, advice. |
| Alert | A type of notification providing tailored analysis of performance indicators (e.g. energy consumption) or event (e.g. asset operation). |
| (Energy) Advice | Suggestions for sustainability provided by iFLEX Assistant. |
| DR event | An event of implicit or explicit DR programmes. Describes the details of participation (e.g. price, control setpoints). |
| Flexibility | The adjustment of generation injection and/or consumption patterns as a response to an external signal in order to provide a service within the power system. |
| Flexibility signal | An external signal providing flexibility information e.g. price, load schedule to the receiver. |
| Flexibility request | An external activation signal (related to explicit DR) specifying the flexibility requested from the receiver. |
| DR program | Schemes incentivising changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity (implicit), or to monetary/non-monetary incentives (explicit). |
| Implicit DR | DR actions related to price of electricity. |
| Explicit DR | DR actions related to monetary/non-monetary incentives. |
| Primary Use Case | A system Use Case that describes a primary function of a HLUC, defining the device/system boundaries and interactions between the system(s) and external actors. |
| Schedule | A schedule calculated by iFLEX Assistant proposing control setpoints for dispatchable assets. |
| Self-consumed Energy | Locally generated energy (primarily by a PV system), which is consumed on site by the prosumer. |
| Self-consumption Ratio | The share of PV-generated energy which is consumed on site by the prosumer with respect to the total PV-generated energy. |
| Feed-in Power | The PV-generated power that a prosumer exports to the local distribution grid. |
| PV Curtailment | Reduction of PV power output compared to the maximum capacity. |

## 13.2 Use Case Template

### 13.2.1 General information

#### 13.2.1.1 Version management

Version management and information about authors, documenting changes of the use case briefly in the column "Changes".

| Version management | | | | |
|---|---|---|---|---|
| Version No. | Date | Name of author(s) | Changes | Approval Status |
| | | | | |

#### 13.2.1.2 Scope and objectives of the use case

Section for providing background or motivation of this use case:

- Scope: The scope defines the limits of the use case.
- Objectives: List of objectives of the use case
- Related business case(s): Reference to a business case/business requirements

| Scope and objectives of the use case | |
|---|---|
| Scope | |
| Objective | |
| Related business case(s) | |

#### 13.2.1.3 References

Related reference that affected the use case formulation or can facilitate the reader to understand it:

- **No.**: Reference number.
- **Type**: Type of reference (e.g. standards, regulation, contract, others like publications).
- **Reference**: Reference name.
- **Status**: The status of the referenced document.
- **Impact**: Main influence to the use case.
- **Originator/organisation**: Author of the document.
- **URL**: If publicly available, a link to the reference.

| References | | | | | | |
|---|---|---|---|---|---|---|
| No. | Type | Reference | Status | Impact | Originator / Organisation | URL |
| | | | | | | |

Important Key performance indicators (KPIs) related to the use case objectives.

| Key performance indicators | | | |
|---|---|---|---|
| ID | Name | Description | Reference to mentioned use case objectives |
| | | | |

#### 13.2.1.4 Classification

Information for classifying the Use Case:

- **Relation to other use cases**: Link to other use cases of the project. The type of relation like "include", "extends", "invokes" might be used in order to specify this relation in more detail.
- **Level of Depth**: The conceptual level of the use case e.g. high level, detailed, or specialised.
- **Prioritisation**: Prioritisation of UC in the context of the project. Level definition may differ e.g. mandatory/optional, high/medium/low.
- **Generic, regional or national relation**: Used for describing that the UC refers to regional or national specific circumstances (like laws) or project-specific details.
- **Nature of the use case**: Used to classify the viewpoint of the UC e.g. technical, business/market, test etc.
- **Further keywords for classification**: Keywords for classification of the UC.

| Classification information |
|---|
| Relation to other use cases |
| |
| Level of Depth |
| |
| Prioritisation |
| |
| Generic, regional or national relation |
| |
| Nature of the use case |
| |
| Further keywords for classification |
| |

### 13.2.2 High-Level Analysis

Presents the main analysis of the use case in the form of narratives.

#### 13.2.2.1 Narratives

Provides the narrative of the use case in two forms:

- **Short description**: Short text intended to summarise the main idea as service for the reader who is searching for a use case or looking for an overview. Recommendation: This short description should have not more than 150 words. Describes the intent of the actor in performing the use case, relevant actions and explain key concepts on the domain.
- **Complete description**: Provides a complete narrative of the use case from a user's point of view, describing what occurs when, why, with what expectation, and under what conditions. This narrative should be written in plain text so that non-domain experts can understand it. The complete description of the Use Case can range from a few sentences to a few pages. This section often helps the domain expert to think through the user requirements for the function before getting into the details required by the next sections of the Use Case.

| Narrative of use case |
|---|
| Short description |
| |
| Complete description |
| |

#### 13.2.2.2 Use case conditions

Conditions relate to the realisation of the use case, in the form of:

- **Assumption(s):** General assumptions about systems' configurations, statuses etc.
- **Precondition(s):** Describes what condition(s) should have been met prior to the initiation of the use case, such as prior state of the actors and activities.

| Use case conditions |
| --- |
| Assumption(s) |
| |
| Precondition(s) |
| |

### 13.2.3 General remarks

Includes any additional information that does not fit in any other category.

| General Remarks |
| --- |
| |

#### 13.2.3.1 Actors

List of actors of the use case, detailing:

- **Actor name**: The name of the actor.
- **Actor type**: Classification of actor (e.g. person, system, device or application)
- **Actor description**: A short description of the actor.
- **Further information**: Further information specific to this use case (optional).

| Actors | | | |
| --- | --- | --- | --- |
| Actor name | Actor type | Actor description | Further information |
| | | | |

#### 13.2.3.2 Use Case Diagram

This section presents UML diagrams (e.g. use case, activity, sequence) or graphics that elaborate the understanding of the UC.

| Diagram(s) of use case |
| --- |
| |