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D3.2 *CASSANDRA* requirements

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Abstract

This document provides the software requirements of the *CASSANDRA* platform. More specifically, it presents the essential functional and non-functional requirements, along with use case scenarios describing the basic functionality of the *CASSANDRA* software platform. The aim of the document is to serve as the basis for the actual implementation of the platform.

Document History

Version [1]	Issue Date	Stage [2]	Content and changes
#1.0	11th Apr 2012	Draft	Initial version of the document (AUTH)
#1.1	24th Apr 2012	Draft	Second version of the document after taken into consideration the comments of the CERTH-ITI team (AUTH)
#1.2	24th Apr 2012	Draft	Revised Use Cases (CERTH-ITI)
#1.3	27th Apr 2012	Draft	Addition of Mock-up screens (CERTH-ITI)
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[1] Please use a new number for each new version of the deliverable. Add the date when this version was issued and list the items that have been added or changed. The 'what's new' column will help the reader in identifying the relevant changes. Don't forget to update the version number and date on the front page and the header.
[2] A deliverable can be in either of these stages: "draft" or "final". For each stage, several versions of a document can be issued. *Draft:* Work is being done on the contents. *Final*: All chapters have been completed.

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1 Introduction

Project *CASSANDRA* aims to develop an expandable software platform for modelling the demand side of a power system. The structural elements of the models will be the basic level electrical installations (i.e. households, commercial stores, small industries etc.), the respective appliances comprising them, as well as the activities of the people involved related to electrical consumption. Apart from that, the models will also be able to provide information regarding the heating/cooling of the involved installations, as well as the respective CO_2 emissions. The ultimate goal of the *CASSANDRA* platform is to serve as a tool for the simulation of real demand side environments, providing decision support for energy market stakeholders. The functionality of this simulation includes the determination of good practices that lead to energy efficiency, the clustering of electric energy consumers according to their consumption patterns, as well as their anticipated behaviour when presented with specific demand response programmes.

1.1 Purpose of the document

The aim of this document is to provide a general description of what the prospective *CASSANDRA* users want to perform with the software platform. To this purpose, a number of business procedures, functional and non-functional requirements, as well as relevant use cases are analyzed, encompassing the *CASSANDRA* basic functionality.

1.2 Methodology and user interviews

The set of user requirements presented in this document have been collected in the following steps:

1. Initially, a set of abstract user requirements were identified after a series of meetings between the core model and platform developers (AUTH and CERTH-ITI).
2. A number of preliminary software modules were developed to support research, experiments, and the design of the platform (CERTH-ITI).
3. D3.1: "Preliminary model identification" described the core simulation entities of *CASSANDRA*. (ERASMUS, CERTH-ITI, AUTH).
4. The collected requirements were discussed with all partners at the First Project Meeting (Milan, March 8-9, 2012, All partners)
5. The Pilot Case leaders carried out a set of interviews with relevant stakeholders. (POLIMI, LTU-CDT, COVUNI)
6. A set of interviews were carried out with stakeholders of the Network of Interest (VaasaETT).

For the Pilot Cases the following interviews were carried out:

1. Pilot Case 1: Interview with manager of "Campo dei Fiori" **shopping center** in Gavirate (VA), Italy.

2. Pilot Case 2: Interviews with **Luleå Energi** and **KYAB.**
3. Pilot Case 3: Interviews with **Coventry University** administrative authorities.

The Network of Interest (NoI) energy market stakeholders interviewed by VaasaETT up to the finalization of this document are:

- **2 Save Energy**
- **BaseN**
- **Bord Gais Energy**
- **CyberGRID**
- **DuneWorks**
- **EA Technology**
- **eMeter**
- **Entelios**
- **Flexiwatt**
- **Greenbox Group**
- **Maingate**
- **Salient Systems**
- **UC Partners/Delft University of Technology**

The interview process is currently in progress. The discussions in the interviews with the above members of the NoI have provided valuable information to support the identification of new user requirements and to set accurate priorities for existing ones.

The questionnaire that is used as a basis for the interview process is included in the Appendix of this document. For reasons of confidentiality the answers to the interview questions have not been included in this document.

1.3 Definitions, acronyms and abbreviations

1.3.1 Writing conventions

The text in this document is written with Times New Roman font, of size 12pt. The first level header titles are written in **bold** and 16pt in size. The second level header titles are given in **bold** and 14pt in size, whereas the third level header titles are given in **bold** and 13pt in size. Instructions and remarks are included in brackets (< >). The notions that are presented in the Nomenclature are given with `Courier New` in the document, and the font size is 12pt. The sub-flows included in the Use Cases are indicated with bold fonts inside the basic flow and analyzed in detail later on. The Business processes in chapter 2, as well as the functional and non-functional requirements in chapter 3 are named and numbered according to next sub-chapter. Use Case and Activity Diagrams have been developed using the Star UML open source UML/MDA platform (http://staruml.sourceforge.net/)

1.3.2 Glossary - Abbreviations

BP-xx Business Process xx

FR-xx Functional Requirement xx

NFR-xx Non Functional Requirement xx

UC-xx Use Case xx

1.3.3 Nomenclature

`User`**:** The person using the *CASSANDRA* platform.

`CRUD`**:** Four basic functions in computer programming: Create, Read Update Delete

`Scenario`: The environment where the `User` designs the entities, pricing schemes, simulation parameters etc. to be simulated by the software platform.

`System`: The *CASSANDRA* software platform.

`Appliance/Appliance model`: The combination of parameters, along with the respective process, aiming to simulate the actual electrical consumption of an electric appliance.

`Person/Person model`: The combination of parameters, along with the respective process, aiming to simulate the actual person behaviour, associated to a specific electrical `Installation model`.

`Installation/Installation model`: The aggregation of all the `Appliance models` in the premises of a single electric energy consumer be it residential, commercial, industrial or other, along with their respective operational parameters, that will enable the modelling of these premises as a single entity. Each Installation model includes the `Person models` (residents, employees, customers etc.). An `Installation` may have associated `Measurement data`.

`Installation type model`: The various types of electrical consumer models such us: residential, commercial, industrial or other

`Group of installations models`: The aggregation of all the appliances in the premises of a combination of different electric energy consumers such as residential, commercial, industrial or other, along with their respective operational parameters.

`Activity/Activity model`: The combination of parameters, along with the respective process, aiming to simulate the actual electrical consumption of a group of electric devices that are associated to a specific activity.

`Pricing Scheme model`: Various types of pricing incentives or penalties, aiming to modify the consumer demand for electrical energy.

`Consumer utility function model`: The modeling of a metric that, for a given set of preferences and incentives, assigns an overall ranking to the consumer's satisfaction.

`Entity`: We define as an entity every object that is modelled in our platform (`Group of installations, Installation, Person, Appliance, Activity, Pricing scheme, Consumer utility function`)

`Library`: The *CASSANDRA* storage place for `entity` models. There are three model types in `Library`: *CASSANDRA* validated models, 3rd party models and user custom models.

`Consumer group`: A number of `Installation models` with characteristics that allow them to be simulated as a single entity.

`CSN`: Consumer Social Network. A `Group of installation models`, made up from binary ties where there is a proximity factor between them, such as: neighbouring consumers, young or elder consumers, eco-friendly consumers etc.

`Measurement data`: Data of active and reactive power, taken from electrical meters. Sampling of measurements is expected at the `Installation` level or, conversely, `Installations` may be defined in terms of data availability.

`Disaggregate`: The separation process of one consumer's total power curve, to the identified active appliances

`Disaggregation products`: The identified performed activity models, along with the activated appliances and their activation time durations.

`Training models`: The process aiming to improve simulation models using information extracted from real `Measurement data`.

`Demand Side Management(DSM)`: The term generally includes every action taken on the demand side of an energy system[3]. In this document we use it to refer to all changes in electricity usage as a response to incentives provided to the consumer.

`Fuel type mixture`: The ratio of all fuel types used for electrical energy production.

CO_2 `emission factor`: The per unit amount of CO_2 mass emitted to produce electrical energy

`Simulation statistics`: Values that will be available after the end of a simulation, such as minimum value of active and reactive power, maximum value of active and reactive power, total consumed energy, time periods that the active power consumption is above 90% as compared to its maximum value, time periods that the active power consumption is below 10% as compared to its maximum value, base energy consumption, time analysis per activity and appliances, disaggregation of the consumption of existing or proposed consumer groups, information regarding activities per time period.

`Grouping criteria`: Set of rules that will be used by the `User` to form consumer groups.

[3] P. Palensky, D. Dietrich, "Demand Side Management: Demand Response, Intelligent Energy Systems, and Smart Loads", *IEEE Transactions on Industrial Informatics*, Vol. 7, No. 3, Aug 2011, pp. 381-388.

`Clustering criteria`: Set of rules that will be used by the `System` for the proposition of the creation of consumer clusters.

`Web service`: A method of communication between *CASSANDRA* software platform and remote *CASSANDRA* web server.

1.4 Intended audience and reading suggestions

The intended audience of this document is basically the software development team of the *CASSANDRA* software platform. However, the document is prepared in such a way, that the system users may easily read it, in order to understand the basic functionality and capabilities of the platform. Since there are many Projects that are on progress on the same Scientific and Market Field, or even under the same European Project Call, the document is classified as public, so as to assist similar research.

The reader should follow a serial reading procedure through the chapters in order to fully understand the potential and functionality of the platform, utilizing the nomenclature as a guide, when an unclear term appears.

1.5 Overview of the document

In Part 2 of this document, a general description of the *CASSANDRA* functionality is presented, through the analysis of the respective Business Procedures. Subsequently, in Part 3 the Functional and Non-Functional Requirements of the software platform are analyzed and the respective Use Case Scenarios are presented.

2 General description of *CASSANDRA*

Energy markets have undergone fundamental changes at the conceptual level over the last years. The necessity for sustainability has transformed the traditional power production scheme to a distributed energy resource one. The past was dominated by large scale power plants, mainly fossil fueled or nuclear powered. The future points towards a great number of decentralized, small-scale production sites based on renewable energy sources or on efficient production systems like mini and micro co- and tri-generators. Moreover, the deregulation of energy markets has produced great business potential for energy-related companies, along however with a number of both technical and policy challenges. Energy companies may now expand their business implementing novel ways to interact with other market stakeholders, and seeking to approach customer groups that were not available until some years ago.

Finally, the Smart Grid paradigm is here to stay. The great advancements in ICT in general, along with the novel prospects offered by the deregulation of energy markets, have boosted R&D activities aiming to automate the monitoring and control of power grids, enhance their management, offer alternatives to individual electricity consumers, and achieve large scale energy saving. The Smart Grids are extensively researched at academic and commercial level, and, what is even more important, they have found their way into international strategic planning directives.

All these changes offer substantial opportunities for all energy market stakeholders. These opportunities, however, remain largely unexploited. On the one hand, the small-scale consumers comprising the vast majority of the energy market stakeholders are individually insignificant and their market power is practically non-existent. On the other hand, there is currently a lack of tools for modeling the energy market with respect to the complexity introduced by the aforementioned changes. As a result, even major market stakeholders are often reluctant to implement novel techniques and capitalize on the new opportunities, as they are unable to anticipate the possible benefits. The same holds true for regulatory bodies attempting to impose novel policies on the energy market. Novel policies are usually imposed without sufficient prior modeling and investigation, resulting thus more often than not to market fluctuations as well as operational difficulties (e.g. power outages).

The necessity rises, thus, for the development of dynamic models, which could be used in order to help energy market stakeholders improve their market power, as well as in order to assess the impact and possible consequences of certain policies and actions imposed on energy markets in general, before their actual implementation. Such models should offer various levels of abstraction, in order to multiply their functionality, as they could be thus used by a number of different stakeholders for their own purposes. Moreover, the existence of such models would even serve as a basis for the implementation of novel market schemes, such as the formation and operation of customer coalitions, aiming to improve their market power through the pursuit of common benefits.

The *CASSANDRA* platform aims to address the lack of such models. *CASSANDRA* is envisioned as

a software platform which will provide the end users with the ability to dynamically model and investigate segments of the energy market, according to their specific needs.

The **main objectives** of *CASSANDRA* are to:

1. Provide the theoretical model that clearly defines the energy profiles and energy consumption patterns of all relevant stakeholders, as well as their interrelations, in order to support energy efficiency.
2. Promote and validate methodologies that will provide increased market power to low level consumers, through consumer coalitions (Consumer Social Networks – CSNs).
3. Develop a modular, extendable and interoperable software platform that will implement the *CASSANDRA* theoretical paradigm to model, simulate and benchmark scenarios and operations, and act as a decision making tool for energy performance, considering consumer behavior.

To this end, we present the Business Processes that drove the system development.

2.1 *CASSANDRA* modeling entities

This section provides a summary of foundational entities of the consumer models that will be used within the *CASSANDRA* platform. These entities will constitute the basis in the modeling process. Based on the entities recognized, there will be a consumer's instance analysis, where specific consumer types such as household consumer, commercial and industrial (C&I) consumer, multi-installation consumer etc. will be described. The classification of these consumers will be accomplished using the attributes of the basic entities. More specifically, the entities that comprise the consumer models are the `Installation` entity, the `Appliance` entity, the `Person` entity, the `Activity` entity and the `Producer` entity.

The following subsections briefly describe each of these entities. For additional details the reader may refer to Deliverable D3.1: "Preliminary model identification".

2.1.1 Installation entity

For each consumer instance (household, industrial etc) the installation is determined after having identified the appliances that comprise it as a whole.

The `Installation` entity is referring to the aggregation of all the appliances installed in a specific building/household etc. This entity has as attributes:

- appliances that are installed,
- people that interact in this specific installation (occupants),
- energy class of the specific installation,
- estimated CO_2 emissions,
- losses, and
- topology within the Distribution network.

The energy class of each installation is included in the features attributes, as the power consumption and the environmental impact differ among the different energy classes.

The estimated CO_2 emissions will be embedded in the model at the `Installation` level. This way, there will be the possibility of creating Demand Side Management (DSM) programs that will be able to achieve lower emission rates.

There may be the case that an installation consists of other installations, such as the case of the distribution network segment. In this case there is the attribute installation which contains all the particular installations aggregated at this node of the network. In this case the power losses in this node of the network are considerable and are embedded in the model as a special attribute. This will support the accuracy in the case of a DSM program in which precision in consumption and losses is necessary.

2.1.2 Appliance entity

The `Appliance` entity represents each appliance/electric device in an `Installation` (e.g. apartment/household/commercial building etc). The particular attributes of this entity are:

- active and reactive power consumption during an operating period (cycle),
- number of periods (cycles) that are needed to complete its function,
- standby consumption, and
- installation in which the appliance belongs.

2.1.3 Person entity

The `Person` entity is defined as each occupant of the `Installation` entity who may participate in specific activities. The attributes of this entity (as depicted in Annex B) are:

- `Activities` in which the person may be involved, and
- `Installations` associated with the person.

As far as the performed `Activities` are concerned, they vary among the different types of `Installations` that a `Person` may occupy (e.g., household, industrial installation). Through `Activities` a `Person` operates a set of `Appliances` with various consumption features.

The utility/satisfaction level of the `Person` entity is used in order to be able to model acceptance of DSM Programs by consumers as well as their use of specific energy products. More specifically, a `Consumer utility function model` is used to represent a consumer's comfort level given a set of `Activity` parameters (starting time, duration, appliance operation point etc.) as well as a set of external parameters (such as temperature or lighting). Consumer's comfort is therefore an important attribute in the model, as it affects the ability to shift the function of an `Appliance` at different time intervals, or change the operation scale of `Appliances`.

2.1.4 Activity entity

The activities performed by `Persons` in a residential, commercial or industrial building determine the total active and reactive power consumption at specific time intervals. Thus, it is important to have detailed description of the particular activities as well as the appliances involved.

The `Activity` entity represents each activity that may be performed in a consumer with or without being triggered by a `Person`. The attributes of this entity are:

- `Appliances` which need to be turned on during the particular activity,
- `Persons` which are involved both with their presence in the household and their intention to turn on an appliance even if they are absent,
- weather conditions sensitivity, and
- probability of occurrence.

CASSANDRA's main target is to model in high accuracy the activities taking place in each consumer's instance (household, C&I building etc) combining the appliances and people involved. This modelling will provide the advantage of DSM Programs simulation based on the concept of activity shifting.

2.2 Description of the business processes

A **business process** or **business method** is a collection of related, structured activities or tasks that produce a specific service or product (serve a particular goal) for a particular customer or customers. It often can be visualized with a flowchart as a sequence of activities with interleaving decision points or with a Process Matrix as a sequence of activities with relevance rules based on the data in the process.

There are three types of business processes:

- **Management processes**, the processes that govern the operation of a system. Typical management processes include "Corporate Governance" and "Strategic Management".
- **Operational processes**, processes that constitute the core business and create the primary value stream. Typical operational processes are Purchasing, Manufacturing, Advertising and Marketing, and Sales.
- **Supporting processes**, which support the core processes. Examples include Accounting, Recruitment, Call center, Technical support.

The *CASSANDRA* Business Processes are:

<BP-1> Simulation of Demand Side Environments

The current state of the art in load modeling utilizes top down approaches, aiming to measure, model and predict load at the transmission level of a power system. At the same time, there is a lack of respective tools for the modeling and prediction of the demand of individual (and/or small groups of) electric energy consumers, mainly due to the

respective lack of measurements in traditional power distribution networks. For that reason, electricity providers cannot efficiently monitor and estimate the consumption behavior of their customers, and are thus unable to offer them pricing schemes and services accustomed to their specific needs.

The *CASSANDRA* platform aims to be a simulation tool that will use a bottom up approach towards the modeling and estimation of the realistic electrical energy consumption of individual consumers, as well as groups of consumers. This modeling will be based on the appliances within the premises of a consumer, in combination with the consumers' activities that result in electric energy consumption. The user of *CASSANDRA* platform will be able to create Scenarios by adding `Installation`, `Appliance` and `Activity models` in order to model accurately real world environments. With this kind of demand side modeling, the *CASSANDRA* platform could be a very useful tool for energy providers aiming to deliver high quality services to their customers according to their own needs. Furthermore, *CASSANDRA* could be used by Distribution Network Operators (DNOs), providing them with information regarding peak and base loads of specific parts of the network, aiming to reduce infrastructure overloading.

<BP-2> Activity Based Simulation

Current research concerning the modelling of small-scale consumers is concerned with the utilization of specific electric appliances. This means that the respective incentives for an electric energy consumer to optimize his/her consumption are correlated with the manipulation of specific electric appliances, rather than the manipulation of the consumer's activities.

The *CASSANDRA* platform will provide **activity based modeling**. This will be achieved by correlating groups of appliances with the performing of specific activities. The result of this procedure is expected to provide better incentives for the optimization of a consumer's demand.

<BP-3> Modeling of Demand Side Management

Demand Side Management (DSM) is utilized today as a means to manipulate electric energy consumption at power distribution level, in order to achieve specific goals (such as energy reduction, or profit maximization). There is a lack however of tools for the modeling of consumer acceptance with respect to the different available DSM programs. This situation is aggravated by the respective lack of tools for the monitoring, modeling and simulation of the consumption patterns of individual consumers, or groups of consumers.

The *CASSANDRA* platform aims to provide a simulation tool for the application of DSM scenarios on small-scale consumers or groups of small-scale consumers, by modeling their level of acceptance/response to specific economic or other incentives. In order to achieve this *CASSANDRA* will use a consumer utility/satisfaction modeling approach that will allow

users to map changes in the electrical energy pricing scheme or the consumer behavior to changes in the consumer satisfaction level.

<BP-4> Modeling of Consumer Social Networks

Currently, small scale consumers are classified by energy providers into a few specific categories (e.g. residential, small/large commercial, small/large industry), due to the lack of tools that could track and identify the inherent heterogeneity within these groups. This leads to the inability of the energy providers to provide to their customers custom made services and pricing schemes.

The *CASSANDRA* platform aims to identify and group common or complementary consumption patterns and consumer profiles among large numbers of small scale electric energy consumers, offering thus the capability to form targeted groups of consumers (Consumer Social Networks, CSNs), and offer them accustomed services and pricing schemes.

<BP-5> Disaggregation of electrical power consumption

The disaggregation of load curves is a very useful procedure that may offer valuable understanding of electric energy consumption, by allocating this consumption to specific activities and/or electric appliances. Nowadays, this procedure is performed using statistic and demographic data derived from respective surveys.

The *CASSANDRA* platform will provide a tool for effective load disaggregation down to the level of small scale electric energy consumers. Combined with the bottom up approach in the modeling performed by the platform, this procedure will provide valuable information concerning the consumption patterns of large groups of consumers.

<BP-6> Usage of historic data for model training

The top down approach used today for the modeling of the demand side leads to the inability to utilize measurements at the level of small scale electric energy consumers in order to enhance the understanding concerning their consumption patterns.

The *CASSANDRA* platform aims to utilize historic data concerning the power demand of small scale consumers, in order to train their `Appliance` and `Activity models` and ultimately achieve a realistic estimation of their respective consumption.

<BP-7> Model retrieval from a `Web Service`

The Cassandra platform will provide a `web service` where users will be able to share (download or upload) *CASSANDRA* models. This process will lead to the creation of a continuously growing model repository with ready-to-use models that will cover a wide range of simulation scenarios, saving users from the trouble of having to create new consumer models from scratch.

<BP-8> Estimation of CO_2 emissions

The fuel mixture for the electric energy production in EU countries is today publicly available information, along with the CO_2 emissions per generated energy unit regarding every operating energy plant. The clear association between the energy consumed by each appliance in an installation and the CO_2 emission caused by this action can be deduced.

The *CASSANDRA* platform will be able to calculate the CO_2 emissions caused by every operating appliance and installation. This information could lead to increased awareness and, hence, reduction of CO_2 emissions. For example, this could be achieved by creating eco-friendly consumer groups, which will consume small amounts of energy, with their consumption performed during time periods that polluting power plants are not operating.

3 System Requirements

3.1 Functional Requirements

Functional Requirements are defined as the set of functionalities that the system or its components should provide to the user, as well as its behaviour, given certain inputs or system states.

Functional requirements may be calculations, technical details, data manipulation and processing and other specific functionality that define what a system is supposed to accomplish. Behavioral requirements describing all the cases where the system uses the functional requirements are captured in **Use Cases**.

A typical functional requirement will contain a unique name and number, a brief summary, and a rationale. This information is used to help the reader understand why the requirement is needed, and to track the requirement through the development of the system.

The crux of the requirement is the description of the required behavior, which must be clear and readable. The described behavior may come from organizational or business rules, or it may be discovered through elicitation sessions with users, stakeholders, and other experts within the organization.

<FR-1>

The `User` shall have the ability to Create Read Update and Delete `(CRUD)` a desired `Scenario`.		
Reference to BP:	*<BP-1>*	
Description:	The `User` shall be able to create/modify a `Scenario` by adding `Entity models`. Furthermore, the `User` may fork to/delete an already available `Scenario`, want to `CRUD` a desired `Scenario`.	
User priority:	5/5	It is very important for the `User` to be able to create, delete, load and edit a desired `Scenario`. This will allow him/her to use the *CASSANDRA* platform for the simulation of the respective consumer energy behavior.
Technical priority:	5/5	This requirement is very important from a technical point of view, because it is a prerequisite for the simulation.
Stability:	The stability of this functional requirement is certain, because the `User` will always have to create – delete – load – edit a desired simulation environment.	

<FR-2>

The `User` shall be able to create the desired `Group of installations models` by adding copies of `entity models` from `Library` or by adding demographic data.		
Reference to BP:	*<BP-1>*	
Description:	The `User` will be able to choose and add from the available `entity models` for the `Scenario`, in order to create the desired `Group of installations`. The `User` can also automatically create it utilizing demographic data.	
User priority:	5/5	It is very important for the `User` to be able to choose the important components that will comprise the `Group of installations` for each `Scenario`.
Technical priority:	4/5	This requirement is very important from a technical point of view, because it ensures that the platform will provide the necessary tools for the `Scenario` creation.
Stability:	The stability of this functional requirement is certain, because the `User` will always have to add desired `models` to the `Scenarios` from `Library`.	

<FR-3>

The `User` shall be able to modify the copies of the `entity models` included in the `Group of installations models` of the `Scenarios`.		
Reference to BP:	*<BP-1>*	
Description:	The `User` will be able to edit the parameters of the copied `entity models` in `Scenarios` in order to modify the `Group of installations`.	
User priority:	5/5	It is very important for the `User` to be able to edit the important components that will comprise the `Group of installations` for each `Scenario`.
Technical priority:	4/5	This requirement is very important from a technical point of view, because it ensures that the platform will provide the necessary tools for the `Scenario` modification.

Stability:	The stability of this functional requirement is certain, because the `User` will always have to edit desired `models` included in `Scenarios`.

<FR-4>

The `User` shall not be able to modify the *CASSANDRA* Verified and 3rd party `entity models` included in the `Library`.

Reference to BP:	*<BP-1>*	
Description:	The `User` is not authorized to edit predefined `Library` models. In order to modify the already available models should copy them to the `Scenarios` before editing.	
User priority:	5/5	It is very important for the `System` that the `User` is not able to edit the predefined Library models.
Technical priority:	4/5	This requirement is very important from a technical point of view, because it ensures the Library models' integrity.
Stability:	The stability of this functional requirement is certain.	

<FR-5>

The `User` shall have the ability to insert `Activity models` from `Library` to a `Person model`.

Reference to BP:	*<BP-2>*	
Description:	The `User` may insert a number of different `Activity models` that are already stored in the platform's `Library`, into `Person models` in the `Scenario` in order to customize them.	
User priority:	5/5	It is very important for the `User` to be able to add `Activity models` to every `Person model`, aiming to make every simulated behavior resemble the real case.
Technical priority:	5/5	This requirement is very important from a technical point of view, as the information regarding the `Activity`

		models takes place by each Person model are essential for the simulation output.
Stability:	The stability of this functional requirement is certain, because it will always be useful to add Activity models into Person models.	

<FR-6>

The User shall have the ability to insert Appliance and Person models from Library to an Installation model.		
Reference to BP:	*<BP-1>*	
Description:	After having inserted the desired installations types, the User may want to add in the installation model specific appliance models that are already stored in the platform's Library.	
User priority:	5/5	It is very important for the User to be able to add appliance models to every installation, aiming to make every installation resemble the real case.
Technical priority:	5/5	This requirement is very important from a technical point of view, as the information regarding the appliances of each installation is essential for the simulation output.
Stability:	The stability of this functional requirement is certain, because it will always be useful to add appliance models into installations.	

<FR-7

The User shall be able to export the modified entity models from the Scenarios to the Library's custom models.		
Reference to BP:	*<BP-1>*	
Description:	The User may want to add modified entity models in the Library for later reuse in another Scenario.	
User priority:	5/5	It is very important for the User to be able to reuse the custom made entity models.

Technical priority:	4/5	This requirement is important from a technical point of view, because it ensures that the platform will be able to save custom made `entity models` in `Library`.
Stability:	The stability of this functional requirement is certain, because the `User` may always want to save custom made `entity models` in `Library`.	

<FR-8>

The `User` shall be able to download `entity models` to the `Library`, using a `web service`.		
Reference to BP:	*<BP-7>*	
Description:	The `User` may want to use an `entity model` that is not preinstalled, but it is available through a `web service`. The `User` downloads the desired model and stores it to the `Library`.	
User priority:	5/5	It is very important for the `User` to be able to use an `entity model` not included in the *CASSANDRA* platform, but is only available through a `web service`.
Technical priority:	5/5	This requirement is important from a technical point of view. Given this functionality, the `User` may use a variety of `entity models` making the `Scenario` more similar to the actual consumer installations.
Stability:	The stability of this functional requirement is certain, because it will always be useful to download new `entity model` using a `web service`.	

<FR-9>

The `User` shall be able to upload custom made `entity models` from `Library`, using a `web service`.		
Reference to BP:	*<BP-7>*	
Description:	The `User` may want to upload an `entity model` custom made by him/her through a `web service`. This will be	

	available as 3rd party model to other *CASSANDRA* `Users` for their `Scenarios`.	
User priority:	3/5	It is of minor importance for the `User` to be able to upload new custom made `entity models` created.
Technical priority:	4/5	This requirement is important from a technical point of view.
Stability:	The stability of this functional requirement is certain, because it may be useful to upload new `entity model` using a `web service`.	

<FR-10>

The `User` shall be able to create new `pricing schemes` by modifying several pricing parameters.		
Reference to BP:	*<BP-3>*	
Description:	The `User` may want to create diverse pricing policies to evaluate their impact on the `Group of installation models`. Pricing policies' parameters are the electrical energy cost, tiered electricity rates, peek pricing and so on.	
User priority:	5/5	This requirement is very important for the `User`, because it will allow him/her to test a number of different `pricing schemes`.
Technical priority:	5/5	This requirement is very important from a technical point of view, because the `User` shall be able to choose different `pricing schemes` and apply them to the `Scenario`.
Stability:	The stability of this functional requirement is certain.	

<FR-11>

The `User` shall be able to insert weather data using an external source.	
Reference to BP:	*<BP-1>*
Description:	The electrical consumption of specific appliances may be

	influenced by weather conditions. For this reason, the `System` shall be able to receive data concerning the temperature data for the `Scenario` using an external source.	
User priority:	5/5	This functionality is important for the `User`, because it influences some appliance models, and thus the simulation results.
Technical priority:	5/5	This requirement is very important from a technical point of view, because it influences some appliance models, and thus the simulation results.
Stability:	The stability of this functional requirement is certain.	

<FR-12>

The `User` shall be able to insert data regarding either the hourly `Fuel type mixture` or the annual `Fuel type mixture` of active power plants.		
Reference to BP:	*<BP-8>*	
Description:	The `User` shall have the ability to insert data regarding the operating power plants with respective information regarding to their CO_2 emissions. This information will be used by the `System` during the calculations of CO_2 emissions, and the association of each operating appliance's energy consumption with CO_2 emissions. The `User` can provide manually both hourly and annual data.	
User priority:	5/5	This requirement is very important for the `User`, because this information will be used for the CO_2 emissions calculation procedure.
Technical priority:	5/5	This is really important for our team, because this information will be used for the CO_2 emissions calculation procedure.
Stability:	The stability of this functional requirement is certain.	

<FR-13>

The `User` shall have the ability to modify default CO_2 `emission factor`.		
Reference to BP:	*<BP-8>*	
Description:	While editing the parameters concerning the CO_2 emissions calculations, the `User` may want to modify the predefined CO_2 emission factors that the platform takes into account, so as to adjust them according to the real factors of the power plants considered.	
User priority:	5/5	This requirement is very important for the `User`, because it allows him/her to adjust the data to the real CO_2 emission factors of the power plants considered.
Technical priority:	5/5	This requirement is very important from a technical point of view, because it allows the `User` to adjust the data to the real CO_2 emission factors of the power plants considered.
Stability:	The stability of this functional requirement is certain.	

<FR-14>

The `User` shall be able to utilize a calendar to specify the temporal simulation parameters.		
Reference to BP:	*<BP-1>, <BP-6>*	
Description:	The platform will provide an embedded calendar in order to fully specify the Scenario simulation duration, the type of days, associated to the respective weather and fuel type mixture data.	
User priority:	5/5	This functionality is important for the `User`, because it defines crucial simulation parameters.
Technical priority:	5/5	This requirement is very important from a technical point of view, because it influences the simulation results.
Stability:	The stability of this functional requirement is certain.	

<FR-15>		
The `User` shall be able to define several `Scenario` simulation parameters.		
Reference to BP:	*<BP-1>*	
Description:	The `User` can specify simulation parameters for every Scenario, such as enabling Monte Carlo simulation, the number of iterations, keeping of random seed etc.	
User priority:	5/5	This functionality is important for the `User`, because it defines crucial simulation parameters.
Technical priority:	5/5	This requirement is very important from a technical point of view, because it influences the simulation results.
Stability:	The stability of this functional requirement is certain.	

<FR-16>		
The `User` shall be able to form CSNs by defining `grouping criteria`.		
Reference to BP:	*<BP-4>*	
Description:	After having determined the desired installations in the `Scenario`, the `User` may want to create `CSN's` among installations that may correspond to existing or new groups of consumers. To this end he defines a set of separation rules.	
User priority:	5/5	It is very important for the `User` to be able to define separation rules in order to insert and edit consumer groups into the platform.
Technical priority:	5/5	This requirement is very important from a technical point of view, because CSN's will influence drastically the simulation results.
Stability:	The stability of this functional requirement is certain, because it will always be useful for the `User` to create consumer groups.	

<FR-17>		
The `User` shall be able to modify the clustering criteria.		
Reference to BP:	*<BP-4>*	
Description:	The `User` may want to modify the clustering criteria so as to simulate a specific consumer clustering approach. The `System` shall provide this functionality.	
User priority:	5/5	This requirement is very important for the `User`, because the consumer clustering may enhance the providing service.
Technical priority:	5/5	This requirement is very important from a technical point of view, because the consumer clustering may enhance the services provided by the `User`.
Stability:	The stability of this functional requirement is certain.	

<FR-18>		
The `System` shall be able to propose to the `User` `CSN` patterns over the `Group of Installations models`, using meaningful `clustering criteria`.		
Reference to BP:	*<BP-4>*	
Description:	After having determined the desired installations in the `Scenario`, the `User` may want to create `CSN`'s among installations that may correspond to existing or new groups of consumers. To this end, the `System` may propose a several solutions resulting from `clustering criteria`.	
User priority:	5/5	It is very important for the `User` to have multiple `CSN` suggestions in order to decide over the consumer groups into the platform.
Technical priority:	5/5	This requirement is very important from a technical point of view, because `CSN's` will influence drastically the simulation results.
Stability:	The stability of this functional requirement is certain, because it will always be useful for the `User` to create consumer groups.	

<FR-19>		
The `User` shall be able to insert `Measurement data` of active and reactive power using a predefined structured format.		
Reference to BP:	*<BP-6>*	
Description:	The `User` may want to import measurement data of active and reactive power in the *CASSANDRA* platform for further processing and training to use them as custom made `entity models`.	
User priority:	5/5	It is very important for the `User` to be able to import `Measurement data` using an external data source.
Technical priority:	5/5	This requirement is very important from a technical point of view, because it will help improve and customize the models of each installation.
Stability:	The stability of this functional requirement is certain, because it will always be useful for the `User` to import existing `measurement data` for the improvement of simulation results.	

<FR-20>		
The `System` shall be able to display stored `Measurement data` and basic statistics, such as total energy consumption, peek values, `CSN`s.		
Reference to BP:	*<BP-6>*	
Description:	The `User` may have imported `measurement data`. If this is the case, the `System` shall have the ability to display corresponding diagrams and statistics. The data shall be displayed for a single installation or a group of installations depending on the will of the `User`.	
User priority:	3/5	The availability of diagrams and statistics corresponding to historical measurement data is of medium importance for the `User`.
Technical priority:	3/5	This requirement is of medium importance from a technical point of view.
Stability:	The stability of this functional requirement is certain.	

<FR-21>		
The `System` shall be able to `Disaggregate` imported `Measurement data`, using specific `disaggregation` algorithms.		
Reference to BP:	*<BP-5>*	
Description:	After having imported measurement data concerning specific installations the `User` may want to disaggregate the measurements in order to detect the activities and the corresponded appliances that take place in the `installation`.	
User priority:	5/5	This functional requirement is very important for the `User` as it gives him/her the possibility to exploit `measurements data`.
Technical priority:	5/5	This requirement is very important from a technical point of view as it is the first step all the procedures of simulation and training.
Stability:	The stability of this functional requirement is certain.	

<FR-22>		
The `System` shall be able to create new `Appliance` and `Activity models`, by `Training models` using the available `Disaggregation products`.		
Reference to BP:	*<BP-5>,<BP-6>*	
Description:	The available `Measurement data` corresponding to a certain installation can be used for the training of its `Appliance` and `Activity models` by the `User`. In order to this the `System` will use the `Disaggregation products`. This could lead to simulation results improvement.	
User priority:	5/5	This requirement is very important for the `User`, because this procedure may drastically improve the simulation results.
Technical priority:	5/5	This requirement is very important from a technical point of view, because this procedure may drastically improve the simulation results.

Stability:	The stability of this functional requirement is certain, because the models shall always be trained by available `Measurement data`.

<FR-23>

The `System` shall save `Trained Appliance` and `Activity models` in the `Library` as custom made models.

Reference to BP:	*<BP-6>*	
Description:	After the training procedure the `Activity` and `Appliance` models that correspond to the specific installation will be stored in the platform's `Library` for future use.	
User priority:	5/5	This requirement is very important for the `User`, because he can have `trained models` for each installation stored in the `Library`.
Technical priority:	5/5	This requirement is very important from a technical point of view, because the `trained models` will be used in the design of the `Scenario`.
Stability:	The stability of this functional requirement is certain, because the `trained models` shall always be stored in the platform `Library`.	

<FR-24>

The `User` shall be able to impose different `pricing scheme models` for different `CSN`s.

Reference to BP:	*<BP-3>,<BP-4>*	
Description:	The `User` may want to simulate a different pricing scheme for a specific `group of installations`, and a different one for another group, in order to determine the best approach for every individual group. The `System` shall have the ability to accept and simulate such schemes.	
User priority:	5/5	This requirement is very important for the `User`, because this functionality will provide him/her with further

		knowledge regarding the consumers' behavior.
Technical priority:	5/5	This requirement is very important from a technical point of view, because this functionality will provide further knowledge to the `User` regarding the consumers' behavior.
Stability:	The stability of this functional requirement is certain.	

<FR-25>

The `System` shall simulate created `Scenarios`, producing realistic operation instances for the given `Scenarios'` configurations.		
Reference to BP:	*<BP-1>, <BP-2>*	
Description:	After having configured the desired `Scenarios`, the `User` may want to simulate their operation regarding their energy consumption for a predefined time period. The `System` shall simulate and produce a realistic instance of their electrical consumption.	
User priority:	5/5	This requirement is very important for the `User`, because this functionality corresponds to the main objective of the platform.
Technical priority:	5/5	This requirement is very important from a technical point of view, because this functionality corresponds to the main objective of the platform.
Stability:	The stability of this functional requirement is certain.	

<FR-26>

The `User` shall be able to start/pause/stop the currently running simulation.		
Reference to BP:	*<BP-1>, <BP-2>*	
Description:	The `User` may want to control the simulation flow. The platform should give this ability.	
User priority:	4/5	This requirement is important for the `User`, because this

		functionality will make the platform easier to use.
Technical priority:	4/5	This requirement is important from a technical point of view, because this functionality will provide a user friendly simulation environment.
Stability:	The stability of this functional requirement is certain.	

<FR-27>

The `System` shall associate every `Appliance model`'s energy consumption to CO_2 emissions, and display them to the `User`.		
Reference to BP:	*<BP-8>*	
Description:	The CO_2 emissions due to the operation of an appliance are related to the national fuel mixture for the specific time frame. The `System` shall calculate these CO_2 emissions and display them to the `User`.	
User priority:	5/5	This requirement is very important for the `User`, because this particular association is essential for a potential CO_2 reduction policy.
Technical priority:	5/5	This requirement is very important from a technical point of view, because the CO_2 calculation procedure is a crucial functionality of the platform.
Stability:	The stability of this functional requirement is certain.	

<FR-28>

The `System` shall display in real time `User` selected diagrams and statistics for each simulation run.		
Reference to BP:	*<BP-1>*	
Description:	While simulation is running, the `System` shall be able to display current calculated curve values and the corresponding statistics.	

User priority:	5/5	This requirement is very important for the `User`, because it will allow him/her to evaluate the simulation results.
Technical priority:	5/5	This requirement is very important from a technical point of view, because it will allow the evaluation of the simulation results.
Stability:	The stability of this functional requirement is certain.	

<FR-29>

The `System` shall have the ability to display the simulation results at all levels of abstraction from an individual `Appliance model` to the whole `Scenario`.		
Reference to BP:	*<BP-1>*	
Description:	After concluding a simulation, the `User` may want to observe its results at different levels of abstraction. The `System` shall provide this functionality producing results regarding from an individual appliance to the whole simulated world.	
User priority:	5/5	This requirement is very important for the `User`, because it will allow him/her to evaluate the simulation results.
Technical priority:	5/5	This requirement is very important from a technical point of view, because it will allow the evaluation of the simulation results.
Stability:	The stability of this functional requirement is certain.	

<FR-30>

The `System` shall be able to display comparison diagrams and statistics between `User` selected `Scenarios`.		
Reference to BP:	*<BP-1>*	
Description:	The User may want to compare results between preselected Scenarios in order to evaluate the resulting outcomes of alternate configurations.	
User priority:	5/5	This requirement is very important for the `User`, because it will allow him/her to evaluate the simulation results.

Technical priority:	5/5	This requirement is very important from a technical point of view, because it will allow the evaluation of the simulation results.
Stability:	The stability of this functional requirement is certain.	

3.2 Use case scenarios

In software and systems engineering, a Use Case (a case in the use of a system) is a list of steps, typically defining interactions between a role (known in UML as an "actor") and a system, to achieve a goal. The actor can be a human or an external system.

The use case diagrams concerning the platform functionality are presented below, followed by the Use Case Analysis.

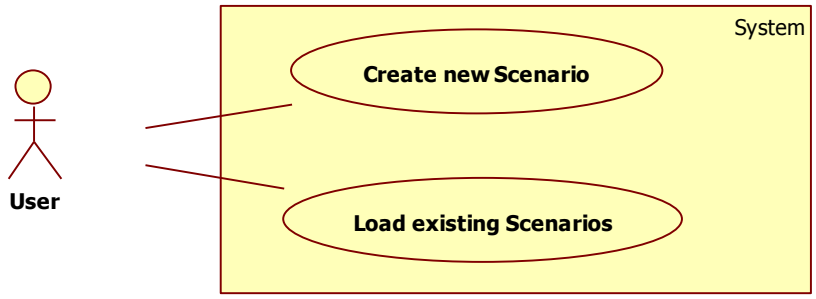

Diagram 1: Use Case Diagram, `System` Entry

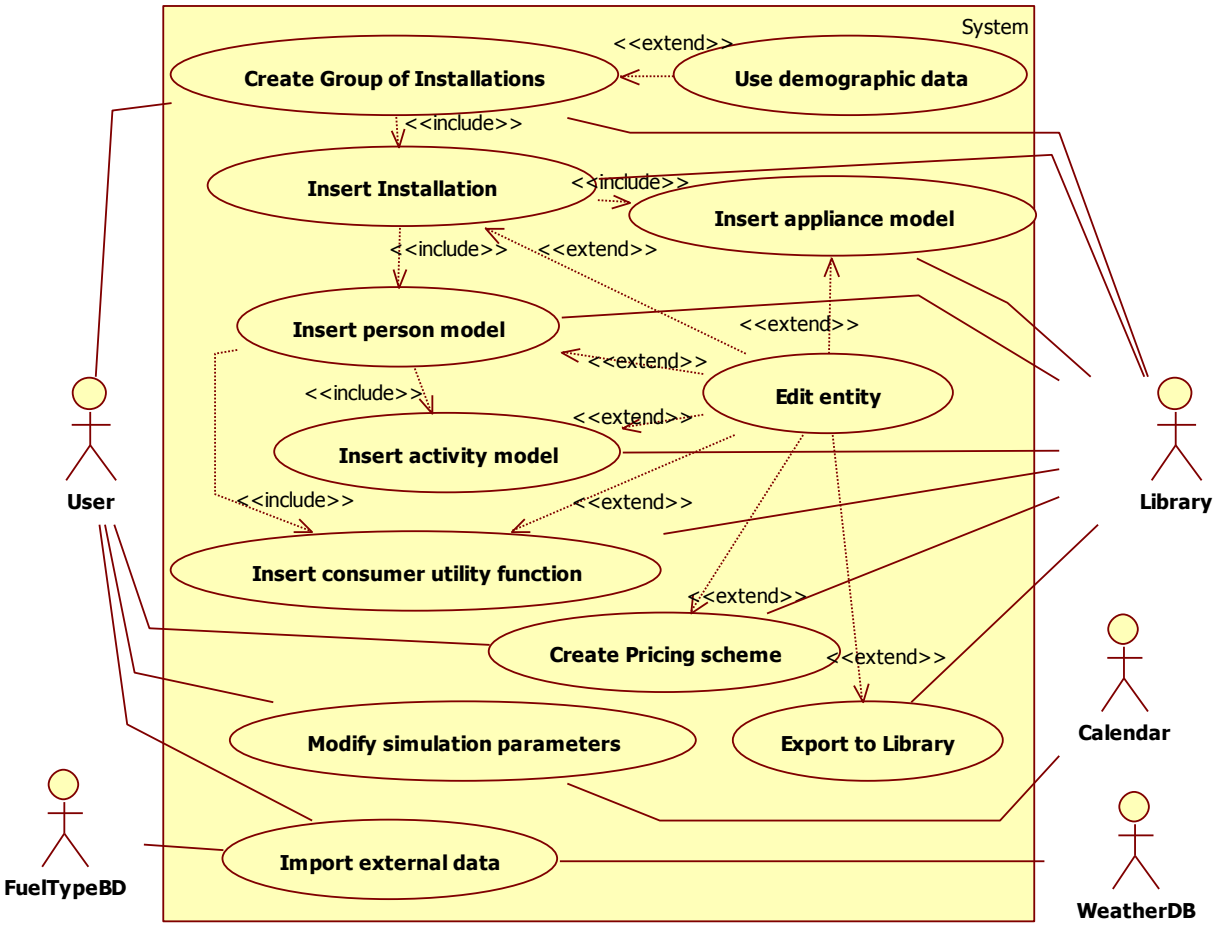

Diagram 2: Use Case Diagram, Create `Scenario`

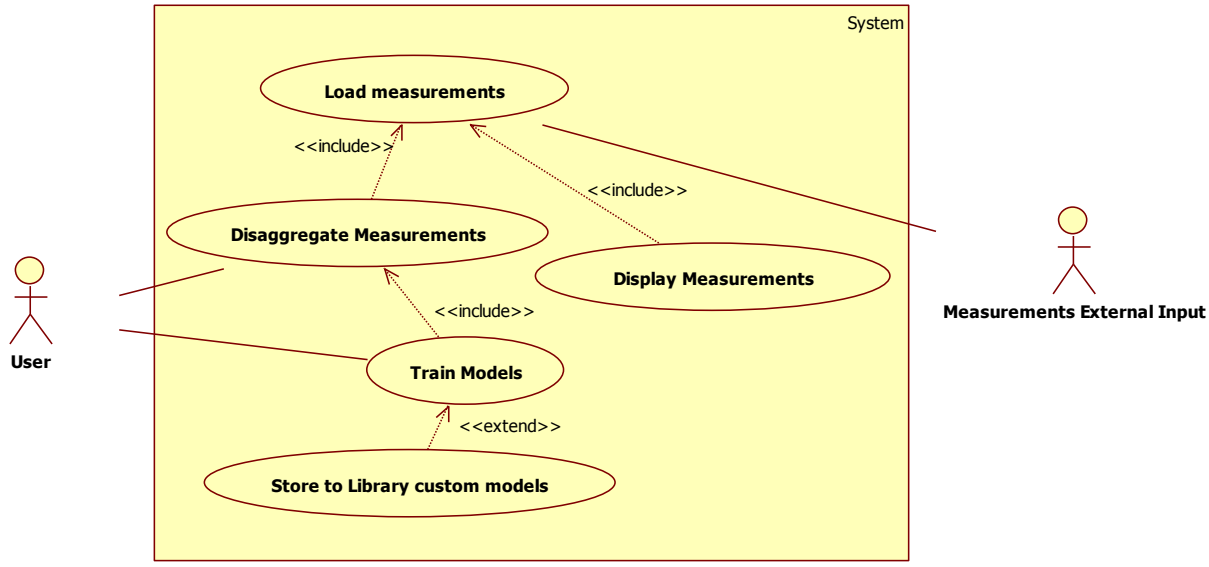

Diagram 3: Use Case Diagram, `Model training`

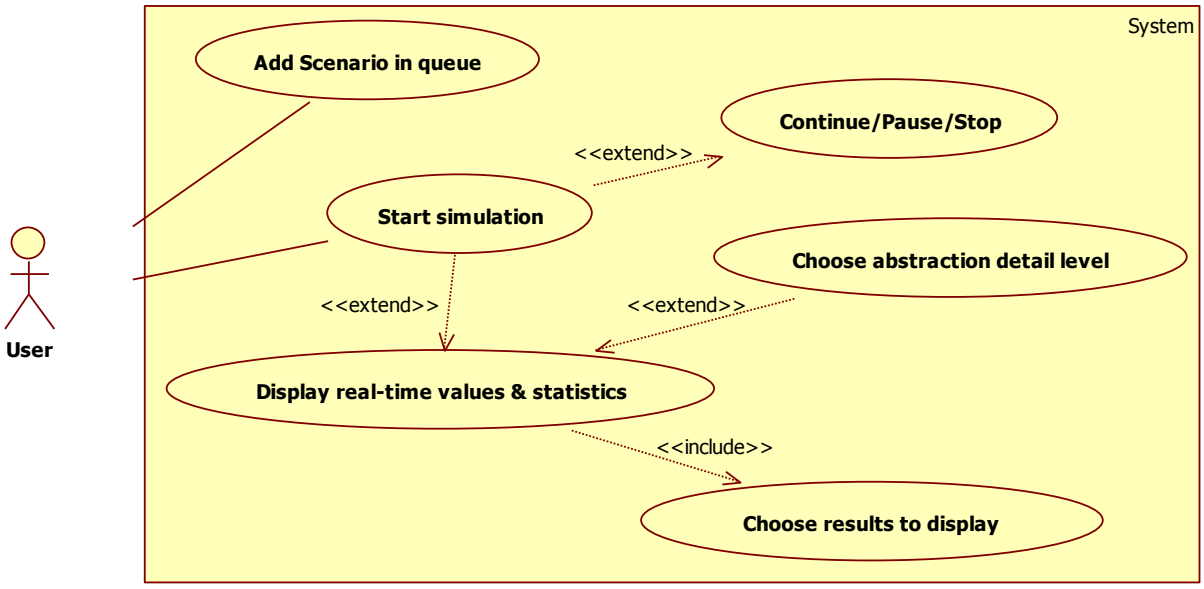

Diagram 4: Use Case Diagram, Simulation workspace

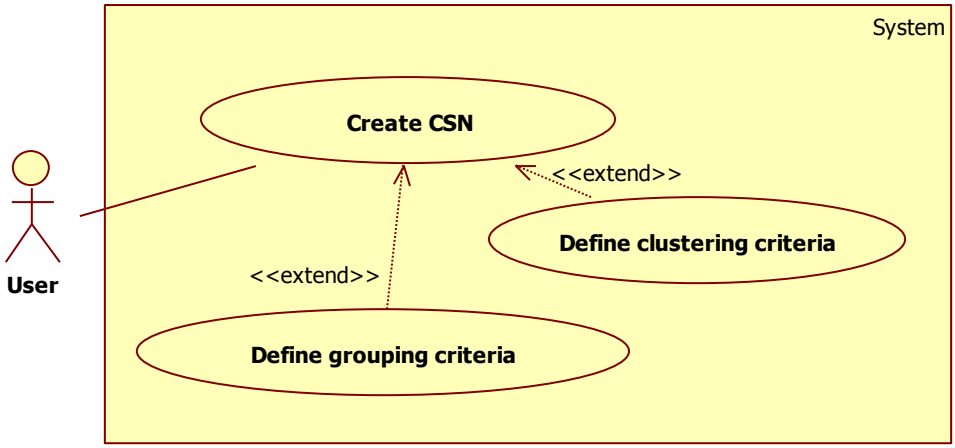

Diagram 5: Use Case Diagram, CSN creation

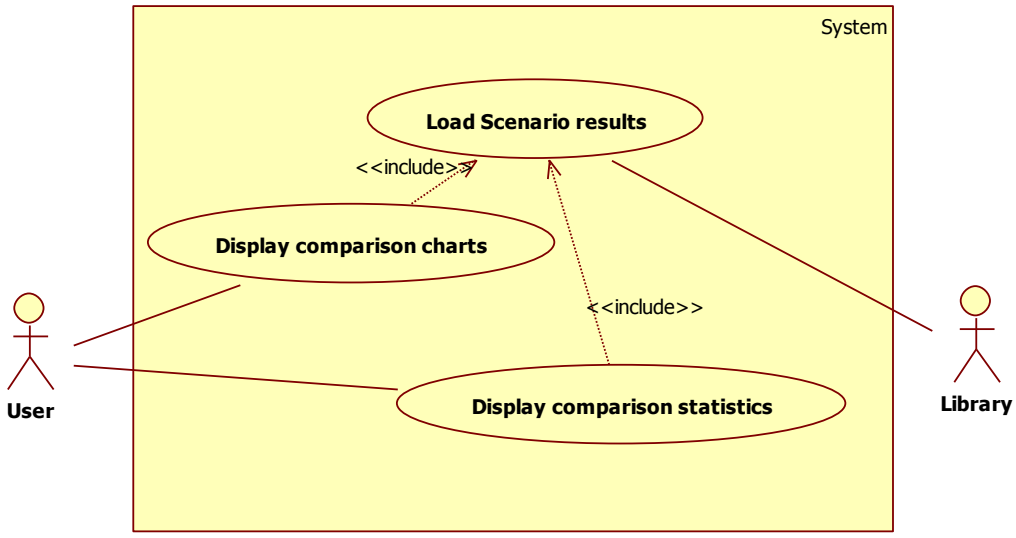

Diagram 6: Use Case Diagram, Result's comparison

3.2.1 <UC-1>: Create new `Scenario`

Reference to FR:	FR-1 – FR-14, FR 24
Short Description	The `User` creates a new `Scenario` by adding several `Installation models` with desirable `Person` and `Appliance models`, creating and adding `Pricing Schemes`, import weather or fuel data and modify the simulation parameters.
Activity Firing:	The `User` enters the system and chooses to create a new `Scenario`.
Precondition:	The `User` has already entered in the `System`

Main Flow: The `User` adds/modifies the important `Entity models` and parameters that comprise the `Scenario`.

Line	User Action	System Response
1	The `User` adds a set of new `Installation models` from the `Library`.	The `System` adds a set of `installation models` to the `Scenario's Group Of Installations` in the `Scenario` Environment. The `System` adds the set of `Installation models` to the `Scenario's Library`
2	The `User` adds a set of new `Appliance models` from the `Library` to the included `Installation models`.	The `System` adds a set of `Appliance models` to the `Scenario's Installation models` in the `Scenario` Environment. The `System` adds the set of `Appliance models` to the `Scenario's Library`.
3	The `User` adds a set of new `Person models` from the `Library` to the included	The `System` adds a set of `Person models` to the `Scenario's Installation models` in the

	Installation models.	Scenario Environment. The System adds the set of Person models to the Scenario's Library.
4	The User adds a set of new Activity models from the Library to the included Person models.	The System adds a set of Activity models to the Scenario's Person models in the Scenario Environment. The System adds the set of Activity models to the Scenario's Library
5	The User adds a set of new Utility Function models from the Library to the included Person models.	The System adds a set of Utility Function models to the Scenario's Person models in the Scenario Environment. The System adds the set of Utility Function models to the Scenario's Library
6	The User adds a set of Pricing Scheme models from the Library for the current Scenario.	The System adds the set of Pricing Scheme models to the Scenario's Library.
7	The User imports external Weather and Fuel data files for the current Scenario.	The System reads the data and adds them to the Scenario Weather and Fuel parameters.
8	The User configures the simulation parameters of the Scenario.	The System saves the Simulation parameters for the current Scenario.
9	The User presses the "Save" button.	The System saves the Scenario in the Library.
Subsequent State:	The User created a new Scenario and the Entity models are now stored in the Scenario's Library.	

Alternative Flow (AF1): Use Demographic Data For `Scenario's Group Of Installation` creation		
While in line 1 of the Main Flow of the <UC-1>, the `User` may want to load a file that contains demographic data of an `Group Of Installations`, then:		
Line	**User Action**	**System Response**
1	The `User` presses the "Load Demographics" Button.	The `System` opens a File Browser.
2	The `User` selects the demographic data file from a File Browser.	The `System` reads the demographic data from the file and creates the according `Group Of Installations`. The `System` stores the newly created `Group Of Installations` to the `Scenario's Library`.
The Use Case continues form the 6th line of the Main Flow of <UC-1>		
Subsequent State:	The `User` has created a `Group Of Installations` for the current `Scenario`.	

Alternative Flow (AF2): Edit `Entity Model`		
While in line 1,2,3,4, 5 or 6 of the Main Flow of the <UC-1>, user may want to edit the `Entity model` he added to the `Scenario`, then:		
Line	**User Action**	**System Response**
1	The `User` edits the parameters of the `Entity model` of the `Scenario`.	The `System` recalculates the `Entity model` behavior given the new parameters. The `System` displays the new behavior to the user.
2	The `User` presses the "Save" Button.	The `System` saves the changes to a copy of the `Entity model`. The `System` saves the new edited copy of the `Entity model` to the `Scenario's Library`.

The Use Case continues form the next line where the Main Flow of <UC-1> forked.	
Subsequent State:	The `User` has edited the `Entity model` and added it to the `Scenario's Group Of Installations`.

Alternative Flow (AF3): Export `Entity model` to `Library`.		
While editing an `Entity model`, the `User` may want to Export the newly created model to the *CASSANDRA* Library, in order to use it on other scenarios. Then:		
Line	**User Action**	**System Response**
1	The `User` selects "Export to `Library`" Button.	The `System` stores the `Entity model` to the displays the available `Scenarios`.
2	The `User` selects the desirable `Scenario`.	The `System` loads and displays the selected `Scenario`.
The Use Case continues form the next line where the Main Flow of <UC-1> forked.		
Subsequent State:	The User has edited the Entity model and added it to the `Scenario's Group Of Installations`, as well as to the *CASSANDRA* `Library` as custom made models.	

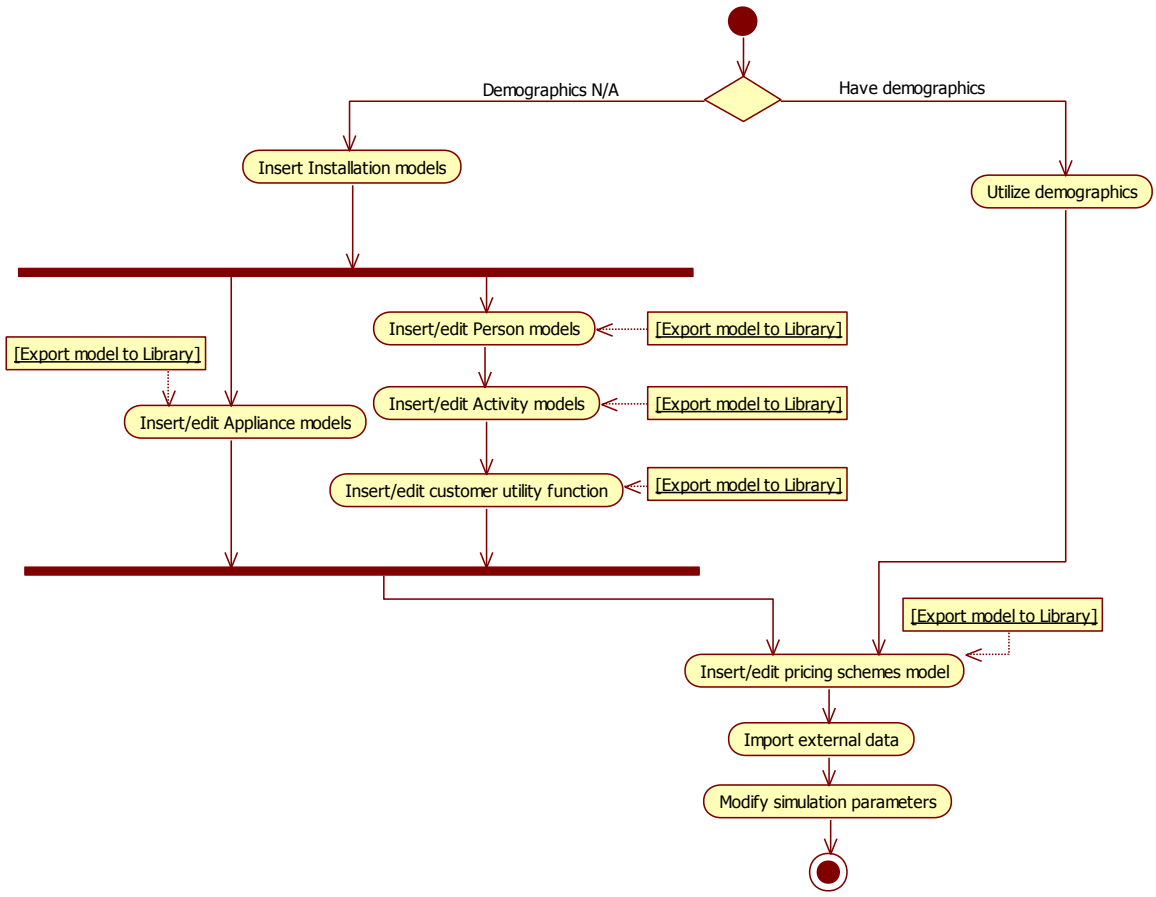

Diagram 7: Activity Diagram UC-1

3.2.2 <UC-2>: Manage Measurements

Reference to FR:	FR-19 – FR-23
Short Description:	The `User` imports `Measurement data` from an external input. Subsequently the `Disaggregation` process is applied and optionally the `System` trains the `Activity` and `Appliance models` exploiting the disaggregation product.
Activity Firing:	The `User` chooses "`Train Models`" Tab.
Precondition:	The `User` has already stored `Measurement data` in the external

	input

Main Flow: The User imports Measurement data from an external input. The System Disaggregates the Measurement data, trains the Activity and Appliance models and stores them to the Library. Afterwards the User can display the results		
Line	**User Action**	**System Response**
1	The User selects to import Measurement data from an external input.	The System imports the Measurement data from the external input.
2		The System displays the options: "Dissagregate Measurement Data", "Train models from Measurement data" or "Display Measurement data".
3	The User selects "Disaggregate Measurement Data"	The System Disaggregates the Measurement data.
4	The User selects "Train models from Measurement data".	The System trains the Activity and Appliance models.
5		The Systems saves the trained models in the *CASSANDRA* Library as custom made models.
6	The User selects to display the desirable results.	The System displays the desirable results.
Subsequent State:	The User has created trained Activity and Appliance models associated to the measurement data and stored them to the *CASSANDRA* Library.	

Alternative Flow (AF1): The User imports Measurement data without Disaggregation and Activity and Appliance model train processes.

While in line 3 of the main Flow of the UC-2 User selects to "Display Measurement data", then:		
Line	**User Action**	**System Response**
1	The `User` selects to "Display Measurement data".	The `System` displays the parameters that can be calculated from the `Measurement data`.
2	The `User` selects to display the desirable results.	The `System` displays the desirable results.
The Use Case Scenario ends		
Subsequent State:	The `User` had displayed the imported `Measurement data`	

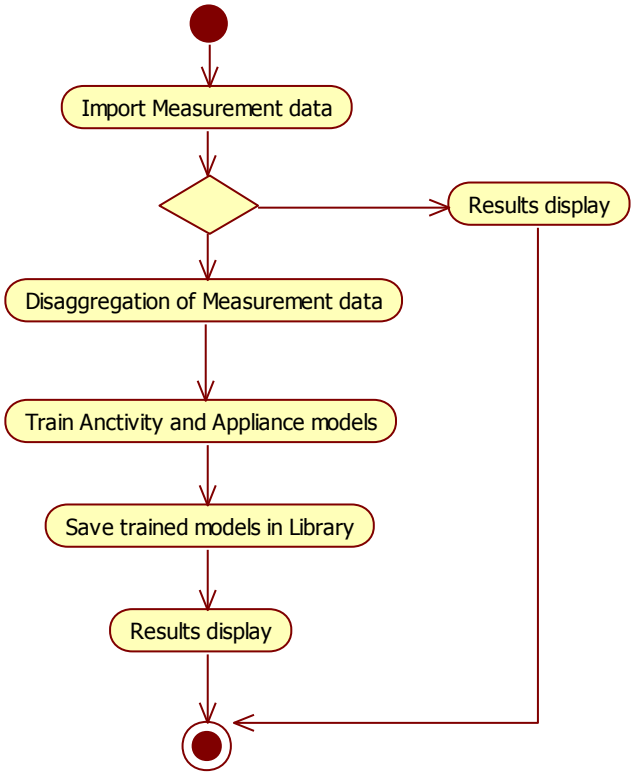

Diagram 8: Activity Diagram UC-2

3.2.3 <UC-3>: Run Simulation

Reference to FR:	FR-25 – FR-29
Short Description:	The `User` adds `Simulation Scenarios` in queue, executes `Simulation`, chooses the displayed parameters and controls the `Simulation` flow.
Activity Firing:	The `User` wants to simulate the consumption and behavior of the `Group of Installation models` existing in the `Scenarios`
Precondition:	The `User` created `Scenario`

Main Flow: The `User` adds in queue the desired `Scenario` wanting to simulate it. The `User` chooses the displayed parameters, can control the simulation flow and can choose whether to see the real-time statistics

Line	User Action	System Response
1	The `User` selects "Add `Scenario` in queue".	The `System` displays all the available `Scenarios`.
2	The `User` selects the desirable `Scenario`.	The `System` accepts.
3	The `User` selects "Start `Simulation`".	The `System` starts the simulation.
4	If the `User` selects to Pause / Stop / Continue the `Simulation` flow.	The `System` pauses/stops/continues the `Simulation`.
5	If the `User` selects to see real-time statistics.	The `System` displays the desirable real-time statistics.

Subsequent State:	The `User` simulated the energy consumption and behavior of the `Installations models` in the `Scenario`.

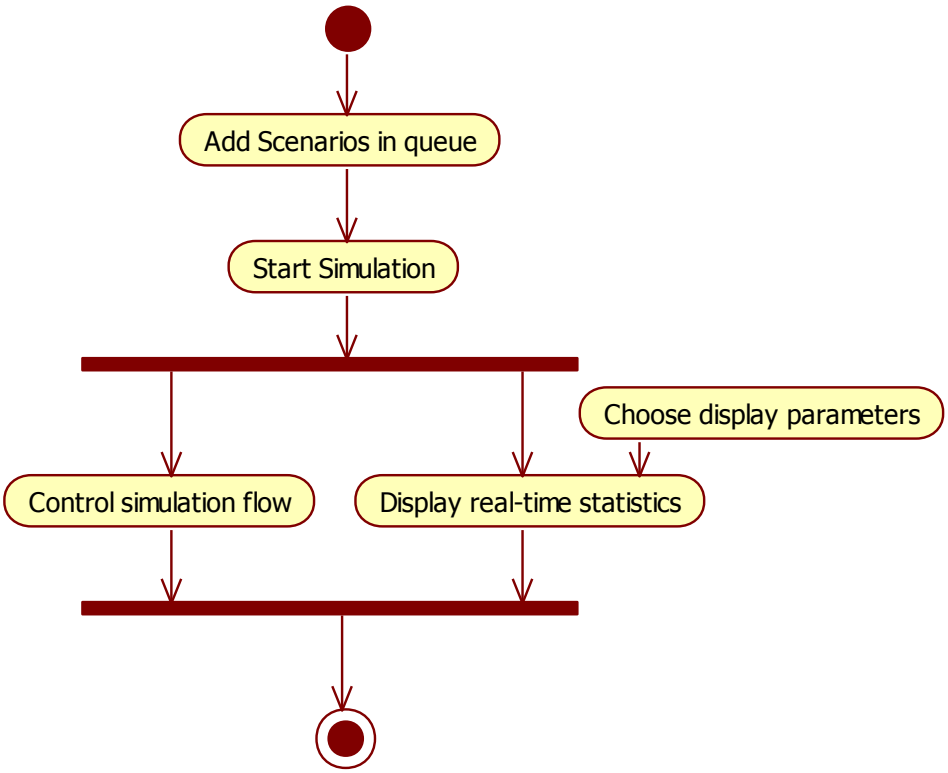

Diagram 9: Activity Diagram UC-3

3.2.4 <UC-4>: Create CSNs

Reference to FR:	FR-16 – FR-18
Short Description:	The `User` wants to create `CSNs`.
Activity Firing:	The `User` selects "`CSNs`" Tab.
Precondition:	The `User` should have inserted multiple `Installation models` in the `Scenario` under construction.

Main Flow: Create new `CSN` from the `Scenario's Installation models`.

Line	User Action	System Response
1	The User selects "Create New CSN Group"	The System displays the options: "Define Grouping Criteria" and "Define Clustering Criteria".
2	The User selects "Define Grouping Criteria"	The System displays the parameters over which user has power for the grouping of the available Installation models of the Scenario.
3	The User defines the parameters over the Grouping Criteria.	The System utilizes the available Installation models in order to create the correct CSNs from the parameters.
4	The User selects "Save the Created Groups".	The System saves the selected group in the Scenario's Library.
Subsequent State:	The User has created CSN models and stored them to the Scenario's Library.	

Alternative Flow (AF1): Load a preciously stored CSN.		
While in line 1 of the Main Flow of the <UC-4>, user may want to Load an already available CSN from the *CASSANDRA* Library, then:		
Line	**User Action**	**System Response**
1	The User selects to "Load an Existing CSN"	The System returns the existing CSN models available in the Library.
2	The User selects one of the available CSNs for the Installation models.	The System creates the CSN for the current Scenario. The System saves the newly created CSN to the Scenario's Library.

End of Use Case.	
Subsequent State:	The User has created CSN and stored it to the Scenario's Library.

Alternative Flow (AF2): Create CSNs by Clustering Criteria.		
While in line 2 of the Main Flow of the <UC-4>, user may want to utilize Clustering Criteria instead of the manual Grouping Criteria, then:		
Line	**User Action**	**System Response**
1	The User selects to "Define Clustering Criteria"	The System displays a set of different Clustering conditions for CSN creation.
2	The User chooses one of the available Clustering Criteria.	The System utilizes the available Installation models in order to create the correct CSNs from the parameters.
3	The User selects "Save the Created Groups".	The System saves the selected group in the Scenario's Library.
End of Use Case.		
Subsequent State:	The User has created CSN models and stored them to the Scenario's Library.	

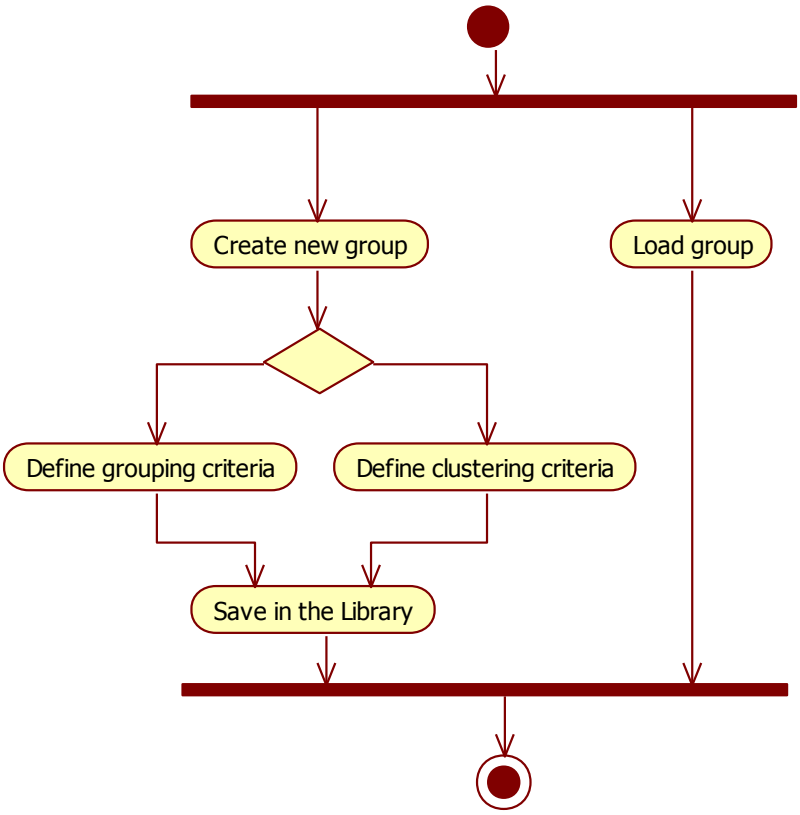

Diagram 10: Activity Diagram UC-4

3.2.5 <UC-6>: Scenario Results Comparison

Reference to FR:	FR-27 – FR-30
Short Description:	In this Use Case Scenario the `User` wants to compare simulation results
Activity Firing:	The `User` selects "`Scenario` Results Comparison" Tab
Precondition:	The `User` has simulated various `Scenarios`

Main Flow: The `User` wants load scenario results from the system `Library` and display comparison results and statistics.

Line	User Action	System Response
1	The `User` selects "Load Scenario Results"	The `System` displays available Scenario results that can be loaded.
2	The `User` chooses the desired `Scenarios`.	The `System` loads the desired `Scenario` results.
3	The `User` selects the desired comparison statistics to be displayed.	The `System` accepts the selection of the `User`.
4	The `User` selects the desired comparison charts to be displayed.	The `System` accepts the selection of the `User`.
5		The `System` displays the desired parameters.
Subsequent State:	The `System` has displayed the desired comparison parameters	

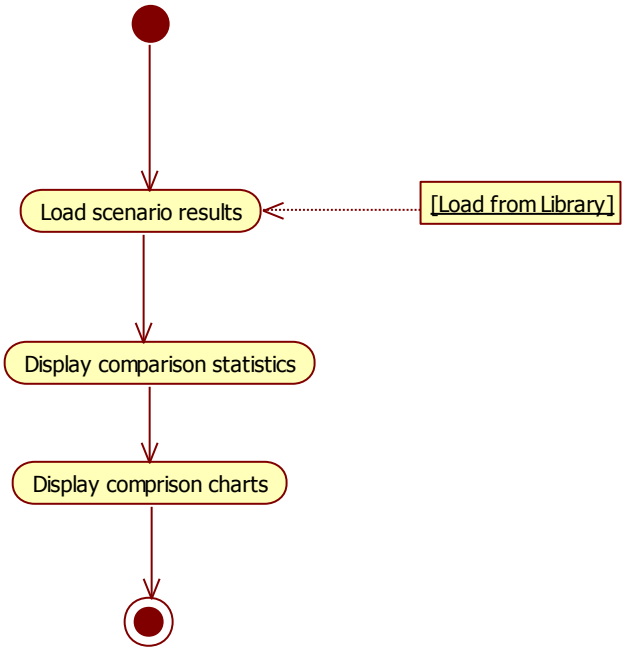

Diagram 11: Activity Diagram UC-5

3.2.6 <UC-7>: Download model from Web Service

Reference to FR:	FR-8 – FR-9
Short Description	The User wants to download an Activity or an Appliance model from the *CASSANDRA* Web Service and store it to the Library.
Activity Firing:	The User enters the system and wants to download a model
Precondition:	The User already entered in the System

Main Flow: Download model from Web Service		
Line	**User Action**	**System Response**
1	The User selects upload / download model feature.	The System displays the options: "Download model" or "Upload model".
2	The User selects to download an Appliance or Activity model from the web service.	The System communicates with the web service.
3		The System displays the available models
4	The User selects the desirable Appliance or Activity model.	The System downloads the selected Appliance or Activity model in the Library.
Subsequent State:	The User downloaded an Appliance or Activity model in the Library.	

Alternative Flow (AF1): Upload Appliance or Activity model from the Library to the web service		
While in line 2 of the Main Flow of the <UC-2>, user wants to Upload an Appliance or Activity model, then:		
Line	**User Action**	**System Response**

4	The `User` selects to Upload an Appliance or Activity model to the web service	The `System` asks the `User` to select the `Appliance` or `Activity model` which he wants to Upload
5	The `User` selects the Appliance or Activity model which he wants to Upload	The `System` communicates with the `web service`
6		The `System` Uploads the selected model to the `Web service`
Use case end		
Subsequent State:	The `User` uploaded an Appliance or Activity model from the `Library` to the `web service`.	

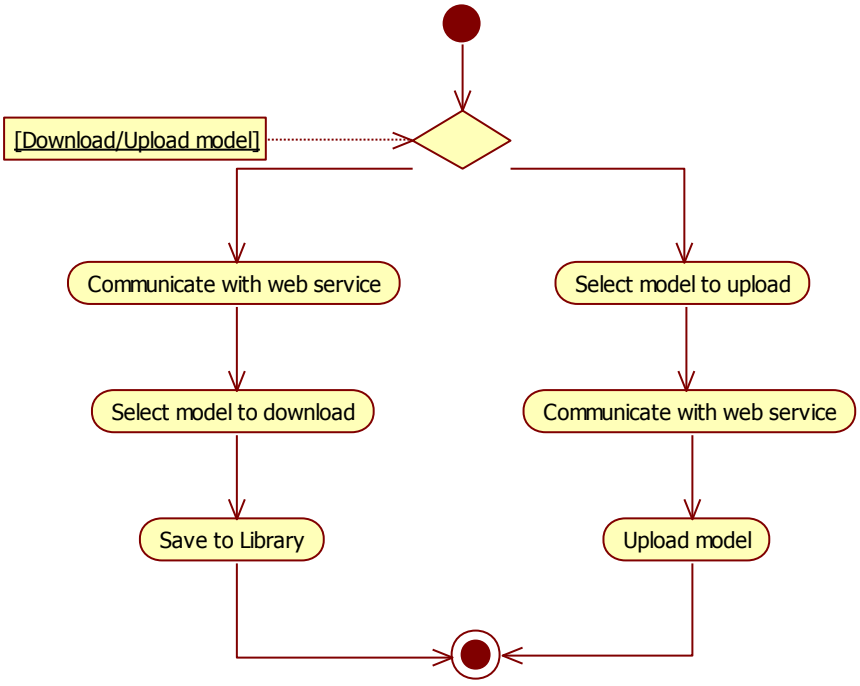

Diagram 12: Activity Diagram UC-6

3.3 Users and external systems

3.3.1 Users

The user: is the person who utilizes the *CASSANDRA* Platform. He has the right to exploit all the capabilities of the platform.

3.3.2 External Systems

ES Library: It contains the *CASSANDRA* approved and 3rd party models that can be used in the platform. The `System` must communicate with the ES `Library` in order to download or upload the desirable models.

ES Calendar: Provides calendar information on the simulation days (day of the week, time of year, working/non-working day etc.).

ES Measurements External Input: It contains the measurement data that the user has collected. The System must communicate with ES Measurements External Input in order to insert the desirable data sets into the project.

ES Weather DB: It contains data regarding the environmental temperatures in the location where the user wants to simulate his world. The System must communicate with ES Weather External Input in order to insert temperature data in the project.

3.4 Nonfunctional requirements

Non Functional Requirements are specified criteria that can be used to judge the operation of a system, rather than specific behaviours.

In general, functional requirements define what a system is supposed to *do* whereas non-functional requirements define how a system is supposed to *be*.

Non-functional requirements are often called **qualities** of a system. Other terms for non-functional requirements are "constraints", "quality attributes", "quality goals", "quality of service requirements" and "non-behavioral requirements".

<NFR-1>	
The `System` shall have a user friendly GUI.	
Description:	The `User` will be able to interact with the *CASSANDRA* platform by the usage of a user friendly GUI.

User priority:	5/5	It is very important for the `User` to be able to interact with the *CASSANDRA* platform by using a user friendly GUI.
Technical priority:	5/5	This requirement is very important from a technical point of view, because this will ensure that the platform will be widely used.
Stability:	The stability of this non-functional requirement is certain, because the `User` will always have to interact with the platform.	

<NFR-2>

The `System` shall associate imported `Measurement data` to the correct `Installation models`, according to a unique installation identifier.		
Description:	The `System` shall be able to import an external `Measurements data` input, to recognize, separate and associate measurements data for each different meter to the respective installation in the `Scenario Builder`.	
User priority:	5/5	It is very important for the `User` that the *CASSANDRA* platform will be able to associate imported Measurement data to the correct `Installation models`.
Technical priority:	5/5	This requirement is very important from a technical point of view, because this will ensure that the platform can use the real measuring data for the improvement of the used models.
Stability:	The stability of this non-functional requirement is certain, because the `User` will always want to associate imported `Measurement data` to the correct `Installation models`, according to a unique `installation` identifier.	

<NFR-3>

The `System` shall associate the measurement data to the implementation of a specific pricing scheme.	
Description:	When the `User` wants to import `Measurement data`, the `System` shall define if there is any association of the `Measurement data` with the implementation of any pricing

	scheme, to be able to train `Activity` and `Appliance models` correctly.	
User priority:	5/5	It is very important for the `User` that the *CASSANDRA* platform will be able to associate imported Measurement data to the implementation of a specific pricing scheme.
Technical priority:	5/5	This requirement is very important from a technical point of view, because this will ensure that the platform can use the real measuring data for the improvement of the used models.
Stability:	The stability of this non-functional requirement is certain, because the `User` will always want to associate imported Measurement data to the implementation of a specific pricing scheme.	

<NFR-4>

The `System` shall be able to handle Active and Reactive Power measurement data per minute.		
Description:	The `System` shall be able to handle Active and Reactive Power measurement data per minute. These data will be used by the `System` for the training and customization of the used models.	
User priority:	5/5	It is very important for the `User` that the *CASSANDRA* platform will be able to handle Active and Reactive Power measurement data per minute.
Technical priority:	5/5	This requirement is very important from a technical point of view, because this will ensure that the platform can use the real measuring data for the improvement of the used models.
Stability:	The stability of this non-functional requirement is not certain because the available data at the future could be of different measuring sampling.	

<NFR-5>

The `System` shall be able to export data corresponding to models and simulation results in structure formats, such as XML or CSV.	
Description:	The `System` shall be able to export data corresponding to models

	and simulation results in predefined structure formats such as XML or CSV.	
User priority:	5/5	It is very important for the `User` because this will ensure that the data corresponding to platform's models and simulation results could be further processed.
Technical priority:	5/5	This requirement is very important from a technical point of view.
Stability:	The stability of this non-functional requirement is not certain because the supported file types could be altered.	

<NFR-6>

The `System` shall warn the `User` when insufficient, incompatible or invalid information or data have been provided.		
Description:	The `System` shall display an warning when important information is missing or when the information/data provided is incorrect.. Nevertheless, the `System` will be able to continue its operation.	
User priority:	5/5	It is very important for the `User` because this will protect from errors.
Technical priority:	5/5	This requirement is very important from a technical point of view.
Stability:	The stability of this non-functional requirement is certain because it comprises a very important information.	

4 Mock up screens

Based on the requirements presented in this document, three basic views of the system were envisioned and presented in this section, through the use of mock-up screens. These views were built under the premises that the user creates scenarios by incorporating and editing existing models in the *CASSANDRA*, third party or user created component libraries. The scenarios, after their definition, are simulated through the platform.

The first view is that of the *CASSANDRA* library editing screen, where the user edits or creates either existing or new *CASSANDRA* entities. The entities can be installations, groups of installations, appliances, consumption models, person types etc. This view is depicted on Diagram 13. The user drags and drops entities from the *CASSANDRA* library into his or her scenario (e.g. Scenario A in the diagram), while, in the right pane, the user can edit the entities presented in the scenario to match the scenario requirements.

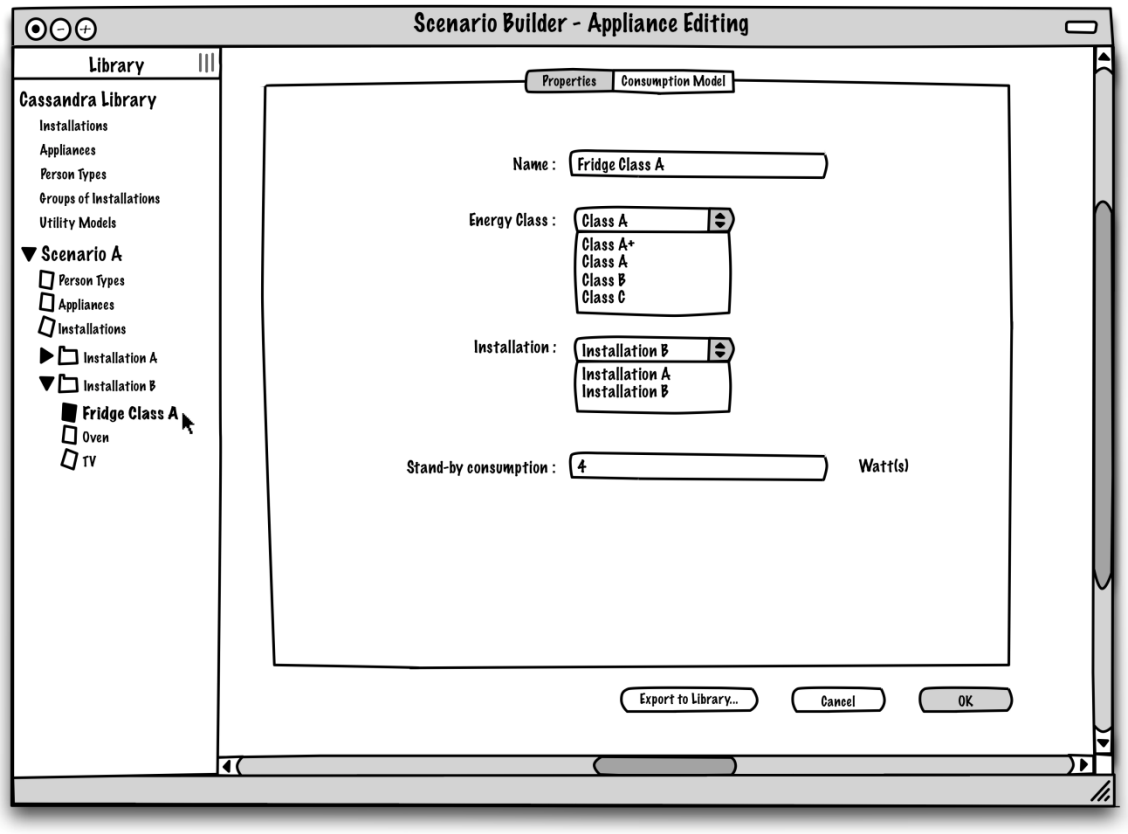

Diagram 13: Adding and editing entities to the *CASSANDRA* scenarios through library components.

After filling up the scenario definition with all the related entities, the user proceeds with the scenario configuration with respect to simulation parameters. In this view, presented in Diagram 14, the user edits certain parameters related to the simulation like: the pricing scheme to choose, awareness levels, the fuel/CO_2 emission parameters, any weather information available or other details related with the simulation time period and randomness.

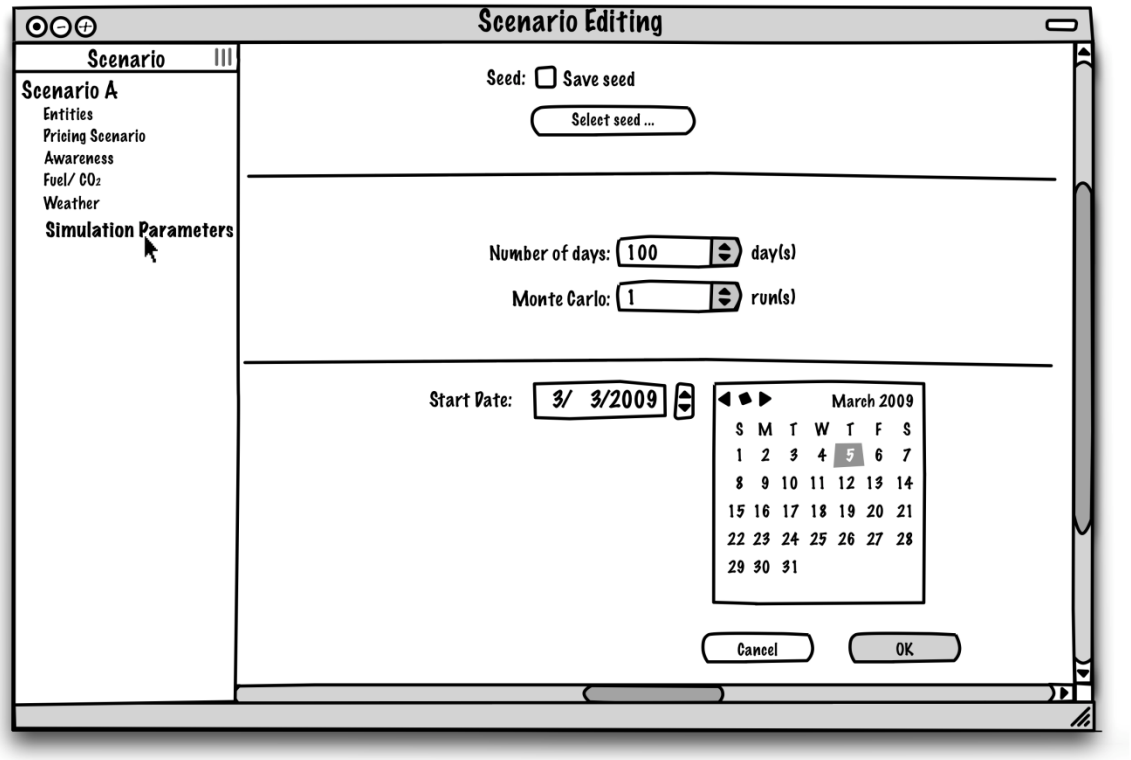

Diagram 14: Scenario configuration

Finally, the simulation view found in Diagram 15, informs the user about the running simulations or those in queue, waiting, and the actions that the user is capable of choosing. These actions include: pausing, previewing, saving the state and results, deleting the simulation, adding a new one in the queue, using the "plus" button, or comparing selected, but completed simulations. Upon clicking on a particular simulation line, the right pane refreshes and depicts the available graph charts along with statistics and metrics in text/table format. The progress bar informs the user about the status of the simulation and provides an estimate of the finishing time.

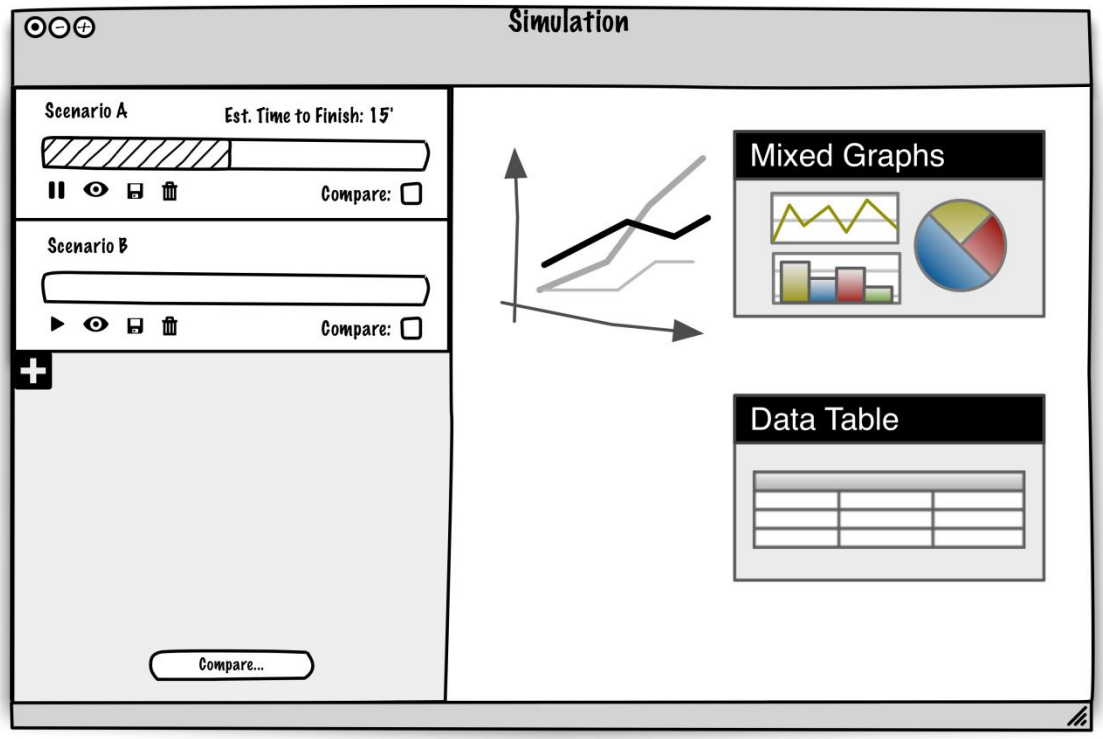

Diagram 15: Simulation view

A. Appendix

The following guidelines were given to everyone involved in the user requirements collection process. These present a methodology and sample questionnaires that were used as a guide for the user interviews. There is one questionnaire for each user type. Furthermore, an example on how to extract a set of functional requirements from a user interview is also provided.

A.1 Requirements collection guidelines

The interview process can be divided into three steps:

1. Send the following use cases (Section A.2) to the interviewees, a couple of days prior to the interview and ask them to identify any of them that match/approach the current business model of their company/organization. They could declare interest in any of the use cases, or propose others.
2. Pick the appropriate questions below for the interview according to the type of company.
3. After the interview, and while the data is still fresh in your mind, summarize the highest-priority needs or problems identified by this user/customer. Also, record the interview for further use in the requirements deliverable.

A.2 Sample *CASSANDRA* use cases

In a nutshell, the *CASSANDRA* platform can help you:

- Model installations based on single point (smart meter) data.
- Group consumers based on their activities.
- Identify the carbon footprint of installations and/or complex structures.
- Generate consumer social networks.
- Correlate Load forecasting and Peak Consumption to consumer activities, rather than appliance use.
- Test hypotheses related to Effective consumer models.
- Test hypotheses related to Demand-Response/Feedback-Response programs.
- Test hypotheses related to new Pricing schemes.

A number of indicative scenarios follow, concerning the implementation of the *CASSANDRA* platform, and the possible benefits for various market stakeholders. Please take a minute to review them and identify which fit your interests/business model:

1. **Energy Services and Action Inc.** is an Energy Service Company. Acting as an Aggregator, it has contracts with small scale electricity consumers. According to these contracts, it gathers data concerning the energy consumption of its customers. This data helps the company model its network of consumers in the *CASSANDRA* platform.

Subsequently, the company uses these models to accurately forecast the demand of its network of consumers, thus maximizing its profit in the Energy Market. Moreover, *CASSANDRA* models consumers' behavior, correlating their consumption with specific everyday activities. This way Energy Services and Action Inc. is able to model the potential impact of introducing dynamic pricing tariffs and feedback in groups of customers. In addition, the company groups its customers into Consumer Social Network (CSN) in the Cassandra platform, and runs frequent simulations in order to determine the optimum aggregated power demand. To do so, Energy Services and Action Inc. issues a number of simple rules its customer groups have to follow in their daily energy consumption schedule, so that the aggregated CSN power demand lies within specific limits, without presenting unwanted peaks. Energy Services and Action Inc. furthermore uses the information concerning the optimum aggregated CSN power demand in order to achieve a better contract with an energy provider for its customers.

2. **MTSO** is the Transmission System Operator of a medium sized Control Area. The local Regulator has introduced Demand Side Response schemes in the Electricity market. As a result, there has been a change in the overall Electricity Demand Curve. TSOs traditionally use Reserves (Primary, Secondary and Tertiary) to cope with short term demand volatility. These reserves are expensive but indispensable for a safe System Operation. MTSO now needs a tool in order to estimate the amount of Reserves required for Efficient and safe System Operation under the new Regulatory framework. Cassandra provides such functionality.

3. **Every Day Goods Co.** is a multinational chain of super markets. All its stores are built according to strict specifications. The company central management is always looking for ways to minimize expenses. To that purpose, it investigates possible actions that will, on the one hand, decrease stores' energy costs, while at the same time will highlight the company's environmental concerns. Therefore, the management develops a model for its stores in the Cassandra platform. This model is used frequently, in order to estimate the feasibility and the cost effectiveness of the implementation of specific modifications aiming to optimize the stores' energy consumption.

4. **Lights Everywhere Ltd.** is a company which designs and develops lighting systems, ranging from simple light bulbs to sophisticated lighting solutions for various implementations. The company wants to test its products on realistic models, so as to be able to investigate the feasibility of its new designs, as well as present thorough studies about the superiority of its products concerning their energy efficiency. To that purpose, the Cassandra platform is used in order to provide realistic models of lighting

profiles concerning an area as large as a city. The Cassandra models are fully configurable, which means that the company is able to simulate various schemes in order to support its studies.

5. **South Terranea** is a small Mediterranean city. The city authorities want to investigate methods to improve the energy sustainability of South Terranea, reducing its ecological footprint. Therefore, they use the Cassandra platform in order to generate a model of the city with respect to its energy consumption and carbon dioxide emissions. Subsequently, they use this model in order to study the impact of specific actions and energy saving campaigns towards their purpose.

A.3 Interview questions

Interview questions depend on the type of user that is interviewed. The user types that have been identified are

1. Aggregators
2. Regulators, DNOs/TSOs
3. Consultants
4. Tech and IT companies
5. Production/Industrial sites
6. Energy Traders/Suppliers
7. Energy monitoring devices/Energy Efficiency Solutions

The following sections present the interview questionnaire that has been compiled for each user type.

A.3.1 Aggregator

General Questions

Name:

Company:

Industry:

Job Title:

What are your key responsibilities?

What services does your company/organization produce and for which clients?

What are key factors (our "KPIs") upon which you measure success in the services you provide?

Which problems interfere with your success?

Specific Questions for Problem-Solution Identification (functional requirements)

For which problems do you lack good solutions? (With respect to *CASSANDRA* domain)

Load forecasting?

Effective consumer models?

Demand-Response/Feedback-Response? Do you run Demand-Response or Feedback-Response pilots?

Peak consumption?

Consumption at peak price times?

Overall energy consumption?

Other?

For each problem answered, ask the following questions:

Why does this problem exist?

How do you solve it now?

How would you like to solve it?

What type of measurements do you collect from your users? Active/Reactive power? Sample Intervals? Other information?

What kind of intervention capabilities do you have at your customers/installations?

Do you model consumer acceptance for specific incentives?

Do you use specialized software (ICT solutions)? What are the main features you use?

Are you satisfied? Is there a feature missing from your ICT solution? How would you rank the importance of these?

How easy is it to adapt your existing software, in order to include more functionality?

What types of users handle the ICT solution? Educational background? Computer Background? Freelance? What are your expectations for training time?

Reliability, Performance, Support, Legal etc. (non-functional requirements)

What are your expectations for reliability?

What are your expectations for performance? What type of system do you expect? Search-engine like with query-response? Simulation type?

What about maintenance and service access?

What are the security measurements?

What are the installation and configuration requirements?

Are there any legal, regulatory, or environmental requirements or other standard that must be supported? (Perhaps with respect to data collection)

Can you think of any other requirements we should know about?

A.3.2 Regulators/DNOs/TSOs

General Questions

Name:

Company:

Industry:

Job Title:

What are your key responsibilities?

What services does your company/organization produce?

For whom?

What are key factors (our "KPIs") upon which you measure success in the services you provide?

Which problems interfere with your success?

Specific Questions for Problem-Solution Identification (functional requirements)

For which problems do you lack good solutions? (With respect to *CASSANDRA* domain)

- Load forecasting?
- Effective consumer models?
- Peak consumption at specific sections of the system/network? (e.g. TSO: city, DNO: MV/LV power transformer)
- Consumption at peak price times?
- Overall energy consumption?
- Network problems?
- Other?
-

For each problem answered, ask the following questions:

- Why does this problem exist?
- How do you solve it now?
- How would you like to solve it?

Do you monitor consumption at specific transformers/points in the distribution grid or the transmission network? What type of data do you collect?

Do you use macro analysis (time series, historical and current data) to forecast consumption?

Would micro-decomposition of the consumption into consumer activities be useful?

Do you have any specific requirements for demand side control?

Do you use specialized software (ICT solutions)? What are the main features you use?

Are you satisfied? Is there a feature missing from your ICT solution? How would you rank the importance of these?

-
-

How easy is it to adapt your existing software, in order to include more functionality?

What types of users handle the ICT solution? Educational background? Computer Background? Freelance? What are your expectations for training time?

Reliability, Performance, Support, Legal etc. (non-functional requirements)

What are your expectations for reliability?

What are your expectations for performance? What type of system do you expect? Search-engine like with query-response? Simulation type?

What about maintenance and service access?

What are the security measurements?

What are the installation and configuration requirements?

Are there any legal, regulatory, or environmental requirements or other standard that must be supported? (Perhaps with respect to data collection)

Can you think of any other requirements we should know about?

After the interview, and while the data is still fresh in your mind, summarize the three highest-priority needs or problems identified by this user/customer.

A.3.3 Consultants

General Questions

Name:

Company:

Industry:

Job Title:

What are your key responsibilities?

What services does your company/organization produce?

For whom?

What are key factors (our "KPIs") upon which you measure success in the services you provide?

Which problems interfere with your success?

Specific Questions for Problem-Solution Identification (functional requirements)

For which problems do you lack good solutions? (With respect to *CASSANDRA* domain)

- Problems your energy market related clients face? (Refer to the respective questions if the company identifies customers that fall in our other categories)

For each problem answered, ask the following questions:

- Why does this problem exist?
- How do you solve it now?
- How would you like to solve it?

Do you think *CASSANDRA* will be a useful tool for your clients?

Would you use *CASSANDRA* to provide decision support to your clients?

Do you use specialized software (ICT solutions)? What are the main features you use?

Are you satisfied? Is there a feature missing from your ICT solution? How would you rank the importance of these?

-
-

How easy is it to adapt your existing software, in order to include more functionality?

What types of users handle the ICT solution? Educational background? Computer Background? Freelance? What are your expectations for training time?

Reliability, Performance, Support, Legal etc. (non-functional requirements)

What are your expectations for reliability?

What are your expectations for performance? What type of system do you expect? Search-engine like with query-response? Simulation type?

Would you support such a product like *CASSANDRA*, or do you prefer others to support it?

What about maintenance and service access?

What are the security measurements?

What are the installation and configuration requirements?

Are there special licensing requirements?

Are there any legal, regulatory, or environmental requirements or other standard that must be supported? (Perhaps with respect to data collection)

Can you think of any other requirements we should know about?

After the interview, and while the data is still fresh in your mind, summarize the three highest-priority needs or problems identified by this user/customer.

A.3.4 Tech and IT companies

General Questions

Name:

Company:

Industry:

Job Title:

What are your key responsibilities?

What is your relation with the energy market?

What types of customers do you have in that domain?

What are key factors (our "KPIs") upon which you measure success in the services you provide?

Which problems interfere with your success?

Specific Questions for Problem-Solution identification (functional requirements)

If you have any energy related companies to your customer portfolio, for which problems do you lack good Tech/ICT solutions? (With respect to *CASSANDRA* domain)

- Do you offer solutions for energy efficiency, consumption optimization or demand response?

For each problem answered, ask the following questions:

- Why does this problem exist?
- How do you solve it now?
- How would you like to solve it?

Do you think *CASSANDRA* will be a useful tool for your clients?

Would you use *CASSANDRA* to provide decision support to your clients?

Do you use specialized software (ICT solutions)? What are the main features you use?

Are you satisfied? Is there a feature missing from your ICT solution? How would you rank the importance of these?

-
-

How easy is it to adapt your existing software, in order to include more functionality?

What types users handle the ICT solution? Educational background? Computer Background? What are your expectations for training time?

Would you be interested to include the *CASSANDRA* functionality to your products? What are the requirements for doing so?

Reliability, Performance, Support, Legal etc. (non-functional requirements)

What are your expectations for reliability?

What are your expectations for performance? What type of system do you expect? Search-engine like with query-response? Simulation type?

Would you support such a product like *CASSANDRA*, or do you prefer others to support it?

What about maintenance and service access?

What are the installation and configuration requirements?

Are there any legal, regulatory, or environmental requirements or other standard that must be supported? (Perhaps with respect to data collection)

Can you think of any other requirements we should know about?

After the interview, and while the data is still fresh in your mind, summarize the three highest-priority needs or problems identified by this user/customer.

A.3.5 Production/Industrial sites

General Questions

Name:

Company:

Industry:

Job Title:

What are your key responsibilities?

What services does your company/organization produce?

Which energy related problems interfere with your success?

Specific Questions for Problem-Solution identification (functional requirements)

For which problems do you lack good solutions? (With respect to *CASSANDRA* domain)

- Peak consumption?
- Consumption at peak price times?
- Overall energy consumption?
- Other?
-

For each problem answered, ask the following questions:

- Why does this problem exist?
- How do you solve it now?
- How would you like to solve it?

What type of measurements do you collect from your industrial installation?

How flexible are you in shifting in time within a day your processes relating to electric energy consumption?

Are you able to negotiate your contract with the energy provider?

Do you use specialized software (ICT solutions)? What are the main features you use?

Are you satisfied? Is there a feature missing from your ICT solution? How would you rank the importance of these?

-
-

How easy is it to adapt your existing software, in order to include more functionality?

What types of users handle the ICT solution? Educational background? Computer Background? Freelance? What are your expectations for training time?

Reliability, Performance, Support, Legal etc. (non-functional requirements)

What are your expectations for reliability?

What are your expectations for performance? What type of system do you expect? Search-engine like with query-response? Simulation type?

Would you support such a product like *CASSANDRA*, or do you prefer others to support it?

What about maintenance and service access?

What are the installation and configuration requirements?

Are there special licensing requirements?

Are there any legal, regulatory, or environmental requirements or other standard that must be supported? (Perhaps with respect to data collection)

Can you think of any other requirements we should know about?

After the interview, and while the data is still fresh in your mind, summarize the three highest-priority needs or problems identified by this user/customer.

A.3.6 Energy Traders/Suppliers

The same questions as **Regulators/DNOs/TSOs/Aggregator** plus:

- Is there any aspect for which your current forecasting mechanism is insufficient? Please provide input.

A.3.7 Energy Monitoring Devices/Energy Efficiency Solutions

The same questions as **Tech and IT companies** as well as **Consultants** plus:

- Would your measuring equipment provide additional input that would be useful for a demand response modeling platform such as *CASSANDRA*? (Current *CASSANDRA* specifications for modeling include active and reactive power measurements taken at minute intervals)
- Would you find *CASSANDRA* a useful software addition to your current product range? What would you need for that to happen?

A.3.8 Universities

The same questions as **Aggregator** plus:

- Do you perform any benchmarks before investing in specific electrical equipment/devices?
- Do you have any schedule of use/guidelines to optimize energy consumption (e.g., dimming lights, motion sensors, turn off PCs)
- Are you able to negotiate your contract with the energy provider?

A.4 Example of an Interview

What is your job?

I am an employee of the Energy Max Enterprise, who is an Energy Aggregator company, mainly interested in large residential buildings.

What are your key responsibilities?

We are intermediaries between consumers and producers of energy. My main task is to approach as many customers as possible, providing energy saving/cost efficient solutions.

How is success measured?

I think that from the consumers' point of view, money saving is the greater incentive. On the other hand, what producers really need is as smooth consumption curve during the day as possible, in order to have their production on a stable level.

Which problems interfere with your success?

It is really hard to find the best way to convince the consumers to follow a specific consumption pattern, a time schedule if you prefer, by choosing the correct incentive for each one to reduce the peaks of the aggregated load curve.

How do you solve it now?

Presently, we are using a custom made software platform, which employs neural networks in order to make predictions at the MV transformers level and create the time series of the predicted consumption. The problem is that even though we have a lot of demographic data from our customers, we cannot use them optimally to make certain useful deductions.

How would you like to solve the problem?

I think that it would be useful to be able to utilize our demographic and past data in order to see how each of our present or potential customers fit in our prediction model. It would be of great value to be able to create certain demand – response programs which would be individualized to certain groups of costumers to make the consumption curve smoother.

If you could implement additional functionality to your current solution what would it be?

It should be noted that we are trying to create new green-policy awareness programs with use of renewable energy power providers. It would be useful assess their potential before throwing them out in the market.

Do you have special needs for support or past software used?

Currently we are using smart meters in each customer house, in order to keep the historic consumption data for further analysis. The extracted data is collected in a server at our HQ. We would like to utilize the data collected for the classification of users or in order to create realistic customer models from them. Maybe it would be nice if we could extract several policies to apply in our new tariff programs.

A.5 Example of Exporting Functional Requirements from the Interview

<FR-1>

The User must be able to add the demographic data in the platform for his models.

Description: In the model selection page there will be an option to import files that are describing in an analytical way the consumers / producers that are subject to the use case scenario in question.

<FR-2>

The User must be able to choose models from the model repository.

Description: In the model selection page there will be a repository of the already available models of the platform, made by developers of the platform or other users.

<FR-3>

The User must be able to add create his models by usage of historical data of consumption / production.

Description: The user will have the opportunity to create realistic models by using his past data in the platform.

<FR-4>

The User must be able to simulate Demand – Response or Feedback – Response programs.

Description: The platform will give the chance to users to create a fully configurable Demand – Response or Feedback – Response programs, by choosing from a range of possible incentives.

<FR-5>

The User must be able to choose an incentive from a list of options (money, environmentally correctness, reduction of peaks, etc).

Description: After the definition of the modeled entities in the simulation, the user will be able to create a demand – response program with the utilization of the chosen incentive. There will be some generic directions but that option will be fully programmable.

<FR-6>

The Users must be able to select the Key Performance Indicator (KPI) of their choice.

Description: The platform, during the configuration process of the simulation, will give to the user the possibility to choose the metric that will show the success or failure of the simulation in question.

<FR-7>

The User must be able to add certain policies in order to see their effect in the simulated world.

Description: The platform will have an easy-to-understand system for adding certain policies that apply to real or an imaginary situation and the user wants to try them before realizing them in the real Energy Market.