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WP 1: D1.1 Requirements Specification and Use-case Specification

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Abstract (for dissemination)	<p>BEAMS strategic goal is the development of an advanced, integrated management system which enables energy efficiency in buildings and special infrastructures from a holistic perspective (e.g., considering the indoors areas, the public spaces around the facility and the interaction of the overall compound with the grid and urban network outside it).</p> <p>In order to achieve this goal it has been proposed an architecture that relies on the interoperability gateway OGEMA (developed within in Smart House Smart Grid project and the German national project Modellstadt Manheim), which will be further extended and adapted to the requirements of more complex scenarios. In addition, it will be developed within the project a Facility Management Environment (FAME), where it will reside the intelligence needed to coordinate control strategies to increase energy efficiency across an entire facility.</p> <p>This document presents a common view of BEAMS project scope as well as an overview of the architecture envisioned for BEAMS system, its main components and key stakeholders involved. From these concepts, several scenarios and use-cases of interest were defined and used as the starting point for the definition of the overall BEAMS system requirements.</p>
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1 Introduction

1.1 Purpose and scope of the Document

The purpose of this document is to present a summary of the initial activities performed during the first work package of the project as well as presenting the results obtained.

A commonly shared understanding of the goals and scope of the project is required for its success. The first activities triggered the discussion and agreement among all partners regarding the project scope, scenarios and use cases of interest and finally the definition of the requirements for the main components of the BEAMS architecture.

The results of these activities, which are presented in this document, are the basis for the design and development work packages of the project.

1.2 Structure of the Document

The document includes a first section with a basic summary of the project scope and objectives. This section is supposed to be the basic information to be used internally when presenting the project within each organisation of the BEAMS consortium.

The following sections are intended to present a description of the main steps followed during the definition of the project scope, scenario and use-cases of interest.

The requirements section provides a description of the specific tools and methodologies used to derive requirements for each of the main components of the BEAMS architecture.

Last but not least, a first draft description of the pilot sites is presented and a methodology for testing and quality assurance is proposed.

2 Project Summary

2.1 Introduction

BEAMS strategic goal is the development of an **advanced, integrated** management system which enables energy efficiency in buildings and special infrastructures from a **holistic perspective**. The project will include an **open interoperability gateway** that will allow the management of diverse, **heterogeneous sources and loads**.

BEAMS is a **user driven, demonstration oriented** project, where evidence of the energy and CO₂ savings achieved by the project's technologies will be collected.

By means of a decentralised architecture, BEAMS will enable new mechanisms to extend current building management systems and achieve higher degrees of efficiency. **BEAMS strategic goal will be to define and develop an advanced, integrated management system for buildings and special infrastructures of public use.** This system will rely on an open interoperability gateway that will allow the control of already identified heterogeneous subsystems acting as sources and loads in such facilities. Some of them typically present nowadays in spaces of public use, such as public lighting or ventilation and air conditioning; some others, to become widely adopted in the next years, such as renewable sources or electric vehicles.



Figure 1: BEAMS approach

It is also within the scope of the project to develop the development of an integrated Facility Management Environment (FAME) that provides a facility manager the right decision support and simulation tools required for coordinated common control strategies to increase the energy use efficiency across an entire facility.

The solution proposed will not only support the human operator of the building or facility to achieve higher efficiency in the use of energy, but it will also open new opportunities to third parties -such as Energy Service Companies (ESCO), utilities and grid operators– needing and willing to interact with BEAMS management system through the interoperability gateway in order to improve the quality and efficiency of the service –both inside and outside the perimeter of the facility.

2.2 Objectives of the Project

The BEAMS project and its consortium are geared towards addressing the previously described challenge and mission in order to provide an innovative integrated energy management system.

BEAMS strategic goal is the development of an **advanced, integrated**, management system which enables energy efficiency in buildings and special infrastructures from a **holistic** perspective. To that end, the subsystems in such facilities that are consuming or producing energy, which nowadays normally count with their own Monitoring and Control (M&C) solutions will be connected through an open interface among themselves and to external third party applications. This will enable the design and development of higher level applications that will be able to take control of the energy processes ongoing considering the different requirements of each subsystem.

At the same time, the use of such gateway will open new opportunities to ESCOs and grid operators, who could negotiate different Service Level Agreements (SLA) to affect the normal operation of the subsystems and address specific quality of service and critical situations.

Current industrial access to electricity already considers the interruptibility of the service as a demand management tool –a rough one indeed- to give a rapid and efficient response to the needs of the electricity system in emergency situations. It consists of reducing the active power demanded to a required residual power level, in response to a power reduction order issued by the main grid operator, to consumers subscribed to this service.

The deployment of the open gateway proposed by BEAMS will provide a more granular and accurate tool to respond to emergency situations without actually interrupting the service. In this way, to avoid an overload, the grid operator could request to reduce the consumption from public lighting, or HVAC systems (Heating, Ventilating, and Air Conditioning); it could request the generation of energy in the case of facilities with their own generators, or the access to previously stored energy, etc. On the other hand, the more granular solution proposed by BEAMS also enables a finer control of different QoS levels for the different services managed by ESCOs.

BEAMS will validate this approach through the development of a facility management environment that will be deployed in two high profile pilot sites:

- The Stadium of the **Football Club Barcelona** in Spain.
- The campus of the **University of Salento** in Italy.

The general goals described above can be specified into a set of concrete scientific and technical objectives of the project:

1. Specification of **requirements, use-cases and architectures** associated to scenarios of efficient energy management, including subsystems (e.g. lighting, HVAC, generation, vehicle recharge, storage), local energy grids, interface to external grids and integration of dedicated services and applications via local and wide area communication networks.
2. **Definition of common ontology, information models and interfaces** to facilitate industry deployment and adoption by end-user, operators, designers, ESCOs, and system integrators.
3. Inclusion of new **Greening Energy Positive Tools** as Renewable Sources (RES) and Electrical Vehicles (EV) to locally balance the load inside the considered system and support the grid.

4. Development of an open **gateway** to interact with ICT solutions from different vendors. The gateway will not only serve to the building/microgrid operator to optimise its service, but also will open new management opportunities out of the microgrid.
5. Design and Implementation of a **FAcility Management Environment (FAME)**, which will include three different modules:
 - a. A Smart Control Algorithm with learning capabilities.
 - b. A Decision Support and Simulation tool.
 - c. An Energy Efficiency Balanced Score Card.
6. **Validation** and demonstration of the project results in two different pilot sites:
 - a. The Stadium of the Football Club Barcelona in Spain.
 - b. The campus of the University of Salento in Italy.
7. **Evaluation** and Assessment by means of a thorough **methodology** of the amount of energy and CO₂ emissions saved through the deployment of BEAMS technology.

The focus of BEAMS will not be so much to develop breakthrough technologies from scratch but instead to integrate different innovative technologies so that their combined use leads to increased energy savings and emission reduction. This approach will allow having a rapid impact on the market, in the spirit of the European Economic Recovery Plan 2010-2013 (PPP in Research Areas) [1].

Objective	Achieved within WP	Measurable indicator
Specification of requirements, use-cases and architectures relevant to scenarios of energy efficient management.	WP1 and WP2	D1.1 D1.2 D2.1.x
Definition of common ontology, information models and interfaces to facilitate industry deployment and adoption by end-users.	WP2	D2.2.x
Inclusion of new Greening Energy Positive Tools as Renewable Sources (RES) and Electrical Vehicles (EV).	WP3	D3.1 D3.2 D3.3
Development and publication of a highly configurable open gateway to interact with ICT solutions from different vendors.	WP4	D4.1.x D4.2
Design and Implementation of a FAcility Management Environment.	WP5	D5.1.x

Table 1 – Objectives vs. WPs

These objectives will be achieved during the 30 month duration of the project by performing the work specified in the 8 scientific work packages, the dissemination and exploitation work package and the project management work package detailed in the work programme. In order to assess the project success, a number of deliverables will be associated to each project objective and used as measurable indicators of its level of fulfilment – see Table 1.

The ultimate goal is to achieve higher energy efficiency and optimise its usage by being able to have a global view of the different subsystems, and therefore applying common synergetic strategies to implement saving policies. Moreover, self-generation from renewable sources– and the related balance problem in the microgrid– will be studied as a main way to reduce CO₂ emissions. Last but not least, interaction with third party services to increase the robustness of the grid and the Quality of Service –e.g., exchanging information with the utilities or letting an ESCO manage the energy processes within a facility-, or the access to valuable information to adapt the behaviour of the building management system –e.g., exploiting weather forecasts– will be assessed.

3 BEAMS domain model

3.1 BEAMS system scope definition – Initial proposal

Before the definition of use-cases, in this section we present a brief description of the scope of BEAMS project. This vision will be used as reference for the use-cases identification and definition of further sections of this document.

The use-case modelling methodology used in this document is based on the concepts presented in [1]. The following Figure illustrates the activities involved in the development of a use-case model, where group activities are shown in grey and are focused on preparing the groundwork for the evolution of the use-case model and its supporting supplementary specification by establishing the vision, scoping the system, addressing areas of uncertainty and instability in the requirements definition, and consolidating and reviewing the use-case model as a whole.

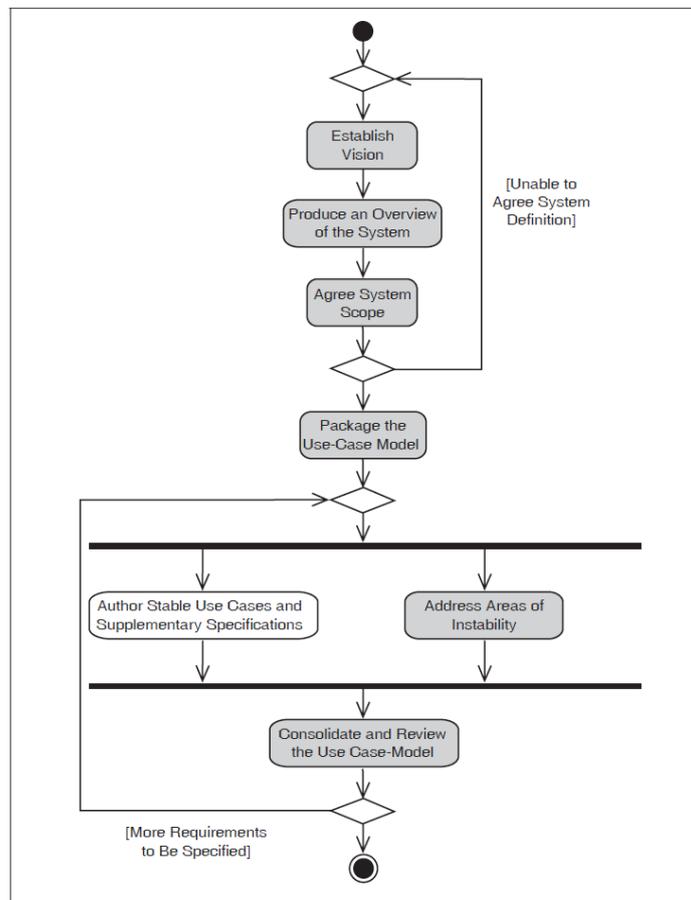


Figure 2: Use-case modelling process

In this section, however, we focus in the first three steps intended to establish a common vision and system limits for the project. Use-cases definition can help to further define the system boundaries and in general, generate a clearer and common vision of the project among all the partners involved.

¹ Bittner, Kurt and Ian Spence, Use Case Modelling. Addison-Wesley, 2003

3.1.1 OGEMA framework in the scope of BEAMS project

The candidate architecture should follow the natural extension of the OGEMA approach developed in Smart House Smart Grid project² and the German national project Modellstadt Mannheim³. In this way, instead of having households, we are having buildings, or control rooms managing a number of subsystems. Instead of having electrical appliances as main loads, we will have subsystems as HVAC, lighting, water – hot water and watering, electrical vehicles (EV), etc. And in addition we are introducing as greening positive tools photovoltaic (PV) and EV – that is two new resources to consider the storage and production of energy. In summary:

- Households → buildings or control rooms
- Appliances (resources) → subsystems

Each building should have similar capabilities as the one provided by OGEMA nowadays e.g. management of loads based on variable tariffs, scheduling, storage of measurements, etc (check original OGEMA framework hereafter)

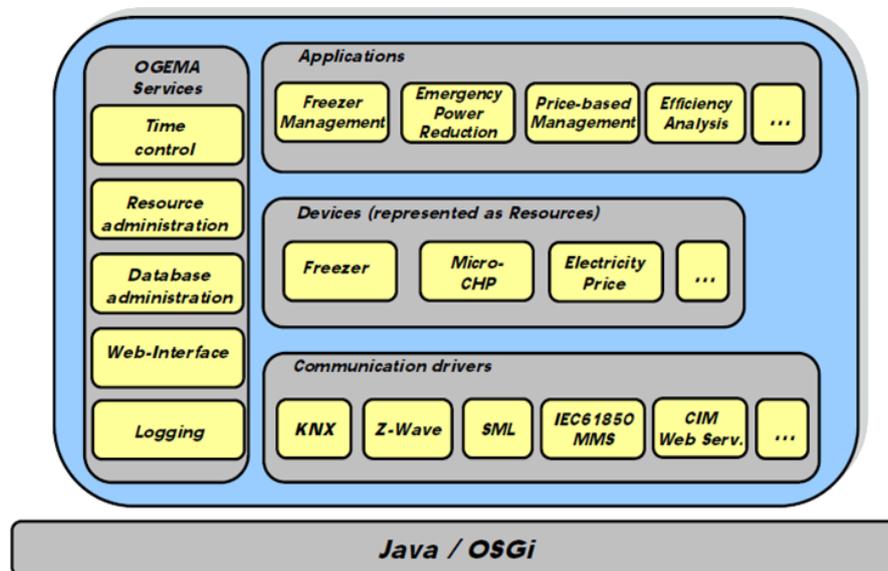


Figure 3: Current OGEMA building blocks architecture

The extension of OGEMA from its application in the residential market to more complex scenarios such as big facilities (e.g., sport facilities, university campus, industrial environment, etc) is possible due to its inherent modular architecture as well as its current support to international standards such as IEC 61850 or CIM. Requirements regarding these complex scenarios will be well considered from the beginning in order to properly extend OGEMA framework. This framework will have to be extended:

- In order to deploy particular communication drivers for the subsystems to be controlled. It might be necessary to develop and deploy new drivers in OGEMA besides those already implemented (e.g. Z-wave, ZigBee, etc).
- In order to deploy new resources (the subsystems).
- In order to deploy new applications.
 - To include new applications in order to allow the introduction of greening positive tools such as PV and EV.

² <http://www.smarthouse-smartgrid.eu/>

³ <http://www.modellstadt-mannheim.de/moma/web/en/home/index.html>

- To distribute the intelligent control strategies for the overall facility (or group of buildings or control rooms).

This last point is critical in order to obtain coordinated responses. Most probably, the subsystems that would need to adapt its behaviour in response to a certain situation will not be hosted in the same room, therefore, they will not depend on the same gateway, and cooperation at a higher level must be granted.

The following Figure illustrates how the OGEMA+ framework should look like:

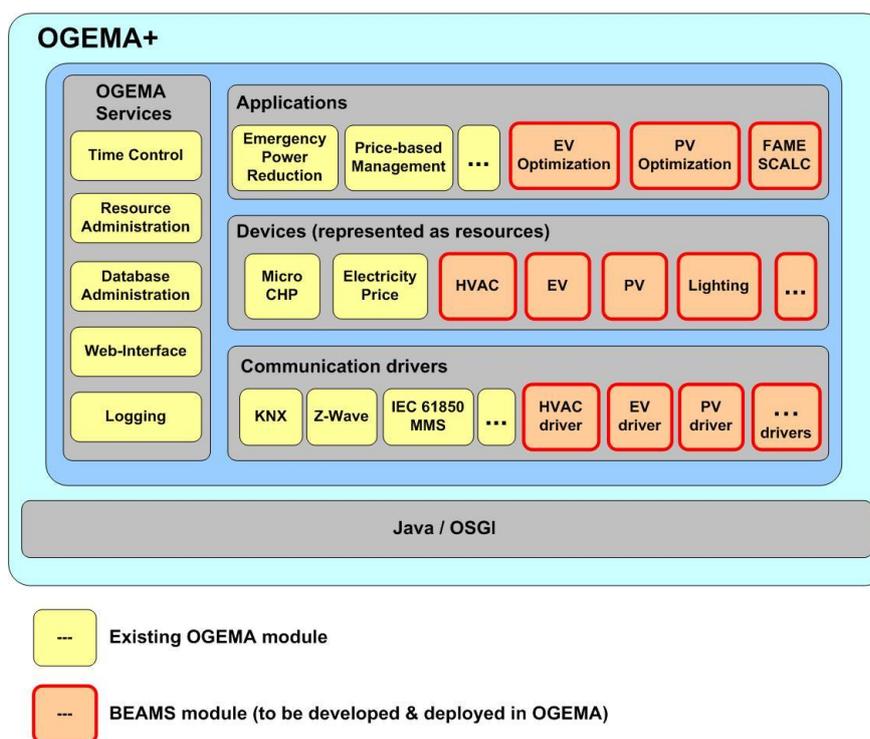


Figure 4: BEAMS' extended OGEMA building blocks architecture (OGEMA+)

This OGEMA+ framework will have to be customized to each building – e.g., if a building is not controlling any HVAC, it makes no sense to include its related drivers and resources in OGEMA.

Besides controlling several different subsystems within a facility, the new gateway (OGEMA+ platform) will be able to interface with a number of third parties:

- In order to provide information to the apps running in OGEMA: The price-based management app will have to access the utility variable tariffs (or receive them).
- In order to accept requests from the utility for energy power reduction to avoid a blackout (emergency power reduction app).
- In order to implement higher level control strategies involving more than one building (SCALC-execution layer)
 - That is where overriding capabilities as well as certain priority levels are needed.

All in all, FAME, will be just a third party application accessing OGEMA (through the SCALC module) to run a global facility management system. Obviously, FAME will have the advantage of being able to affect the design of OGEMA, and deploy the needed application to grant coordinated monitoring and control.

3.1.2 BEAMS project architecture

The following Figure illustrates a high level system architecture that could be used as starting point for the discussion and agreement of BEAMS system scope:

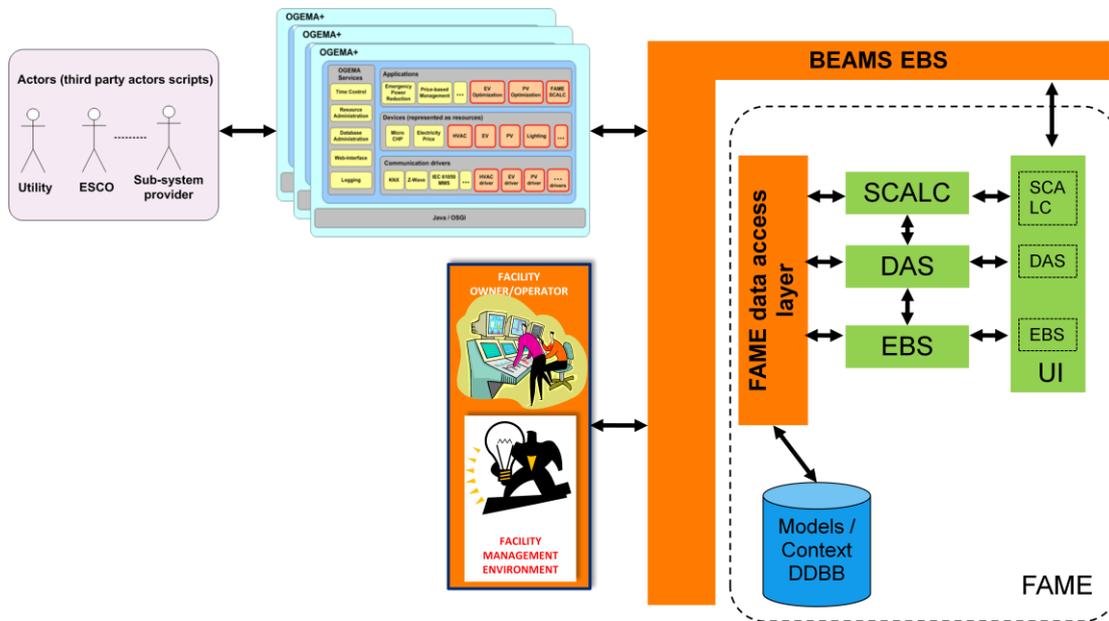


Figure 5: BEAMS high level system architecture (draft)

From this architecture there can be derived several important aspects regarding the scope of the project and BEAMS system limits. The main important aspects are listed below:

- From the point of view of the architecture, requirements should be defined in a first step as independent of the pilot sites, and then try to map the constraints of each site (the configuration proposed is transferable to both the stadium and the campus).
- Within a single facility there can be many different energy generating or consuming subsystems. These subsystems can have an impact within a single building, or a building and its surroundings. For instance, as we can find in FCB stadium facility, lighting of the stadium and its surrounding is controlled by different control rooms spread across the stadium building. This might imply the deployment of one or several instances of OGEMA within a single building or facility.
- One OGEMA instance will be the gateway between one or many subsystems within a building or facility e.g. HVAC, lighting, etc and FAME. Each of these subsystems can be already in place in the facility or might be deployed in the near future, but in any case they will be interfaced with OGEMA through the specific communication drivers developed for these subsystems as components of the OGEMA gateway. Communication between OGEMA instances and FAME will be granted through the communications infrastructure already in place in the facility, or newly infrastructure to be deployed within the scope of the project.
- There can be third party actors e.g., a utility, ESCO, etc that could interact with the BEAMS system of a facility through its OGEMA gateways. In fact, FAME can be considered also as a third party from the point of view of OGEMA since FAME will have access to OGEMA instances in the same way third parties have. In other words, FAME should be seen as a third party system accessing OGEMA.

- Even though is not yet completely defined, communication interface between different OGEMA instances and FAME and even with third-party actors might be implemented based on enterprise service buses (ESB). Regarding communication with third-party actors international initiatives such as OpenADR might be taken into account, although this is not the main focus of the project.

Besides OGEMA, FAME will play a vital role within BEAMS architecture since it is the module where it will be included the intelligence needed to coordinate common control strategies across an entire facility. The following section presents a high level description of FAME as well as its main components.

3.1.2.1 FAME architecture

Figure 5 presents a first approach for the internal architecture of FAME, where it can be observed the main modules and interfaces between them to be developed. The three main modules that will be developed within FAME are listed below:

- **Smart Control Algorithm with learning capabilities (SCALC):** This module will be the responsible for providing the modelling of situation/context capabilities to the system. By defining known situation/context within a facility and enabling the system to learn or detect new ones, a better and optimized control of the entire facility can be provided at any moment.
- **Decision Support and Simulation system (DAS):** Within this module will be provided a simple and user-friendly interface to present the human operator all the information obtained from the subsystems and devices in the facility. It will be developed as a tool to support the decision making process, presenting a high level view of the state of an entire facility as well as enabling low level control capabilities to manage the entire facility.
- **Energy Efficiency Balanced Score Card (EBS):** This module will be a particular instantiation of a BSC with a focus on Energy Efficiency. The objective is to provide the human operator with a number of indicators on how the system is behaving. These indicators will help the end-user to assess the suitability of each of the strategies and policies planned and deployed through the DAS. In the same way, jointly with the simulation tool, it will be possible to evaluate the investments to be made in order to achieve specific objectives (and their turnover).

Additionally, some common modules will be developed within FAME so that previous modules can use them to implement their basic functionalities. Two modules already identified are:

- **User interface layer (UI):** It was already mentioned that FAME-DAS will provide a simple user interface. However, in practice all modules within FAME could have some kind of UI module through which a facility manager can interact with the system to perform concrete tasks related to each of these modules. In consequence, following some good software development practices, all common UI functionalities will be developed within one single module that could be re-used by other components within FAME.
- **Data Access Layer:** This module will be integrated by a local data base in FAME as well as the proper data access layer that would enable all components of FAME to access the data of an entire facility.

Finally, once a clearer vision of BEAMS architecture has been presented, some of its main components, and the system scope, the following sections present further ideas and guidelines necessary for a clearer and precise BEAMS use-cases definition.

3.1.3 BEAMS project terminology

Following we present some concepts that have been agreed by all partners within the consortium and that represent the basic terminology to be used when defining the use-cases for the project. These main concepts are:

- **Gateway:** A gateway (within the scope of BEAMS project) is a platform allowing the communication between the different energy generating and consuming subsystems (e.g., lighting, HVAC, PV panels, etc) and the high level facility monitoring and control platform (in this case FAME). OGEMA platform plays the role of a gateway in the BEAMS architecture.
- **Communication driver:** As stated in OGEMA documentation, different real energy generating and consuming subsystems (and particularly their control modules) can be interfaced, monitored and controlled accordingly by OGEMA platform. This is achieved due to the development and deployment of software components within OGEMA that allow the communication with these subsystems. These Sw components are called communication drivers.

3.1.4 BEAMS system – Main actors (stakeholders)

The next step towards the definition of use-cases is the analysis and presentation of the main actors or stakeholders involved in the interaction with BEAMS system. In general, an actor can be an external role, human or device, that interacts with the system. In the case of BEAMS project, the main actors identified are listed below:

- **Facility manager**
- **Utility-Energy trading company (market operator)**
- **Utility-Energy DSO (Distribution System Operator)**
- **Weather information/forecast providers**
- **Other third parties (e.g., ESCOs, subsystems operators, etc)**
- **EV owner (end user)**
- **Energy generating and consuming systems**

A detailed description for each actor is presented in the following tables:

Table 2 BEAMS actor - Facility Manager

Actor	Role, description and goals
Facility manager	This actor could be a facility owner, third-party company or a person responsible for the operation of all the different systems within a facility (e.g., HVAC, lighting, etc). In case of a third-party company, it could provide additional services to the facility owner (e.g., maintenance, cleaning services, etc). From the point of view of BEAMS project, the facility manager is the end-user, and can be seen as a human operator interacting with BEAMS system through FAME user interface.

Table 3 BEAMS actor – Utility-energy trading company

Actor	Role, description and goals
Utility-Energy trading company (market operator)	This actor represents the electricity, gas or in general the energy supplier of a facility. Normally, this actor is responsible for energy trading in wholesale markets and its retail trading (energy sell) to end customers. Depending on legislations of each country this actor might be responsible for billing to end customers (sometimes based on energy consumption data obtained by metering devices owned by a utility-DSO company). DSO will be considered as an external actor to BEAMS system and for the purpose of the project this actor will be

	implemented as a set of scripts that can be used to simulate a bidirectional communication between BEAMS system and “utility systems”. For example, “utility scripts” will be used to simulate an open market with variable tariff.
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Table 4 BEAMS actor – Utility-Energy DSO (Distribution System Operator)

Actor	Role, description and goals
Utility-Energy DSO (Distribution System Operator)	<p>This actor represents the electricity, gas or in general energy company normally in charge of managing energy generation and transmission systems.</p> <p>Depending on legislations of each country a DSO might be responsible for energy consumption reduction requests; it is the owner of electricity meters installed in a user facility, etc.</p> <p>DSO will be considered as an external actor to BEAMS system and for the purpose of the project this actor will be implemented as a set of scripts that can be used to simulate a bidirectional communication between BEAMS system and “utility systems”. For example, “utility scripts” will be used to simulate the transmission of emergency control signals to end customers.</p>

Table 5 BEAMS actor - Weather information/forecast providers

Actor	Role, description and goals
Weather information / forecast providers	<p>This actor represents another external system interacting with BEAMS system in order to provide update weather information and/or weather forecast that can be used internally by BEAMS to perform energy optimizations. If this kind of systems can not be available at the moment of performing the field trials for BEAMS project, weather forecast providers will be implemented as a set of scripts that will be used to simulate a bidirectional communication with BEAMS system.</p>

Table 6 BEAMS actor – Other third parties

Actor	Role, description and goals
Other third parties (e.g., ESCOs, subsystems operators, etc)	<p>There can be a variety of different external systems besides those already mentioned that can interact with BEAMS system. All these actors can interact with BEAMS system through the different OGEMA instances deployed within a facility (more or less in the same way a utility or facility manager through FAME module interacts with OGEMA instances). Some examples of actors that can play an interesting role within the scope of BEAMS project are ESCOs or specific subsystems operators (e.g., HVAC, PV panels, etc) that could take profit of BEAMS to interact with their systems, monitoring and controlling them remotely.</p>

Table 7 BEAMS actor – Electrical Vehicle (EV)

Actor	Role, description and goals
EV owner (end user)	<p>For those scenarios where the integration of EV will be possible (e.g. University of Salento Campus), an EV owner will be considered as an actor that can interact with BEAMS system. For example, EV owner might interact with BEAMS</p>

	<p>system in order to provide particular requirements regarding his EV charging process management (by BEAMS). This interaction is not yet clearly defined and might depend on EV characteristics, user interfaces defined for the project, etc.</p>
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Table 8 BEAMS actor – Energy generating and consuming systems

Actor	Role, description and goals
Energy generating and consuming systems	<p>These systems can be seen as actors that can be monitored and controlled by BEAMS system. There can be many different systems that are already in place in an infrastructure (or would be in place in the short term) e.g. HVAC, lighting, PV panels, EVs etc. These systems could have (or not) control systems, or in the best case there is a Building Management System (BMS) through which OGEMA can interact with, and gain access/control the different subsystems of the facility. Within the scope of the project, in those cases where there is not any BMS or control interface for the subsystems of a facility, these will be deployed by the project consortium.</p>

3.2 BEAMS pilot sites characterization and needs

In order to understand the characteristics of the pilot sites where BEAMS system will be deployed, we propose to follow some ideas used in the FP7 project SportE2 for the characterization of sport facilities and development of an energy efficiency system for this type of facility⁴. In this project, several different pilot sites surveys were performed in order to obtain the following data:

- Characterisation of all energy sources used at the facility.
- Identification of the type of energy contract in place with the energy suppliers.
- Identification of the functional areas present at the facility in question.
- A characterisation of the energy flows at the facility.
- Identification of the energy consuming systems (or loads) in all the areas of the facility (devices are identified, counted and inspected). Possible controllable systems, control equipments required and actions can be derived from this survey.
- Current management and energy efficiency mechanisms used by the facility managers, and what they main requirements are.
- Identification of possible energy efficiency goals a facility manager is willing to obtain with the deployment of a system such as BEAMS.
- Additionally, it would be important to know the kind of communication infrastructure already in place in each of the pilot sites.

For an initial survey (of a sport facility), SportE² project proposed a survey intended to answer the following questions. Following these ideas, we present an initial list with questions adapted to the goals of BEAMS project.

1. General features of the structure: when the structure was built, does the facility have a building energy rating certificate?
2. What does the overall energy picture look like?
3. Total Energy consumption data and energy consumption per each typology of facilities within the whole pilot site (e.g., ice skating facility, football

⁴ SportE2 Deliverable D 1.1 Performance Criteria and Requirements.

- stadium, offices, etc), and systems that consume that energy (ventilation, heating, lighting, cooling, hot water, acoustic protection, etc.
4. Detailed technical characteristics and operation of the energy consuming systems of the whole pilot site e.g., HVAC system in place and scheduled operation, lighting control in place, etc.
 5. Are there renewable energy sources or any other DER sources in the facility? Technical characteristics and operation schedules available?
 6. Facilities' user characteristics. Can be extracted predictable patterns of use of each facility within each pilot site?
 7. Within the analysed facilities, are there any energy efficient policies / energy conservation measures that have been put in place? Which ones? Is it possible to measure and verify the associated energy impact?
 8. Are there sub or smart metering systems in place – or does facility manager just receive one bulk energy bill?
 9. When corresponding, is it energy generated by renewable energy systems sold or used internally within the pilot site?
 10. Are there any kinds of energy storage systems available in the facility?
 11. Are environmental parameters monitored? Is there any infrastructure already in place?
 12. Do facility managers already have an idea of what they would like to improve with energy efficiency? Example of problematic issue that facility managers want to address with the project.
 13. Is possible to create awareness among customers in order to apply ICT system able to reduce the overall energy consumptions?
 14. For energy supply, which kind of contract does the facility manager have?, flat rate tariffs?, or any rewards for peak shaving activities?
 15. Possible savings that the structure could achieve?
 16. Is there any lack of incentives to implement energy efficiency devices and encourage efficiency among customers that could be improved?
 17. Is there any communication infrastructure already within the facility? Can this infrastructure be used by BEAMS subsystems (and particularly OGEMA instances and FAME)?

Answering these questions will certainly help in the definition of use-cases of interests for the project and in particular for the facility managers of both pilots sites. Additionally, it will be helpful in the identification of possible areas or subsystems to be improved and that can be controlled by an OGEMA, and in the end to be integrated within BEAMS architecture.

A clear vision of the characteristics of each of the pilot sites as well as its facility manager needs will be very important in the definition of specific use-cases adapted to the characteristics of each of the pilot sites of the project.

Despite at the beginning of the project there are not answers for all questions previously listed, some initial cases can be proposed and improved in further iterations as more details about each pilot site and its sub-systems arrive. The result of this process is presented along the following sections where we provide an initial list of high level scenarios and use-cases of interest for BEAMS project.

It is important to highlight that the result of the each pilot site survey and the definition of all subsystems to be integrated within the BEAMS architecture in both cases, will be provided as an annex to this document (in month 7 of the project).

4 BEAMS scenarios

The identification and definition of scenarios and use cases are the first steps towards the architecture design of BEAMS project. Along this section, we present the results of the analysis performed regarding key scenarios (high level scenarios) and use-cases definition for the project.

First, we present a summary table with the main scenarios identified, and then we provide a detailed description each of these scenarios. These scenarios will be later mapped to use-cases proposed by the all partners of the consortium.

4.1 Summary table of BEAMS scenarios

Table 9 Summary table – BEAMS scenarios

BEAMS scenario ID	Title
SC-001	(strategic) Monitoring of energy consumption (entire installation)
SC-002	Facility energy consumption control/optimization
SC-003	Facility energy consumption advanced control/optimization supported by FAME
SC-004	Facility active market participation (monitoring and control based on utility or third party information)
SC-005	Simulation of situation/contexts not available in an existing deployment (pilot site or facility)

4.2 Scenario SC-001: (strategic) Monitoring of consumption (entire installation)

Table 10 BEAMS scenario SC-001

BEAMS scenario	Explanation
Common	
ID	SC-001
Title	(strategic) Monitoring of energy consumption (entire installation)
Description (narrative)	<p>As a basic condition to establish advanced and intelligent control strategies, availability of information in real time describing the electrical characteristics and states of the entire installation needs to be granted.</p> <p>This is something that depends strongly on the equipment and BMS currently installed.</p> <p>The objective is to provide added-value processed reports on strategic objectives and metrics for the building manager –e.g. KWh consumed and produced per facility, per m2, per person in the facility; emissions due to the energy in use; etc.</p> <p>These reports will be generated and provided by FAME based on the data received from the different OGEMA instances within a facility.</p>
Decision	
Status	Approved
Actions proposed	
Realisation	

Main responsible partners (Author)	ETRA
Contributing partners	BDigital
Priority	High
Comments	-

4.3 Scenario SC-002: Facility energy consumption control/optimization

Table 11 BEAMS scenario SC-002

BEAMS scenario	Explanation
Common	
ID	SC-002
Title	Facility energy consumption control/optimization
Description (narrative)	<p>This scenario describes the situation where BEAMS system performs energy consumption optimizations. Particularly, the OGEMA instances within a facility (if several instances are deployed) will perform energy monitoring and optimizations based on the different energy generating and consuming systems under their control.</p> <p>For example, this scenario can describe the situation for DER generation forecasting (particularly PV generation) and demand forecasting (e.g. building occupancies), and how it can influence energy management algorithms optimizations.</p>
Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	IWES, BDigital
Contributing partners	Thales
Priority	High
Comments	-

4.4 Scenario SC-003: Facility energy consumption advanced control/optimization supported by FAME

Table 12 BEAMS scenario SC-003

BEAMS scenario	Explanation
Common	
ID	SC-003
Title	Facility energy consumption advanced control/optimization supported by FAME
Description (narrative)	<p>This scenario describes the situation where BEAMS system performs a coordinated energy optimization action or measure, across an entire facility. This capability is coordinated by FAME, and can be triggered by a facility manager or performed automatically by FAME based on data received from different OGEMA instances within a facility.</p> <p>Besides OGEMA decentralized optimization capabilities, different OGEMA gateways across a facility can be influenced or coordinated based on information exchange with FAME</p>

	subsystem.
Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	BDigital
Contributing partners	Thales
Priority	High
Comments	-

4.5 Scenario SC-004: Facility active market participation (monitoring and control based on third party information)

Table 13 BEAMS scenario SC-004

BEAMS scenario	Explanation
Common	
ID	SC-004
Title	Facility active market participation (monitoring and control based on third party information)
Description (narrative)	<p>Within this scenario, a utility or third party actor (e.g., ESCOs, etc) can send requests messages to facilities' OGEMA instances in order to participate actively in the energy market. Thus the facilities may alter the consumption (increase/decrease) according to the system marginal price or the needs for ancillary services.</p> <p>Utility or third party requests to a facility can include variable price tariff information, demand response requests (DR) or simply load reduction/shifting within the facility.</p>
Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	ICCS
Contributing partners	IWES, BDigital, SDXFM
Priority	High
Comments	-

4.6 Scenario SC-005: Simulation of situation/contexts not available in an existing deployment (pilot site or facility)

Table 14 BEAMS scenario SC-005

BEAMS scenario	Explanation
Common	
ID	SC-005
Title	Simulation of situation/contexts not available in an existing deployment (pilot site or facility)
Description (narrative)	This scenario describes the situation where BEAMS system offers a facility manager a tool where different

	<p>situations/contexts can be evaluated, avoiding the inconvenience to test or evaluate these situations on the real systems of the facility.</p> <p>In addition, the simulation scenario can be used to assess the successful impact of the application of a certain energy efficiency measure, viability of the deployment of new DER systems, etc.</p> <p>Historic energy consumption can be taken into consideration in order to assess optimization possibilities. Historic data can be retrieved from OGEMA instances by FAME and stored locally so that it can be provided to facility manager or used for simulation purposes in a faster way.</p>
Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	BDigital
Contributing partners	SDXFM
Priority	High
Comments	-

5 BEAMS use-cases

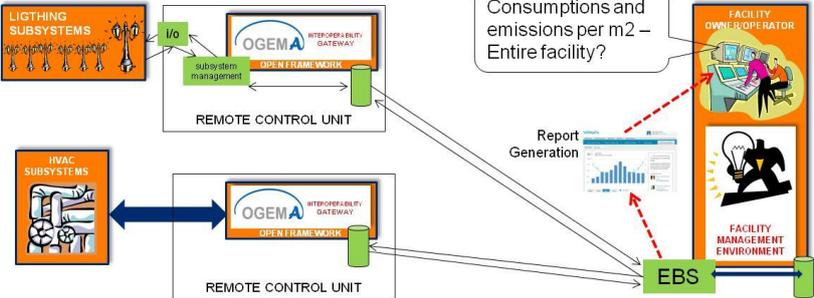
Along this section different use-cases of interest for the project are presented. At the same time all use-cases presented will be mapped to any of the scenarios identified and presented in previous sections.

5.1 Scenario SC-001 use-cases ((strategic) Monitoring of consumption (entire installation))

5.1.1 Use-case UC-001: Monitoring of energy consumption (entire installation)

Table 15 BEAMS use-case UC-001

Use Case	
Common	
ID	UC-001
Title	Monitoring of energy consumption (entire installation)
Related scenario	SC-001
Description (narrative)	<p>As a basic condition to establish advanced and intelligent control strategies, availability of information in real time describing the electrical characteristics and states of the entire installation needs to be granted.</p> <p>This is something that depends strongly on the equipments and monitoring and control systems (e.g., BMS) currently installed in a facility.</p> <p>The objective is to obtain real time and historical data from the different subsystems of a facility, and provide added-value processed reports on strategic objectives and metrics for the building manager –e.g. KWh consumed and produced per facility, per m2, per person in the facility; emissions due to the energy in use; etc.</p>
Pre-condition	<ul style="list-style-type: none"> • The facility has a BMS running, or at least the capability to adapt its equipment to retrieve information. • The facility has a communication network, or at least the capability to deploy one. • OGEMA gateway(s) has control over several different sub-systems within the facility. Several instances of OGEMA may be installed in different rooms and buildings. • New communication drivers are developed and deployed in OGEMA in order to support the communication with the different subsystems of a facility. This might be required in case current OGEMA drivers cannot be used (to interface current facility subsystems). • OGEMA gateway is capable to run applications for data acquisition and store the information locally. • If renewable sources of energy are not available, simulated sources are granted. • Common data structures and interfaces have been defined. • The EBS could provide for a local data base, so it is not necessary to download all the historic data, but just sync the last information with the different OGEMA instances.
Actors (stakeholders)	<ul style="list-style-type: none"> • Facility manager
BEAMS systems involved	<ul style="list-style-type: none"> • FAME-EBS • OGEMA

	<ul style="list-style-type: none"> Building management system, HVAC systems, other mechanical systems (shading, opening)
Trigger	Human Operator queries the FAME-EBS (through corresponding UI) to know the status of the entire installation.
Basic Path	<ul style="list-style-type: none"> The EBS will interface with the different instances of OGEMA to extract the last data stored. EBS interfaces directly to the data storage management module within each OGEMA instances. Each OGEMA gateway within the facility provides updated information regarding the energy generation or consumption of the subsystems within its control. The EBS will update its local database. The EBS prepares a report for the human operator based on updated and historic information. The EBS presents a dynamic report of the entire facility. Optionally, a real time updated of the report might be provided.
Post-condition	Facility report presented to the user through the UI. Human operator or decision maker, evaluating the outcome in order to run what-if simulations on the DAS or update the DAS. (DAS: Decision Support and Simulation, FAME module).
Exception Paths	<p>Information not available due to:</p> <ol style="list-style-type: none"> Lack of connectivity to the OGEMA gateways Lack of information stored in the OGEMA gateways Lack of application querying the subsystem in the gateways. <p>Error message to be presented to the human operator</p>
Diagram (optional)	
Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	ETRA
Contributing partners	All
Priority	High
Comments	-

5.2 Scenario SC-002 use-cases (Facility energy consumption control/optimization)

5.2.1 Use-case UC-002: Real-time update/optimization of a facility energy demand curve

Table 16 BEAMS use-case UC-002

Use Case	
Common	
ID	UC-002
Title	Real-time update/optimization of a facility energy demand curve
Related scenario	SC-002
Description (narrative)	<p>This use-case describes the situation where each OGEMA gateway within a facility performs local energy optimizations according to the different subsystems controlled (e.g. energy generating and consuming systems such as DER sub-systems and different types of loads).</p> <p>In general, the overall consumption or just the energy requested from the grid should be the lowest possible. For example, the operation of certain loads under control of an OGEMA gateway can be controlled (load shedding or shifting) according to situation/context of the facility, availability of DER resources (e.g. PV panels installed), facility operator requirements, etc.</p> <p>Operation of different OGEMA gateways within the facility can be further controlled if required by means of FAME algorithms.</p>
Pre-condition	<ul style="list-style-type: none"> • Facility has a BEAMS system installed and properly managing energy efficiency actions within the facility. • If within a facility there is not a BMS or different subsystems control mechanism already in place, these will be deployed within the scope of BEAMS project. • OGEMA gateway(s) is capable to run applications for data acquisition and store the information in local. • Common data structures and interfaces have been defined.
Actors (stakeholders)	<ul style="list-style-type: none"> • Energy generating and consuming systems
BEAMS systems involved	<ul style="list-style-type: none"> • OGEMA(s) gateway(s)
Trigger	<p>There can be different triggers for the optimization of the demand curve of a facility (performed by local optimizations of OGEMA gateways):</p> <ul style="list-style-type: none"> • System starts • A particular operation schedule for different subsystems expires so that a new one should be generated according to actual data from energy generating and consuming subsystems • New loads or DER resources are detected by an OGEMA gateway, so that local optimization mechanisms are triggered to adapt to the new situation/context
Basic Path	<ul style="list-style-type: none"> • Based on data received from different subsystems (either energy generating or consuming), each OGEMA gateway generates “control schedule plans” with a resolution of 15 minutes for each of the different subsystems under its control. Optimization operations are performed continuously

	<p>according to data received.</p> <ul style="list-style-type: none"> • When DER subsystems available, and in particular RES subsystems, energy generation forecast applications can provide “artificial” generation forecasts to energy optimization applications, so this information can influence the control schedule plan generation process. • “Control schedule plans” generated for each of the subsystems for a specific period of time are assigned a priority and stored locally (by each OGEMA gateway). • OGEMA gateway executes the local optimizations of different loads or subsystems under its control. • While executing a specific operation schedule, OGEMA gateway continues the generation of new schedules based on data received from the systems (and possible external actors). Every 15 minutes a new control schedule plan is generated and executed.
<p>Post-condition</p>	<p>Each OGEMA gateway has an updated and optimized operation schedule for each of the subsystems under its control (based on availability of energy resources and systems load). The subsystems are controlled according to this schedule.</p>
<p>Exception Paths</p>	<ul style="list-style-type: none"> • If required, energy loads operation can be adapted or modified by FAME or internally by OGEMA despite of RES availability or forecast, in order to accomplish a certain Service Level Agreement (SLA) or operation condition required for a particular context within the facility. This could be triggered by facility manager or any other external actor. • Operation schedule should be updated immediately due to the reception of new operation requirements with a high priority. For example, in case of reception of a mandatory demand response (DR) request from a third party, or new operation requirements are set by the facility manager through FAME UI, OGEMA should generate a new control schedule plan so that main loads operation should be adapted (e.g. reduced or shifted).
<p>Diagram (optional)</p>	
<p>Status</p>	<p>Approved</p>
<p>Actions proposed</p>	
<p>Main responsible partners (Author)</p>	<p>ICCS</p>
<p>Contributing partners</p>	<p>BDigital</p>

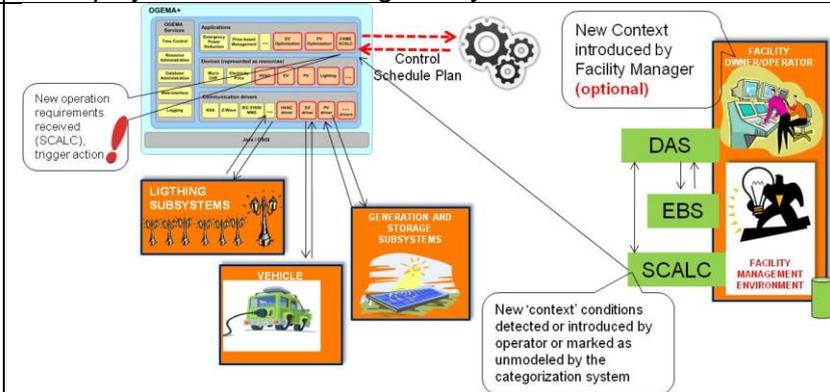
Priority	High
Comments	-

5.2.2 Use-case UC-003: Real-time update/optimization of a facility energy demand curve based on a situation/context information

Table 17 BEAMS use-case UC-003

Use Case	
Common	
ID	UC-003
Title	Real-time update/optimization of a facility energy demand curve based on a situation/context information
Related scenario	SC-002
Description (narrative)	<p>This use-case describes the process where new situations or context within a facility (e.g. buildings occupancy) are detected and consequently used for the generation of new control schedule plans (by each OGEMA within the facility).</p> <p>For example, in Long-Occupancies contexts, the following could happen: Short-Occupancies, Season-Availability and PV-Fluctuation. For instance: During holidays (Long-Occupancies), there will be some events (Short-Occupancies) in a facility (e.g. University). These events could also be in summer or winter holidays (Season-Availability). Of course, the PV-Fluctuation could happen in all seasons.</p> <p>A control schedule plan should be generated for certain situations. The control schedule plan is performed locally by OGEMA considering local information as well as third party data e.g. weather forecast, energy price tariff, etc.</p> <p>Once a control schedule plan is already applied, previous control plans could be delayed or simply changed according to new local data or by an external actor. However, it may be necessary to generate new control schedule plans based on a new situation within the facility.</p> <p>FAME-SCALC module gets data from all OGEMA instances within a facility in order to analyze it and detect/derive a new situation/context. New situation/context detected are presented for validation to the facility manager so that new operation requirements would be sent from FAME to OGEMA in order to trigger the generation of new control schedule plans (local to each OGEMA). The new context can be properly identified and stored by FAME-SCALC.</p> <p>Additionally, a new control schedule plan can be simulated within FAME-DAS, and then deployed to a particular OGEMA or all OGEMA instances within the facility (if required).</p>
Pre-condition	<ul style="list-style-type: none"> • Facility has a BEAMS system installed and properly managing energy efficiency actions within the facility. • If within a facility there is not a BMS or different subsystems control mechanism already in place, these will be deployed within the scope of BEAMS project. • OGEMA gateway(s) is capable to run applications for data acquisition and store the information in local. • Common data structures and interfaces have been defined. • Pre-defined types of situation/contexts (e.g., occupancies,

	<p>PV generation, etc). Identified and stored well known situation/contexts (FAME-SCALC).</p> <ul style="list-style-type: none"> • Pre-defined load priorities or control schedule plan prioritization mechanisms within OGEMA and the interaction mechanism OGEMA-FAME.
Actors (stakeholders)	<ul style="list-style-type: none"> • Energy generating and consuming systems • Facility manager (optional) • Utility (optional as price tariff, DR request provider, etc)
BEAMS systems involved	<ul style="list-style-type: none"> • OGEMA gateway • FAME-SCALC • FAME-DAS
Trigger	<p>Situation or unplanned event detected within a facility (or alternatively a new situation/context defined manually by facility manager)</p>
Basic Path	<ul style="list-style-type: none"> • Assuming all loads within a facility are controlled and properly working according to a defined schedule plan, a new context is learned or detected by FAME-SCALC module and presented to the facility manager through the corresponding UI (so that the different facility's sub-systems operation could be adapted). • Based on the new situation/context, the facility manager can define manually new operation requirements for certain (or all) subsystems within the facility. Additionally, the facility manager can assign priorities to each load or subsystem to be controlled within the situation/context, and once defined the whole scenario, it can receive also a priority. • Optionally, the new facility context (including the new operation requirements) can be simulated by the facility manager through FAME-DAS module. Finally, if decided by the facility manager, the new situation/context is properly identified and stored by FAME-SCALC module. • New operation requirements will be properly deployed or sent from FAME to OGEMA gateways (through the OGEMA based SCALC application) so that new control schedule plans are generated for the different loads or subsystems. Operation requirements received from FAME have higher priorities than those generated locally within an OGEMA instance. • According to the new schedule plan and local or third party information (e.g. energy price tariff), local optimizations can be performed e.g. the load with low priorities or with high potential storage could be shifted.
Post-condition	<p>Different load subsystems are adapted and controlled according to a new context.</p> <p>At the end of a particular control schedule plan (developed for a particular context), OGEMA instances generate new local control schedule plans taking into account the schedules already deployed as well as current local data.</p>
Exception Paths	<ul style="list-style-type: none"> • Current energy demand of a facility can not be adapted to required situation/context due to problems in the grid (e.g. previous reception of mandatory demand consumption from utility). • Facility manager is notified that the time schedule proposed can not be deployed on OGEMA gateways, so that further

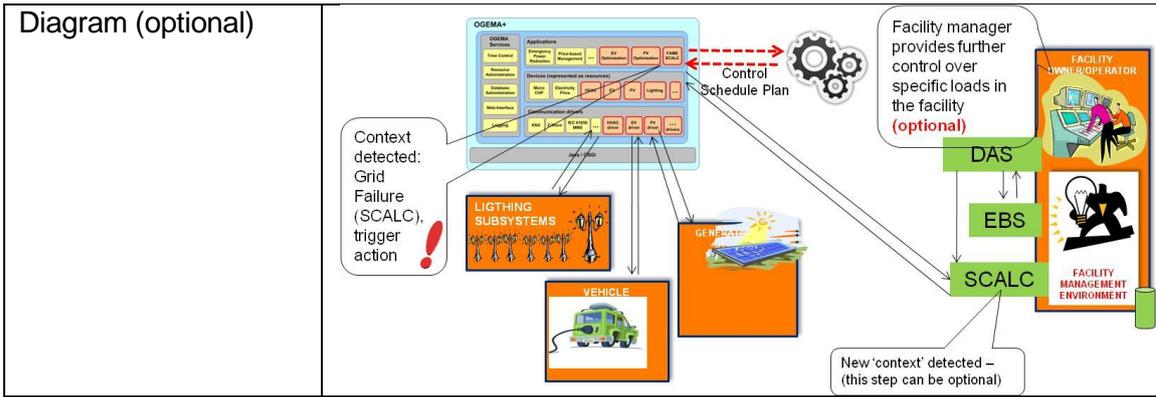
	<p>considerations should be taken into account.</p> <ul style="list-style-type: none"> Facility manager can decide not to change current time schedules, or perform new changes in the FAME-DAS scenario to evaluate, get a successful result and finally deploy it on the OGEMA gateways.
Diagram (optional)	 <p>The diagram illustrates the system architecture. At the top, the OGEMA gateway is shown with various services and applications. A 'Control Schedule Plan' is generated and sent to the Facility Management Environment. This environment includes a Facility Owner/Operator, DAS (Demand Side Management), EBS (Energy Storage), and SCALC (Smart Control and Load Control). The Facility Management Environment is connected to several subsystems: Lighting Subsystems, Vehicle, and Generation and Storage Subsystems. A callout indicates that 'New operation requirements received (SCALC), trigger action' are sent to the OGEMA gateway. Another callout notes that 'New Context introduced by Facility Manager (optional)' is also sent to the OGEMA gateway. A final callout states that 'New context conditions detected or introduced by operator or marked as unmodeled by the categorization system' are also sent to the OGEMA gateway.</p>
Status	Approved
Actions proposed	
Main responsible partners (Author)	IWES
Contributing partners	BDigital
Priority	High
Comments	-

5.2.3 Use-case UC-004: Facility overall consumption reduction/optimization in case of grid failures (islanding operation of a facility)

Table 18 BEAMS use-case UC-004

Use Case	
Common	
ID	UC-004
Title	Facility overall energy consumption reduction/optimization in case of grid failures (islanding operation of a facility)
Related scenario	SC-002
Description (narrative)	<p>This use-case describes the situation where the overall facility demand should be adapted due to a grid failure (e.g. if a message is received from utility or just a grid failure is detected).</p> <p>Under this scenario, OGEMA gateways should perform local optimizations (e.g., load shifting/shedding actions), in order to assure energy supply for critical loads in the system. The critical loads are those that could not be shut-down in case of grid failures (they have been assigned a high priority when defining situation/contexts for the facility).</p> <p>Energy storage as well as RES generation subsystems must provide power firstly to the critical loads within the facility, before supporting the grid. Other uncritical loads could be shifted. If required the whole facility can operate in “islanding mode”, which means that the facility energy generating and consuming subsystems are properly optimized so that energy</p>

	<p>from the grid is not required for a specific period of time. This use-case can be seen as a particular scenario of use-case 003, since a grid failure is a particular situation/context within a facility.</p>
Pre-condition	<ul style="list-style-type: none"> • For each context, a facility manager has defined critical loads within the facility (pre-defined critical loads with high priority within a facility). • Loads within a facility have been assigned priorities. • DER subsystems already in place in a facility and capable of providing energy internally to a facility grid.
Actors (stakeholders)	<ul style="list-style-type: none"> • Energy generating and consuming systems • Utility (optional grid failure request) • Facility manager
BEAMS systems involved	<ul style="list-style-type: none"> • OGEMA gateway • FAME-SCALC
Trigger	<p>Detection of a grid failure by BEAMS system (or possibly reception of a grid failure message from a utility).</p>
Basic Path	<ul style="list-style-type: none"> • OGEMA gateways detect a grid failure (or utility sends proper message to OGEMA gateways). • If this scenario is well-known and identified in FAME-SCALC, and consequently by OGEMA, proper optimizations (load shifting and shedding) are performed locally in order to guarantee energy supply for critical loads according to a load operation schedule. Load priorities are already known by OGEMA. • In case the situation/context is new, updated information regarding the new context is sent from OGEMA gateways to FAME through the corresponding FAME-SCALC application running in OGEMA (as described in UC-003). • RES generation subsystems and, if available, energy storage subsystems can be requested to provide support to facility grid so that the whole facility can possibly operate in islanding mode. This can be performed in a decentralized way by OGEMA gateways, or in coordination with FAME. • Facility manager can provide further control on specific loads within the facility so that energy demand of the facility is further reduced. This can be achieved by defining new scenarios in FAME-SCALC, validating them, and finally sending new operation requirements to OGEMA so that new control schedule plans are generated locally.
Post-condition	<p>Only critical loads operate according to time schedule operation. Possibly, facility can operate in islanding mode.</p>
Exception Paths	<p>OGEMA gateways can not perform enough energy optimizations to assure the energy supply to critical loads within the facility. An energy supply failure affects a facility.</p>



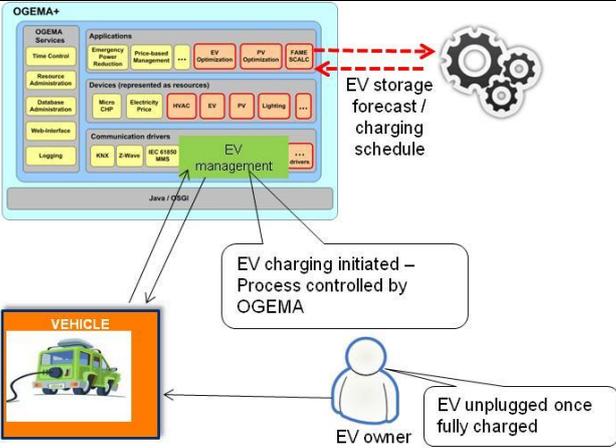
Status	Approved
Actions proposed	
Main responsible partners (Author)	IWES
Contributing partners	BDigital
Priority	High
Comments	-

5.2.4 Use-case UC-005: BEAMS EV (Electrical Vehicles) local management and storage capacity forecasting

Table 19 BEAMS use-case UC-005

Use Case	
Common	
ID	UC-005
Title	BEAMS Electrical Vehicles (EV) local management and storage capacity forecasting
Related scenario	SC-002
Description (narrative)	<p>Within a facility, when Electric Vehicles (EV) and Plug-in Hybrid Electric Vehicles (PHEV) are available, OGEMA gateway EV management application will manage the charging of EVs so this can be used as a mechanism to optimize demand curve of the facility. EV management application will be responsible at the end for the definition of charging periods, when to extract energy from EVs, etc. The task to actually charging or discharging an EV is left to the charging station (or to the battery management systems).</p> <p>On the other hand, energy storage forecasting mechanisms developed as an OGEMA application will provide a forecast of the amount of EV storage capacity for a determined period of time. This can be translated either into energy demand from the system or energy source that can be supplied to the system if necessary.</p> <p>Data obtained from forecasting mechanism can be used as input by another application in an OGEMA gateway to manage EVs on the system. Optionally, data gathered by OGEMA gateways can be provided to FAME algorithms to further optimize (and coordinate) EV batteries charging operation (e.g., when more RES are available, price of</p>

	electricity is cheaper; avoid a peak demand hour, customer requirements, etc).
Pre-condition	<ul style="list-style-type: none"> • Proper EV infrastructure is deployed within pilot site and EV or similar (e.g., electrical or hybrid buses, etc) are available within the facility. • Proper user-interface for the EV charging stations. This will enable the interaction between users and OGEMA in order to provide specific requirements regarding the EV charging process. • Proper EV models and EV systems drivers are properly deployed in OGEMA gateway. OGEMA provides full control over EV systems.
Actors (stakeholders)	<ul style="list-style-type: none"> • End user (EV owner)
BEAMS systems involved	<ul style="list-style-type: none"> • OGEMA gateway • FAME (optional)
Trigger	An EV is plugged in into a facility's charging station controlled by OGEMA gateway.
Basic Path	<ul style="list-style-type: none"> • An end user connects an EV to a proper charging station controlled by an OGEMA gateway. • Though the proper EV user interface of the charging station, the EV owner introduces a set of parameters or preferences regarding the expected EV charge he expects. Some requirements might be minimum expected EV charge, and charging time (e.g. departure time). • Depending on EV and charging station characteristics, EV charging unit senses it is being plugged and starts a charging state (or any other state according to user defined charging preferences). • Charging station sends proper message to corresponding OGEMA EV management application, indicating a new EV has been plugged as well as the EV owner requirements introduced through the proper interface. • EV storage forecasting applications updates EV forecast and provides this information to EV management applications. • OGEMA generates a new local control schedule plan. EV charging operation is scheduled according to current and future context e.g., available and future RES and electricity price, EV charging requirements defined by user or facility manager, etc. • Proper control messages are sent to the corresponding charging station control system, which acknowledges the reception of messages, and takes control over EV charging process. • EV charging completes successfully before EV is unplugged by its owner. • EV owner disconnects EV from charging station. • OGEMA gateway is notified of EV disconnection from charging station, updates EV storage capacity forecast, and generates new control schedule plans according to new context.
Post-condition	An end user charges successfully its EV while this has had a minimal impact in the overall facility energy demand curve, mainly due to OGEMA (and possibly FAME) optimized control

	of EV charging process.
Exception Paths	<ul style="list-style-type: none"> • One possible exception path can be the interruption of the EV charging process due to, for example, the reception of a mandatory DR request from a utility. Such situation will imply to stop charging EVs and to update the overall facility schedule. Final state can be an EV not fully charged. • In the same line of previous path, the EV charging is shifted in case of DR request from utility or grid failure. • Other possible exception path can be the detection of a grid failure, and consequently the EV subsystem is required to provide support to facility energy grid so that the energy stored in the EV can be used to supply critical loads within the facility. • EV owner can also disconnect its vehicle from charging station before the charging time specified (e.g. in case of an emergency).
Diagram (optional)	 <p>The diagram illustrates the OGEMA+ architecture for EV management. It is divided into three main layers: Applications, Devices (represented as resources), and Communication drivers. The Applications layer includes Time Control, Emergency Power Reduction, Price-based Management, EV Optimization, PV Optimization, and FAME SCALC. The Devices layer includes Micro CHP, Electricity Price, HVAC, EV, PV, and Lighting. The Communication drivers layer includes IEC 61850, Modbus, and other protocols. A central 'EV management' component is shown, which interacts with a 'VEHICLE' (represented by a green car icon) and an 'EV owner' (represented by a person icon). A callout box indicates 'EV charging initiated - Process controlled by OGEMA'. Another callout box indicates 'EV unplugged once fully charged'. A dashed red arrow points from the EV management component to a gear icon labeled 'EV storage forecast / charging schedule'.</p>
Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	BDigital
Contributing partners	All
Priority	Low
Comments	-

5.2.5 Use-case UC-006: Facility manager EV fleet management

Table 20 BEAMS use-case UC-006

Use Case	
Common	
ID	UC-006
Title	Facility manager EV fleet management
Related scenario	SC-002
Description (narrative)	<p>This scenario differs slightly from the scenario previously presented since in this case EV management or even a whole EV fleet management is performed according to facility manager requirements.</p> <p>An EV fleet might be available within a facility besides third</p>

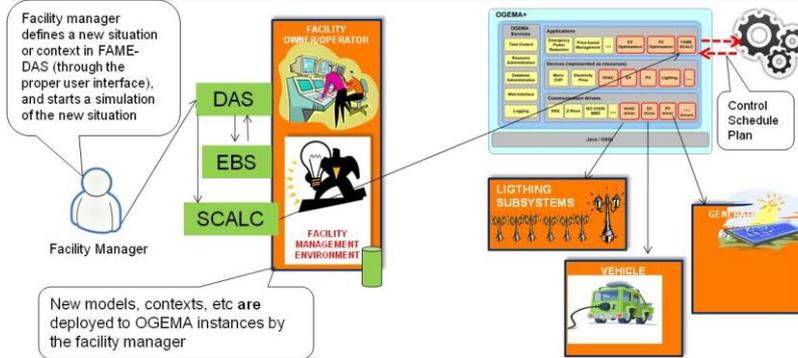
	<p>party EVs also using EV charging stations available. The entire EV fleet might be managed by the facility manager from FAME.</p> <p>For example, a facility manager should be able to define in a daily basis what should be a minimum acceptable charge for its EV fleet at a specified point in time. Additionally charging process might be further controlled based of external data.</p> <p>The information regarding the state of an EV fleet should be available in FAME so that it can be displayed through the proper UI.</p>
Pre-condition	<ul style="list-style-type: none"> • Proper EV infrastructure is deployed within pilot site and EV or similar (e.g., electrical or hybrid buses, etc) are available within the facility. • Proper EV models and EV systems drivers are properly deployed in OGEMA gateway. OGEMA provides full control over EV systems.
Actors (stakeholders)	<ul style="list-style-type: none"> • Facility manager
BEAMS systems involved	<ul style="list-style-type: none"> • OGEMA gateway • FAME
Trigger	A facility manager defines how a part (or an entire) EV fleet charging process should be performed for a specific period of time.
Basic Path	<ul style="list-style-type: none"> • Facility manager checks the state of its EV fleet, and decides to set new requirements to trigger the charging process of part (or the entire) EV fleet. • The new requirements can be simulated in FAME-DAS module and possibly assessed (according to certain metrics) in FAME-EBS. • Depending on the results obtained, the facility manager might deploy the requirements to the OGEMA instances of a facility. OGEMA gateways will perform new control schedule plans based on local data obtained from the EV charging stations and the requirements received from FAME.
Post-condition	EV fleet charging optimized based on facility requirements/needs.
Exception Paths	<ul style="list-style-type: none"> • EV fleet charging process should be interrupted due to, for example, the reception of a mandatory DR request from a utility. Such situation will have to be notified to the facility manager so that updated control schedule plans have to be generated. Final state can be some EVs not fully charged.
Diagram (optional)	
Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	BDigital
Contributing partners	All
Priority	Low
Comments	-

5.3 Scenario SC-003 use-cases (Facility energy consumption advanced control/optimization supported by FAME)

5.3.1 Use-case UC-007: Facility update/optimization of the real-time demand curve supported by FAME

Table 21 BEAMS use-case UC-007

Use Case	
Common	
ID	UC-007
Title	Facility update/optimization of the real-time demand curve supported by FAME
Related scenario	SC-003
Description (narrative)	This use-case describes the situation where a facility manager uses BEAMS system to deploy a coordinated energy optimization action across an entire facility. The reasons that can trigger this scenario could be many e.g. reception of optional DR request from utility, facility manager willingness to increment energy efficiency of the whole facility in a particular scenario, deployment of a new system within the facility, etc.
Pre-condition	<ul style="list-style-type: none"> • BEAMS system properly deployed and in operation.
Actors (stakeholders)	<ul style="list-style-type: none"> • Facility manager
BEAMS systems involved	<ul style="list-style-type: none"> • OGEMA gateway(s) • FAME-DAS • FAME-EBS
Trigger	Utility manager defines a new situation/context in FAME-DAS (through proper user interface) and assesses the situation defined from an economical point of view by means of FAME-EBS. Finally, the facility manager decides to deploy the new context requirements across the different OGEMA gateways of the facility (so that they can generate new control schedule plans for each of the subsystems).
Basic Path	<ul style="list-style-type: none"> • Facility's manager (human operator) defines a situation/context in FAME-DAS. • In case a particular situation, policies, subsystems, etc are not available in the existing deployment, the facility manager will firstly define the new situations, policies and even subsystem's models to be simulated or evaluated. This will be done through the simulation tool integrated in FAME-DAS module. • Additionally, the situation/Context can be assessed in FAME-EBS, according to parameters defined by the facility manager. The objective is to assess the new context from an economical point of view (or any other metrics of interest). Some additional metrics can be used by FAME-EBS to assess a situation/context. • A detailed report assessing the suitability of the strategies or policies defined, deployment of new subsystems within the facility, etc is provided through the user interface of FAME-DAS. • Proper operation schedules for all the subsystems within the facility are generated. FAME-DAS requests FAME-SCALC module to generate new operation requirements for the entire facility.

	<ul style="list-style-type: none"> Depending on results obtained, the facility manager decides to deploy the new operation requirements to all OGEMA gateways. Since these operation requirements come from FAME, they are assigned a high priority, so that they are used to generate new control schedule plans within each OGEMA gateway. OGEMA gateways generate new control schedule plans, and consequently start controlling different subsystems under their control according to the schedule received.
Post-condition	The facility manager obtains the results of the simulations and assessment performed in FAME. A detailed report is presented through the user interface. New operation requirements for the different subsystems of the facility are defined in FAME and deployed to OGEMA gateways. Facility subsystems are controlled according to new control schedule plans.
Exception Paths	<ul style="list-style-type: none"> Facility manager decides not to deploy a new operation schedule, so that the whole facility, and particularly OGEMA gateways remains working in a decentralized way.
Diagram (optional)	 <p>The diagram illustrates the process flow. A Facility Manager defines a new situation in FAME-DAS and starts a simulation. FAME consists of DAS, EBS, and SCALC components. The Facility Manager also deploys new models and contexts to OGEMA instances. OGEMA+ (OGEMA gateway) receives these and generates a Control Schedule Plan, which is then used to control subsystems like Lighting, Vehicle, and Gen.</p>
Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	BDigital
Contributing partners	All
Priority	High
Comments	According to the discussions during the consortium meeting in Lecce, it should be clear that FAME is able to send requirements to OGEMA so that each OGEMA generates its own control schedule plan.

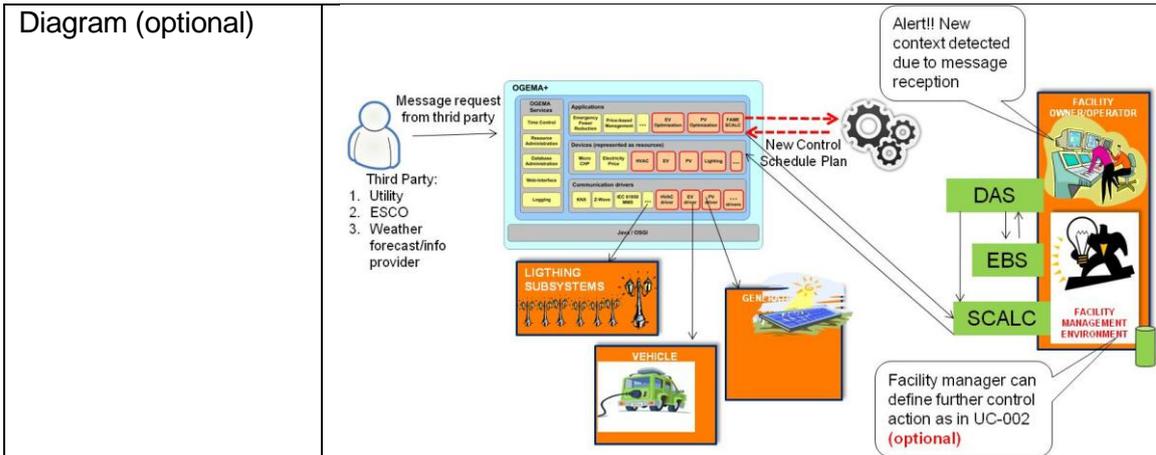
5.4 Scenario SC-004 use-cases (Facility active market participation)

5.4.1 Use-case UC-008: Facility energy demand curve optimization based on a “non-critical” third-party request

Table 22 BEAMS use-case UC-008

Use Case	
Common	
ID	UC-008
Title	Facility energy demand curve optimization based on a non-critical third-party request

Related scenario	SC-004
Description (narrative)	<p>This use-case describes the situation where the energy consumption (demand curve) of an entire facility should be optimized based on the reception of data from a third party.</p> <p>This is not a critical scenario mainly due to the nature of the information received. For example, this can be the case when new weather forecast information, or new price tariff information is received by one or all OGEMA instances in a facility.</p> <p>Once the information is received, it can be used or not locally by each OGEMA instance in a facility to generate new control schedule plans that optimize the operation of the different subsystems under its control.</p> <p>In this case there is no need to notify facility manager (or send received data to FAME module).</p>
Pre-condition	<ul style="list-style-type: none"> • BEAMS system properly deployed and in operation. • OGEMA gateway has control over several different sub-systems within a facility, including energy sources and sinks. • Energy consuming systems are in operation according to OGEMA gateway control instructions. • The interface with third parties are properly implemented or simulated (by means of a proper set of energy efficiency scripts within FAME).
Actors (stakeholders)	<ul style="list-style-type: none"> • Utility or third party (simulated)
BEAMS systems involved	<ul style="list-style-type: none"> • OGEMA gateway • Third party simulation scripts (FAME)
Trigger	A third party (e.g. weather forecast provider, utility, etc) sends updated “non-critical” information to one or all OGEMA instances within a facility.
Basic Path	<ul style="list-style-type: none"> • Facility’s OGEMA instance(s) acknowledges the reception of information from a third party. • Information received is assigned a priority. This can be based on a prioritization mechanism and priority levels defined by the facility manager. • Assuming information received is assigned a priority level that implies a “non-critical” situation, local optimization applications will be triggered in each OGEMA instance. • As a result, new control schedule plans are generated for each of the subsystems under control of each OGEMA instance. These control schedule plans are deployed by each OGEMA so that the operation of the different subsystems of the facility is adapted to the situation/context.
Post-condition	A facility energy demand is optimized based on the information received from third parties and local data used to generate local control schedule plans by each OGEMA instance.
Exception Paths	<ul style="list-style-type: none"> • One option can be that OGEMA gateway cannot optimize the energy consumption of the facility according to the information received, so that subsystems continue to operate in the same way they were doing before the information reception.



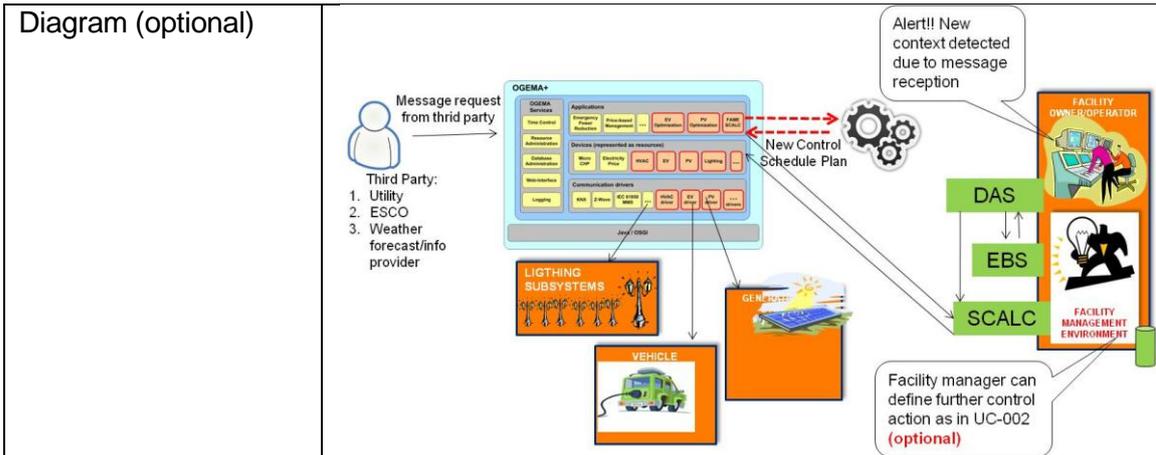
Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	BDigital
Contributing partners	All
Priority	High
Comments	-

5.4.2 Use-case UC-009: Facility energy demand curve optimization based on a “critical” third-party request

Table 23 BEAMS use-case UC-009

Use Case	
Common	
ID	UC-009
Title	Facility energy demand curve optimization based on a critical third-party request
Related scenario	SC-004
Description (narrative)	<p>This use-case describes the situation where the energy consumption (demand curve) of an entire facility should be optimized, in order to accomplish with a “critical” utility or third party request. Critical information received from a third party is notified to the facility manager before any local optimization or control schedule plan is generated locally in OGEMA.</p> <p>For example, this situation can be met normally when a utility is facing a peak demand period, so that it sends a demand response (DR) request to its users, in this case a facility OGEMA instance within a facility, in order to reduce the consumption in a specific amount of kWh during a specific amount of time (possibly indicating start and end times). This request is notified to facility manager, who can decide to trigger the optimizations locally in OGEMA, manually control certain loads within the facility, or simply reject the DR request.</p>
Pre-condition	<ul style="list-style-type: none"> • BEAMS system properly deployed and in operation. • OGEMA gateway has control over several different sub-systems within a facility, including energy sources and sinks.

	<ul style="list-style-type: none"> • Energy consuming systems are in operation according to OGEMA gateway control instructions. • The interface with a utility is properly in place or simulated by means of a proper set of energy efficiency scripts. Within this simulated scenario, the facility can be registered in a utility DR program.
Actors (stakeholders)	<ul style="list-style-type: none"> • Utility or third party (simulated) • Facility Manager
BEAMS systems involved	<ul style="list-style-type: none"> • OGEMA gateway • FAME-SCALC • FAME-DAS • FAME-EBS • Third party simulation scripts (FAME)
Trigger	Utility sends a “critical” request (e.g. a DR request) to a facility OGEMA instance (e.g. indicating amount of energy to be reduced and period of time to accomplish the task).
Basic Path	<ul style="list-style-type: none"> • Facility’s OGEMA gateway(s) acknowledges the reception of the DR request from a utility. • Information received from the third party is pushed or sent from OGEMA gateways to FAME through the corresponding FAME-SCALC application running in OGEMA, so that the facility manager is aware of the situation in order to decide or not to trigger coordinated actions within a facility. • Once the facility manager receives the information, if, for example, the DR request is accepted; FAME SCALC algorithms detect the new situation/context and generate new control requirements within the facility. • The new situation/context can be simulated in FAME-DAS. • Further controls can be defined by facility manager through FAME-DAS. All scenarios can be assessed in FAME-EBS before its deployment to OGEMA gateways. • Finally, if decided by facility manager, new operational requirements for the entire facility are sent to each OGEMA instance by FAME-SCALC module. • Requirements received by each OGEMA instance will be used to generate new control schedule plans locally. • Subsystems (e.g., HVAC, water heating and EV charging) are adjusted accordingly to reduce the energy consumption. • Energy consumption reduction is accomplished. A notification message is sent to the utility indicating that the energy demand curve was adapted.
Post-condition	A facility energy demand is reduced exactly in the amount of energy request by the utility. At the end of the DR operation, subsystems operation controlled during the DR event can be re-scheduled by OGEMA gateway to adapt its operation to new facility conditions or requirements.
Exception Paths	<ul style="list-style-type: none"> • The facility manager directly rejects the DR request from the utility, by indicating this through the proper UI. This action is transmitted to OGEMA gateway in order to avoid further actions over the facility sub-systems. In this case, the utility is notified with a message rejecting the DR request.



Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	BDigital
Contributing partners	All
Priority	Medium
Comments	-

5.4.3 Use-case UC-010: Facility energy demand curve optimization based on available price tariff (dynamic energy market participation)

Table 24 BEAMS use-case UC-010

Use Case	
Common	
ID	UC-010
Title	Facility energy demand curve optimization based on available price tariff (dynamic energy market participation)
Related scenario	SC-004
Description (narrative)	<p>This use-case describes the situation where the energy consumption (demand curve) of an entire facility can be optimized based on available price tariff information received from a utility, ESCO or third-party actor. This use-case can be seen as a particular case of the UC-008 (Facility energy demand curve optimization based on a non-critical third-party request).</p> <p>Additionally, based on the price tariff and constant feed-in power tariff, OGEMA gateways can perform optimizations where for example DER or RES energy available can be sold to the grid or used internally within a facility (e.g. to charge EV).</p>
Pre-condition	<ul style="list-style-type: none"> A bidirectional communication with a utility or third party is available (or simulated). Utility or third-party provides price tariff information (e.g. in an hourly rate). There are DER or RES subsystems available on a facility.
Actors (stakeholders)	<ul style="list-style-type: none"> Utility (simulated)
BEAMS systems involved	<ul style="list-style-type: none"> OGEMA gateway FAME-SCALC (optional) FAME-DAS (optional)

	<ul style="list-style-type: none"> • Third party simulation scripts (FAME)
Trigger	Reception of price tariff information
Basic Path	<ul style="list-style-type: none"> • Facility's OGEMA gateway acknowledges the reception of the price tariff information to its sender. • Price tariff received by OGEMA gateway triggers the optimization applications within OGEMA. • New control schedule plans are generated for each of the subsystems under control of each OGEMA instance. These control schedule plans are deployed by each OGEMA so that the operation of the different subsystems of the facility is adapted to the situation/context. • A reception of new price tariff information can triggers the whole process again. Optionally, facility manager can modify the time schedule operation of the different systems by controlling the system through FAME-DAS.
Post-condition	The facility participates actively in the energy market, either by selling energy to the grid, or adjusting its energy demand according to price tariff received from utility or third party.
Exception Paths	No optimization of the system is possible due to a special event/context in the facility. This can imply for example that the facility is consuming energy during a high price tariff period.
Diagram (optional)	
Status	Approved
Actions proposed	
Main responsible partners (Author)	ICCS, IWES
Contributing partners	All
Priority	Low
Comments	-

5.4.4 Use-case UC-011: Facility – Pre-emptive regulation depending on meteorological forecasts

Table 25 BEAMS use-case UC-011

Use Case	
Common	
ID	UC-011
Title	Facility – Pre-emptive regulation depending on meteorological forecasts
Related scenario	SC-004
Description (narrative)	<p>This use-case describes the situation where the energy consumption (demand curve) of an entire facility can be optimized based on external or third-party information, in this case meteorological data. This use-case can be seen as a particular case of the UC-008 (Facility energy demand curve optimization based on a non-critical third-party request).</p> <p>Meteorological data providers (online services and/or local meteo-stations) provide weather information useful to adjust promptly and in advance the building conditioning: e.g. outdoor temperature decrease or fresh wind rising, are favourable</p>

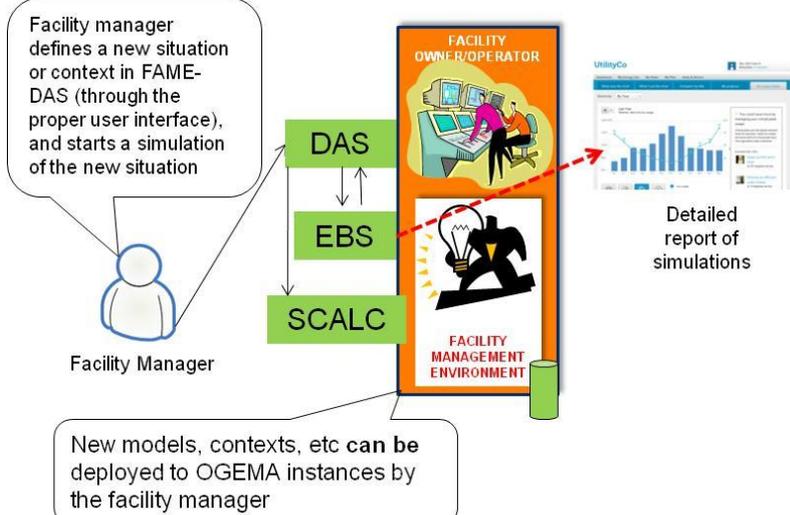
	environmental conditions for reducing primary energy consumption by adjusting conditioning, ventilation or shading systems appropriately, and at the right time.
Pre-condition	<ul style="list-style-type: none"> • A facility has a BEAMS system installed • OGEMA gateway has control over several different sub-systems within the facility, including weather data sources and building management systems. • The interface with a weather forecast provider is properly implemented (if available) or simulated (if experimental set of data are required for validation purposes). • The interface with a building management system used to control the settings of HVAC systems or mechanical systems (shadings, openings) is implemented (if available) or simulated (if experimental regulation in the real environment is not allowed).
Actors (stakeholders)	<ul style="list-style-type: none"> • Weather information/forecast providers
BEAMS systems involved	<ul style="list-style-type: none"> • OGEMA gateway • FAME-SCALC (optional) • FAME-DAS (optional) • Third party simulation scripts (FAME)
Trigger	Weather forecast received from the weather forecast provider
Basic Path	<ul style="list-style-type: none"> • Weather forecast provider sends (or after a request, answers with) a weather forecast report (e.g. temperature, wind, cloudiness) in the next 2 hours (or less). This can be an accurate weather forecast from satellite systems or simple weather information from a local meteo-station. • OGEMA applications can use the information received to generate new control schedule plans. • OGEMA-based SCALC module can detect a new situation/context so that facility manager is notified about the activity. • Controlled subsystems are adjusted accordingly to reduce the energy consumption.
Post-condition	Facility energy consumption optimized according to current and forecasted weather conditions.
Exception Paths	Being an optimization for a standard operational mode, there are no specific exceptions to consider.
Diagram (optional)	
Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	Thales Italy
Contributing partners	All
Priority	Medium
Comments	-

5.5 Scenario SC-005 use-cases (Simulation of situation/contexts not available in an existing deployment)

5.5.1 Use-case UC-012: Simulation of situation/contexts not available in a facility

Table 26 BEAMS use-case UC-012

Use Case	
Common	
ID	UC-012
Title	Simulation of situation/contexts not available in a facility
Related scenario	SC-005
Description (narrative)	<p>This use-case describes the situation where BEAMS system is used to assess new optimization scenarios or new subsystems operation (or impact) within a facility.</p> <p>It is of special interest the case when a particular subsystem (either RES or loads) is not available in the facility (e.g. installation of new PV subsystem, EV charging station, etc).</p> <p>New subsystems within a facility can be simulated in FAME-DAS submodules and the new facility situation/context can be assessed in FAME-EBS. Results can be compared or analyzed to historical data.</p>
Pre-condition	<ul style="list-style-type: none"> • BEAMS system properly deployed and in operation.
Actors (stakeholders)	<ul style="list-style-type: none"> • Facility manager
BEAMS systems involved	<ul style="list-style-type: none"> • OGEMA gateway (depending on final implementation) • FAME-DAS • FAME-EBS
Trigger	Facility manager defines a new situation/context in FAME-DAS (through the proper user interface), and starts a simulation/assessment of the new situation defined.
Basic Path	<ul style="list-style-type: none"> • Facility's manager (human operator) defines a new context/situation that should be simulated in FAME-DAS. • In case a particular situation, policies, subsystems, etc are not available in the existing deployment, the facility manager will firstly define the new situations, policies and even subsystem's models to be simulated or evaluated. This will be done through the simulation tool integrated in FAME-DAS module. • If the facility manager wants to further evaluate the new scenario, simulation data is sent from FAME-DAS to FAME-EBS so that an economical assessment is performed. • If the new situation/context requires the use of a subsystem module already deployed in OGEMA, FAME will send simulation data requirements to OGEMA. • Simulation data received is used as input parameters in OGEMA subsystem models. Then simulations are performed locally in OGEMA and the result is sent back to FAME. • A detailed report assessing the suitability of the strategies or policies defined, deployment of new subsystems within the facility, etc is provided through the user interface of FAME-EBS.
Post-condition	The facility manager obtains the results of the simulations performed by FAME algorithms. A detailed report is presented

	through the user interface.
Exception Paths	<ul style="list-style-type: none"> There is any kind of problem during the simulation process, and in consequence the process is interrupted and the facility manager obtains the proper error or indication message.
Diagram (optional)	 <p>Facility manager defines a new situation or context in FAME-DAS (through the proper user interface), and starts a simulation of the new situation</p> <p>Facility Manager</p> <p>DAS</p> <p>EBS</p> <p>SCALC</p> <p>FACILITY OWNER/OPERATOR</p> <p>FACILITY MANAGEMENT ENVIRONMENT</p> <p>UtilityCo</p> <p>Detailed report of simulations</p> <p>New models, contexts, etc can be deployed to OGEMA instances by the facility manager</p>
Decision	
Status	Approved
Actions proposed	
Realisation	
Main responsible partners (Author)	BDigital, SDXFM
Contributing partners	All
Priority	High
Comments	-

5.6 Use-cases workflow – Summary

From the scenarios and use-cases analysis performed in the previous sections, it is possible to derive several workflow diagrams that present in a summarized and graphical way the main interaction between the different components of the BEAMS system.

The workflows presented below have not been created using any particular standard or technology, they simply have been develop to summarize the main concepts gathered through the use-case analysis as well as being a reference point and possibly a tool to trigger the discussion during the requirements analysis stage.

In order to better understand the information presented in these workflows, the following concepts should be taken into account:

- Each BEAM’s architectural module relevant to the key ideas presented in each workflow is presented as coloured boxes. All components of BEAMS architecture are not necessarily present in all workflows.
- Within each coloured box is presented the main flow required to provide a result to be presented to the facility manager or to be provided to other BEAMS component.
- FAME components (presented also coloured boxes) can be seen as independent modules that can interact among them or other components of

BEAMS such as OGEMA. This allows seeing clearly the internal flow within a FAME module as well as the interaction within different FAME modules. Interaction between FAME and OGEMA is supported through the corresponding mechanism already presented in the architecture section (namely an ESB).

5.6.1 Workflow – Monitoring of energy consumption

The following workflow illustrates the main steps described in use-case UC-001 for the energy consumption monitoring of an entire facility.

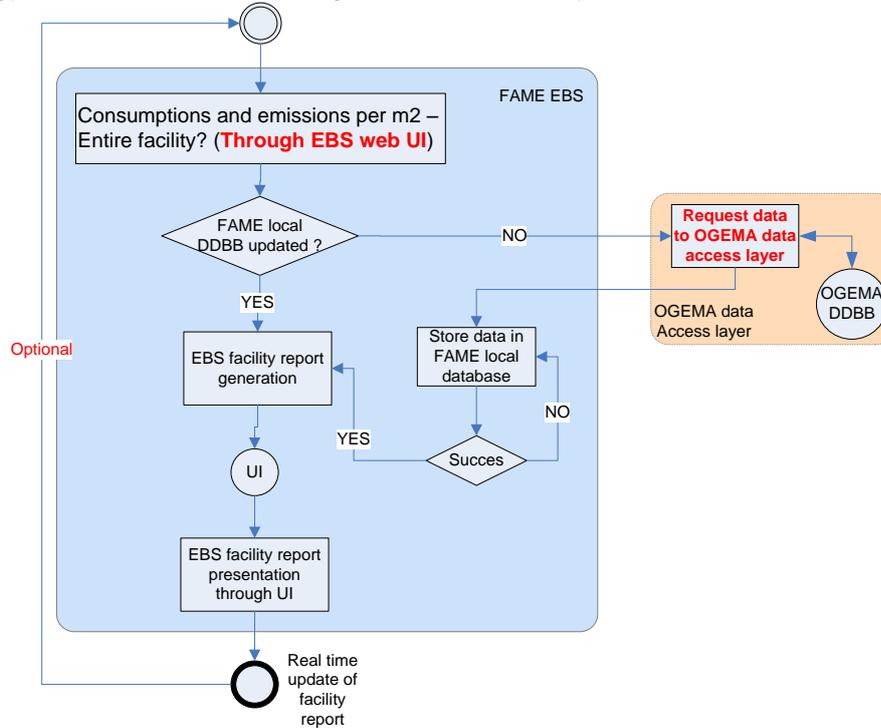


Figure 6: Workflow – Monitoring of energy consumption

5.6.2 Workflow – Facility energy consumption control/optimization

The following workflow illustrates the main ideas presented through all use-cases within the scenario SC-002 (facility energy consumption control/optimization). The scenario SC-002 covers also use-cases where optimizations can be performed locally in OGEMA. However, this workflow focuses on those cases where an interaction between OGEMA and FAME is required. For example, the workflow illustrates those cases where a new or unknown situation/context is detected and, in consequence, new control schedule plans should be generated in OGEMA (possibly based on some requirements introduced by the facility manager as well as local information).

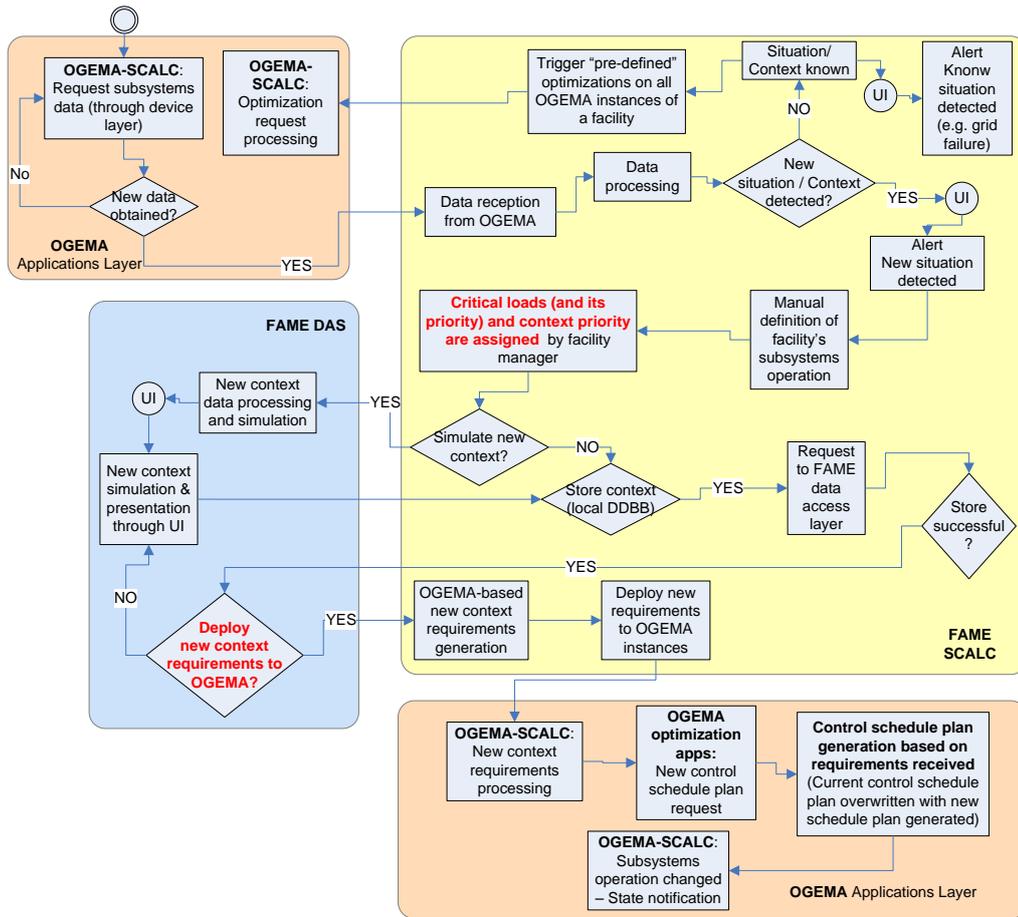


Figure 7: Workflow – Facility energy consumption control/optimization

5.6.3 Workflow – Facility advanced control/optimization supported by FAME

The following workflow illustrates the main ideas presented through all use-cases within the scenario SC-003 (facility energy consumption advanced control/optimization supported by FAME) and SC-005 (simulation of situation/contexts not available in an existing deployment).

In both cases, the process can start with the facility manager defining a situation/context that can be simulated and assessed within FAME, and depending on the results obtained, the new operational requirements are sent from FAME to OGEMA so that the overall facility operation is affected.

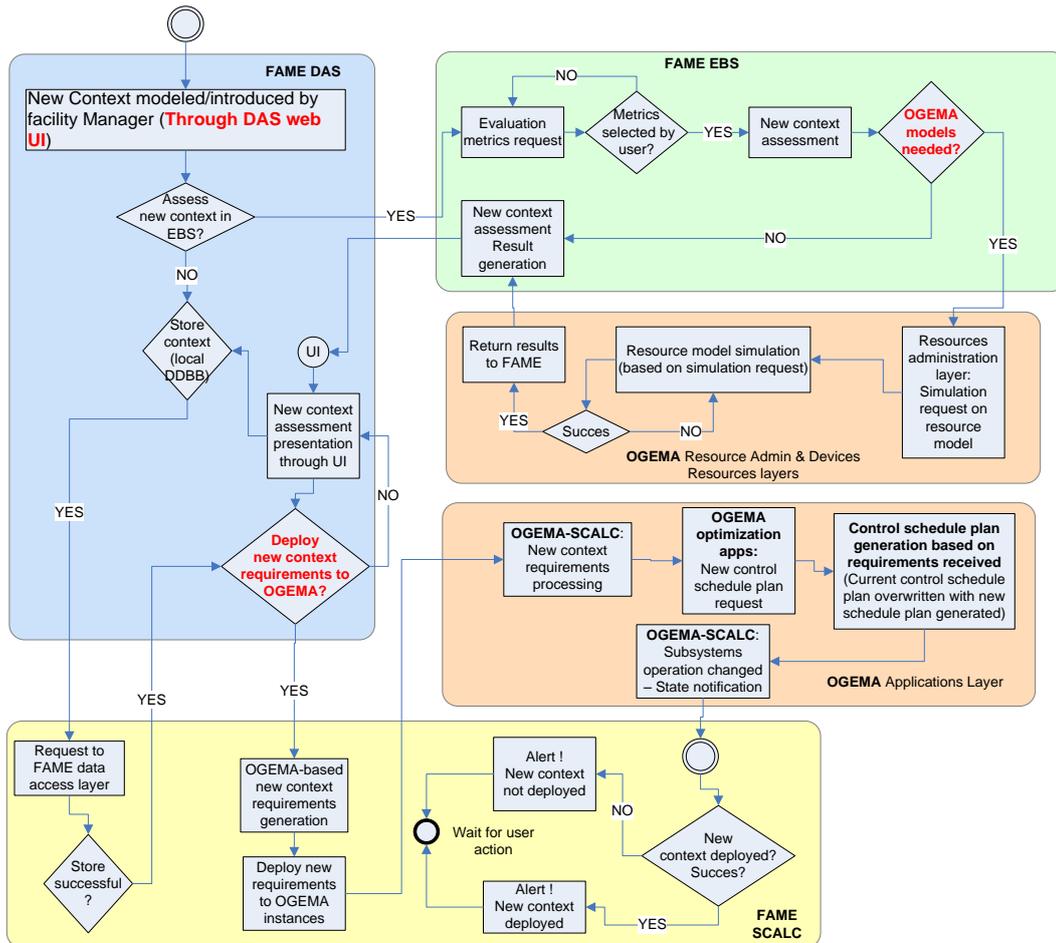


Figure 8: Workflow – Facility advanced control/optimization supported by FAME

5.6.4 Workflow – Facility active market participation

The following workflow illustrates the main ideas presented through all use-cases within the scenario SC-004 (Facility active market participation), where an interaction between BEAMS system and third parties is described.

It is important to highlight that third parties access BEAMS system through OGEMA instances, as illustrated in the upper left corner of the workflow.

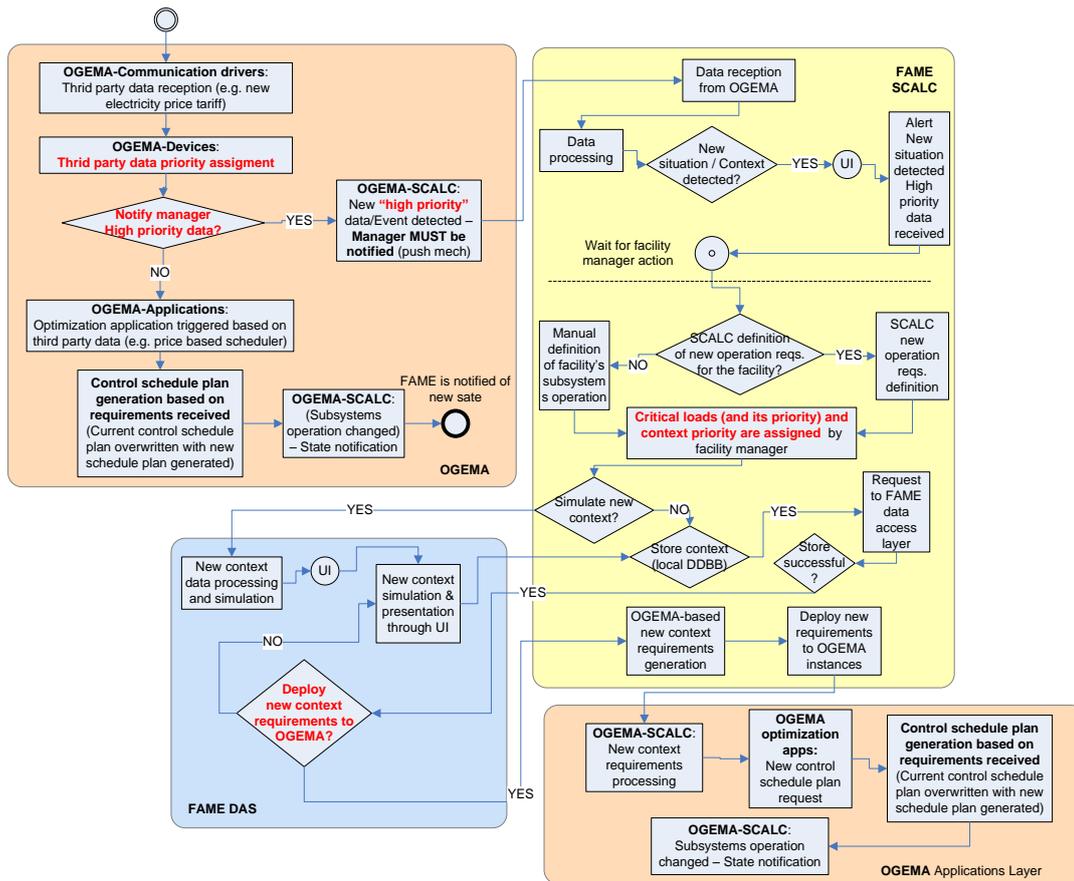


Figure 9: Workflow – Facility active market participation

5.7 Prioritization of scenarios & Use-cases

Along this section we present a prioritization of the scenarios and use-cases provided along this document. At this stage of the project a prioritization of use-cases is not critical, however, the list showed below can be used as a reference (or summary) of all use-cases presented along the document. All these use-cases have been agreed within the project consortium and will be used as the starting point for the BEAMS system project requirements definition.

Table 27 Use-cases summary table - Prioritization

Scenario	Use-cases	Priority
SC-001 (strategic) Monitoring of consumption (entire installation)	UC-001 Monitoring of energy consumption (entire installation)	High
SC-002 Facility energy consumption control/optimization	UC-002 Real-time update/optimization of a facility energy demand curve	High
	UC-003 Real-time update/optimization of a facility energy demand curve based on a situation/context information	High
	UC-004 Facility overall consumption reduction/optimization in case of grid failures (islanding operation of facility)	High
	UC-005	Low

	BEAMS EV (Electrical Vehicles) local management and storage capacity forecasting	
	UC-006 Facility manager EV fleet management	Low
SC-003 Facility energy consumption advanced control/optimization supported by FAME	UC-007 Facility update/optimization of the real-time demand curve supported by FAME	High
SC-004 Facility active market participation (monitoring and control based on utility or third party information)	UC-008 Facility energy demand curve optimization based on a non-critical third-party request	High
	UC-009 Facility energy demand curve optimization based on a critical third-party request	Medium
	UC-010 Facility energy demand curve optimization based on available price tariff (dynamic energy market participation)	Low
	UC-011 Facility – Pre-emptive regulation depending on meteorological forecast	Medium
SC-005 Simulation of situation/contexts not available in an existing deployment (pilot site or facility)	UC-012 Simulation of situation/contexts not available in a facility	High

It is important to highlight that the scenarios and use-cases provided have been authored to be as general as possible. From these scenarios and use-cases can be later derived specific use-cases adapted to the particular characteristics of the pilot sites to be used in BEAMS project, FCB Stadium facilities and UNISAL campus facilities.

6 Requirements Analysis

6.1 Methodology

Gathering the requirements from all stake-holders in a project is a key success factor. The requirements not only describe different aspects of a project but they also help to identify conflicting features in early stages. Such an important step – that identifies and affects the overall outcome of the project - is worth investing considerable efforts and utilizing proper tool. Considering this, we have chosen Volere methodology (1) for describing and managing requirements which we have extended with a consecutive prioritization phase. In the following, we discuss the rationale for using Volere and we describe the classification categories and the process.

6.1.1 Requirement Elicitation

The Volere methodology is not new to some of the project partners. It was first used by a number of the project partners in EMMA project where it was used mainly because of its simplicity. It helped project partners to describe, formalize and track the project requirements in an explicit and unambiguous manner. Besides being a success in the EMMA project, the Volere methodology was selected for the following three reasons:

1. The Volere methodology requires simple steps to identify and formalize the requirements in an unambiguous manner.
2. The Volere methodology provides an easy process to track and evaluate the progress of the project.
3. A number of the project partners have already experience with the Volere methodology. Hence, they did not experience an extra learning effort.

The consequent application of the Volere methodology is not only useful in the initial phases of the project for specifying requirements but it is also helpful in specifying a reference point for the later stages. During the use case analysis, for example, it can be used to ensure that different use cases cover different aspects of the requirements and that all important requirements are covered by them. During the implementation and management, it can be used to track and evaluate the progress of the individual work packages and the overall project. Besides being efficient and easy to use, the Volere methodology provides a mechanism for all partners to specify the requirements in a standard format. Thereby, specifying additional context of a requirement such as the rationale and the acceptance criteria for every requirement helps to build a common understanding of the overall system. Furthermore, defining priorities helps to clarify the focus of the project.

6.1.2 Requirement Prioritization

In order to prioritize requirements, the project consortium has introduced three different classes of priorities. These classes range from **five (high priority)** over **two (medium priority)** to **one (low priority)** and the consortium has defined them as follows:

1. **High:** Requirements in this class are either realizing a key innovation of the project or they are needed to realize it. These requirements are necessary to achieve the goals of the project.
2. **Medium:** Requirements in this class are not necessary to realize a key innovation but they are necessary or very helpful to realize the application prototypes. These requirements are important to the application developer.

3. **Low:** Requirements in this class are neither realizing a key innovation nor necessary for the application prototypes. However, in a broader context – possibly beyond the scope of the project – they may be important.

The implementation of requirements defined through the Volere tool, and in general use cases and scenarios within the scope of the project will be subject to further consideration, including the consideration of efforts and resources within the project as well as capabilities of local hardware at the pilot sites.

As a consequence, for the success of the project, it is essential to realize the requirements with high priority. With respect to providing thorough support for application developers, it is important to realize the requirements with medium priority as well. The requirements with low priority, however, are not of immediate relevance for the project. However, their realization may provide additional features or benefits for applications or users that should be considered after all requirements of the other two classes have been implemented successfully.

In order to give all stake-holders and interested parties an insight into the prioritization process, the consortium has not only assigned categories to each requirement but it decided to include the main rationale for this classification in this document. Besides from being informative, this can be helpful in later stages of the project where unforeseeable issues may require the introduction of new requirements or changes to existing ones.

6.2 Tool

Aiming at defining an optimum and complete list of requirements, a web tool based on the Volere methodology was developed originally during the EMMA project and has been defined since. This web tool has facilitated the definition, the validation and the prioritization of the BEAMS requirements.

For security reasons, the access to the web tool has been restricted to authorized users. Anyone can fill in the registration form to request a valid user name and password (c.f. Figure 10). This request is processed by the administrator who decides who must be granted access to the website.

The image shows a web registration form for 'Volere'. At the top, there is a logo with a lightbulb and the word 'Volere'. Below the logo, the title 'Registration' is centered. A message reads: 'Please, fill in the registration form and a username-password will be sent to you as soon as possible.' The form contains five input fields: 'Name *', 'Organization *' (with a dropdown arrow), 'E-mail *', 'Phone', and 'Username *'. A dashed box encloses the first five fields. Below the fields, it says '* Required fields'. At the bottom, there are two buttons: 'Register!' and 'Cancel'.

Figure 10: Website Registration Form

If the administrator approves the request, then, an email with the user name and password is sent to the requester. From that moment, the user will be able to access the BEAMS requirements definition website (c.f. Figure 11).

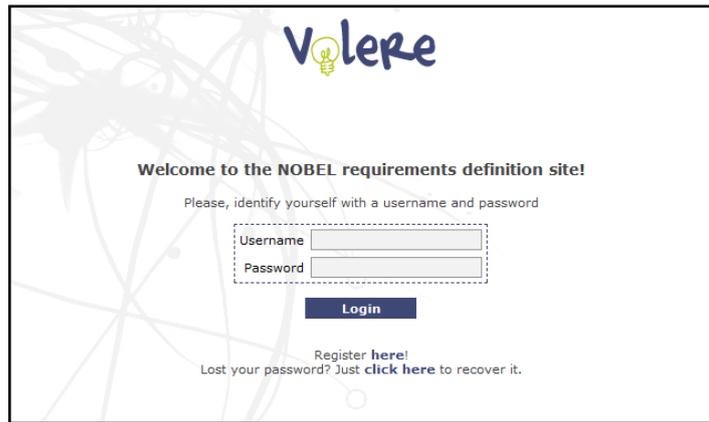


Figure 11: Login

Access to the web tool is granted after a successful identification on the system. The application allows the administrator to control the status of the validation process from the initial definition to the final list of requirements passing through the required validation and revision status.

6.2.1 Specification Process

The overall process of Volere as supported by the web tool is depicted in Figure 12. After an initial specification of requirements, the users can specify conflicts, dependencies and objections. After specifying them, they can iteratively revise the specification and identify additional issues until it is free of conflicts, dependencies and objections. The result will constitute the final list of requirements. The following subsections briefly outline the individual steps.

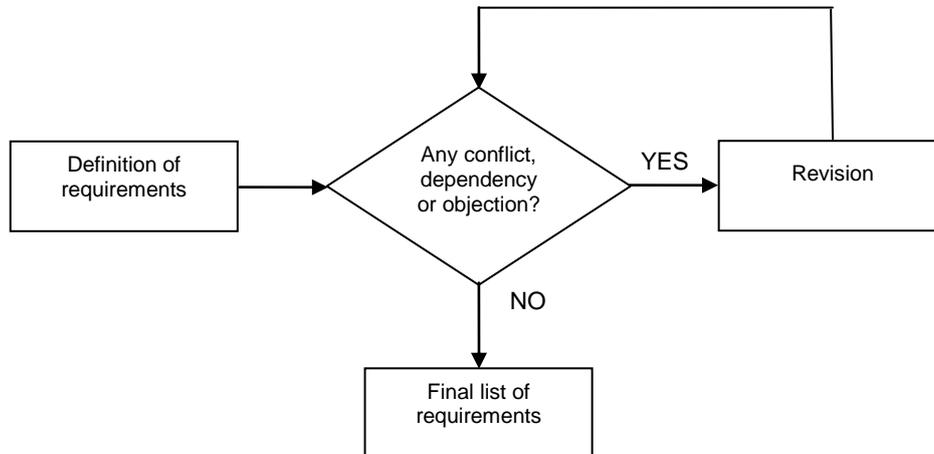
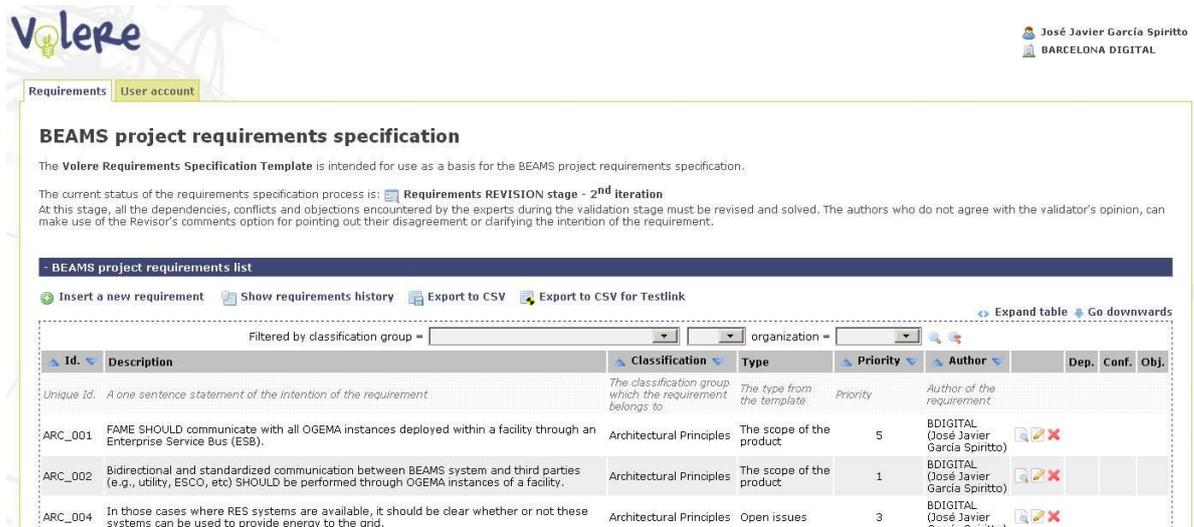


Figure 12: Requirement Specification and Validation Process

6.2.2 Requirement Definition

In this first stage all the requirements needed to accomplish the project objectives must be defined. These will be refined in future stages. The most useful information and the main functionalities at this stage available at the home page are (c.f. Figure 14):



BEAMS project requirements specification

The Volere Requirements Specification Template is intended for use as a basis for the BEAMS project requirements specification.

The current status of the requirements specification process is: **Requirements REVISION stage - 2nd iteration**

At this stage, all the dependencies, conflicts and objections encountered by the experts during the validation stage must be revised and solved. The authors who do not agree with the validator's opinion, can make use of the Revisor's comments option for pointing out their disagreement or clarifying the intention of the requirement.

BEAMS project requirements list

Insert a new requirement | Show requirements history | Export to CSV | Export to CSV for Testlink

Filtered by classification group = [] organization = [] Expand table | Go downwards

Id.	Description	Classification	Type	Priority	Author	Dep.	Conf.	Obj.
ARC_001	FAME SHOULD communicate with all OGEMA instances deployed within a facility through an Enterprise Service Bus (ESB).	Architectural Principles	The scope of the product	5	BDIGITAL (José Javier García Spiritto)			
ARC_002	Bidirectional and standardized communication between BEAMS system and third parties (e.g., utility, ESCO, etc) SHOULD be performed through OGEMA instances of a facility.	Architectural Principles	The scope of the product	1	BDIGITAL (José Javier García Spiritto)			
ARC_004	In those cases where RES systems are available, it should be clear whether or not these systems can be used to provide energy to the grid.	Architectural Principles	Open issues	3	BDIGITAL (José Javier García Spiritto)			

Figure 13: Volere Tool Homepage

- **Help:** An external link to Volere requirements specification template.
- **List of requirements:** The list of requirements with some additional options.
 - Filtering options: The list of requirements filtered by id, type and/or filtered by author.
 - Expand table: Show/hide some columns, displaying more or less information about the requirement.
- **Requirements management:** Modification options for requirements.
 - View a requirement
 - Edit a requirement (only available for the author)
 - Delete a requirement (only available for the author)
- **Requirements tracing:** After the first validation, a new service is made available for keeping track of all the requirements history.
- **Export to CSV:** Export all requirements to a CSV file for external handling.
- **Insert a new requirement:** Opens a new window (c.f. Figure 14) to allow adding a new requirement. All the fields are required except for “Comments” which is optional. The required fields are:
 - **ID:** The scope of this requirement (BAF, DCP, etc.). Appended by an automatically generated sequential number, this ID uniquely identifies each requirement. This ID will be generated after the requirement has been added (c.f. Figure 15).
 - **Description:** A one sentence statement which describes the intention of the requirement.
 - **Type:** The type of the requirement as defined by Volere.
 - **Rationale:** A justification of the requirement.
 - **Acceptance criteria:** A measurement of the requirement for further verification that the solution matches the original requirement.
 - **Priority:** The importance for the customer of successfully implementing the requirement.

Figure 14: Definition of Requirements

Id.	ARC_001
Classification	Architectural Principles
Description	FAME SHOULD communicate with all OGEMA instances deployed within a facility through an Enterprise Service Bus (ESB).
Type	Functional requirements - The scope of the product
Author	BDIGITAL (José Javier García Spiritto)
Date	16/03/2012
Rationale	Since several different OGEMA instances could be deployed within a facility, communication between these instances and FAME should be performed through and ESB
Acceptance criteria	All data exchange between OGEMA instances and FAME subsystem should be performed through an ESB.
Priority	5
Comments	The bidirectional communication interface (through the ESB) should be based on standards (e.g., web services).

Figure 15: Requirements Details

6.2.3 Requirement Validation

After the initial definition of requirements, the validation process begins. All the requirements should be approved by all the users. At this stage, conflicts and dependencies between requirements must be detected. Furthermore, any objection must be pointed out (c.f. Figure 16):

- **Dependency:** Requirements that have some dependency on other requirements.

- **Conflict:** Requirements that cannot be implemented if another requirement is implemented or a conflict due to an insufficient definition of the requirement.
- **Objection:** A reason or argument offered in disagreement, opposition, refusal or disapproval of the requirement.

Please, insert the **dependencies** and **conflicts** detected on the list above or any other **objection**.

Go downwards

dependencies, conflicts and objections				
Id.	Dependency	Requirements revised	Validator	
DEP_00	Requirements that have some dependency on other requirements	Authors of the dependant requirements detected	Name and organization of the validator	
Id.	Conflict	Requirements revised	Validator	
CONF_00	Requirements that cannot be implemented if another requirement is	Authors of the requirements in conflict detected	Name and organization of the validator	
Id.	Objection	Requirements revised	Validator	
OBJ_00	A reason or argument offered in disagreement, opposition, refusal or disapproval with the requirement	Author of the requirement objected	Name and organization of the validator	

Go upwards

Figure 16: Validation of Requirements

6.2.4 Requirement Revision

All the dependencies, conflicts and objections encountered by the experts during the validation stage must be revised and solved. However, if the authors do not agree with the validator’s opinion, then they can make use of the “Reviser’s comments” option for pointing out their disagreement or clarifying the intention of the requirement. Note that only the authors of the requirements that have to be revised are able to add comments to the dependency, conflict or objection.

dependencies, conflicts and objections				
Id.	Dependency	Requirements revised	Validator's approval	Revisor's comments
DEP_00	Requirements that have some dependency on other requirements	<ul style="list-style-type: none"> • Author A <ul style="list-style-type: none"> <input type="checkbox"/> MW_X1 • Author B <ul style="list-style-type: none"> <input type="checkbox"/> MW_Y1 	<input type="checkbox"/> Validator C	
Id.	Conflict	Requirements revised	Validator's approval	Revisor's comments
CONF_00	Requirements that cannot be implemented if another requirement is	<ul style="list-style-type: none"> • Author D <ul style="list-style-type: none"> <input type="checkbox"/> MW_K1 <input type="checkbox"/> MW_Z1 	<input type="checkbox"/> Validator E	
Id.	Objection	Requirements revised	Validator's approval	Revisor's comments
OBJ_00	A reason or argument offered in disagreement, opposition, refusal or disapproval with the requirement	<ul style="list-style-type: none"> • Author C <ul style="list-style-type: none"> <input type="checkbox"/> MW_J1 	<input type="checkbox"/> Validator G	

Figure 17: Revision of Requirements

The checkboxes in “Requirements revised” column and “Validator’s approval” column help the users to check the status of the revision and together with the possibility of adding comments facilitate the interaction and communication between the author and the validator. For security reasons, the checkboxes on the “Requirements revised” column are only enabled for the authors of the requirements who have also enabled the possibility of adding comments. Moreover, for the same reason, the checkboxes on the “Validator’s approval” column are enabled only for the author of the validation.

The revision process consists of four steps:

- First, the authors should identify which requirements have been objected to or are involved in any conflict or dependency.
- Second and after analyzing the validator’s opinion:

- The author may agree with the validator and proceed to modify or delete the requirement.
- The author may disagree with the validator, therefore he/she should make appropriate comments trying to clarify the requirement with a better explanation or justify the intention of the requirement.
- Third, the author should mark the checkbox of the requirement as revised.

Finally, the validator should be aware of the revised requirements and approve the actions taken by the author for resolving the dependency/conflict/objection.

It is possible to review the history of a requirement as illustrated below (c.f. Figure 18).

Id.		1 st it.	1 st rev.	
Id.	BAF_027	<p><u>Dependency 8 detected by ETRA I+D (Manolo Serrano):</u> For clarity, it would be good to clarify when, where and who will perform the user estudy. We assume it is in WP7.</p> <p>» Comment 1 by UDE (Robert Sauter): <i>Yes. I was referring to the 'questionnaires' mentioned in T7.1. I've added "in WP7". Etra/Certh: is this OK with you?</i></p> <ul style="list-style-type: none"> • BAF_028 • BAF_030 	Id.	✓ BAF_027
Description	The BAF should be easy to use for non-technical users.		Description	The BAF should be easy to use for non-technical users.
Type	Usability and humanity requirements		Type	Usability and humanity requirements
Author	UDE		Author	UDE
Rationale	The target group are all customers of electricity companies.		Rationale	The target group includes all customers of electricity companies.
Acceptance criteria	A user study shows that the BAF is easy to use.		Acceptance criteria	A user study in WP7 shows that the BAF is easy to use.
Priority	3		Priority	3
Comments			Comments	

Figure 18: Requirement's History

The following sections present the results of the requirements definition process. All requirements have been grouped into categories, each one related to the main components of the BEAMS architecture (and at the same time to the work packages dealing with development of those components). Within each section, a brief overview of the requirements related to that category is presented.

7 Requirements – Architectural Principles (WP2)

7.1 Overview

The definition and development of all components of BEAMS project starts with the agreement and definition of a common architecture for all systems within the project. The reference architecture will enable the design and development of all energy efficiency management components, including the data models and interoperability interfaces between BEAMS components as well as BEAMS and external actors, smart grids and services.

7.2 Requirements

A brief description of a draft architecture proposal for BEAMS project was presented when analyzing all scenarios and use-cases for the project. In this architecture it can be seen all main components and interfaces between the different BEAMS components. Since several “Architectural Principles” requirements are related to each of these components, interfaces between them, etc, in this section we will organize the requirements presentation according to the following sub-categories:

- OGEMA-based architectural principles
- FAME-based architectural principles
- Green Energy Positive (GPE) architectural principles
- Communication interfaces between BEAMS components
- Communication interfaces between BEAMS and external systems
- Particular pilot sites requirements
- Functional and systems constraints

A complete description of the requirements, including their rationale and acceptance criteria can be found in the Annex section.

7.2.1 OGEMA-based architectural principles

ID	ARC_005
Description	OGEMA SHOULD be able to generate artificial long term DER generation forecast from accurate weather information obtained from third parties.
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3

ID	ARC_006
Description	Communication between OGEMA and the subsystems under its control SHOULD be based in a bidirectional interface based on one uniform publicly available standard/technology.
Classification	Architectural Principles
Type	The scope of the product
Priority	5

ID	ARC_010
Description	OGEMA SHOULD be able to generate artificial short term DER generation forecasts from weather information obtained locally, seasonal and historical data.
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5

ID	ARC_041
Description	OGEMA SHOULD provide proper update/maintenance mechanisms that inform FAME of current running OGEMA Sw version.
Classification	Architectural Principles
Type	Mandated constraints
Priority	3

ID	ARC_072
Description	Communication interface between one OGEMA instance and all subsystems under its control should be based on bi-directional standardized protocols that allow data transmission as well as control commands requests/responses exchange.
Classification	Architectural Principles
Type	The scope of the product
Priority	5

ID	ARC_076
Description	OGEMA SHOULD provide proper mechanisms for core Sw update
Classification	Architectural Principles
Type	Mandated constraints
Priority	5

ID	ARC_077
Description	OGEMA SHOULD provide proper mechanisms for Sw components installation/update.
Classification	Architectural Principles
Type	Mandated constraints
Priority	1

7.2.2 FAME-based architectural principles

ID	ARC_001
Description	FAME SHOULD communicate with all OGEMA instances deployed within a facility through an Enterprise Service Bus (ESB).
Classification	Architectural Principles

Type	The scope of the product
Priority	5

ID	ARC_070
Description	FAME SHOULD support a publish-subscribe communication mechanism with all OGEMA instances in facility, allowing reception of alarms, events, etc from OGEMAs.
Classification	Architectural Principles
Type	The scope of the product
Priority	5

ID	ARC_071
Description	FAME SHOULD support a request-response data communication mechanism that allow it to request measurements data from all OGEMA instances in a facility.
Classification	Architectural Principles
Type	The scope of the product
Priority	5

7.2.3 Communication interfaces between BEAMS components

ID	ARC_002
Description	Bidirectional and standardized communication between BEAMS system and third parties (e.g., utility, ESCO, etc) SHOULD be performed through OGEMA instances of a facility.
Classification	Architectural Principles
Type	The scope of the product
Priority	1

ID	ARC_039
Description	Events and alerts (high priority data) detection and notification mechanism SHOULD be provided for the interface OGEMA-FAME.
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5

ID	ARC_062
Description	Communication to all subsystem measurements
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5

7.2.4 Communication interfaces between BEAMS and external systems

ID	ARC_009
Description	Bidirectional data exchange interfaces between BEAMS and a third-party SHOULD support existing or under development communication protocols and data models.
Classification	Architectural Principles
Type	Mandated constraints
Priority	1

ID	ARC_032
Description	FAME to OGEMA (and vice versa) communication messages shall be delivered within 5 seconds.
Classification	Architectural Principles
Type	Performance requirements
Priority	5

ID	ARC_066
Description	Some messages sent from the utility or from third parties COULD be automatically accepted without the requirement of an operator validation
Classification	Architectural Principles
Type	Usability and humanity requirements
Priority	4

ID	ARC_068
Description	The OGEMA adaptation after receiving messages from utility and third party SHOULD be delayed
Classification	Architectural Principles
Type	Operational requirements
Priority	4

ID	ARC_073
Description	OGEMA should support a bi-directional and standardized interface to third parties, allowing reception of data as well as command requests from these external actors
Classification	Architectural Principles
Type	The scope of the product
Priority	1

ID	ARC_074
Description	Third-party "high priority data" such as alarms, DR messages, etc should be sent from OGEMA to FAME before local optimizations are performed in OGEMA (facility manager authorization is required for this type of data)

Classification	Architectural Principles
Type	Functional and data requirements
Priority	5

7.2.5 Particular pilot sites requirements

ID	ARC_004
Description	In those cases where RES systems are available, it should be clear whether or not these systems can be used to provide energy to the grid.
Classification	Architectural Principles
Type	Open issues
Priority	3

ID	ARC_059
Description	FCB pilot-site main components
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3

ID	ARC_060
Description	Energy Systems at FCB Pilot Site
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3

ID	ARC_080
Description	UNISAL pilot-site main components
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3

ID	ARC_081
Description	Energy Systems at UNISAL Pilot Site
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3

7.2.6 Functional and operational system requirements

ID	ARC_007
Description	OGEMA and FAME SHOULD have a modular architecture design that assures scalability and adaptability to different deployment sites.
Classification	Architectural Principles

Type	The scope of the product
Priority	5

ID	ARC_030
Description	FAME and BEAMS components system clock shall be aligned to a clock reference
Classification	Architectural Principles
Type	Operational requirements
Priority	5

ID	ARC_034
Description	In case of BEAMS system unavailability all site energy subsystems shall not be affected (it shall be possible for the subsystems to operate independently). Subsystems MUST be self-secure.
Classification	Architectural Principles
Type	Operational requirements
Priority	5

ID	ARC_035
Description	BEAMS project should consider safety aspects
Classification	Architectural Principles
Type	Operational requirements
Priority	5

ID	ARC_036
Description	One subsystem within a facility (e.g., HVAC, lighting, etc) COULD be controlled entirely by one single instance of OGEMA.
Classification	Architectural Principles
Type	Operational requirements
Priority	5

ID	ARC_040
Description	Data privacy issues should be taken into account when designing BEAMS system (based on an analysis and verification of Use-cases sensible to privacy)
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5

ID	ARC_042
Description	BEAMS shall use open source products for implementation of the ESB

Classification	Architectural Principles
Type	Functional and data requirements
Priority	5

ID	ARC_043
Description	BEAMS Architecture shall be based on Enterprise Service Bus (ESB) approach and Enterprise Integration Patterns (EIP)
Classification	Architectural Principles
Type	Relevant facts and assumptions
Priority	5

ID	ARC_044
Description	A BEAMS protocol shall be defined and implemented using Web Services and defined with WSDL and XML Schema standards.
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5

ID	ARC_046
Description	BEAMS Architecture design
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5

ID	ARC_048
Description	System Time Step 15min
Classification	Architectural Principles
Type	Functional and data requirements
Priority	4

ID	ARC_049
Description	Max Data Resolution 1 min
Classification	Architectural Principles
Type	Functional and data requirements
Priority	4

ID	ARC_050
Description	Easy update in the database of the technical characteristics of the Field Devices
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3

ID	ARC_051
Description	The database SHOULD have advanced historical capabilities
Classification	Architectural Principles
Type	Functional and data requirements
Priority	2

ID	ARC_052
Description	Forecasting Error Estimation
Classification	Architectural Principles
Type	Functional and data requirements
Priority	2

ID	ARC_053
Description	The database SHOULD support the capability to manage scenarios
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3

ID	ARC_055
Description	The system SHOULD have an error handling mechanism
Classification	Architectural Principles
Type	Functional and data requirements
Priority	4

ID	ARC_056
Description	The system SHOULD have a deadlock/bottleneck management mechanism
Classification	Architectural Principles
Type	Functional and data requirements
Priority	4

ID	ARC_057
Description	The system SHOULD have the ability of fixing missing data in the database
Classification	Architectural Principles
Type	Functional and data requirements
Priority	4

ID	ARC_058
Description	The system should cope with summer time change
Classification	Architectural Principles

Type	Functional and data requirements
Priority	4

ID	ARC_063
Description	Public lighting
Classification	Architectural Principles
Type	Operational requirements
Priority	4

ID	ARC_064
Description	The system SHOULD allow defining calendars
Classification	Architectural Principles
Type	The scope of the work
Priority	4

ID	ARC_065
Description	The system SHOULD allow having more than one situation detected as active at the same time
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5

ID	ARC_067
Description	There SHOULD be a simulation-run mode on FAME and the OGEMA+'s
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5

ID	ARC_069
Description	The ESB should support many MEP (Message Exchange Pattern), specifically it should support at least Request-Response, Publish-Subscribe, One-Way messages
Classification	Architectural Principles
Type	The purpose of the product
Priority	3

ID	ARC_075
Description	Different parts of one subsystem COULD be controlled by several different OGEMA instances while optimizations of the whole "logical subsystem" are performed at a higher level by FAME.
Classification	Architectural Principles
Type	The scope of the product

Priority	5
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ID	ARC_078
Description	Install two different types of off-the-shelf solutions in each pilot site. On one hand they should allow monitoring "only", and on the other hand they COULD allow control and manual connection/disconnection of this control capability.
Classification	Architectural Principles
Type	Operational requirements
Priority	5

8 Requirements – Greening Energy Positive Tools (WP3)

8.1 Overview

The integration of key energy loads namely the electrical vehicle (EV) as well as renewable energy sources such as PV generation will play an important role in the overall energy efficiency management within any facility and in particular within the pilot sites of the BEAMS project.

To enable the integration of PV and EV optimization in spaces of public use will be one of the main objectives of the work package WP3, either if real infrastructure is already in place or not. The technical and economical impact model of PV and EV in the energy management of any facility should be one of the main outputs of this work package, so that the requirements defined and presented in this section will be the starting point for all activities aiming at achieving these objectives.

8.2 Requirements

The requirements listed hereafter cover the main functionalities (at a high level) that the GPE module to be developed should comply with in order to achieve the objectives of the work package WP3.

ID	GPE_001
Description	PV generation models SHOULD be used to provide power output information
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5

ID	GPE_003
Description	PV and EV models and applications to all (or some) OGEMA instances within a facility SHOULD be deployable
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5

ID	GPE_005
Description	EV charge and discharge SHOULD be modelled
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5

ID	GPE_007
Description	PV and EV optimization apps third-parties management
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Acceptance criteria	Third-party actor (e.g. ESCO) monitors and controls a PV installation within a facility

ID	GPE_008
Description	Forecasting model or information (complementary to GPE_001)
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5

ID	GPE_009
Description	Power prediction model (Complementary to GPE_001 & GPE_008)
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5

ID	GPE_010
Description	Protocol of PV System
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	4

ID	GPE_012
Description	PV-System on-top of OGEMA
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5

ID	GPE_013
Description	There SHOULD be a user interface to support EV owners to provide detailed information to the system regarding EV charge needs
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	1

ID	GPE_014
Description	EV management/optimization application in OGEMA SHOULD manage EV charging process based on following data: User requirements, available price tariff information and availability of DER resources. This application runs on top of EV BMS
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	1

ID	GPE_015
Description	OGEMA's EV optimization application SHOULD guarantee that an EV charge will be managed according to data introduced by the user when EV was plugged into the charging station (through the proper UI interface)
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	1

ID	GPE_016
Description	OGEMA EV management application SHOULD provide EV energy use schedule, updated EV storage capacity and EV demand forecast
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5

ID	GPE_017
Description	Interaction between EV user and BEAMS SHOULD be provided
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	1

ID	GPE_018
Description	EV static features SHOULD be provided
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5

ID	GPE_020
Description	EV Management SHOULD be context aware
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5

ID	GPE_021
Description	There SHOULD exist an historic database from EV arrivals and departures
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5

ID	GPE_022
Description	Charging stations SHOULD be able to receive control commands
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5

ID	GPE_023
Description	Charging stations SHOULD be able to convert to "generation" stations
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	2

ID	GPE_024
Description	Power set points calculated by the optimisation algorithm in BEAMS for the charging of EVs are NOT RESTRICTED only to on/off. A number between 0 to 1 COULD be provided
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	3

ID	GPE_025
Description	The State of Charge of EV SHOULD be provided to BEAMS when plugged. Additionally, State of Charge SHOULD be dynamically updated while plugged. It is REQUIRED that the communication protocol of charging station complies with OGEMA.
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5

9 Requirements – Interoperability Gateway (WP4)

9.1 Overview

The interoperability gateway OGEMA is one of the main components of BEAMS system. Despite OGEMA has been developed and used mainly in residential scenarios, its modular and scalable architecture can be extended to cope with the requirements of energy management in bigger and more complex scenarios such as the FCB stadium or UNISAL campus.

It is a complex task to adapt the OGEMA platform to the requirements of energy management in buildings, mainly because it will have to be integrated to current systems already deployed in a facility (e.g. a BMS system), new sources and loads should be taken into account (e.g. EV and PV systems) and finally integrating OGEMA with the facility management environment. At the same time the platform to be developed should be independent of any particular site characteristics, maximizing in this way the scalability and replicability of the solution.

9.2 Requirements

The requirements listed hereafter cover the main functionalities (at a high level) that the OGEMA+ platform should have in order to achieve the objectives of the work package WP4, and, in general, contribute to the overall BEAMS project objectives. The requirements presented cover a broad range of requirement types such as functional and non-functional requirement.

ID	OGE_002
Description	Prioritized control schedule plans generation mechanism/application already developed within OGEMA SHOULD be reviewed and adapted to the scope of BEAMS project
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	5

ID	OGE_003
Description	OGEMA instances within a facility SHOULD have the capability to interface different subsystems (e.g., HVAC, lighting, etc) and execute control actions on these subsystems
Classification	Interoperability Gateway
Type	Mandated constraints
Priority	5

ID	OGE_004
Description	OGEMA instances SHOULD be able to received energy optimization requests from a utility or third party, forward this data to FAME for facility manager authorization, and perform optimizations based on answer received from FAME

Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	4

ID	OGE_005
Description	OGEMA instances SHOULD be able to received price tariff information (e.g. day-ahead price tariff) from a utility or third party
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	4

ID	OGE_006
Description	OGEMA SHOULD support a data push mechanism that enable sending data from OGEMA to FAME
Classification	Interoperability Gateway
Type	The scope of the product
Priority	5

ID	OGE_007
Description	OGEMA SHALL be able to store data of the building which is controlling for a minimum of 30 days
Classification	Interoperability Gateway
Type	Operational requirements
Priority	3

ID	OGE_008
Description	It SHALL be possible to cleanup the OGEMA database
Classification	Interoperability Gateway
Type	Maintainability and support requirements
Priority	3

ID	OGE_009
Description	In case one or more OGEMA instances are not reachable on the network, the OGEMAs SHALL publish the data to the ESB as soon as the network is available again
Classification	Interoperability Gateway
Type	Operational requirements
Priority	4

ID	OGE_010
Description	In case one subsystem (lighting, HVAC, EV) is not available at OGEMA driver level for control, OGEMA SHALL report to FAME the fault condition and SHALL exclude from energy

	optimizations that subsystem
Classification	Interoperability Gateway
Type	Operational requirements
Priority	4

ID	OGE_011
Description	In case one subsystem (lighting, HVAC, EV) is not available at OGEMA driver level for monitoring energy consumption, OGEMA SHALL report to FAME the fault condition and SHALL exclude from total energy consumption that subsystem
Classification	Interoperability Gateway
Type	Operational requirements
Priority	4

ID	OGE_012
Description	Third party messages to OGEMA SHALL include a validity period
Classification	Interoperability Gateway
Type	Operational requirements
Priority	5

ID	OGE_013
Description	OGEMA SHOULD use all available internal and external data (e.g. power output from GPE models, FAME requirements, price tariff, weather forecast, etc) to optimize the load of systems under its control
Classification	Interoperability Gateway
Type	The scope of the product
Priority	5

ID	OGE_014
Description	OGEMA instances to be deployed in the pilot sites SHOULD run in industrial PCs
Classification	Interoperability Gateway
Type	Operational requirements
Priority	3

ID	OGE_015
Description	In case of power supply failures or any other problem, an OGEMA instance SHOULD be able to recover its normal operation and notify the problem the soonest possible to FAME
Classification	Interoperability Gateway
Type	Operational requirements
Priority	3

ID	OGE_016
Description	The system SHOULD support existing or under development communication protocols and data models for EVs
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	2

ID	OGE_017
Description	Security on OGEMA like FAM_028
Classification	Interoperability Gateway
Type	The scope of the product
Priority	4

ID	OGE_018
Description	The behaviour of the simulated resources SHOULD be based on predefined models, and COULD also take into account the historical data of other similar existing resources
Classification	Interoperability Gateway
Type	Operational requirements
Priority	1

ID	OGE_019
Description	All new Hw equipment (off-the-shelf solutions) for monitoring and control to be integrated in each pilot site SHOULD be physically tested first by IWES in Germany (to allow also proper development of OGEMA platform)
Classification	Interoperability Gateway
Type	Off-the-self solutions
Priority	5

ID	OGE_020
Description	Timestamp of sensor data WILL be set by the OGEMA gateway connected to the sensor
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	5

ID	OGE_021
Description	Operation schedules are computed according to the priorities defined for connected subsystems
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	4

ID	OGE_022
Description	Operation schedules are selected according to their priority
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	4

10 Requirements – Facility Management Environment (WP5)

10.1 Overview

FAME is the module of the BEAMS architecture which has the high level view of the entire facility and the right intelligence mechanisms to detect how a facility is behaving. In addition, it provides the right tools to control the facility. FAME will interact with all OGEMA instances within a facility (getting data from them as well as sending control commands or any other data) in order to provide the facility manager an updated view of the facility at any moment.

10.2 Requirements

The requirements defined for FAME cover at a high level the functionalities that this module should have as well as aspects related to usability, maintainability and many others. Since FAME is at the same time composed of several different subsystems, it is important to provide a high level view of the overall system but also a detailed view of what each module should do and the interaction between the modules.

ID	FAM_001
Description	FAME subsystem SHOULD support local data storage of all information gathered from the different OGEMA instances within a facility
Classification	Facility Management Environment
Type	The scope of the product
Priority	5

ID	FAM_002
Description	The EBS module of FAME SHOULD be able to present reports of energy consumption (and production) within a facility through the corresponding user interface
Classification	Facility Management Environment
Type	Look and feel requirements
Priority	5

ID	FAM_004
Description	Situation/contexts used to generate specific control schedule plans in OGEMA COULD be introduced by a facility manager through the corresponding FAME UI module
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5

ID	FAM_005
Description	FAME SHOULD allow the definition, simulation and assessment of existing or new situation/context, subsystems, etc through a corresponding UI

Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5
ID	FAM_006
Description	FAME SHOULD provide manual (individual) remote control of different subsystems within a facility.
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5

ID	FAM_007
Description	FAME subsystem SHOULD provide real-time feedback about the current state of an entire facility through a well designed and user friendly UI
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5

ID	FAM_008
Description	FAME MUST store in a local data base situation/contexts either defined by a facility manager or learned/detected by SCALC algorithms.
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5

ID	FAM_009
Description	FAME components SHOULD be designed to be modular in order to enable integration of future new applications and customization to new deployments sites
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5

ID	FAM_011
Description	It SHOULD be clearly specified the data models and interfaces between the different components of FAME
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5

ID	FAM_012
Description	Use of simulation scripts in those cases where real data coming from external third-parties is not possible
Classification	Facility Management Environment

Type	Functional and data requirements
Priority	5

ID	FAM_013
Description	FAME SHALL be able to store energy consumption data of the entire site for a minimum of 12 months
Classification	FAcility Management Environment
Type	Operational requirements
Priority	3

ID	FAM_014
Description	It SHALL be possible to make a backup&restore of FAME data
Classification	FAcility Management Environment
Type	Maintainability and support requirements
Priority	3

ID	FAM_015
Description	It SHALL be possible to cleanup the FAME database
Classification	FAcility Management Environment
Type	Maintainability and support requirements
Priority	3

ID	FAM_016
Description	In case one or more OGEMA instances are not reachable on the network, the FAME SHALL be able to work without some data and indicate that calculation and report are incomplete
Classification	FAcility Management Environment
Type	Operational requirements
Priority	4

ID	FAM_017
Description	FAME SHALL be able to elaborate real time incomplete consumption data and generate incomplete reports
Classification	FAcility Management Environment
Type	Operational requirements
Priority	4

ID	FAM_018
Description	Context conditions introduced by FAME SHALL have a validity period for their execution. If that period is elapsed then the command SHALL be ignored by OGEMA
Classification	FAcility Management Environment
Type	Operational requirements

Priority	5
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ID	FAM_019
Description	OGEMA: operation schedules are computed according to the priorities defined for connected subsystems
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	4

ID	FAM_020
Description	OGEMA: operation schedules are selected according to their priority
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	4

ID	FAM_021
Description	FAME SCALC module SHOULD have two components: one OGEMA-based SCALC application and one module running in FAME system
Classification	Facility Management Environment
Type	The scope of the product
Priority	5

ID	FAM_022
Description	FAME SHOULD provide a data management layer or component that allow all FAME modules to store data in the local database
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5

ID	FAM_023
Description	FAME-DAS module SHOULD provide a BEAMS user-friendly interface
Classification	Facility Management Environment
Type	The scope of the product
Priority	5

ID	FAM_024
Description	FAME-DAS module SHOULD be able to obtain data from all OGEMA instances in a facility as well as managing the storage of this information in the FAME data base (through the proper data access layer)
Classification	Facility Management Environment

Type	The scope of the product
Priority	5

ID	FAM_025
Description	FAME-DAS module SHOULD enable simulation of situation/contexts defined by the user
Classification	FAcility Management Environment
Type	The scope of the product
Priority	5

ID	FAM_027
Description	FAME SHOULD provide the proper mechanisms to allow the upgrade/maintenance of OGEMA instances in a remote way
Classification	FAcility Management Environment
Type	Functional and data requirements
Priority	3

ID	FAM_028
Description	FAME security management interface SHOULD be available for facility manager
Classification	FAcility Management Environment
Type	The scope of the product
Priority	5

ID	FAM_029
Description	BEAMS user interface provided by FAME SHOULD support different languages
Classification	FAcility Management Environment
Type	Usability and humanity requirements
Priority	3

ID	FAM_030
Description	The Load Forecast SHOULD handle special days
Classification	FAcility Management Environment
Type	Functional and data requirements
Priority	3

ID	FAM_031
Description	FAME SHOULD run over windows
Classification	FAcility Management Environment
Type	Mandated constraints
Priority	5

ID	FAM_032
Description	FAME should offer a web GUI
Classification	FAcility Management Environment
Type	The scope of the product
Priority	4

ID	FAM_033
Description	FAME MUST make use of the resources modelled at OGEMA
Classification	FAcility Management Environment
Type	Functional and data requirements
Priority	4

ID	FAM_034
Description	Any user interface SHOULD support multilingual
Classification	FAcility Management Environment
Type	Cultural and political requirements
Priority	4

ID	FAM_035
Description	FAME SHOULD store the information coming from the OGEMA instances
Classification	FAcility Management Environment
Type	Performance requirements
Priority	4

ID	FAM_036
Description	FAME-DAS SHOULD provide a user interface offering maps visualization
Classification	FAcility Management Environment
Type	Look and feel requirements
Priority	3

ID	FAM_037
Description	FAME SHOULD integrate the management of the maintenance
Classification	FAcility Management Environment
Type	Operational requirements
Priority	2

ID	FAM_038
Description	FAME-DAS SHOULD enable the graphical interaction and edition of data
Classification	FAcility Management Environment
Type	Usability and humanity requirements

Priority	3
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ID	FAM_039
Description	FAME-DAS SHOULD enable the graphical interaction and edition of data
Classification	Facility Management Environment
Type	The scope of the work
Priority	3

ID	FAM_040
Description	FAME SHOULD provide information for different users
Classification	Facility Management Environment
Type	Security requirements
Priority	1

ID	FAM_041
Description	FAME SHOULD enable the treatment of alarms
Classification	Facility Management Environment
Type	Operational requirements
Priority	1

ID	FAM_042
Description	FAME subsystem SHOULD be able to obtain the version of all the OGEMA components
Classification	Facility Management Environment
Type	Maintainability and support requirements
Priority	2

ID	FAM_043
Description	EV charging status SHOULD be monitored as part of the FAME user interface
Classification	Facility Management Environment
Type	Usability and humanity requirements
Priority	2

11 Pilot sites definition

As part of the scenarios, use-cases and requirement definition phases within work package WP1, several visits were organized to each of the pilot sites of the project. In these visits all partners got a clearer vision of each facility as well as the main subsystems that might be integrated within the project.

The following sections present a first definition of each of the test sites. However, there are still ongoing tasks where each pilot site and in particular all subsystems within each pilot site are analyzed, so that definition of all subsystems to be integrated within BEAMS project will be provided. This information will be included in an annex document.

11.1 Football Club Barcelona Stadium

The guided visits to the facilities of the FCB stadium have enabled the progress in the definition of the main systems to be integrated within BEAMS project.

In particular, an analysis of the IT and electrical infrastructure was performed, as well as the analysis of the possible equipments to be installed within the FCB facilities. The following figure shows:

- Green boxes: Optical fibre concentrator
- Blue/red boxes: Banks of transformers rooms (possible where OGEMA instances will be installed)
- Pink boxes: Backup electricity generators
- Green lines: Optical fibre links

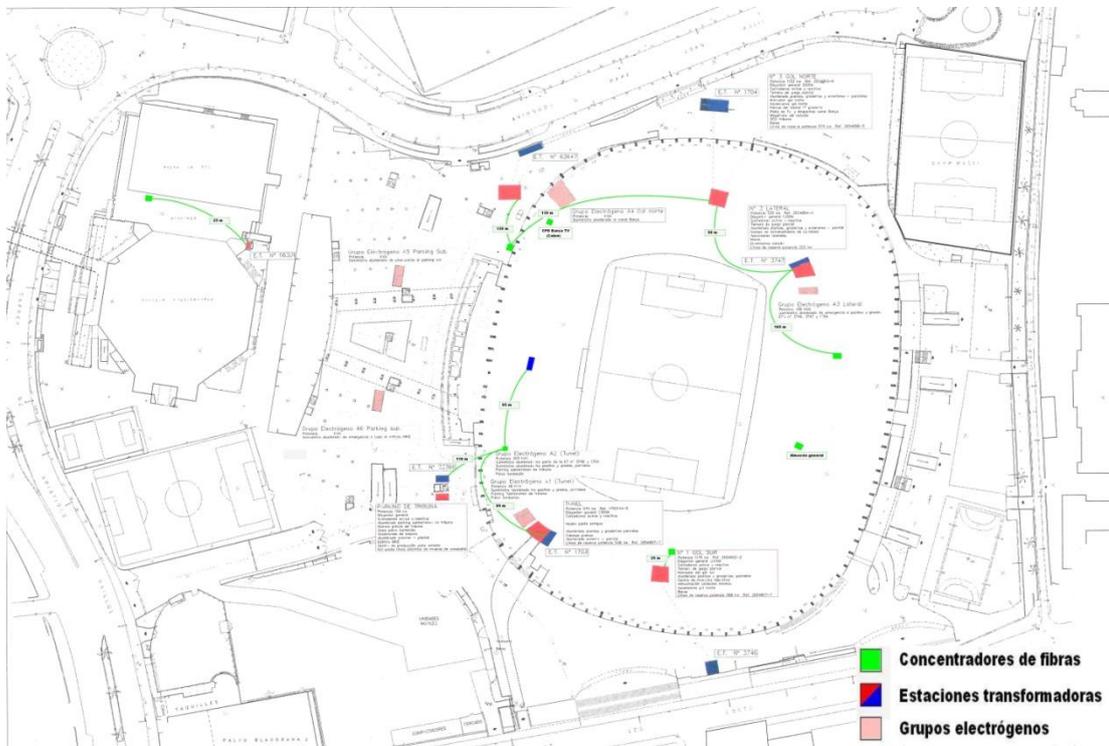


Figure 19: FCB stadium IT and electrical infrastructure

On the FCB stadium facilities it will be required the installation of additional hardware components that allow not only monitoring but also controlling different subsystems within the facility. Despite is not yet defined the complete list of equipment to be installed, the following Figure illustrates a possible architecture and commercial equipments that could be installed in these facilities:



Figure 20: draft architecture and commercial equipments to be installed in FCB stadium facilities

The communication infrastructure to be used between the different OGEMA instances distributed across the facility and FAME as shown previously, should take profit as much as possible of the current infrastructure of the facility. For those cases this is not possible, or new communication infrastructure should be deployed, this should be based on wired technologies (e.g., Ethernet, etc).

11.2 University of Salento (UNISAL) Campus

The demonstrations activities within the scope of BEAMS project will be performed in the engineering school compound of the campus. Four main buildings and areas will be considered:

- Building “La Stecca”
- Building “Corpo Y”
- Building “Corpo O”
- Parking lots and outdoor areas within previous buildings

The following Figure shows where these buildings are located:



Figure 21: Campus of the University of Salento (Lecce, Italy) – The Engineering School compound considered

Within each of these buildings several subsystems have been identified as potential systems to be integrated within BEAMS project. Several considerations have been defined after visiting these facilities. The conclusions are listed below:

Optimization of lighting systems

The optimization of the lighting system can be done taking in consideration the following factors:

- **Use of the rooms:**
 - TIME PROGRAMMING in the areas where the presence of people can be certainly predicted during specific time periods (e.g. classrooms, study halls) or in areas in which a certain short-term activity is scheduled (e.g. meetings or seminars).
 - PRESENCE SENSORS with timer functions installed in the restrooms.
 - INFRARED SENSORS with programmed working installed in stairwells and corridors. They will operate after a certain time (e.g. after 7 pm), according to the number of persons in transit, external light and the counting admissions system.
 - POSSIBILITY OF MANUAL CONTROL.
- **External sunshine considerations:**
 - TIME PROGRAMMING according to the intensity of external light.
 - ADJUSTMENT THROUGH PHOTOCELL replacing the time programming (as a result of cost comparison).
 - POSSIBILITY OF MANUAL CONTROL.
 - SHUTTERS CONTROL automatically or manually.
- **Building “CORPO O”**
 - Classrooms - Forecast of human presence (high priority):
 - The system will be monthly updated according to the scheduled activity (classrooms, examinations, seminars).

- The system planning in each time slot contemplates:
 - Automatic lighting switching on according to the external darkness (differently for winter and summer).
 - Automatic lighting switching on when the photocells detect uncomfortable light intensity.
 - Manual lighting switching on for a not-programmed activity.
- Laboratories and offices - Forecast of human presence (medium priority)
 - Since the presence of staff is not regular during the day, the lighting system cannot be programmed. For this reason, a system able to certify the presence of people should be adequately designed. For example, an access control system at the building entrance will associate the lab/office to each identity and control the automatic lighting. In particular, the system will automatically switch the light on, depending on the time, or activate the photocells. However, the cost/benefit of the automatic lighting, previously described, should be compared with this of the manual one.
- Laboratories and offices - Meeting rooms (Forecast of human presence (medium priority))
 - The lighting system could be automatically programmed for the planned activities or manually for not-scheduled ones.
- Restrooms - Forecast of human presence (low priority)
 - In these areas, a sensor will detect the human presence and turn on the lighting system.
- Corridors and stairwells - Forecast of human presence (low priority): Since these are transit areas, also for security reasons, it is necessary to ensure a constant illumination.
 - If these areas are sufficiently lit by the natural light during a part of the day, the infrared system will operate from a certain time;
 - Otherwise, if the natural light is not sufficient, the infrared system will work during all day long.
- Machinery spaces - Forecast of human presence (unknown priority)
 - Manual switching on the system

Optimization of HVAC systems

Adjust the system according to:

- Level of human presence
- Level of exposure to external factors (e.g. sunshine, wind)
- Indoor air quality
- Release air from the outside at night
- Level of indoor moisture
- Shutters control

- **Building “Corpo O”**
 - Classrooms - Forecast of human presence (high priority):
 - The system will be monthly updated according to the scheduled activity (classrooms, examinations, seminars).
 - The planning in each time slots contemplates:
 - Automatic switching on/off of the HVAC system
 - Additional function of the climate control according to the number of people
 - Manual switching on/off for a not-programmed activity
 - Laboratories and offices - Forecast of human presence (medium priority)
 - The presence of staff is not regular during the day; therefore the HVAC system cannot be programmed.
 - The access control system will certify the human presence in these spaces.
 - One possibility is to automate the climate system according to the working habits of the staff, in order to guarantee comfortable living conditions during the early hours of the day and then adapt its performance to the number of access actually recorded
 - Manual switching on/off for a not-programmed activity.
 - Laboratories and offices - Meeting rooms - Forecast of human presence (medium priority)
 - A comparison between the cost of a manual and automatic turning on/off of the system should be necessary.
 - Restrooms - Forecast of human presence (low priority)
 - For these areas the switching on/off of the HVAC system will be estimated in function of the occupancy.
 - Corridors and stairwells - Forecast of human presence (low priority):
 - For these areas the switching on/off of the HVAC system will be estimated in function of the number of presences.
 - Machinery spaces:
 - Forecast of human presence (unknown)

Electrical vehicle integration

After visiting the facilities some progress was done regarding the installation of the infrastructure required for the EV management within the campus. The following Figure shows the charging station already installed in the campus as well as an example of the vehicle that will be using it.



Figure 22: EV installation in UNISAL campus, in Lecce, Italy

12 Project quality and test plan

Taking into consideration all previous sections, a test plan will be proposed in order to assure the quality of any software component developed within the scope of the project.

The test plan can be considered as a component of the overall project quality plan, and its main objective is to provide the overall quality framework for the whole system development lifecycle, together with the operational guidelines for the testing activities.

12.1 BEAMS system development quality assurance

12.1.1 Development lifecycle

Within the scope of the project quality plan, it has been defined an iterative approach for the development of the whole BEAMS system. Two check points have been defined where cross-tests of the different project components will be assessed. The first one will take place by the end of the first year, where the first results of work packages WP2 and WP3 will be checked and if necessary revised. To that end, these work packages will deliver two well defined versions of their results.

In the first checkpoint, the preliminary models and architecture prototypes will be designed and used by WP4 and WP5 to start building in parallel a first version of the gateway and FAME. In a second step, the validation of the interfaces and data models in WP4 and WP5 will produce valuable feedback that will be treated in the previous WPs in order to introduce corrective actions and refine the prototypes producing the second and final version of the reference architecture and Greening Energy Positive Tools.

The second checkpoint will be in the middle of WP4 and WP5, where the results of both WPs will start to be deployed at the test sites. This will enable two different test campaigns involving different season condition. Furthermore, the feedback gathered during the first campaign will be introduced in the development of the second and final version of the gateway and FAME, which will also count with the second version of the results in WP2 and WP3.

The following section presents the methodology proposed for the development as well as the verification, validation and testing of the whole system at each of the checkpoints of the project.

12.1.2 Verification and validation methodology

In order to assure the quality of the results obtained at each of the checkpoints established within the project, in this section we present the methodology proposed to be followed for all development as well as the verification, validation and testing activities. In order to assure the quality of all development work packages (and in general of the whole project), we propose to follow a V-model approach.

The V-Model demonstrates the relationships between each phase of the development life cycle and its associated phase of testing. The following figure illustrates at a high level the development, validation and verification phases according to this model.

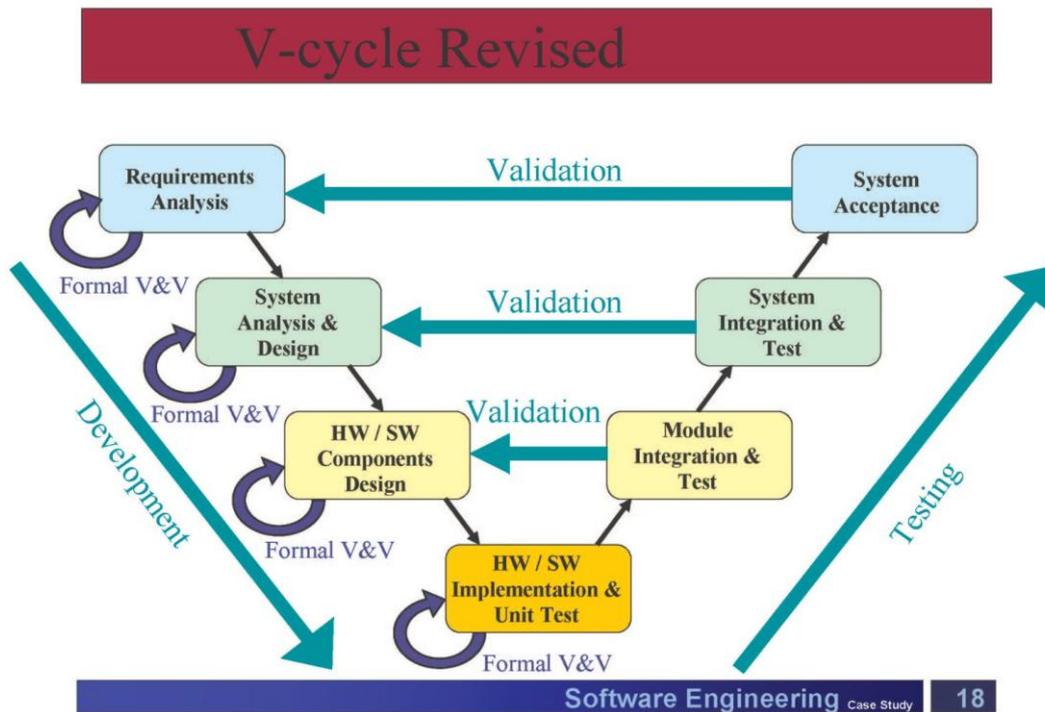


Figure 23: Proposed development and testing methodology to be followed in BEAMS

The use of this approach could be the base for the evaluation activities to be carried out within each work package as well as at each checkpoint of the project. This means that the whole V-model cycle is followed within each checkpoint period, and finally within WP7 in order to assure the quality of the project and assess the impact of the results obtained.

The V-model presented is mapped to the main work packages and activities within BEAMS project as follows:

- **Requirements analysis:** This stage of the V-model can be mapped to the main activities performed within the scope of the WP1. As a results of this work package is produced a document with the high level requirements that will be used for the development of the whole BEAMS. At validation stage, at the end of the project, these requirements will be used to validate that the whole system developed complies with the initial goals of the project.
- **System analysis and design:** This stage of the V-model can be mapped to the activities developed within WP2, where it will be defined the BEAMS system architecture. This will add one level of detail to the requirements defined in WP1, and settle the basis for the development of specific components of the whole BEAMS systems, as well as the interaction between these components.
- **Hw/Sw components design:** This stage of the V-model can be mapped to the activities performed in work packages WP3 (Green Energy Positive Tools), WP4 (Interoperability Gateway) and WP5 (Facility Management Environment). Considering the results of WP1 and WP2, each partner responsible for the development of BEAMS components will perform a HW or Sw design phase that produce the proper documentation required implementation or development team. Some examples of the results for this

stage can be Software Requirement Specification (SRS) and Software Design Descriptions (SDD) documents that clearly specify how each Hw or Sw component should be implemented. These documents will be used later in the validation phase to assure the quality of the components developed.

- **Hw/Sw implementation and unit test:** This stage of the V-model can be mapped to the activities performed in work packages WP3 (Green Energy Positive Tools), WP4 (Interoperability Gateway) and WP5 (Facility Management Environment). Once proper design of each component is performed
- **Testing:** Testing and validation of the whole system is divided in small steps that validate the results obtained for each of the stages described above. The main steps are:
 - Once a Hw/Sw component is developed (besides formal verification and validation activities (V&V) are performed during component development), at the testing stage a complete module is validated against formal requirements specifications and design documents. An example of this stage could be the testing and validation of the Green Energy Positive tools developed as modules or applications within OGEMA.
 - Once components or modules are validated, the next step is the system integration and validation. An example of this stage could be the testing and validation of OGEMA or FAME.
 - System acceptance is the last step of the testing stage and it implies the validation of the whole system once successfully deployed in each pilot site. The validation of the whole BEAMS system will be performed against the requirements document produced as a result of the work package WP1.

12.2 Documentation quality assurance

Besides describing at high level the methodology to be followed in order to assure the quality of the project results, it is also important to take into account quality issues when documenting the result of any design or development activity (and in particular software development activities).

Once the project requirements are gathered, the next step will be the design of all components of BEAMS system. Due to most development activities within BEAMS are related to software development, the specification and documentation of any software component should be done following well known standards such as UML.

The particular details regarding how each component or system design and documentation should be made are left for each work package leader. In any case, before any development activity start a common language should be agreed, and, in this case, due to the main activities of the project will involve software development, UML language is a good candidate.

13 References and Acronyms

13.1 References

1. **EC.** EC Research. [Online] [Cited: 30 11 2010.] <http://ec.europa.eu/research/index.cfm?lg=en&pg=newsalert&year=2009&na=ppp-310309>.
2. **BEAMS Consortium.** *D8.1 Dissemination Master Plan*. Valencia, Spain : s.n., 2011.
3. **EC.** *Annex II General Conditions*. Brussels : v5, 2009.

13.2 Acronyms

Acronyms List	
ADR	Automated Demand Response
BMS	Battery Management System
BMS	Building Management System
BSC	Balance Score Card
CP	Consortium Plenary
DAS	Decision Support and Simulation System
DER	Distributed Energy Resources
DM	Dissemination Manager
DoW	Description of Work
DR	Demand Response
DSO	Distribution System Operator
EBS	Efficiency Balance Scorecard
EM	Exploitation Manager
ESB	Enterprise Service Bus
ESCO	Energy Service Company
EV	Electrical Vehicles
FAME	FACility Management Environment
HVAC	Heating, Ventilating, and Air Conditioning
IPR	Intellectual Property Rights
IVV	
M&C	Monitoring and Control
OGEMA	Open Gateway Energy Management Alliance
PC	Project Coordinator
PHEV	Plug-in Hybrid Electrical Vehicles
PPP	Public-Private Partnership
PPR	Project Periodic Report
PSC	Project Steering Committee

QM	Quality Management
QoS	Quality of Service
QR	Quarterly Report
RES	Renewable Sources
RM	Risk Management
SCALC	Smart Control Algorithm with Learning Capabilities
SLA	Service Level Agreements
SVN	Subversion
TM	Technological Manager
TSO	Transmission System Operator
UI	User Interface
UNISAL	University of Salento
WL	Work package Leaders
WP	Work package

14 Annex A – Requirements description

14.1 Requirements – Architectural Principles (WP2)

14.1.1 OGEMA-based architectural principles

ID	ARC_005
Description	OGEMA SHOULD be able to generate artificial long term DER generation forecast from accurate weather information obtained from third parties.
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3
Rationale	Weather information/forecast is required by an OGEMA in order to perform energy optimizations. If accurate long term weather information is available, then OGEMA will be able to generate DER generation forecasts used by other applications (within OGEMA)).
Acceptance criteria	OGEMA forecast applications are able to generate artificial long term forecast from data obtained from third parties.

ID	ARC_006
Description	Communication between OGEMA and the subsystems under its control SHOULD be based in a bidirectional interface based on one uniform publicly available standard/technology.
Classification	Architectural Principles
Type	The scope of the product
Priority	5
Rationale	In order to avoid the implementation of multiple communication drivers in OGEMA, the communication with different subsystems should be based on one unique technology. Gateway devices might be required between current systems in the pilot sites and OGEMA.
Acceptance criteria	OGEMA-subsystems bidirectional communication based on standards and OGEMA communication drivers fully developed and deployed.

ID	ARC_010
Description	OGEMA SHOULD be able to generate artificial short term DER generation forecasts from weather information obtained locally, seasonal and historical data.
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5
Rationale	Local weather information can be obtained by means of different sensors across a facility. This data together with additional data can be used to generate short term DER generation forecasts used by the different optimization applications in OGEMA.
Acceptance criteria	OGEMA is able to generate artificial short term DER

	generation forecasts from local weather data.
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ID	ARC_041
Description	OGEMA SHOULD provide proper update/maintenance mechanisms that inform FAME of current running OGEMA Sw version.
Classification	Architectural Principles
Type	Mandated constraints
Priority	3
Rationale	OGEMA should provide Sw maintenance mechanisms (e.g. for Sw updates, installation of new components, etc). Within BEAMS we should rely on current OGEMA mechanisms. Additionally, OGEMA should be able to send current Sw version to FAME.
Acceptance criteria	OGEMA support transmission of SW version to FAME for example as a functionality included in current update/maintenance mechanisms of OGEMA.

ID	ARC_072
Description	Communication interface between one OGEMA instance and all subsystems under its control should be based on bi-directional standardized protocols that allow data transmission as well as control commands requests/responses exchange.
Classification	Architectural Principles
Type	The scope of the product
Priority	5
Rationale	Despite different subsystems connected to an OGEMA might support different communication technologies, in general these technologies should support the data transmission from the subsystems to OGEMA and also the transmission of control requests in the opposite way
Acceptance criteria	Data communication interface between OGEMA and a subsystem under its control based on a standard technology that allow data exchange (from the subsystem to OGEMA) as well as control requests/response (from OGEMA to the subsystem)

ID	ARC_076
Description	OGEMA SHOULD provide proper mechanisms for core Sw update
Classification	Architectural Principles
Type	Mandated constraints
Priority	5
Rationale	It might be necessary to update the core Sw components of OGEMA, so that within BEAMS we should rely on current mechanisms offered by OGEMA.
Acceptance criteria	OGEMA core Sw components can be updated (by means of current OGEMA mechanisms)

ID	ARC_077
Description	OGEMA SHOULD provide proper mechanisms for Sw components installation/update.
Classification	Architectural Principles
Type	Mandated constraints
Priority	1
Rationale	Application modules, device resources, communication drivers, etc are some of the Sw components that might be required to be installed or updated in an OGEMA platform. There should be mechanisms to allow this, e.g., locally in OGEMA.
Acceptance criteria	Sw components or modules in OGEMA can be installed or update once the system is deployed.

14.1.2 FAME-based architectural principles

ID	ARC_001
Description	FAME SHOULD communicate with all OGEMA instances deployed within a facility through an Enterprise Service Bus (ESB).
Classification	Architectural Principles
Type	The scope of the product
Priority	5
Rationale	Since several different OGEMA instances could be deployed within a facility, communication between these instances and FAME should be performed through an ESB
Acceptance criteria	All data exchange between OGEMA instances and FAME subsystem should be performed through an ESB.

ID	ARC_070
Description	FAME SHOULD support a publish-subscribe communication mechanism with all OGEMA instances in facility, allowing reception of alarms, events, etc from OGEMAs.
Classification	Architectural Principles
Type	The scope of the product
Priority	5
Rationale	Alarms or un-expected events should be sent from OGEMA to FAME as they appear. It is for this reason that a publish-subscribe mechanism should be in place, allowing OGEMA to publish alarms, events, etc and FAME receiving them as they happen.
Acceptance criteria	FAME support a publish-subscribe mechanism that allows it received data as it is published by OGEMA instances.

ID	ARC_071
Description	FAME SHOULD support a request-response data communication mechanism that allow it to request measurements data from all OGEMA instances in a facility.

Classification	Architectural Principles
Type	The scope of the product
Priority	5
Rationale	In order to obtain updated data (e.g. energy consumption measurements) from all OGEMA instances, FAME should be able to perform requests to all OGEMA. Once received a request, OGEMA instances can response with all information data requested by FAME
Acceptance criteria	FAME can send requests to OGEMA instances and these can response back with all data requested by FAME.

14.1.3 Communication interfaces between BEAMS components

ID	ARC_002
Description	Bidirectional and standardized communication between BEAMS system and third parties (e.g., utility, ESCO, etc) SHOULD be performed through OGEMA instances of a facility.
Classification	Architectural Principles
Type	The scope of the product
Priority	1
Rationale	A bidirectional communication channel between the systems deployed within a facility and third parties SHOULD be available. OGEMA gateway is the module responsible for this interaction.
Acceptance criteria	A bidirectional communication is possible (and is performed in a standard way) between third parties and OGEMA instances within a facility.

ID	ARC_039
Description	Events and alerts (high priority data) detection and notification mechanism SHOULD be provided for the interface OGEMA-FAME.
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5
Rationale	There should be a kind of "push" mechanism that allows OGEMA to send data to FAME when needed, e.g., in the case of important events or alarms detected.
Acceptance criteria	Data push mechanism in OGEMA (push of data from OGEMA to FAME)

ID	ARC_062
Description	Communication to all subsystem measurements
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5
Rationale	
Acceptance criteria	The subsystem measurement data is transmitted using a well

	defined communication protocol.
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14.1.4 Communication interfaces between BEAMS and external systems

ID	ARC_009
Description	Bidirectional data exchange interfaces between BEAMS and a third-party SHOULD support existing or under development communication protocols and data models.
Classification	Architectural Principles
Type	Mandated constraints
Priority	1
Rationale	External interfaces between BEAMS (through OGEMA) an external systems should be based on international standards. This might imply the possibility to use CIM (IEC 61970) for data modelling
Acceptance criteria	External interfaces with certain third-party systems are based on standards

ID	ARC_032
Description	FAME to OGEMA (and vice versa) communication messages shall be delivered within 5 seconds.
Classification	Architectural Principles
Type	Performance requirements
Priority	5
Rationale	5 seconds is a large time, meaning that no particular performance requirements is needed in this project
Acceptance criteria	IVV

ID	ARC_066
Description	Some messages sent from the utility or from third parties COULD be automatically accepted without the requirement of an operator validation
Classification	Architectural Principles
Type	Usability and humanity requirements
Priority	4
Rationale	The third party and utility messages should be inserted and modelled as situations that can be detected by the SCALC. The AUTOMATIC acceptance of such messages could be one of the actions triggered from the situation detected.
Acceptance criteria	

ID	ARC_068
Description	The OGEMA adaptation after receiving messages from utility and third party SHOULD be delayed
Classification	Architectural Principles
Type	Operational requirements

Priority	4
Rationale	OGEMA should wait and answer from FAME after utility and third party messages, but can also work in autonomous way if required.
Acceptance criteria	

ID	ARC_073
Description	OGEMA should support a bi-directional and standardized interface to third parties, allowing reception of data as well as command requests from these external actors
Classification	Architectural Principles
Type	The scope of the product
Priority	1
Rationale	OGEMA should support reception of data from a third party actor (e.g. price tariff from utility, weather data, etc) as well command requests that affect BEAMS systems (e.g. DR request from utility).
Acceptance criteria	OGEMA support a bi-directional and standardized interface to third parties that can send data, commands, etc to OGEMA.

ID	ARC_074
Description	Third-party "high priority data" such as alarms, DR messages, etc should be sent from OGEMA to FAME before local optimizations are performed in OGEMA (facility manager authorization is required for this type of data)
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5
Rationale	For certain high priority data received from third parties (particularly requests that can affect overall facility operation), the facility manager should notify before any optimization is performed locally in OGEMA.
Acceptance criteria	High priority data such as alarms, DR messages, etc are forwarded from OGEMA to FAME for facility manager authorization

14.1.5 Particular pilot sites requirements

ID	ARC_004
Description	In those cases where RES systems are available, it should be clear whether or not these systems can be used to provide energy to the grid.
Classification	Architectural Principles
Type	Open issues
Priority	3
Rationale	Energy market active participation of a facility might be regulated in a different way in different countries. These aspects should be taken into account when defining use-cases and requirements that might influence BEAMS system development.

Acceptance criteria	
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ID	ARC_059
Description	FCB pilot-site main components
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3
Rationale	FCB pilot-site main components should be clearly defined in order to maximised energy efficiency impact of BEAMS system
Acceptance criteria	Pilot-site main components clearly defined

ID	ARC_060
Description	Energy Systems at FCB Pilot Site
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3
Rationale	Energy Systems at FCB pilot site should be clearly defined in order to maximised energy efficiency impact of BEAMS system
Acceptance criteria	Pilot-site main components clearly defined

ID	ARC_080
Description	UNISAL pilot-site main components
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3
Rationale	UNISAL pilot-site main components should be clearly defined in order to maximised energy efficiency impact of BEAMS system
Acceptance criteria	Pilot-site main components clearly defined

ID	ARC_081
Description	Energy Systems at UNISAL Pilot Site
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3
Rationale	Energy Systems at UNISAL pilot site should be clearly defined in order to maximised energy efficiency impact of BEAMS system
Acceptance criteria	Pilot-site main components clearly defined

14.1.6 Functional and operational system requirements

ID	ARC_007
Description	OGEMA and FAME SHOULD have a modular architecture design that assures scalability and adaptability to different deployment sites.
Classification	Architectural Principles
Type	The scope of the product
Priority	5
Rationale	Due to the different nature of pilot sites of BEAMS project, and in general of spaces of public use, any energy management system should be easily scalable and portable so it can be deployed or adapted with minimum effort to new sites.
Acceptance criteria	Modular design and clearly defined standard-based interfaces for all components of BEAMS system (OGEMA+, FAME) are required.

ID	ARC_030
Description	FAME and BEAMS components system clock shall be aligned to a clock reference
Classification	Architectural Principles
Type	Operational requirements
Priority	5
Rationale	alignment of clock is very important in a distributed system
Acceptance criteria	IVV

ID	ARC_034
Description	In case of BEAMS system unavailability all site energy subsystems shall not be affected (it shall be possible for the subsystems to operate independently). Subsystems MUST be self-secure.
Classification	Architectural Principles
Type	Operational requirements
Priority	5
Rationale	This is for security reasons, all the subsystems should be not affected by BEAMS failures or wrong behaviour
Acceptance criteria	IVV

ID	ARC_035
Description	BEAMS project should consider safety aspects
Classification	Architectural Principles
Type	Operational requirements
Priority	5
Rationale	To be defined - it is important to define a minimum safety in the system
Acceptance criteria	To be defined

ID	ARC_036
Description	One subsystem within a facility (e.g., HVAC, lighting, etc) COULD be controlled entirely by one single instance of OGEMA.
Classification	Architectural Principles
Type	Operational requirements
Priority	5
Rationale	One single subsystem within a facility could be controlled entirely by one single Instance of OGEMA if subsystem complexities/size and pilot site characteristics allows it.
Acceptance criteria	A subsystem within a facility is fully controlled and optimized by one single OGEMA instance.

ID	ARC_040
Description	Data privacy issues should be taken into account when designing BEAMS system (based on an analysis and verification of Use-cases sensible to privacy)
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5
Rationale	Data privacy regulations might differ from country to country. Data privacy mechanisms should be in place to allow facility managers to configure the kind of data accessed by any actor, either within the system or any external party.
Acceptance criteria	Availability of data privacy mechanisms within BEAMS system that allow certain data access to particular actors based on authorization privileges.

ID	ARC_042
Description	BEAMS shall use open source products for implementation of the ESB
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5
Rationale	The use of OS ensures all partners involved in the Project will have access to the product doc and have capability to implement it. ESB product to be used for the demo shall be chosen by the partner implementing it.
Acceptance criteria	Technical design for the ESB.

ID	ARC_043
Description	BEAMS Architecture shall be based on Enterprise Service Bus (ESB) approach and Enterprise Integration Patterns (EIP)
Classification	Architectural Principles
Type	Relevant facts and assumptions
Priority	5
Rationale	Using an ESB is the best approach to use when more than 2 systems need to be connected or when the number of systems to be connected could change or is unknown.

	Applying EIPs ensures to follow mature integration approaches already validated and tested.
Acceptance criteria	Delivery of BEAMS Architecture Design documentation

ID	ARC_044
Description	A BEAMS Protocol shall be defined and implemented using Web Services and defined with WSDL and XML Schema standards.
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5
Rationale	Web Services today are the most agile technology to develop application protocols as XML validation and code generation tools reduce the development time and the impact of delivering new protocol releases. Web Services have also wide support
Acceptance criteria	Delivery of XML Schemas and WSDL Files for BEAMS Protocol.

ID	ARC_046
Description	BEAMS Architecture design
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5
Rationale	It is appropriate to follow an Architecture modelling Framework process like the TOGAF. Even if adopting the full TOGAF or others may not be appropriate for BEAMS project, this requirement is intended to put minimal pragmatically constraints, inspired on AF
Acceptance criteria	Roadmap and project Deliverables.

ID	ARC_048
Description	System Time Step 15min
Classification	Architectural Principles
Type	Functional and data requirements
Priority	4
Rationale	
Acceptance criteria	

ID	ARC_049
Description	Max Data Resolution 1 min
Classification	Architectural Principles
Type	Functional and data requirements
Priority	4
Rationale	
Acceptance criteria	

ID	ARC_050
Description	Easy update in the database of the technical characteristics of the Field Devices
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3
Rationale	
Acceptance criteria	

ID	ARC_051
Description	The database should have advanced historical capabilities
Classification	Architectural Principles
Type	Functional and data requirements
Priority	2
Rationale	
Acceptance criteria	

ID	ARC_052
Description	Forecasting Error Estimation
Classification	Architectural Principles
Type	Functional and data requirements
Priority	2
Rationale	
Acceptance criteria	

ID	ARC_053
Description	The database should support the capability to manage scenarios
Classification	Architectural Principles
Type	Functional and data requirements
Priority	3
Rationale	
Acceptance criteria	

ID	ARC_055
Description	The system should have an error handling mechanism
Classification	Architectural Principles
Type	Functional and data requirements
Priority	4
Rationale	
Acceptance criteria	Each module next to the output values should provide a flag describing the quality of the results (e.g. 1 Good, -1 Unreliable etc)

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ID	ARC_056
Description	The system should have a deadlock/bottleneck management mechanism
Classification	Architectural Principles
Type	Functional and data requirements
Priority	4
Rationale	
Acceptance criteria	It is suggested to install a watchdog mechanism.

ID	ARC_057
Description	The system should have the ability of fixing missing data in the database
Classification	Architectural Principles
Type	Functional and data requirements
Priority	4
Rationale	
Acceptance criteria	

ID	ARC_058
Description	The system should cope with summer time change
Classification	Architectural Principles
Type	Functional and data requirements
Priority	4
Rationale	
Acceptance criteria	

ID	ARC_063
Description	Public lighting
Classification	Architectural Principles
Type	Operational requirements
Priority	4
Rationale	Operation of public lighting on OGEMA instances needs to be designed according to technical parameters at each pilot site.
Acceptance criteria	

ID	ARC_064
Description	The system SHOULD allow defining calendars
Classification	Architectural Principles
Type	The scope of the work
Priority	4
Rationale	FAME and OGEMA+ instances will require having a list of festivities to properly manage and create operational

	schedules
Acceptance criteria	The system can be configured with a predefined set of festivities

ID	ARC_065
Description	The system SHOULD allow having more than one situation detected as active at the same time
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5
Rationale	The SCALC will detect active predefined situations from current parameters. Some of these situations could only affect a subset of subsystems. In this case, other situations could also be identified and managed on other subsystems
Acceptance criteria	More than one situation is detected at the same time.

ID	ARC_067
Description	There SHOULD be a simulation-run mode on FAME and the OGEMA+'s
Classification	Architectural Principles
Type	Functional and data requirements
Priority	5
Rationale	The DSS should allow testing new non-existing resources (EV, PV, extra load, etc), as well as the result of applying different strategies and actions modelled by the operator
Acceptance criteria	Through the proper user interface, new simulations can be executed and analysed

ID	ARC_069
Description	The ESB should support many MEP (Message Exchange Pattern), specifically it should support at least Request-Response, Publish-Subscribe, One-Way messages
Classification	Architectural Principles
Type	The purpose of the product
Priority	3
Rationale	The type of interaction between OGEMA and FAME could vary depending on the data. The ESB should be able to support all the MEP required to implement BEAMS..
Acceptance criteria	ESB have Request-Response and Publish-Subscribe and One-way services.

ID	ARC_075
Description	Different parts of one subsystem COULD be controlled by several different OGEMA instances while optimizations of the whole "logical subsystem" are performed at a higher level by FAME.
Classification	Architectural Principles
Type	The scope of the product

Priority	5
Rationale	Depending on pilot site and a subsystem characteristics, it might be required that different OGEMA instances control different parts of a single "logical subsystem"
Acceptance criteria	Different parts of a subsystem (e.g. HVAC, lighting) are controlled by different OGEMAs while high level optimizations of the logical subsystem are performed by FAME.

ID	ARC_078
Description	Install two different types of off-the-shelf solutions in each pilot site. On one hand they should allow monitoring "only", and on the other hand they COULD allow control and manual connection/disconnection of this control capability.
Classification	Architectural Principles
Type	Operational requirements
Priority	5
Rationale	In order to avoid problems during scenarios of interest for the manager, it should be possible to manually disconnect the control capabilities of devices installed in a pilot site (e.g., FCB stadium). Monitoring SHOULD still be allowed.
Acceptance criteria	Manual connection/disconnection of "remote" control capabilities of solutions or devices installed to control subsystems within a facility.

14.2 Requirements – Greening Energy Positive Tools (WP3)

ID	GPE_001
Description	PV generation models SHOULD be used to provide power output information
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5
Rationale	PV generation models, together with additional information (e.g. weather forecast, local meteo station, etc) should provide power output generation. This could be used to forecast energy generation as well as test different PV system configurations
Acceptance criteria	PV models provide power output information in proper units with a resolution no greater than 15 min

ID	GPE_003
Description	PV and EV models and applications to all (or some) OGEMA instances within a facility SHOULD be deployable
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5
Rationale	PV and EV models and applications should be deployable to all OGEMA instances. These applications (especially EV-Apps) should run on-top of charging station battery

	management system (BMS)
Acceptance criteria	New or updated PV or EV model can be deployed to OGEMA and run on top of EV-BMS (in the case of EV models and applications)

ID	GPE_005
Description	EV charge and discharge SHOULD be modelled
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5
Rationale	EV model should provide the capability to model the behaviour of EV batteries charge/discharge process and link this process to economics parameters
Acceptance criteria	EV model can be used to estimate EV energy demand, forecast demand, and link all to economics metrics

ID	GPE_007
Description	PV and EV optimization apps third-parties management
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	1
Rationale	PV and EV optimization apps implemented as OGEMA applications should allow the interaction with third-parties systems or actors
Acceptance criteria	Third-party actor (e.g. ESCO) monitors and controls a PV installation within a facility

ID	GPE_008
Description	Forecasting model or information (complementary to GPE_001)
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5
Rationale	Solar forecasting data can be obtained from other sources, like weather services, etc., and further simulate with power prediction model (GPE_009)
Acceptance criteria	We have got the data from third parties. If not, we have to generate by ourselves based on historic data in order to prove the functionalities of PV generation in OGEMA

ID	GPE_009
Description	Power prediction model (Complementary to GPE_001 & GPE_008)
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5
Rationale	From solar irradiation data, the power output of individual PV

	system can be generated and run on-top of BEMI Apps in OGEMA. Maybe we can also add the forecast accuracy in this model as well
Acceptance criteria	The power output and its accuracy of PV system can be calculated with accuracy lower than a specified percentage (i.e. 10%) from prediction model itself and forecasting

ID	GPE_010
Description	Protocol of PV System
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	4
Rationale	Protocol to communicate with forecasting data services or data measurement to OGEMA for energy management
Acceptance criteria	Above information can communicate with OGEMA on available protocol provided by OGEMA

ID	GPE_012
Description	PV-System on-top of OGEMA
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5
Rationale	PV-Generation Apps will be run on-top of BEMI Apps on OGEMA Platform
Acceptance criteria	In OGEMA provided different power producer components (uncontrollable power producer component)

ID	GPE_013
Description	There SHOULD be a user interface to support EV owners to provide detailed information to the system regarding EV charge needs
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	1
Rationale	In order to allow BEAMS system to manage EV charging process, there should be some interface through which EV owners can provide detailed information to the system e.g. EV minimum desired EV charge at a specific time, etc.
Acceptance criteria	EV charging stations have a user interface through which EV owner can provide inputs to the system regarding his EV charge needs

ID	GPE_014
Description	EV management/optimization application in OGEMA SHOULD manage EV charging process based on following data: User requirements, available price tariff information and availability of DER resources. This application runs on top of EV BMS

Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	1
Rationale	In order to optimize EV charging, EV management application in OGEMA should use all data mentioned above. Taking this into account, EV charging schedules are generated and used to manage EV charging.
Acceptance criteria	EV charging stations have a user interface through which EV owner can provide inputs to the system regarding his EV charge needs

ID	GPE_015
Description	OGEMA's EV optimization application SHOULD guarantee that an EV charge will be managed according to data introduced by the user when EV was plugged into the charging station (through the proper UI interface)
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	1
Rationale	EV owners will provide EV charging requirements to the proper UI in the charging station. This data will be used by the EV applications in OGEMA to handle the EV optimizations
Acceptance criteria	EV charging/optimization application in OGEMA always guarantee a minimum EV charge (that available when vehicle was plugged in)

ID	GPE_016
Description	OGEMA EV management application SHOULD provide EV energy use schedule, updated EV storage capacity and EV demand forecast
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5
Rationale	EV management applications should be able to provide following data to a facility manager upon request: EV energy use schedule, updated EV storage capacity and EV demand forecast
Acceptance criteria	EV management applications provides the information described above to FAME upon facility manager request

ID	GPE_017
Description	Interaction between EV user and BEAMS SHOULD be provided
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	1
Rationale	The information will be transmitted to BEAMS through OGEMA using a bidirectional standardised communication protocol

Acceptance criteria	User can enter information to BEAMS regarding charging parameters through an appropriate interface
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ID	GPE_018
Description	EV static features SHOULD be provided
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5
Rationale	Static features of EV battery like capacity, charging mode (low/fast charge), max power, max current, storage capacity SHOULD be provided to the EV management
Acceptance criteria	EV management app receives the required static features of EV to perform management and optimization functions

ID	GPE_020
Description	EV Management SHOULD be context aware
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5
Rationale	To perform EV storage capacity forecast, context variables should be provided (day type, events,...)
Acceptance criteria	EV management apps receives relevant variables for forecasting purposes

ID	GPE_021
Description	There SHOULD exist an historic database from EV arrivals and departures
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5
Rationale	To perform EV storage capacity forecast historic data is required
Acceptance criteria	It exists a database where arrival and departure time for EV and context variable are stored

ID	GPE_022
Description	Charging stations SHOULD be able to receive control commands
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	5
Rationale	EV management app will control when power would be provided to every vehicle. The EV will not start charging when it plugs in the charging point, but when the platform sends the command
Acceptance criteria	The charging point accepts on/off commands and starts/stops charging process

ID	GPE_023
Description	Charging stations SHOULD be able to convert to "generation" stations
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	2
Rationale	When testing V2G mode, EV are seen as a source of energy, so energy can flow from EV to loads within the facility or to the grid. Commands from BEAMS to the charging point should include not only on/off but charging/discharging
Acceptance criteria	EV battery charges, discharges or neither of them according to commands received from the platform

ID	GPE_024
Description	Power set points calculated by the optimisation algorithm in BEAMS for the charging of EVs are NOT RESTRICTED only to on/off. A number between 0 to 1 COULD be provided
Classification	Greening Positive Energy Tools
Type	The scope of the product
Priority	3
Rationale	In case of emergency power reduction, instead of stopping charging operations, reduction of charging power should be considered. This could afford to fulfil the minimum level required by user
Acceptance criteria	EV management app is able to control the average power in the charging process

ID	GPE_025
Description	The State of Charge of EV SHOULD be provided to BEAMS when plugged. Additionally, State of Charge SHOULD be dynamically updated while plugged. It is REQUIRED that the communication protocol of charging station complies with OGEMA.
Classification	Greening Positive Energy Tools
Type	Functional and data requirements
Priority	5
Rationale	
Acceptance criteria	EV Management app is able to provide current state of charge for each EV

14.3 Requirements – Interoperability Gateway (WP4)

ID	OGE_002
Description	Prioritized control schedule plans generation mechanism/application already developed within OGEMA SHOULD be reviewed and adapted to the scope of BEAMS project

Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	5
Rationale	Control schedule plans generation mechanism already in place in OGEMA should be adapted in order to consider new applications and elements developed in BEAMS, such as FAME, EV and PV applications, etc.
Acceptance criteria	Prioritized control schedule plans generation adapted (or developed) particularly targeting the scope of BEAMS project

ID	OGE_003
Description	OGEMA instances within a facility SHOULD have the capability to interface different subsystems (e.g., HVAC, lighting, etc) and execute control actions on these subsystems
Classification	Interoperability Gateway
Type	Mandated constraints
Priority	5
Rationale	Energy optimizations can be achieved within a facility by monitoring and "controlling" different systems. It is required that OGEMA can interface and control these systems
Acceptance criteria	OGEMA instances can perform control actions over different systems within a facility

ID	OGE_004
Description	OGEMA instances SHOULD be able to received energy optimization requests from a utility or third party, forward this data to FAME for facility manager authorization, and perform optimizations based on answer received from FAME
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	4
Rationale	This requirement illustrates a demand response (DR) scenario where OGEMA instances should be able to handle messages from an third party, forward data to FAME and wait for authorization in order to perform energy optimizations
Acceptance criteria	DR messages can be handle by OGEMA instances and forwarded to FAME for facility manager authorization

ID	OGE_005
Description	OGEMA instances SHOULD be able to received price tariff information (e.g. day-ahead price tariff) from a utility or third party
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	4
Rationale	Price tariff messages received in OGEMA such as day-ahead price tariff, etc might be used for local DER generation forecasts. This information could be forwarded to FAME

	following the prioritization mechanism for third party data
Acceptance criteria	Price tariff information is available from a third party (or simulated) and is used by OGEMA and FAME to perform energy optimizations

ID	OGE_006
Description	OGEMA SHOULD support a data push mechanism that enable sending data from OGEMA to FAME
Classification	Interoperability Gateway
Type	The scope of the product
Priority	5
Rationale	Certain data obtained or generated in OGEMA e.g. alarms or messages from third parties should be sent to FAME asynchronously as data is generated or obtained. A push mechanism should support the transmission of this data from OGEMA to FAME
Acceptance criteria	Data push mechanism in OGEMA (push of data from OGEMA to FAME)

ID	OGE_007
Description	OGEMA SHALL be able to store data of the building which is controlling for a minimum of 30 days
Classification	Interoperability Gateway
Type	Operational requirements
Priority	3
Rationale	Dimensioning of database and disks storage capabilities
Acceptance criteria	Technical specification of the OGEMA

ID	OGE_008
Description	It SHALL be possible to cleanup the OGEMA database
Classification	Interoperability Gateway
Type	Maintainability and support requirements
Priority	3
Rationale	Possibility to clean up the database up to a specified date
Acceptance criteria	IVV

ID	OGE_009
Description	In case one or more OGEMA instances are not reachable on the network, the OGEMAs SHALL publish the data to the ESB as soon as the network is available again
Classification	Interoperability Gateway
Type	Operational requirements
Priority	4
Rationale	A mechanism to avoid data alignment in case of network failures should be implemented
Acceptance criteria	IVV

ID	OGE_010
Description	In case one subsystem (lighting, HVAC, EV) is not available at OGEMA driver level for control, OGEMA SHALL report to FAME the fault condition and SHALL exclude from energy optimizations that subsystem
Classification	Interoperability Gateway
Type	Operational requirements
Priority	4
Rationale	Degraded scenario to be analyzed and consider carefully in the design phase
Acceptance criteria	IVV

ID	OGE_011
Description	In case one subsystem (lighting, HVAC, EV) is not available at OGEMA driver level for monitoring energy consumption, OGEMA SHALL report to FAME the fault condition and SHALL exclude from total energy consumption that subsystem
Classification	Interoperability Gateway
Type	Operational requirements
Priority	4
Rationale	Degraded scenario to be analyzed and consider carefully in the design phase
Acceptance criteria	IVV

ID	OGE_012
Description	Third party messages to OGEMA SHALL include a validity period
Classification	Interoperability Gateway
Type	Operational requirements
Priority	5
Rationale	Define a validity of the schedule or other commands issued from a remote component
Acceptance criteria	IVV

ID	OGE_013
Description	OGEMA SHOULD use all available internal and external data (e.g. power output from GPE models, FAME requirements, price tariff, weather forecast, etc) to optimize the load of systems under its control
Classification	Interoperability Gateway
Type	The scope of the product
Priority	5
Rationale	Load will be optimized within a facility by the different OGEMA instances. To achieve this OGEMA should use all available information to generate the control schedule plans used to control the different subsystems

Acceptance criteria	OGEMA optimizes the load of its subsystems based on all available information
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ID	OGE_014
Description	OGEMA instances to be deployed in the pilot sites SHOULD run in industrial PCs
Classification	Interoperability Gateway
Type	Operational requirements
Priority	3
Rationale	Due to the environments where the OGEMA instances should be installed, it is required that the Hw where this systems will run would be prepared for harsh environments
Acceptance criteria	OGEMA runs on industrial PCs

ID	OGE_015
Description	In case of power supply failures or any other problem, an OGEMA instance SHOULD be able to recover its normal operation and notify the problem the soonest possible to FAME
Classification	Interoperability Gateway
Type	Operational requirements
Priority	3
Rationale	In case of any problem, such as an electric power supply of the OGEMA instance, once electrical supply is recover an OGEMA instance should be able restart its operation autonomously so that the facility optimization is restarted as soon as possible
Acceptance criteria	OGEMA instances are able to recover autonomously from an erroneous state of external problem such as fail in power supply

ID	OGE_016
Description	The system SHOULD support existing or under development communication protocols and data models for EVs
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	2
Rationale	
Acceptance criteria	

ID	OGE_017
Description	Security on OGEMA like FAM_028
Classification	Interoperability Gateway
Type	The scope of the product
Priority	4
Rationale	
Acceptance criteria	

ID	OGE_018
Description	The behaviour of the simulated resources SHOULD be based on predefined models, and COULD also take into account the historical data of other similar existing resources
Classification	Interoperability Gateway
Type	Operational requirements
Priority	1
Rationale	The existence of real resources providing real data can be used to enhance the simulation of new similar resources
Acceptance criteria	

ID	OGE_019
Description	All new Hw equipment (off-the-shelf solutions) for monitoring and control to be integrated in each pilot site SHOULD be physically tested first by IWES in Germany (to allow also proper development of OGEMA platform)
Classification	Interoperability Gateway
Type	Off-the-self solutions
Priority	5
Rationale	It is a requirement from IWES that all Hw to be used in the project should be sent to IWES Germany for proper OGEMA's new components development and testing/validation
Acceptance criteria	New Hw to be used in the project is sent to IWES for OGEMA development, testing and validation

ID	OGE_020
Description	Timestamp of sensor data WILL be set by the OGEMA gateway connected to the sensor
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	5
Rationale	All sensor data needs a time stamp, however the sensor devices may not have a clock or it may be too complicated to synchronize the sensor clock with the OGEMA/FAME system time
Acceptance criteria	

ID	OGE_021
Description	Operation schedules are computed according to the priorities defined for connected subsystems
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	4
Rationale	Follows from use cases UC-002/3/4
Acceptance criteria	

ID	OGE_022
Description	Operation schedules are selected according to their priority
Classification	Interoperability Gateway
Type	Functional and data requirements
Priority	4
Rationale	Follows from use case UC-010
Acceptance criteria	

14.4 Requirements – Facility Management Environment (WP5)

ID	FAM_001
Description	FAME subsystem SHOULD support local data storage of all information gathered from the different OGEMA instances within a facility
Classification	Facility Management Environment
Type	The scope of the product
Priority	5
Rationale	In order to facilitate data presentation to users (e.g. when preparing energy reports, etc), FAME should be able to obtain data from all OGEMA instances and store it locally
Acceptance criteria	Data obtained from OGEMA instances is stored in a local database accessible to all FAME subsystem modules

ID	FAM_002
Description	The EBS module of FAME SHOULD be able to present reports of energy consumption (and production) within a facility through the corresponding user interface
Classification	Facility Management Environment
Type	Look and feel requirements
Priority	5
Rationale	Updated information gathered from OGEMA instances and stored locally in FAME, should be presented upon request in a proper way to the facility manager so that he can take energy optimization decisions based on that information
Acceptance criteria	Updated information regarding energy consumption (and production) within a facility is presented to the facility manager through the corresponding UI

ID	FAM_004
Description	Situation/contexts used to generate specific control schedule plans in OGEMA COULD be introduced by a facility manager through the corresponding FAME UI module
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5
Rationale	Facility managers can introduce/define situation or contexts in FAME (SCALC) and this information is used by SCALC to

	generate operational requirements that are sent to OGEMA to make it generate new control schedule plans for all subsystems under its control
Acceptance criteria	A facility manager can modify the current operation of the different OGEMA instances within a facility by defining new situation/contexts in FAME, and then deploying the situation/context operation requirements (generated by SCALC) in all OGEMAs.

ID	FAM_005
Description	FAME SHOULD allow the definition, simulation and assessment of existing or new situation/context, subsystems, etc through a corresponding UI
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5
Rationale	FAME system should provide the facility manager (through the corresponding UI) the capability to define and simulate new situation/contexts and subsystems that do not exist or are not deployed in the facility
Acceptance criteria	Situation/context and Greening Positive Energy Tools subsystems can be defined, simulated and assessed through a UI interface

ID	FAM_006
Description	FAME SHOULD provide manual (individual) remote control of different subsystems within a facility.
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5
Rationale	FAME smart control algorithms could provide a coordinated facility energy management. However, further control e.g. manual or individual control of different subsystems could be required, for example to adapt the facility to a specific situation/context
Acceptance criteria	Manual control from a proper UI, of any subsystem under control of any OGEMA instance within a facility

ID	FAM_007
Description	FAME subsystem SHOULD provide real-time feedback about the current state of an entire facility through a well designed and user friendly UI
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5
Rationale	Facility manager should be able observe the entire facility state and any message, alarm etc received from OGEMA instances as well as third-parties

Acceptance criteria	Display of messages, alarms, etc through proper UI
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ID	FAM_008
Description	FAME MUST store in a local data base situation/contexts either defined by a facility manager or learned/detected by SCALC algorithms.
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5
Rationale	FAME-SCALC should enable the detection and modelling situation/contexts based on the data obtained from the different OGEMA instances within a facility. The situation/context model should be stored in a local database
Acceptance criteria	There is a FAME local data base for situation/contexts. This data base is accessible from other modules of FAME

ID	FAM_009
Description	FAME components SHOULD be designed to be modular in order to enable integration of future new applications and customization to new deployments sites
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5
Rationale	Despite this is a architectural requirement in general, it is important to highlight that FAME architecture and design should be flexible enough to easily allow integration of future apps and even customize it to deployment site characteristics
Acceptance criteria	FAME design is modular and easy and afford new applications integration, UI customization, etc.

ID	FAM_011
Description	It SHOULD be clearly specified the data models and interfaces between the different components of FAME
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5
Rationale	In order to make easier the integration of FAME and OGEMA, as well as the development of current and future applications, clear and standardized data models and interfaces are required
Acceptance criteria	Open specification of data models and interfaces between the different components of FAME (possibly based on publicly available standards/technologies)

ID	FAM_012
Description	Use of simulation scripts in those cases where real data coming from external third-parties is not possible
Classification	Facility Management Environment

Type	Functional and data requirements
Priority	5
Rationale	Within the scope of BEAMS project, the interaction with third-parties such as a utility, ESCO, etc will be simulated through the use of scripts that should run within FAME
Acceptance criteria	Use of third-party script within FAME

ID	FAM_013
Description	FAME SHALL be able to store energy consumption data of the entire site for a minimum of 12 months
Classification	Facility Management Environment
Type	Operational requirements
Priority	3
Rationale	Dimensioning of database and disks storage capabilities
Acceptance criteria	Technical specification of the FAME

ID	FAM_014
Description	It SHALL be possible to make a backup&restore of FAME data
Classification	Facility Management Environment
Type	Maintainability and support requirements
Priority	3
Rationale	Possibility to make a database backup & restore for archiving old data
Acceptance criteria	IVV

ID	FAM_015
Description	It SHALL be possible to cleanup the FAME database
Classification	Facility Management Environment
Type	Maintainability and support requirements
Priority	3
Rationale	Possibility to clean up the database up to a specified date
Acceptance criteria	IVV

ID	FAM_016
Description	In case one or more OGEMA instances are not reachable on the network, the FAME SHALL be able to work without some data and indicate that calculation and report are incomplete
Classification	Facility Management Environment
Type	Operational requirements
Priority	4
Rationale	Maintain consistency of data and calculation on FAME in case of missing some of them
Acceptance criteria	IVV

ID	FAM_017
Description	FAME SHALL be able to elaborate real time incomplete consumption data and generate incomplete reports
Classification	Facility Management Environment
Type	Operational requirements
Priority	4
Rationale	Maintain consistency of data and calculation on FAME in case of missing some of them
Acceptance criteria	IVV

ID	FAM_018
Description	Context conditions introduced by FAME SHALL have a validity period for their execution. If that period is elapsed then the command SHALL be ignored by OGEMA
Classification	Facility Management Environment
Type	Operational requirements
Priority	5
Rationale	Define a validity of the schedule or other commands issued from a remote component
Acceptance criteria	IVV

ID	FAM_019
Description	OGEMA: operation schedules are computed according to the priorities defined for connected subsystems
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	4
Rationale	It follows from use cases UC-002/3/4
Acceptance criteria	

ID	FAM_020
Description	OGEMA: operation schedules are selected according to their priority
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	4
Rationale	It follows from use case UC-010
Acceptance criteria	

ID	FAM_021
Description	FAME SCALC module SHOULD have two components: one OGEMA-based SCALC application and one module running in FAME system
Classification	Facility Management Environment
Type	The scope of the product
Priority	5

Rationale	SCALC objective is to allow BEAMS system model situation/context either manually introduced by a user or learned from real-time data. This capability should be implemented as an OGEMA app. UI functionalities should be performed by SCALC module in FAME
Acceptance criteria	SCALC implemented as two complementary modules, one OGEMA application and a FAME module

ID	FAM_022
Description	FAME SHOULD provide a data management layer or component that allow all FAME modules to store data in the local database
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	5
Rationale	There should be a layer in FAME that not only handle data management with FAME local data base.
Acceptance criteria	Data management layer in FAME

ID	FAM_023
Description	FAME-DAS module SHOULD provide a BEAMS user-friendly interface
Classification	Facility Management Environment
Type	The scope of the product
Priority	5
Rationale	As indicated in the DoW, BEAMS UI will be developed in FAME-DAS module. All other FAME components UI will be presented as a submodule (e.g. new window, new tab, etc) within the main UI
Acceptance criteria	FAME core UI is implemented as one of the basic functionalities of FAME-DAS module

ID	FAM_024
Description	FAME-DAS module SHOULD be able to obtain data from all OGEMA instances in a facility as well as managing the storage of this information in the FAME data base (through the proper data access layer)
Classification	Facility Management Environment
Type	The scope of the product
Priority	5
Rationale	As stated in DoW, DAS will be the module responsible for retrieving data from OGEMA instances and presenting it in a structure way to the user. The storage of this information is managed by DAS through the proper data access layer in FAME
Acceptance criteria	FAME-DAS retrieves data from all OGEMA instances in a facility, manages the storage of this data and presents it in a structure way to the user

ID	FAM_025
Description	FAME-DAS module SHOULD enable simulation of situation/contexts defined by the user
Classification	Facility Management Environment
Type	The scope of the product
Priority	5
Rationale	Simulation capabilities of FAME should be implemented in DAS as stated in the DoW. All functionalities required to enable such an interaction with models defined in OGEMA instances, presentation of results through the UI, etc will also be part of DAS
Acceptance criteria	FAME-DAS offers simulation capabilities to facility manager

ID	FAM_027
Description	FAME SHOULD provide the proper mechanisms to allow the upgrade/maintenance of OGEMA instances in a remote way
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	3
Rationale	From the point of view of a facility manager it would be necessary to include a new application in OGEMA, update an existing one, or even upgrade OGEMA framework to a newer version. This SHOULD be enabled through a user friendly interface
Acceptance criteria	OGEMA remote management/maintenance from FAME

ID	FAM_028
Description	FAME security management interface SHOULD be available for facility manager
Classification	Facility Management Environment
Type	The scope of the product
Priority	5
Rationale	Data gathered by FAME SHOULD be properly secured. However, it should be possible for different people within a facility or even external parties to access certain data. FAME SHOULD provide security mechanisms that allow definition of security policies.
Acceptance criteria	Security management UI interface available to facility manager

ID	FAM_029
Description	BEAMS user interface provided by FAME SHOULD support different languages
Classification	Facility Management Environment
Type	Usability and humanity requirements
Priority	3
Rationale	Due to the nature of the project and the fact that BEAMS system will be deployed in different pilot sites, the UI should

	support or be prepared to support different languages (e.g. Italian, Spanish and English)
Acceptance criteria	BEAMS UI supports at least three different languages (Italian, Spanish and English)

ID	FAM_030
Description	The Load Forecast SHOULD handle special days
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	3
Rationale	
Acceptance criteria	

ID	FAM_031
Description	FAME SHOULD run over windows
Classification	Facility Management Environment
Type	Mandated constraints
Priority	5
Rationale	ETRA starting point is running over Windows. Thus, the updated system should also run over windows
Acceptance criteria	FAME runs over Windows

ID	FAM_032
Description	FAME should offer a web GUI
Classification	Facility Management Environment
Type	The scope of the product
Priority	4
Rationale	In order to access FAME functionalities from personal devices as smart phones it is convenient to design a HMI based on web-services
Acceptance criteria	FAME offers at least monitoring capabilities over the Internet

ID	FAM_033
Description	FAME MUST make use of the resources modelled at OGEMA
Classification	Facility Management Environment
Type	Functional and data requirements
Priority	4
Rationale	The resources (sub-system) controlled by OGEMA MUST be supported by FAME. This MUST be as independent to the manufacturer as possible
Acceptance criteria	FAME can interact with OGEMA resources

ID	FAM_034
Description	Any user interface SHOULD support multilingual
Classification	Facility Management Environment

Type	Cultural and political requirements
Priority	4
Rationale	Not only the project is run by an international consortium - so English is a must - but also we have two different pilots in two different countries. Additionally in Barcelona there are two languages
Acceptance criteria	Internationalization is feasible easily, by means of an independent translation file

ID	FAM_035
Description	FAME SHOULD store the information coming from the OGEMA instances
Classification	Facility Management Environment
Type	Performance requirements
Priority	4
Rationale	For certain use cases it is easier to keep a local (on FAME) copy of the data retrieved from the OGEMAs, rather than trigger a query to OGEMAs each time data is needed
Acceptance criteria	Data from OGEMA is retrieved from OGEMAs every 15 minutes

ID	FAM_036
Description	FAME-DAS SHOULD provide a user interface offering maps visualization
Classification	Facility Management Environment
Type	Look and feel requirements
Priority	3
Rationale	A user friendly interface is needed to manage a facility. Having the geographic localisation of the OGEMAs and resources helps improving the operation
Acceptance criteria	Information treated by FAME-DAS is presented in a map, positioning the OGEMA instances and resources

ID	FAM_037
Description	FAME SHOULD integrate the management of the maintenance
Classification	Facility Management Environment
Type	Operational requirements
Priority	2
Rationale	Any exploitation system should support the scheduling of the maintenance activities and time life of the different resources
Acceptance criteria	FAME supports the scheduling of the maintenance activities and keeps record of the hours each resource has been working

ID	FAM_038
Description	FAME-DAS SHOULD enable the graphical interaction and edition of data

Classification	Facility Management Environment
Type	Usability and humanity requirements
Priority	3
Rationale	FAME-DAS is a UI to manage the facility from a central post. Thus, a user friendly interface - as opposed to a simple terminal interface - should be granted.
Acceptance criteria	FAME is developed as the main UI to BEAMS functionalities

ID	FAM_039
Description	FAME-DAS SHOULD enable the graphical interaction and edition of data
Classification	Facility Management Environment
Type	The scope of the work
Priority	3
Rationale	The main goal of BEAMS is to save energy. Thus, the final user needs an estimation on the saving of energy implementing different strategies
Acceptance criteria	An estimation on the save of energy when implementing different policies is provided

ID	FAM_040
Description	FAME SHOULD provide information for different users
Classification	Facility Management Environment
Type	Security requirements
Priority	1
Rationale	Different users may be interested in getting reports from the FAME-EBS: engineers, administrative, facility owner etc.
Acceptance criteria	FAME supports the generation of reports with different levels of detail

ID	FAM_041
Description	FAME SHOULD enable the treatment of alarms
Classification	Facility Management Environment
Type	Operational requirements
Priority	1
Rationale	Alarms coming from the OGEMA instances should be accessible to the user managing FAME, so he/she can treat and track them
Acceptance criteria	The alarms triggered from the OGEMA instances are managed at FAME

ID	FAM_042
Description	FAME subsystem SHOULD be able to obtain the version of all the OGEMA components
Classification	Facility Management Environment
Type	Maintainability and support requirements
Priority	2

Rationale	Since this is a logically and geographically distributed system, the interface should at least provide the information about the version of the modules currently installed on each OGEMA+, to assess the proper software deployment in case of updates
Acceptance criteria	Sw version of the OGEMA components can be accessed in the FAME UI

ID	FAM_043
Description	EV charging status SHOULD be monitored as part of the FAME user interface
Classification	FAcility Management Environment
Type	Usability and humanity requirements
Priority	3
Rationale	FAME should monitor all of the system's elements, including EVs.
Acceptance criteria	