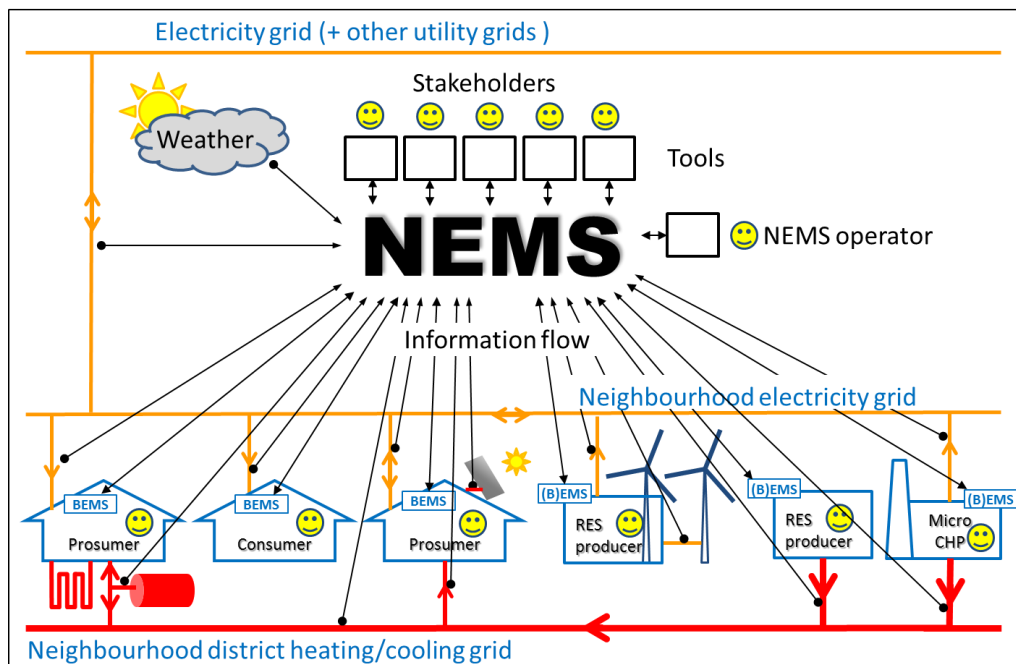


Requirements specifications & modelling approach for neighbourhood energy management information model.



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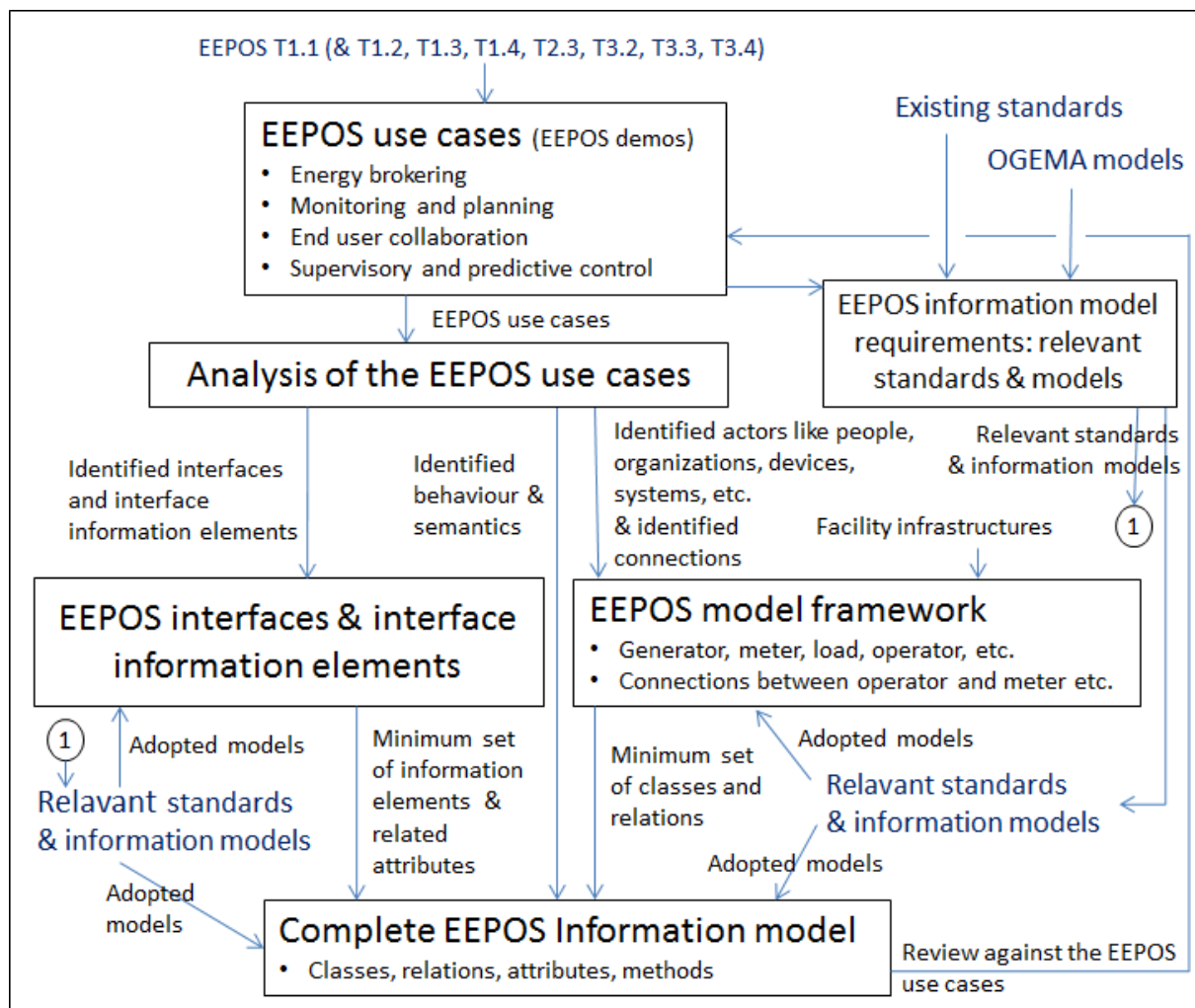
1. EXECUTIVE SUMMARY

This deliverable defines the very basis of the EEPOS information modelling including the information modelling approach and the requirements for the information models.

The information modelling approach includes use case templates provided by CEN/CENELEC/ETSI. Some of these templates have been left out and some of these templates have been further developed.

The requirement specification includes a listing of standards which should be considered when developing the EEPOS information models. Furthermore, concept of the OGEMA data model as relevant for EEPOS, EEPOS relevant communication between building and neighbourhood level and communication between the EEPOS Neighbourhood Automation System and the EEPOS ICT platform are described. In addition, this document describes several use cases which should be considered when developing the EEPOS information models.

This document gives the basic information and templates for use case analysis and related EEPOS information model development.



The main results presented in this report are the description of the EEPOS information modelling approach and the requirements for EEPOS information models including

- Description of the EEPOS information modelling approach including use case templates based on templates provided by CEN/CENELEC/ETSI
- Listing of the standards which should be considered when developing the EEPOS information models
- Description of the OGEMA data model concept as relevant for EEPOS
- Description of the EEPOS relevant communication between building and neighbourhood levels
- Description of the communication between the EEPOS Neighbourhood Automation System and the EEPOS ICT platform
- Description of several use cases for EEPOS tools by using EEPOS use case templates. Rest of the needed use case descriptions are moved to the updated version of the document.

A total of 12 EEPOS use cases are described:

- UC1: Automatic consumption cut off
- UC2: Energy brokering tool
- UC3: Utilising the energy performance monitoring tool in Finnish demonstration
- UC4: Utilising the energy performance monitoring tool in German demonstration
- UC5: Integration of consumers / non-automatized loads
- UC6: Heating grid optimisation in German demonstration
- UC7: Saving energy by end-user collaboration
- UC8: End user collaboration in German demonstration
- UC9: The Trading (Agent-Based) approach
- UC 10: Calculation of neighbourhood level PV generation by the Neighbourhood Automation System
- UC 11: Optimal load shifting planning on the neighbourhood level by the Neighbourhood Automation System
- UC 12: Storage of neighbourhood level historic electric energy consumption and generation rates

2. INTRODUCTION

2.1 Purpose and target group BLA

This document describes very basis of the EEPOS information modelling. It does not describe the final information model, but gathers the needed methods and inputs for starting the model related information analysis and the model development. The EEPOS information model will be published in the final version of this deliverable.

Target group for this document are the software developers of the EEPOS consortium. It is especially important document for those who will further develop the EEPOS information model in T2.2 and related tools in T2.3, T3.2, T3.3 and T3.4.

Most of the partners have participated in this work and they all had possibility to contribute their ideas and wishes they want to the basis of the EEPOS information model.

2.2 Contributions of partners

Partners' contributions are shown in the table below.

Section / Chapter	Contributor
1, 2, 3, 4.1.1, 5.3, 5.7, 6	VTT Technical Research Centre of Finland (VTT)
4.1.1, 4.1.2, 4.2, 4.3, 5.10, 5.11	European Distributed Energy Resources Laboratories e.V. (DERlab)
4.1.2	Fraunhofer IWES (IWES)
5.4, 5.8, 5.9	ENNOVATIS GMBH (ENO)
5.5	AIT Austrian Institute of Technology GmbH (AIT)
5.2	FATMAN OY (FTM)
5.1, 5.6	Caverion Suomi Oy (CAV)

2.3 Baseline

State of the art / available technologies - information model standards for EEPOS:

- Intensive standardisation is going on, covering areas of smart grids, smart metering, energy management etc. on European and international level. Relevant standards, existing and under development, are e.g. IEC 61970 - Common Information Model (CIM) / Energy Management, IEC 61968 - CIM / Distribution Management, IEC 61850, OpenADR and ASHRAE SPC 201P.
- OGEMA uses standardised resource types for modelling of application data.

State of the art / available technologies – information modelling approach:

- Existing Use Case Templates are provided by CEN/CENELEC/ETSI.

Related other (EU) projects:

Odysseus project organised a round table workshop on Energy Efficiency at District Scale Level in Nice on the 12th of September 2013. The members of Ambassador, IDEAS, EEPOS and INTrEPID projects were invited to join to the discussion among others information model related ICT semantics (e.g. ontologies for energy networks). In the workshop the participants

decided to keep in touch and to consider information exchange at least related to information modelling.

2.4 Relations to other activities

The work described here is mainly based on the results of the WP1 (scenarios, actors, etc.). In addition the intermediate inputs from tasks T2.3, T3.2, T3.3 and T3.4 have also been utilised.

This intermediate result of T2.2 is the main starting point when developing the final version of the EEPOS information model (T2.2). The development of EEPOS tools in tasks T2.3, T3.2, T3.3 and T3.4 will be carried out in close collaboration with this task (EEPOS information model).

3. MODELLING APPROACH

3.1 EEPOS information model development

The EEPOS information model development approach is shown in *Figure 1*.

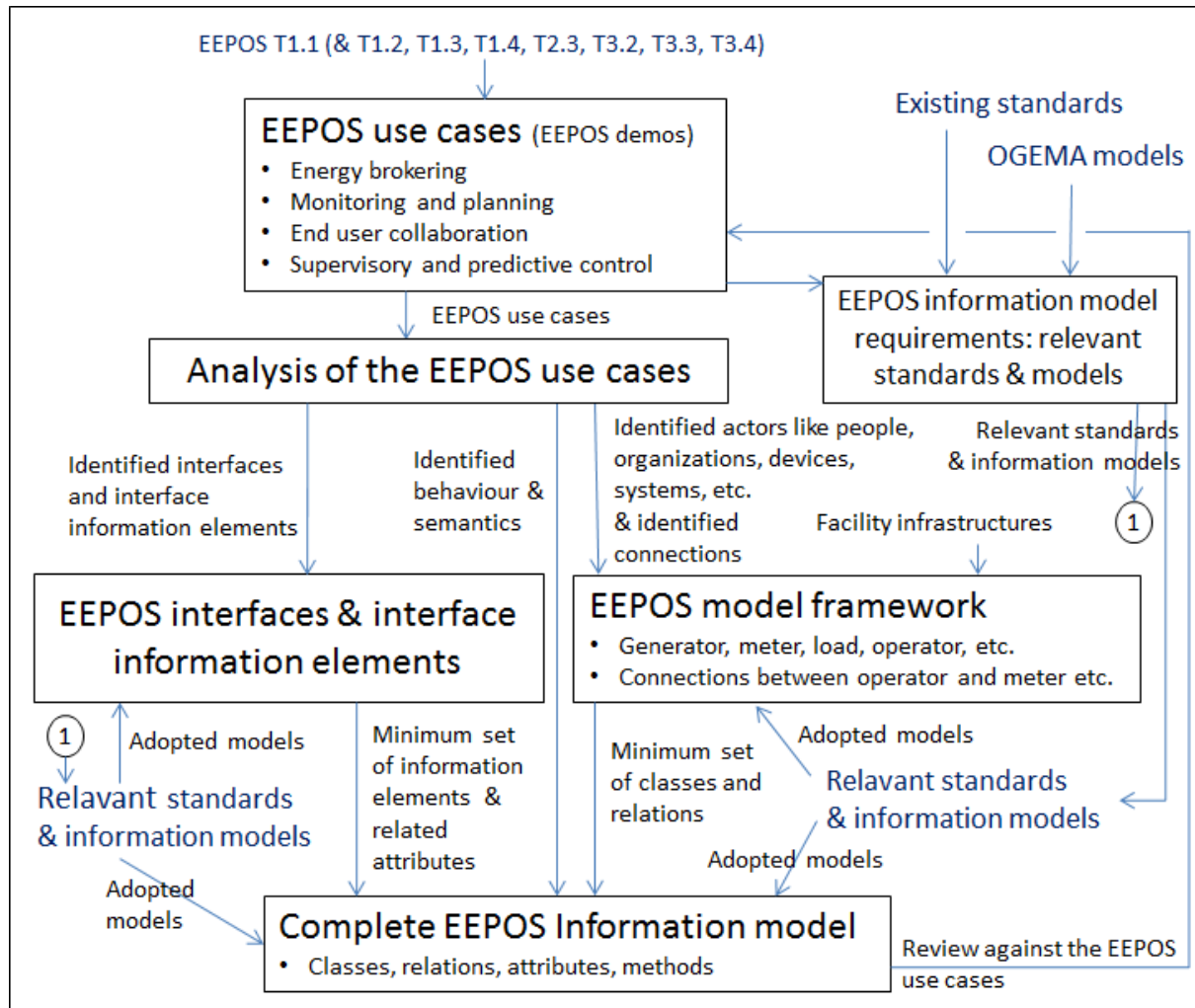


Figure 1. The EEPOS information model development approach

The main result of this task is the complete EEPOS information model. The modelling scope (*Figure 2*) includes the needed information model elements for EEPOS relevant in-house communication and especially the information model elements for EEPOS neighbourhood energy grids covering the basic neighbourhood energy grid topology, node entities like buildings and production units and node profiles like consumption and production components and information elements for communication between them.

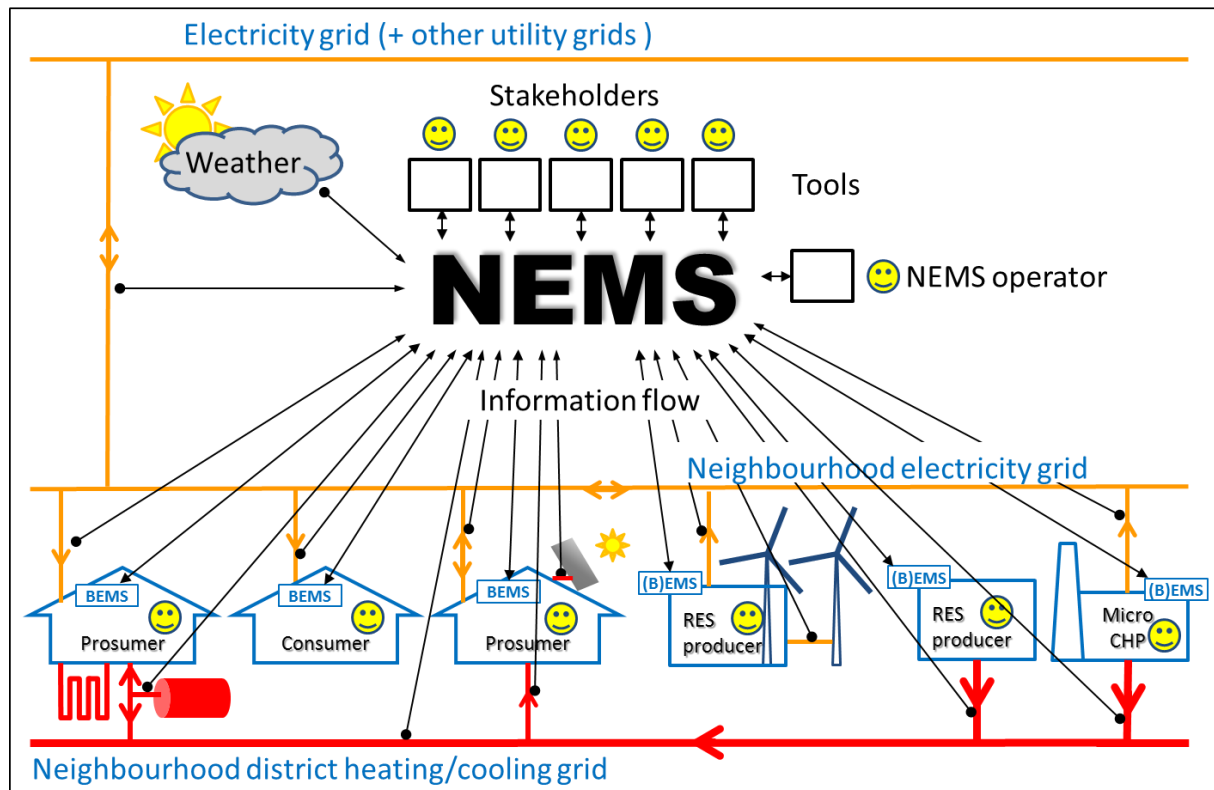


Figure 2. The scope of the EEPOS information model (black coloured lines)

The modelling approach includes the description of the most relevant EEPOS use cases and the analyses of these use cases including the identification of the needed actors, information elements between the actors, the use case related behaviours / semantics and related requirements for the information model. The approach includes that the existing standards including OGEMA models will be utilised if available.

The EEPOS actors are the participants in EEPOS applications. They may be e.g. persons, organisations, devices, computer systems or software programs. Actors can make decisions and exchange information with other actors through interfaces. The EEPOS interface information elements are data elements (single value, collection of data items etc.) which are sent from a source entity to a destination entity.

The EEPOS model framework describes a generalized neighbourhood level energy grid model associating the identified EEPOS devices and system actors and the main connections between them. In other words, the EEPOS framework defines an abstract representation of neighbourhood level energy consumption, production, and storage systems.

The complete EEPOS information model includes classes derived from EEPOS model framework and related attributes based on EEPOS use case related interface information elements.

In the following sections, templates (provided by CEN/CENELEC/ETSI [1][2]) and methods (Unified Modeling Language, UML [3][4]) for use case definition, related data analysis (CEN/CENELEC/ETSI) and the EEPOS information model related modelling (UML) are utilised. The complete EEPOS information models and the model implementation work will be described more detailed in the second version of this deliverable D2.2 (m24).

3.2 Template and methods for the description of EEPOS use cases

The main target of the use case templates is to describe the requirements, functionalities and applications for the EEPOS information modelling and related EEPOS tool development purposes.

The templates are based on the use case templates provided by CEN/CENELEC/ETSI [1][2]. Some of these CEN templates have been left out and some of these templates have been further developed but the basic idea has not changed.

The first template is for the narrative description of the use case (*Table 1*). To avoid duplicate work utilise EEPOS T1.1 as a background document.

Table 1. Template for the narrative description of a use case [1]

Narrative description of the use case
Short description
Write a short description (max 3 sentences) of the EEPOS use case.
Complete description
Write the complete description of the EEPOS use case.

The second template is for the description of the use case related actors (*Table 2*). The column named “Actor Type” can be a person, organisation, system (more detailed application, function, database, device, system), role or generic role. The role is used if more than one actor is capable of fulfilling the function. For example an energy management system, an ESCO, an energy information provider or an energy supplier can do benchmarking so the actor benchmarker is an example of actor which type is role.

A complete description of the use case should include narrative description of the function from a domain expert user’s point of view. It should describe what happens, when it happens, why it happens and with what expectation and under what conditions it happens.

Table 2. Template for the list of the use case related actors [1]

Actor name	Actor Type	Actor Description	Further information specific to this Use Case	Source
Actor name	Actor type (e.g. Person)	Write a short description of the Actor	Write specific information for the use case (if needed)	EEPOS or standard x, ...
...

The third template is for the use case related preconditions, events and assumptions (*Table 3*).

Table 3. Template for the use case related preconditions, events and assumptions [1]

Actor/System/Information/Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
Describe which actor(s) trigger(s) this use case	Describe what event(s) trigger(s) this use case	Describe what condition(s) should have been met before this use case happens	Possible assumptions
...

The fourth utilised template is a UML use case diagram (*Figure 3*). UML is a standard (ISO/IEC 19501:2005) based general purpose modelling language for software engineering. The UML based use case diagram describes in a technology neutral way what the system

must do. In other words the diagram includes the studied EEPOS use case related actors, goals and dependencies by means of graphical presentation.

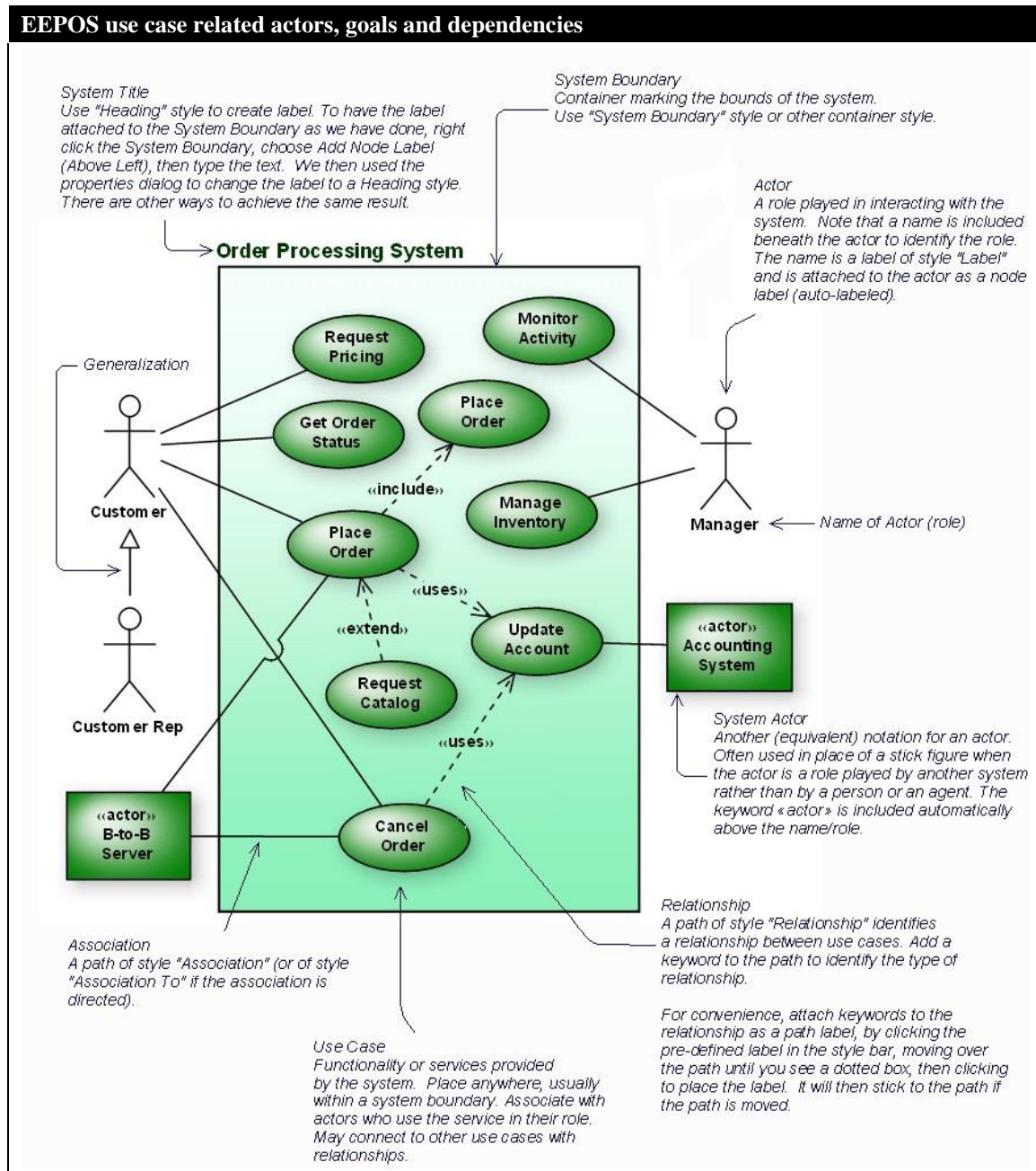


Figure 3. An example based template for UML based use case diagram [5]

Examples of the software which can be used to create UML based use case diagram are e.g. Enterprise architect [6], Microsoft Office Visio (UML Model Diagram template) [7] or free open source UMLet [8] including Eclipse plugin.

3.3 Template for use case analysis

The templates for use case analysis are provided now, but the analysis will be documented in the final version of the deliverable.

The main focus of the use case analysis is to find out the minimum set of actors and the information elements needed to build EEPOS information model.

The use case analysis includes five different types of templates which are mainly based on the use case template provided by CEN/CENELEC/ETSI [1][2]. The first template is for summarising all studied EEPOS use case's primary scenarios (named PS1, PS2, ...) and related alternative scenarios (named AS1, AS2, ...) for the situation that primary scenarios do not succeed (*Table 4*).

Table 4. Template for all the different scenarios of the studied EEPOS use case [1]

Use case's scenario number	Primary Actor	Triggering Event	Pre-conditions	Post-Condition
PS1	Describe which actor(s) trigger(s) this scenario	Describe what event(s) trigger(s) this scenario	Describe what condition(s) should have been met before this use case happens	Describe what condition(s) should prevail after this scenario happens. The post conditions may also define "success" or "failure" conditions for each use case.
PS2 or AS1	...	...	...	...

The second template is for describing all the steps (list of events) and related information elements for the studied use case scenario (*Table 5*). This template can be used also for failure (alternative, error management and/or maintenance/backup) related scenario. The column named "Sending actor" is the actor who sends the information to the actor named in the column "Receiving actor".

Table 5. Template for the use case scenario (list of events) and related information elements

Use case's scenario						
Step no.	Event	Description of Process/Activity	Sending actor	Receiving actor	Information exchanged	Req. id
1	The event that starts the step	What action takes place in this step	Actor name	Actor name	List the information elements to be exchanged	Possible req. id
2 etc.	...	...	...	...	...	...

The template for the summary of all the identified actors in all the EEPOS use cases is shown in *Table 6*.

Table 6. Template for summary of all the needed actors

Actor name	Actor Type	Actor Description	Parent Actor	Possible Roles / Functions	Source
Actor name	Actor type	Description of the Actor	Parent actor name	List of actor names (0...N)	EEPOS or standard x, ...
...

The template for the summary of all needed information elements in EEPOS use cases is shown in *Table 7*. The column named "Sending actor" is the actor who sends the information element to the actor named in the column "Receiving actor". The information element is the information structure name which describes the sent information content (e.g. energy tariff).

Table 7. Template for summary of all needed information elements

Information element name	Sending actor	Receiving actor	Description	Information exchanged	Requirement id
Information element name	Actor name	Actor name	Description of the Information element	Detailed information content of the information element	Possible requirement id.
...

If there are some additional requirements for the EEPOS information model, the next template can be used (Table 8).

Table 8. Template for requirements

Requirement ID	Relevance	Specification
Requirement id	High/must/compulsory/low/option/	Specification of the requirement
...

3.4 Template for the model framework

There are no exact templates for the EEPOS model framework diagram. This diagram should include the main components and the connections between them (see an example in Figure 4).

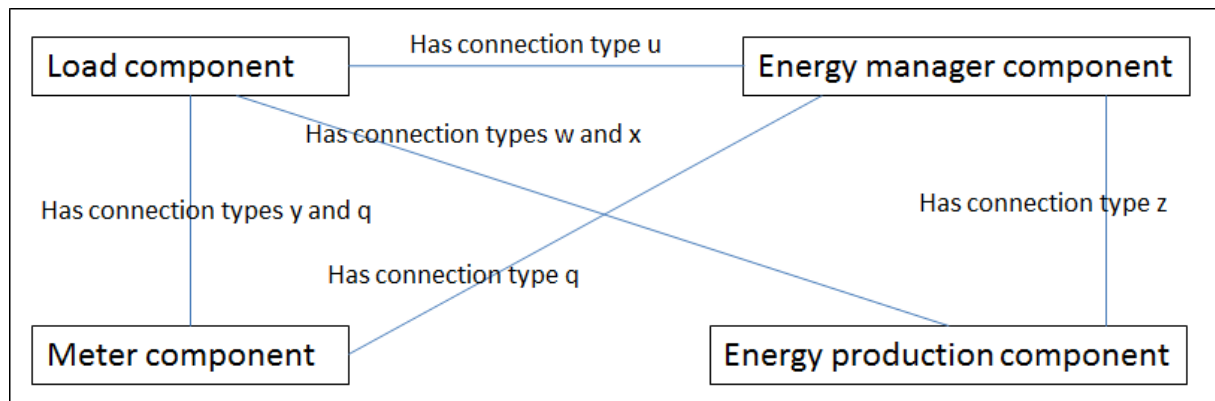


Figure 4. An example based template for the model framework

The basic idea is to describe so general level components that the other components can be presented by combining them. For example energy storage can be presented using energy production and load components. And load component can be building, electric car, HVAC system, end user’s device etc.

3.5 Template and methods for EEPOS information models

The final EEPOS information model will be realised using the UML based classes diagram (Figure 5). The diagram defines the constructs for class-based modelling (system's classes, attributes and the relationships to other classes).

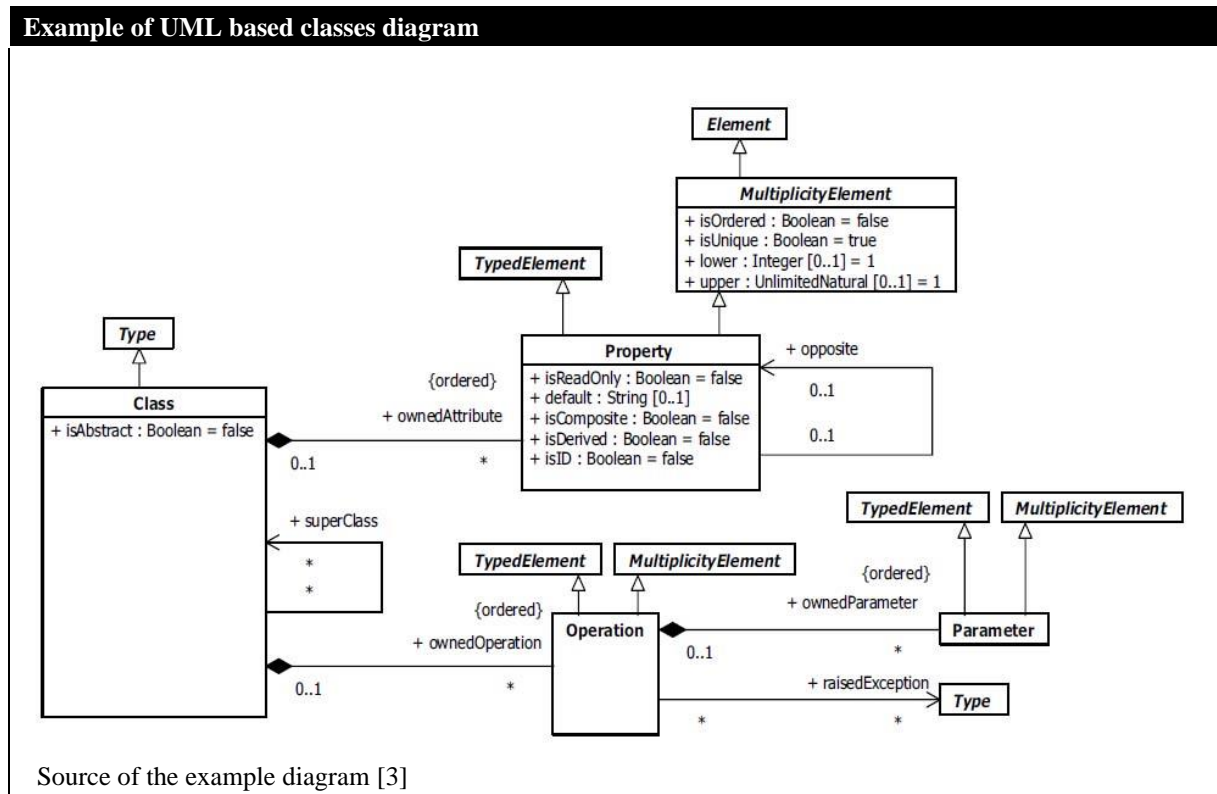


Figure 5. Template for UML based classes diagram [3]

The other UML diagrams are e.g. activity (visualizing a sequence of activities), component (how the software is divided into components and the dependencies between the components), deployment (describes the implementation related hardware and the execution environments), interaction (visualizing a sequence of activities), package (how software is divided into logical groups and the dependencies between the software logical groups) and state machine (the sequence of events relating single object lifetime). If these templates are needed, those diagrams related documentation can be found from the UML specification [3][4].

4. GENERAL REQUIREMENTS FOR EEPOS INFORMATION MODELS

4.1 State-of-the-Art

4.1.1 Standards for the EEPOS related information

The baseline will be the state-of-the-art information models on related domains such as smart grid, building and home automation, building and neighbourhood energy systems, building energy performance metrics, etc. Ongoing standardisation activities within ISO, IEC, CEN and CENELEC as well as within industrial organisations such as buildingSMART, ASHRAE (BACnet, FSGIM), or OASIS (oBIX) will be followed and taken into account:

- IEC 62056 (DLMS/COSEM): Data exchange for electricity meter reading, tariff and load control
- IEC 61850: Design of electrical substation automation
- IEC 61970: Series of standards for the application program interfaces for energy management systems including the Common Information Model (CIM)
- OpenADR: Market communication, load/generation management
- EN 50491: General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS)
- EN 13757 (M-Bus): Communication system for meters and remote reading of meters
- IEC 62746: System interfaces and communication protocol profiles relevant for systems connected to the Smart Grid
- MSCONS
- Z-Wave
- ZigBee
- BACnet
- FSGIM
- oBIX
- LON
- SunSpec
- WAGO-I/O
- EEBus: Commodity prices, load/generation management

As described in EEPOS D1.3 and in the introduction of chapter 4.1 of this document there are a lot of building communication/control network protocols, smart consumption meters and related smart grid standards and building and neighbourhood related information models. The big challenge is how to build the neighbourhood level energy management system and related ICT tools and fully integrate them without considerable effort. This means uniform EEPOS information model and related APIs which should utilise as much as possible existing standards.

From EEPOS information model development point of view the most important energy grid related standards are

- IEC 61968 - CIM / Distribution Management
- ASHRAE / NEMA 201 (Facility Smart Grid Information Model [9])
- OpenADR
- IEC 62056 (DLMS/COSEM): Data exchange for electricity meter reading, tariff and load control

- EN 50491-11: A metering data model for a simple external consumer display [10]
- prEN 50491-12: Neutral API for connecting different Home and Building Electronic Systems (HBES) / smart devices to the smart grid [11]

It is also important to notice general level issues from *IEC 61970 - Common Information Model (CIM) / Energy Management*. *IEC 61970 - Common Information Model (CIM) / Energy Management* was initially developed for generation and transmission problems. The CIM information model describes the electrical network, the connected electrical components, the additional elements and the data needed for network operation and the relations between these elements. The CIM model related packages are basic elements, topology, generation, load model, measurement values and protection. An important feature from EEPOS point of view is that the CIM relations between classes may extend beyond the boundaries of packages. This means that it is possible to extend this model with EEPOS relevant features.

IEC 61968 - CIM / Distribution Management is an extension to the CIM model. It defines needed information models for electrical distribution from substation to the customer meter. It includes network topology models and models for distribution lines, distribution loads, voltage regulators, and distribution feeders.

The ASHRAE/NEMA 201 standard defines an abstract, object-oriented information model to enable appliances and control systems in homes, buildings, and industrial facilities to manage electrical loads and generation sources in response to communication with a “smart” electrical grid and to communicate information about those electrical loads to utility and other electrical service providers. [12]

The ASHRAE/NEMA 201 model provides communication protocol independent basis for common information exchange between control systems and end use devices in buildings. The model defines data objects and actions for energy management applications and electrical service provider interactions including

- On-site generation
- Demand response
- Electrical storage
- Peak demand management
- Forward power usage estimation
- Load shedding capability estimation
- End load monitoring (sub metering)
- Power quality of service monitoring
- Utilization of historical energy consumption data
- Direct load control

Open Automated Demand Response (OpenADR) is a research and standards development effort for energy management led by North American research labs and companies. It is typically applied to send information and signals to cause electrical power-using devices to be turned off during periods of high demand. [13]

In addition IEC technical committee PC 118 (Smart grid user interface) is planning to use OpenADR documents and publish related API specifications as a technical report. On the other hand IEC TC 57/WG10 specialists have been commented that OpenADR is not compatible with IEC 61850 and CIM-models.

It is also important to notify the new work item proposal IEC/TS 62056-6-9, Mapping between the Common Information Model CIM (IEC 61968-9) and DLMS/COSEM (IEC 62056) data models and message profiles. [14]

In addition it is very important to notify the ongoing standardization work in CENELEC TC 205 WG18 related to the defining a neutral layer for connecting different Home and Building Electronic Systems (HBES) / smart devices to the smart grid (prEN 50491-12). The ongoing work includes related data models, data structures and data types and how to addressing the devices. The planned future work (50491-12-xx) includes the definition of the minimum requirements for Customer Energy Manager (CEM), commissioning / discovery / management, dataflow between CEM / mapping, message exchange protocol, encoding of information (e.g. XML / JSON) and security. [11]

The CEM is planned to be an element (specifications not yet available in any standard), which is between smart grid and the installed devices in the building. It will typically utilise smart grid inputs and optionally inputs from other sources (e.g. energy availability and related forecast, energy demand and related forecast) for managing the devices installed in the building. The CEM can also provide feedback to the smart grid, e.g. in forms of load forecasts etc. The interoperability between CEM and the Smart Grid can be ensured by using the IEC 62746.

On the other hand there is a competing CEN TC 247 project for prEN 50491-12. The CEN TC 247 project utilise ISO 17800 for connecting smart buildings to smart grid.

EN 50491-11 specifies a metering data model for a simple external consumer display. The same data model can be used also in interfaces between Meter Communication Functions (MCF) and the Local Network Access Point (LNAP) or Neighbourhood Network Access Point (NNAP) and related interfaces to the HBES devices. [10]

It is also important to notify BACnet etc. standards related smart grid activities and IEEE 1377 version 2 (flexible metering data and information models) and IEC 62056 standard series (Data exchange for meter reading, tariff and load control) when developing the EEPOS information model.

4.1.2 Concept of the OGEMA data model as relevant for EEPOS

In a neighbourhood which is equipped with an EEPOS Energy management system, all communication between buildings and the neighbourhood level will go through the Neighbourhood Automation System which is based on OGEMA (cf.[15]). Accordingly, to enable the communication between the OGEMA-based Neighbourhood Automation System and other players of the EEPOS system, the EEPOS information model elements need to be integrated into the OGEMA data model.

The aim of the OGEMA data model is to be able to represent all kinds of data that need to be exchanged between applications, drivers and user interface applications in the fields of smart grid and smart building. For this, the OGEMA data model defines standardized resource types for modelling of application data [16]. Thanks to this resource based approach, OGEMA realizes an interface-less interoperability of the different players: To facilitate the communication with other applications or the communication with partners outside of an OGEMA system, OGEMA applications write/read their output/input into/from data containers with a tree-like structure, so called resources. These resources are administered by the OGEMA framework and shared with the other applications or, via the REST interface, with external communication partners – provided that they have been granted the appropriate access permissions.

The structure of the resource trees in an OGEMA framework is determined by the standardized resource types. Each resource has an associated standard resource type that defines what type of information the resource represents and what its possibly expected sub-resources (child nodes) are. The resource type does not define a resource's possible parent

resources or their type. Instead, the OGEMA data model defines many generic resource types that are intended to appear as sub-resources of a variety of other resource types. For example, a sub-resource of the type `ElectricalConnection` is defined for all resource types representing a device that consumes or produces electrical energy. As an example, excerpts of the representation of a combined heat and power generator by the OGEMA data model are shown in Figure 6.

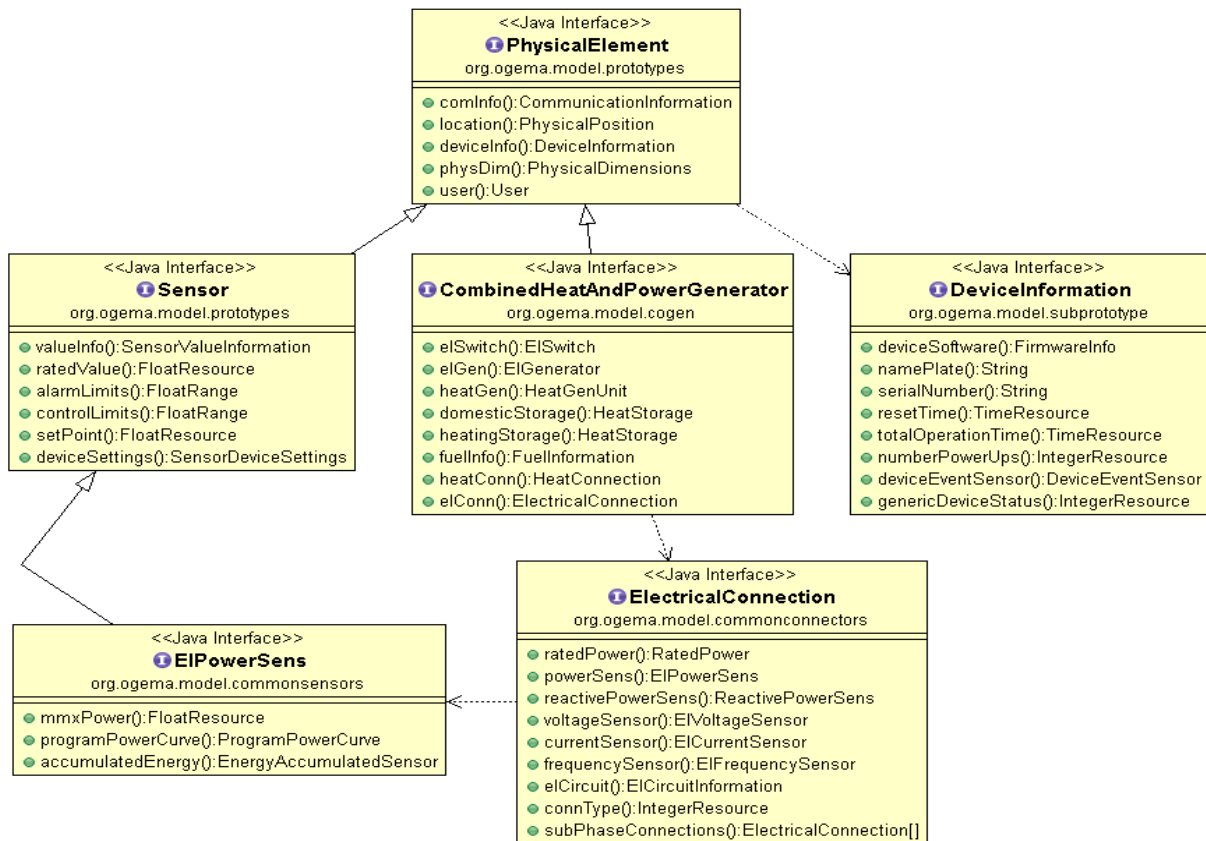


Figure 6. Example of the representation of a combined heat and power generator by the OGEMA data model. For clarity of the representation, only selected paths are shown, e.g., all child resource types of the generator's `ElectricalConnection` are hidden

Many resource types merely define structure, i.e. a set of possible sub-resources. For storing values describing the current state of a system, special resource types are defined: the simple resource types. These types like `FloatResource`, `IntegerResource` and `StringResource` store a value of the respective type (a floating-point value, an integer value or a piece of text in this case). Their respective array resource type counterparts store arrays of the respective types. Simple resource types and array resource types do not define the meaning of their values stored. The values' meanings are entirely determined by their parent resources, i.e. by how the resources are arranged in the structure of data elements.

Except for the values contained in simple resource types and their arrays, all elements defined in the OGEMA data model's resource types are optional. This means that applications wanting to operate on a resource's field must either ensure its availability or add the entry themselves. Due to this flexibility of the resources, applications should be able to work with a minimum set of input data points, while exposing as much information back to the framework as possible. In order to ensure interoperability between applications and drivers, each physical or abstract value that could be exchanged, e.g., between two OGEMA applications or with external players, must be unambiguously identifiable within the OGEMA data model.

As a consequence of the aim to be able to represent all kinds of data that need to be exchanged between applications, drivers and user interface applications in the fields of smart grid and smart building, the OGEMA data model exhibits a rather complex and extensive structure. That is why the formal structure of its elements, the standardized resource types, is determined by modelling rules and not according to certain use cases or existing domain standards. A model which claims to represent all that might be exchanged in a certain field can hardly ever be complete: It is very likely that it will encounter cases in which an initially unexpected energy management service requires an extension. Hence, the OGEMA Data Model is designed to be growing. It is foreseen that it will be extended constantly when new applications and drivers are developed and new use cases and device types are considered. The OGEMA modelling rules are the guidelines for the definition of new resource types when extending the OGEMA data model (“modelling process”) as well as for the usage of already available resource types (“usage”). These modelling rules will be part of the OGEMA 2.0 Framework and API Specification which is scheduled to be published by Fraunhofer in January 2014 [16]. The complete structure of the data model of the OGEMA 1.1 framework is documented and provided to the public in form of a Javadoc at www.ogema-source.net. The Javadoc for the OGEMA 2.0 framework, which will be employed as software platform for the EEPOS Automation System, is planned to be published beginning of 2014.

In addition to extending the data model when no suitable defined resource type is available in the OGEMA data model, it is possible to locally add custom resource types to a specific OGEMA framework. However, the design of such new resource types should strictly be carried out according to the modelling rules. Alternatively, sub-resources that are not defined by the OGEMA data model can be added to a resource via the decorator mechanism (for further information see [16]). Both, using custom resource types and using decorators should be avoided since they tend to break the aims of interoperability and unambiguous identifiability of data elements for which the resource-type approach was chosen in the first place. Hence, the EEPOS consortium will strive to incorporate the whole EEPOS information model into the OGEMA data model without the definition of EEPOS specific custom resource types.

4.2 EEPOS relevant communication between building and neighbourhood level

From the EEPOS perspective, models for in-house communication are of interest as far as they concern the communication between the building and the neighbourhood level. This means that on the building level itself, e.g., for communication between a building energy management system and controlled devices like white goods, different information models may be used by different manufacturers of building level energy management systems. However, to ensure communication between building and neighbourhood level and functioning of the EEPOS energy management system, the energy management systems employed on the building level need to support the EEPOS communication model as developed in this task.

This subsection describes the required data communications between the Neighbourhood Automation System and grid users. Here grid users are seen as energy consumers or producers connected to the electricity grid being buildings (represented by building energy management or automation systems), neighbourhood level electricity generation systems or consumers. The term grid user also refers to thermal systems like CHP plants and heat pumps, which generate electric power as by-product or use electricity to pump heat respectively. Aforementioned grid users independently of their characteristics and functions are able to adapt their electricity consumption or generation patterns up to some grade when necessary.

This adaption of energy patterns should be able to be automatized and doing so, the quality of life of the neighbourhood inhabitants should not be reduced.

The communication between the Neighbourhood Automation System and grid users has to be bidirectional. The Neighbourhood Automation System will for instance make available updated price forecasts and optimal load shifting planning profiles (e.g. 24 hours in ahead updated every 15 min) to the end users. End users will recalculate their load adaption planning profiles after reading the updated load shifting planning profiles and will send feedback of planned load shifting to the Neighbourhood Automation System. Such data communication is required for efficient load management within the neighbourhood. Examples for data communication between the Neighbourhood Automation System and grid users are listed in are listed in the Tables 9 and 10.

Table 9 Examples of Neighbourhood Automation System to grid user communication

Information element	Data type	Description
Price forecast	Array of real values with time stamp	Price forecast for at least one day in ahead every 15 min in €/kWh. Each forecasted value is paired with a time value.
Optimal load shifting planning	Array of integer values with time stamp	Optimal load shifting planning for at least one day in ahead indicating times at which load shifting is required (i) for cost effective load shifting following electricity price and (ii) for peak load shaving in electricity grid. For example, “-1” indicating times from which load is suggested to be shifted; “1” indicating times to which load is suggested to be shifted. “0” indicates a neutral time period without suggestions for load shifting. Each profile value is paired with a time value.

Table 10 Examples of Grid user to Neighbourhood Automation System communication

Information element	Data type	Description
Residual load forecast (grid user #1, grid user #2, ..., grid user #n)	Array of real values with time stamp	Residual load forecast profile of grid users for at least one day in ahead every 15 min in kW. Each predicted value is paired with a time value. Profiles should be saved temporary

In EEPOS, price forecasts will be provided to the Neighbourhood Automation System by the ICT platform. The optimal load shifting planning calculation is described in Deliverable 2.3 [17].

In the German EEPOS demonstration, the communication between the Neighbourhood Automation System and the grid users will be the communication between an OGEMA system and the ennovatis Smartbox. In the German EEPOS demonstration, it will be the communication between an OGEMA system and the Niagara JACE system. In the laboratory prototypes, the communication between building and neighbourhood level will be the communication between two OGEMA systems. Communication with any other building level management system provided by any other manufacturer will be performed on the same level and in the same way.

To ensure data privacy, detailed information on specific appliances in the end user systems will not be required and will not be provided to the Neighbourhood Automation System.

4.3 Communication between the Neighbourhood Automation System and the ICT platform

The Neighbourhood Automation System requires information from external data sources in order to manage neighbourhood load shifting efficiently. Furthermore, it will provide information to the different software tools developed in WP3. The ICT platform will serve as a mediator between WP3 tools, external data sources and the Neighbourhood Automation System. For instance, the Neighbourhood Automation System expects to be provided by the ICT platform with updated information on the electricity price, weather forecast and load forecast for the neighbourhood. Here, the required weather forecast depends on the neighbourhood where the Neighbourhood Automation System will be applied as well as on the complexity of the load management applications. Here, we assume that the neighbourhood equipped with the EEPOS system has neighbourhood level PV systems installed. Accordingly, the application for calculating generation forecast of PV systems which is developed in Task 2.3 [17] requires weather forecast information on solar irradiance and ambient temperature. Examples for data required from the ICT platform by a Neighbourhood Automation System applied in a neighbourhood with photovoltaic systems is listed in Table 11.

Table 11 Examples for communication between the ICT platform and the Neighbourhood Automation System

Information element	Data type	Description
Price forecast	Array of real values with time stamp	Price forecast profile for at least one day in ahead every 15 min in €/kWh. Each predicted value is paired with a time value.
Solar irradiance forecast	Array of real values with time stamp	Solar irradiance (the solar radiation measured perpendicular to the sun, S_{incident}) forecast for at least 24 hours in ahead every 1 min in W/m ² . Each forecast value is paired with a time value.
Ambient temperature forecast	Array of real values with time stamp	Ambient temperature forecast for at least 24 hours in ahead every 15 min in °C. Each forecast value is paired with a time value.
Neighbourhood load forecast	Array of real values with time stamp	Load forecast profile of the neighbourhood load for at least one day in ahead every 15 min in kW. Each predicted value is paired with a time value.

Predicted load of the neighbourhood is an important input in the Neighbourhood Automation System. It gives the information on the total load forecast in the neighbourhood needed to identify peak loads and to calculate residual load (load minus generation).

The Neighbourhood Automation System to ICT platform communication includes all the necessary data communication for energy management feedback, and on current and historical energy data. Depending on the feedback needed and data needed for energy monitoring, the required communication towards ICT platform may differ. From the viewpoint of the Neighbourhood Automation System, this data communication is only for monitoring and feedback purposes. The example of the communication of historical data of the electricity consumption for one building is shown in Table 12.

Table 12 Example for Neighbourhood Automation System to ICT platform communication

Information element	Data type	Description
Residual load (grid user #1, grid user #2, ..., grid user #n)	Real value	Residual electricity consumption of grid users for last 15 min in €/kWh paired with a time value.

5. REQUIREMENT SPECIFICATION - EEPOS USE CASES

The selection of relevant uses cases for the development of the EEPOS information model is based on the need of the EEPOS demonstrations related tools (supervisory and predictive control, energy brokering, monitoring and planning and end user collaboration). The next list (*Table 13*) of use case candidates is based on the EEPOS scenarios documented in deliverable D1.1. The Table contains also information on which use cases will be included in the EEPOS information model development and which not.

Table 13. Selection of the use cases for EEPOS information model development

Use Case candidate	Will be included in the model
Integration of Consumers / non-automatized loads	X
Operations planning supported by performance monitoring (based on D1.1 scenario "Optimisation of heating grid")	X
Activities delayed by end-user	X
Saving energy by end-user collaboration	X
End-user balance card	X
Energy Brokering Tool	X
Automatic consumption cut off	X
Utilising energy performance monitoring tool	X
The Trading (Agent-Based) Approach	X
Considering Power and Heat	X
Optimal load shifting planning on the neighbourhood level by the Neighbourhood Automation System (based on D1.1 scenario Automated Demand Side Management within the Neighbourhood)	X

The next list of the use case candidates shown in *Table 14* are based on the input of other EEPOS WPs.

Table 14. Additional use cases for EEPOS information model development

Additional EEPOS Use Case candidates	Will be included in the model
Collection and management of current electric energy consumption and generation rates within the neighbourhood	Covered by the other use cases
Storage of neighbourhood level historic electric energy consumption and generation rates	X
Calculation of neighbourhood level PV generation by the Neighbourhood Automation System	X
Planning of optimal load shifting on the neighbourhood level by the Neighbourhood Automation System	X
Use cases for additional OGEMA Applications which are not yet specified	X

Use cases with respect to heating grid optimisation	X
Neighbourhood can assign a single broker to buy all energy needed – allowing procuring energy in bulk thus receiving better price conditions	X

The next list of the use case candidates (*Table 15*) are based on ASHRAE SPC 201P. Only the EEPOS relevant validation use cases are listed with minor modifications. If the use case will be used in the EEPOS demonstration then it will be studied more in this document by adding it to use case descriptions related chapter.

Table 15. Possible additional use cases (mainly ASHRAE 201 based) for EEPOS information model development

Additional Use Case candidate
Minimize customers energy costs by managing power demand by contracts and tariffs
Manage neighbourhood level energy production
Forecast customers energy demand
Buy and sell energy
Social, environmental, and regulatory related information for customers who wants to control related aspects of their energy consumption
Customers can buy energy from different energy producers
Balance power purchases between utility and on-site generation
Measure detail level power (e.g. heating, cooling, outdoor lighting, washing machine, selected plug) to calculate related cost and consumption
Measure energy cost, emissions and consumption for online and historical data (e.g. daily, monthly and yearly) reports
Measure energy cost, emissions and consumption for accounting
Measure energy cost, emissions and consumption for benchmarking (comparing against similar buildings, certificate, etc.)
Measure energy cost, emissions and consumption for validating (e.g. using temporary measurement equipment)
Generation for grid maintenance and planning (e.g. when the distribution system maintenance should do etc.)
Receive instantaneous power quality information to validate power service level agreement
Historical energy information for forecasting future use
Defining the customers power demand target (low target -> possible penalties, high target -> no savings)
Neighbourhood operator or energy broker is able to see customer's load shifting parameter setup (e.g. which energy price means lower power consumption)
Direct load control by an external source
Get information of onsite generation capacity
Get information of onsite storage capacity
Get information of weather forecast

The list of the harmonized description of all EEPOS use cases related actors are shown in Table 16.

Table 16. List of the EEPOS use cases related actors

Actor name	Actor Type	Actor Description	Source
Automatic consumption cut off application	«Software»	A computer program which sends energy consumption related cut off decision for execution.	EEPOS
Automation Platform	«System»	The EEPOS Automation Platform is a hardware independent execution environment for neighbourhood related energy management applications. It will provide means to access different devices and meters and provides interfaces for control applications as well as to the EEPOS ICT platform.	EEPOS
Buyer	«Person»	A person who purchases something.	EEPOS
Benchmarker	«Role»	A generalized description for an entity that performs cross-building analysis and defines the energy usage and efficiency of one building in relation to other buildings. This could be an Energy Management System, by an ESCO, by an Energy Information Provider or by an Energy Supplier. [9]	ASHRAE 201
BIM service	«Software»	An existing web service APIs and related existing Building Information Model (BIM) related software(s).	EEPOS
Building Management	«Role»	Building Management is a meta-role within a facility that encompasses various personnel concerned with managing a building. This includes but is not limited to the Facility Manager, the Operations Manager, the Environmental Manager and the Financial Manager. [9]	ASHRAE 201
Building Owner	«Role»	The Building Owner is a meta-role within a facility that defines a Landlord for a leased entity or a Home Owner for residential application. [9]	ASHRAE 201
Energy brokering tool	«Software»	A tool providing a platform for the EEPOS System operators to participate in energy trading on external energy markets on behalf of the members of the neighbourhood.	EEPOS
Energy grid	«System»	A network for delivering electricity or thermal energy from suppliers to consumers.	EEPOS
End user	«Person»	A person who uses the application.	EEPOS
End user collaboration tool	«Software»	An EEPOS software tool for motivating end users to save energy.	EEPOS

Energy consumption component	«System»	A device or system (e.g. building, electric car) that use locally produced energy.	EEPOS
Energy manager	«Person»	A person who analyse the energy data with the objective to optimize the functions of the building automation systems to save energy.	EEPOS
Energy Services Company (ESCO)	«Organization»	A business providing energy savings, efficiency and generation solutions. [9]	ASHRAE 201
EnMS Operator	«Role»	EnMS operator is the party that combines the neighbourhood into a single entity to participate in the energy market (buy heat and fuels and trade electricity), procures the necessary resources and services and ensures the optimum operations of the neighbourhood.	EEPOS
Ennovatis Controlling	«Software»	A software by Ennovatis for data storage and monitoring of EEPOS information.	Ennovatis
Facility manager	«Person»	The person responsible for the maintenance and operation of the facility. In the Residential market, this is the home owner, landlord, or building superintendent. [9]	ASHRAE 201
Fault detection service	«Software»	An existing web service APIs and related existing fault detection software(s).	EEPOS
ICT platform	«System»	The ICT platform is a mediator between the Automation Platform and the Information and Decision Support System (and external data sources).	EEPOS
Local energy production unit	«System»	A device or system that can create energy from local energy source (solar, wind, geothermal, biomass, etc.).	EEPOS
Main grid	«System»	Energy network outside the neighbourhood.	EEPOS
Meter	«Device»	A device that measures physical quantity.	EEPOS
Neighbourhood level energy supplier	«Organization»	A company that delivers energy to customers.	EEPOS
Operations planning tool	«Software»	The operations planning part of the performance monitoring and operations planning tool developed in EEPOS.	EEPOS
Optimal load shifting planning application	«Software»	An application for calculating optimal load shifting profiles for the grid users.	EEPOS
Performance monitoring	«Software»	The monitoring part of the performance monitoring and operations planning tool	EEPOS

tool		developed in EEPOS.	
Performance monitoring and operations planning tool	«Software»	A software for monitoring EEPOS information including related operations planning.	EEPOS
Performance monitoring tool's database	«Software»	A software for saving EEPOS measurement data.	EEPOS
Price forecast service	«Organization»	An organisation or a service providing electricity price forecast.	EEPOS
PV generation forecast application	«Software»	An application for calculating the PV generation forecast profiles.	EEPOS
Seller	«Person»	A person who sells something.	EEPOS
Service Provider	«Organization»	A company providing services to other organisations.	EEPOS
Simulation service	«Software»	An existing web service APIs and related existing building simulation software(s).	EEPOS
Social media	«Software»	An existing social media platform.	EEPOS
Tenant	«Person»	A person who lives in the neighbourhood.	EEPOS
Weather forecast service	«Organization»	An organization providing weather forecasts as well as current and historical weather information. [8]	ASHRAE 201

The EEPOS use cases are described in the following chapters.

5.1 UC1: Automatic consumption cut off

The narrative description of the monitoring tool related use case “automatic consumption cut off” is shown on *Table 17*.

Table 17. Narrative description of the use case “Automatic consumption cut off”

Narrative description of the use case
Short description
Automatic consumption cut off (CAV)
Complete description
In cases of extremely high electricity cost or unstable grid status, an automatic cut-off of certain loads can reduce energy costs or system maintenance costs. In this use case, the limits for power consumption, electricity price as well as suitable loads to cut off are defined. When one or many preset condition is met, the cut-off program is executed. The limits are set to the equipment that is in common use and outdoor areas (equipment that is not controlled by individual inhabitants) or to the equipment that longer operational buffer, e.g.

Air handling units and ventilation system Heating and air conditioning system Electric car charge Outdoor lighting (dimming/switch-off) Lighting of common spaces (dimming, color adjustment, shorter delay of switch-off timer) De-icing applications

The list of the use case related possible actors are shown in *Table 18*.

Table 18. List of the use case “Automatic consumption cut off” related actors

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
End-user	«Person»	See <i>Table 16</i>	Person, service provider or other decision maker who defines what systems to regulate, define the limiting variables and define allowed compromise. This may be private of indoor conditions (other than regulations derived).
Performance monitoring and operations planning tool	«Software»	See <i>Table 16</i>	To acquire needed variables (electricity price, consumption amounts etc.), a performance monitoring tool is needed. Performance monitoring and operations planning tool also calculates relevant variables, based on which the decisions would be made.
Automation platform	«Software»	See <i>Table 16</i>	Cut off commands are executed.
Automatic consumption cut off application	«Software»	See <i>Table 16</i>	
Building owner	«Role»	See <i>Table 16</i>	

The use case related preconditions, events and assumptions are shown in *Table 19*.

Table 19. Use case “Automatic consumption cut off” related preconditions, events and assumptions

Actor/System/Information/Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
Performance monitoring and operations planning tool	Continuous data logging	Performance as well as other relevant (electricity price etc.) data collection in sufficient level of details.	
End user or service company	Set limits for performance or indoor	Possibility to define relevant limits for performance or indoor climate conditions, with explanations regarding	Tenant is participant of the

	climate conditions	the effect of the set limits on overall result. Automatic consumption cut off tool is installed and running.	EEPOS network
Automation platform	Maximum limit is reached	End-users have set the suitable limits to compromise as well as defined the maximum energy costs. The building systems are defined that can be controlled by this application.	
Automatic consumption cut off application	Send cut off decision for execution	Automation platform should be able to execute the cut of commands	

The UML based diagram for the use case “Automatic consumption cut off” is shown in Figure 7.

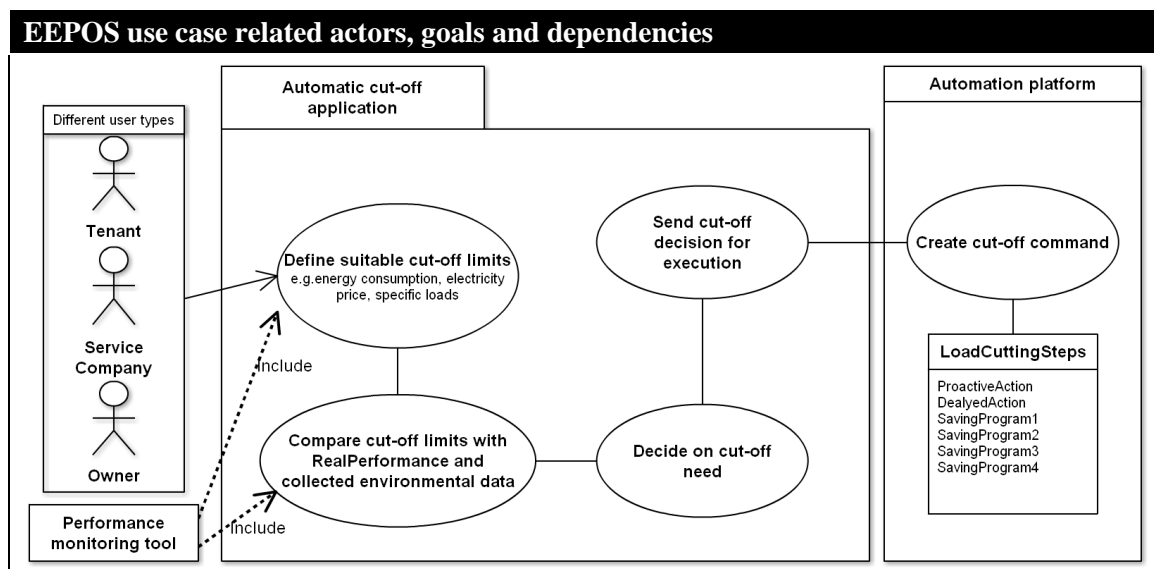


Figure 7. UML based diagram for related use case “Automatic consumption cut off”

5.2 UC2: Energy brokering tool

The narrative description of the monitoring tool related use case “energy brokering” is shown on Table 20.

Table 20. Narrative description of the EEPOS use case “energy brokering”

Narrative description of the use case
Short description
Energy Brokering (FTM)
Complete description
The Energy Brokering Tool (EBT) enables managers who manage the real estate with its own energy production (“EnMS operator”) to measure, calculate and monitor energy consumption and production. EnMS operator can sell energy to tenants by creating a contract within the system with the tenant. End-user/tenant itself isn’t using the software but receives reports and bills generated by it. Selling energy back to the grid is left out for this use case.
Key functions

- The Software enables the EnMS operator:
- to manage the energy consumption data
 - to monitor the energy consumption, peak loads and energy output
 - to monitor competitive sales and purchasing prices of the energy
 - to anticipate sales and purchasing activities according to consumption and forecast
 - to monitor the activities realizations
 - to transfer the anticipated supply requirements to sales and purchasing activities
 - to perform sales and purchasing of energy
 - to perform actual cost calculation

The list of the use case related actors are shown in Table 21.

Table 21. List of the use case “Energy brokering” related actors

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
Facility Manager	«Person»	See Table 16	Optional
Building Owner	«Role»	See Table 16	Optional
Neighbourhood level energy Supplier	«Organization»	See Table 16	Optional
Energy Services Company (ESCO)	«Organization»	See Table 16	Optional
EnMS Operator	«Role»	See Table 16	Optional

The use case related preconditions, events and assumptions are shown in Table 22.

Table 22. Use case “Energy brokering” related preconditions, events and assumptions

Actor/System/Information/Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
EBT	Calculate production/consumption	Relevant meters available	
EBT	Fetch prices and usage forecast	EEPOS System installed with related components	Pricing/forecast information to be available
EnMS Operator	Buy energy	Relevant contracts in place to buy energy from the grid	
EnMS Operator	Sell energy	Sell energy produced on site or purchased from the grid to end-users	
End user	Buy energy	Purchase energy from the EEPOS system	Relevant contracts in place

The UML diagram for the use case is shown in Figure 8.

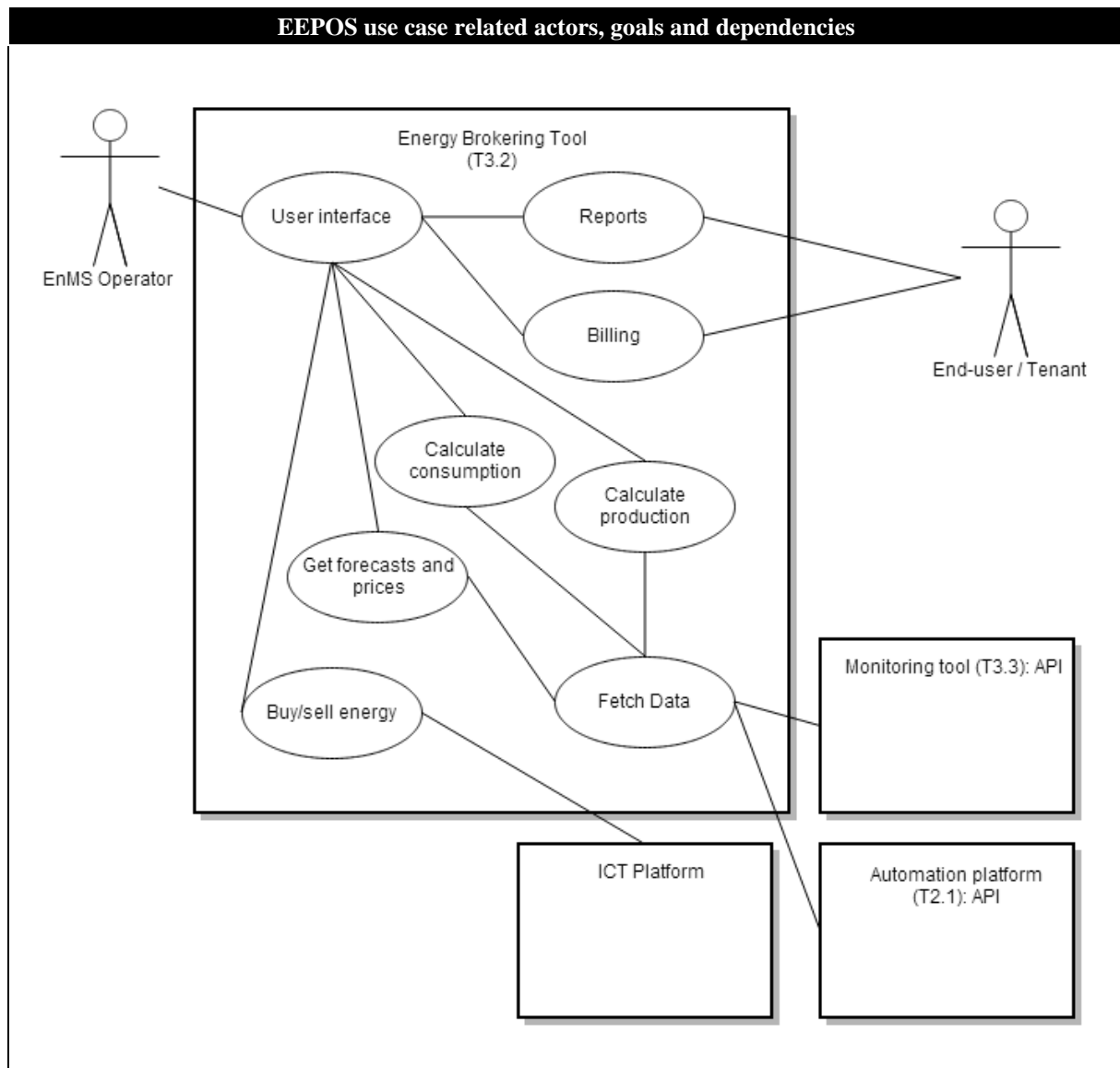


Figure 8. UML diagram for use case “Energy brokering”

5.3 UC3: Utilising the energy performance monitoring tool in Finnish demonstration

The narrative description of the “utilising energy performance monitoring tool” use case for Finnish demonstration is shown in Table 23.

Table 23. Narrative description of the Finnish demonstration use case “utilising energy performance monitoring tool”

Narrative description of the use case
Short description
Utilising the energy performance monitoring tool (VTT)
Complete description
The utilising the energy performance monitoring tool use case is based on visualized 3D virtual neighbourhood including the landscape, buildings and energy production units with navigation, online monitoring, historical data visualisation, benchmarking, and fault detection support.

The flesh out use case from the D1.1 scenario is as follows. The user can navigate in this 3D game engine based neighbourhood and start real time monitoring by clicking the item (building, energy production unit, energy grid component, etc.) and selecting the monitored variable (e.g. available measurements, calculated KPIs etc.). Example of the possible monitoring variables are index of energy positive neighbourhood, neighbourhood level energy reduction, neighbourhood and building level energy performance index, neighbourhood and building level energy consumption and power (heat and electricity), neighbourhood and building level energy production and power (heat and electricity), related costs, RES part of the used energy and load shifting done (moved demand from peak hours to off-peak hours of the day).

Almost identical sub use case is the visualizing historical data. In that case the user must also give the start time and the end time.

The user can also do benchmarking between buildings. The results can be shown by colouring the most energy efficient items by green and the least energy efficient ones by red.

The tool can also detect some energy consumptions related faults and show the target item(s) in virtual neighbourhood by colouring it red and by linking it. [18]

The list of the use case related possible actors are shown in *Table 24*.

Table 24. List of the Finnish demonstration use case “utilising energy performance monitoring tool” related actors [9]

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
Benchmarker	«Role»	See Table 16	
Building Management	«Role»	See Table 16	
Tenant	«Person»	See Table 16	
EnMS Operator	«Person»	See Table 16	Optional
Weather forecast service	«Software»	See Table 16	
BIM service	«Software»	See Table 16	Existing VTT’s BIM service based on open source BIMserver [19]
Simulation service	«Software»	See Table 16	Existing simulation service(s) developed by VTT
Fault detection service	«Software»	See Table 16	Existing fault detection service(s) developed by VTT

The use case related preconditions, events and assumptions are shown in *Table 25*.

Table 25. Finnish demonstration use case “utilising energy performance monitoring tool” related preconditions, events and assumptions

Actor/System/Information/Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
Performance monitoring and	Command “Get data”	EEPOS monitoring system “core” with relevant API’s	

operations planning tool		must be installed and working.	
Different types of end users (tenant, building management, etc.)	Navigation and selecting items in 3D virtual neighbourhood	3D model of the neighbourhood must be installed.	Landscape and building 3D models must exist.

The UML based diagram for the use case “utilising energy performance monitoring tools” is shown in Figure 9.

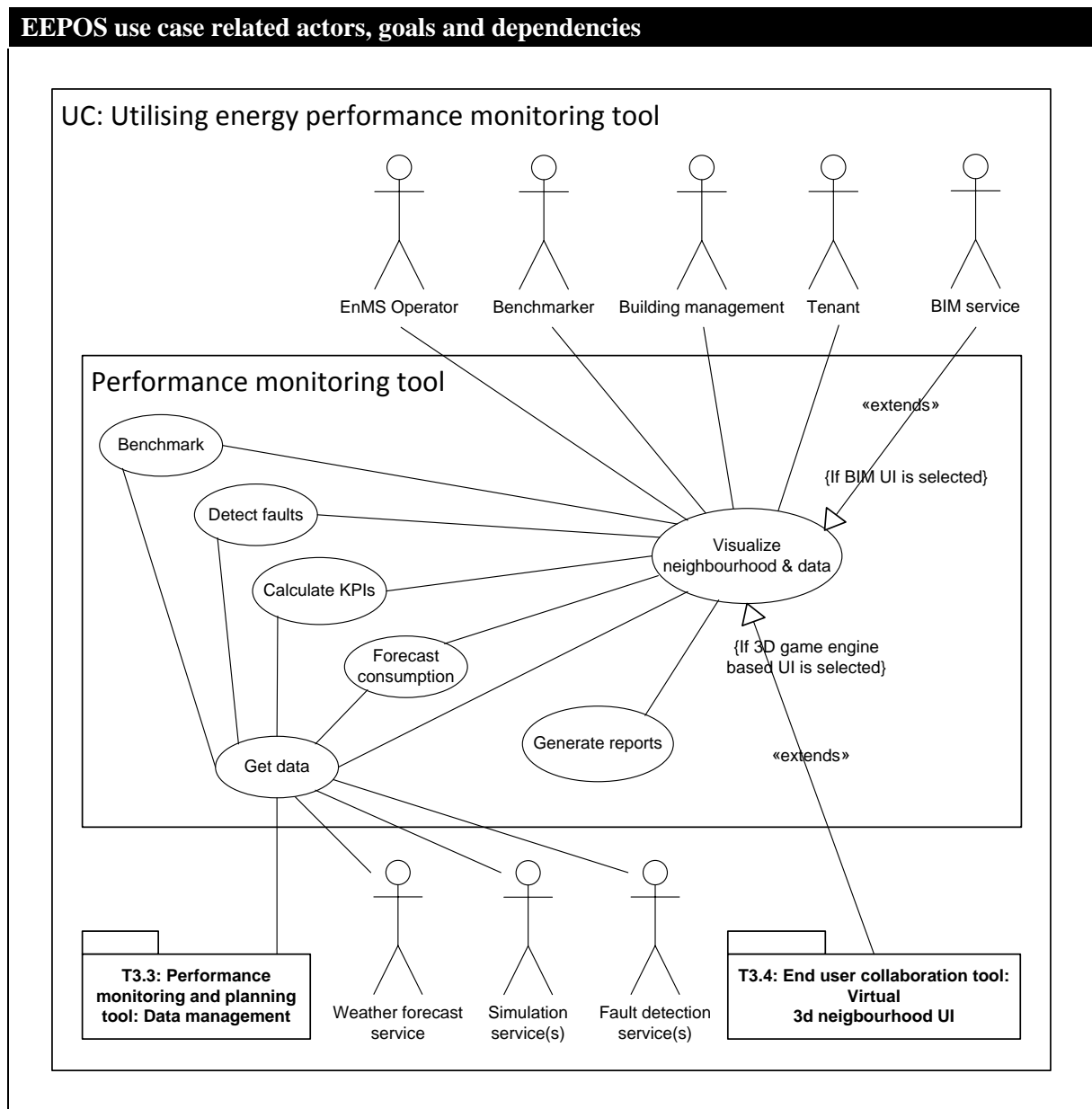


Figure 9. UML based diagram for Finnish demonstration related use case “utilising energy performance monitoring tools”

5.4 UC4: Utilising the energy performance monitoring tool in German demonstration

The narrative description of the German demonstration use case “utilising monitoring and planning tool” is shown on Table 26.

Table 26. Narrative description of the German demonstration related use case “utilising monitoring and planning tool”

Narrative description of the use case
Short description
Utilising monitoring and planning tool (ENO)
Complete description
<p>Ennovatis and the building owner of the buildings in the German field test site will use in this use case the ennovatis Controlling Energy Management software. The energy manager can use the software Ennovatis Controlling for data management, assessment and further processing. The user of the software can create benchmarking reports or other types of reports, which can be created customized. To maintain the recorded data each data file can be opened and edited separately e.g. for the inclusion of a meter change. The software user can also use the graphical data analyser (GDA) which provides great opportunities to visualize and compare the recorded data like RES energy production versus energy consumption in the neighbourhood in different ways, such as scatter graphs and other types of diagrams. For the analysis tasks the ennovatis Controlling provides for the user a powerful software solution enabling individual collection, analysis and administration of different types of measurement data. Automatically and permanently recorded data (e.g. weather, water, heat, electricity consumption and temperature) will be stored via distance reading (GSM or TCP/IP) in the database of the software. The following features of Ennovatis Controlling will be used:</p> <ul style="list-style-type: none"> • Data collection • Data administration • Data analysing • Load profiles • Forecasting • Benchmarks • Saving potential • Web-based reports <p>Key functions</p> <p>The key functions of the energy performance monitoring and planning tool are historical and real-time trend data monitoring, different kinds of statistical data analysis, calculation of duration curves and dependencies between different monitored values, neighbourhood level benchmarking, value based automatic fault detection and related basic level fault diagnostics. In the user interface of the tool BIM and the neighbourhood map will be utilised for visualising the NEMS status.</p>

The list of the use case related actors are shown in Table 27.

Table 27. List of the German demonstration use case “utilising monitoring and planning tool” related actors

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
Ennovatis Controlling	«Software»	See Table 16	A software that monitors and performs cross-building analysis and defines the energy usage and efficiency related KPI's of one apartment / building in relation to other apartments / buildings.

Energy manager	«Person»	See Table 16	
Weather forecast service	«Organisation»	See Table 16	
Meter	«Device»	See Table 16	

The use case related preconditions, events and assumptions are shown in Table 28.

Table 28. German demonstration use case “utilising monitoring and planning tool” related preconditions, events and assumptions

Actor/System/Information/Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
Energy manager	In case of recognized mal functions or over consumptions of energy.	Existing metering data with at least 15-min reading cycles of all energy consuming devices in the household/building .	Technical systems are not yet optimised.

The UML based diagram for the use case is shown in Figure 10.

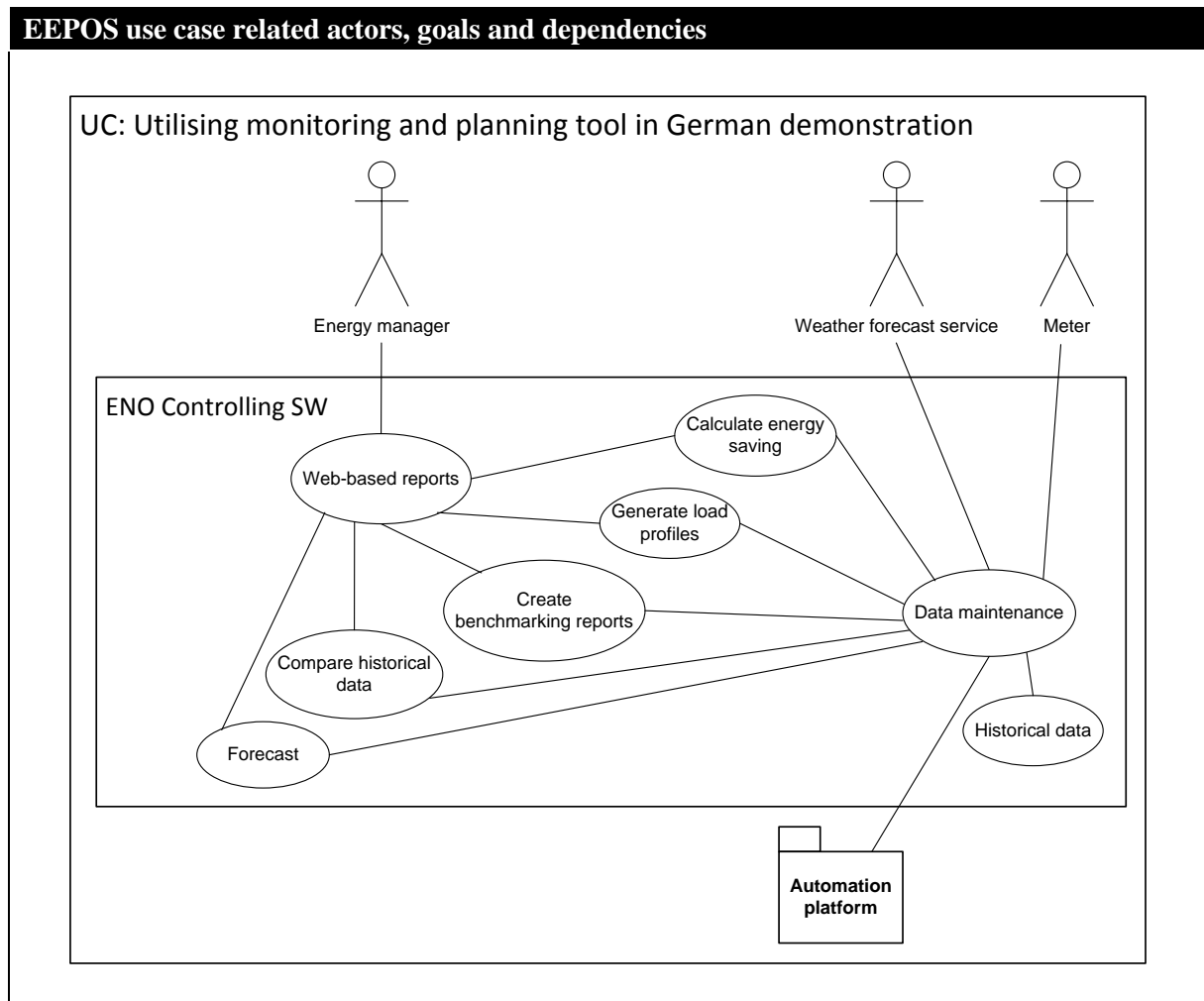


Figure 10. German demonstration related use case “utilising monitoring and planning tool”

5.5 UC5: Integration of consumers / non-automatized loads

The narrative description of the use case “Integration of consumers / non-automatized loads” is shown in *Table 29*.

Table 29. Narrative description of the use case “Integration of consumers / non-automatized loads”

Narrative description of the use case
Short description
“Integration of consumers / non-automatized loads” (AIT)
Complete description
Based on the prediction of the NEMS, the tenants get recommendations when the use of energy (mainly electric) is most beneficial or least detrimental to the neighbourhood energy grid. Based on these recommendations, the tenants then operate their non-automatized loads, e.g. white goods, leading to a more grid friendly behaviour.

The list of the use case related actors are shown in *Table 30*.

Table 30. List of the use case “Integration of consumers / non-automatized loads” related actors

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
End user	«Person»	See Table 16	
Automation platform	«Software»	See Table 16	
Energy grid	«System»	See Table 16	

The use case related preconditions, events and assumptions are shown in *Table 31*.

Table 31. Use case “Integration of consumers / non-automatized loads” related preconditions, events and assumptions

Actor/System/Information/Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
Automation platform	Grid status forecast	Grid status must be available in NEMS. Feedback device must be connected to NEMS.	

The diagram for the use case is shown in *Figure 11*.

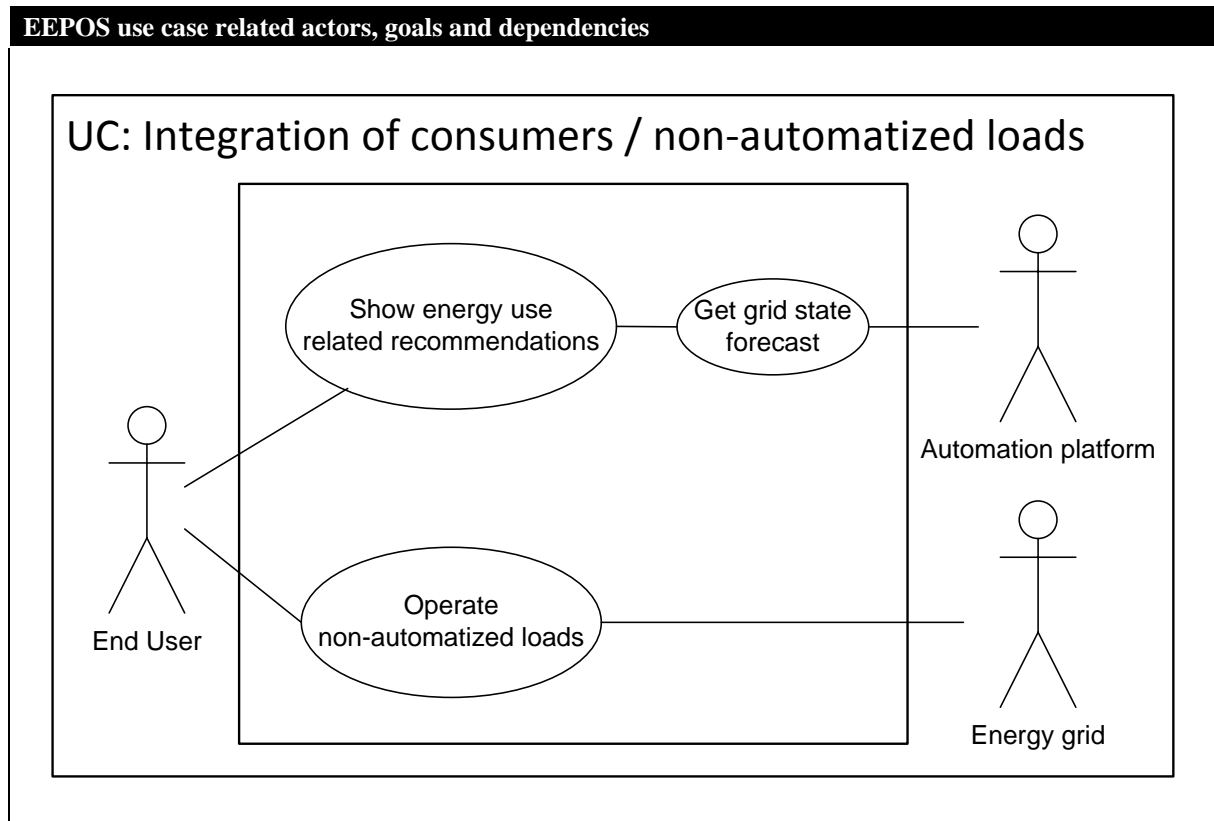


Figure 11. Use case “Integration of consumers / non-automatized loads”

5.6 UC6: Heating grid optimisation in German demonstration

Narrative description of the use case “heating grid optimisation in German demonstration” is shown in Table 32.

Table 32. Narrative description of the use case “heating grid optimisation in German demonstration”

Narrative description of the use case
Short description
Heating grid optimisation in German demonstration (AIT)
Complete description
Based on the production profile of the local heating plant – most often a CJP unit – and data from the heating grid and the individual substations. The production of heat is optimized by employed one or both of the following optimization methods. One possibility is to use the entire heating network as temporary heat storage, raising the desired temperatures to the upper limit before the end of the usual night setback period, allowing the substations to draw from this storage when heating up the dwellings in the morning. On the other hand, using data from the heat meters, average profiles for the individual substations can be identified, and the substations can be controlled in a way that their profiles are combined to a smoother profile by shifting the end of their night set in time, up to certain limits given by the end user.

The list of the use case related possible actors are shown in Table 33.

Table 33. List of the use case “heating grid optimisation in German demonstration” related actors

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
End user	«Person»	See Table 16	Sets limits to time shift.
Automation platform	«Software»	See Table 16	
Ennovatis Controlling	«Software»	See Table 16	Controls substation.

The use case related preconditions, events and assumptions are shown in Table 34.

Table 34. Use case “heating grid optimisation in German demonstration” related preconditions, events and assumptions

Actor/System/ Information/ Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
End user	Feels need to adjust time shifting limits		Included in demand response program.
Ennovatis Controlling	Load shift requested	Connections established, limits set	
Automation platform	Load shift needed	Connections established	Data available

The UML based diagram for the use case “heating grid optimisation in German demonstration” is shown in Figure 12.

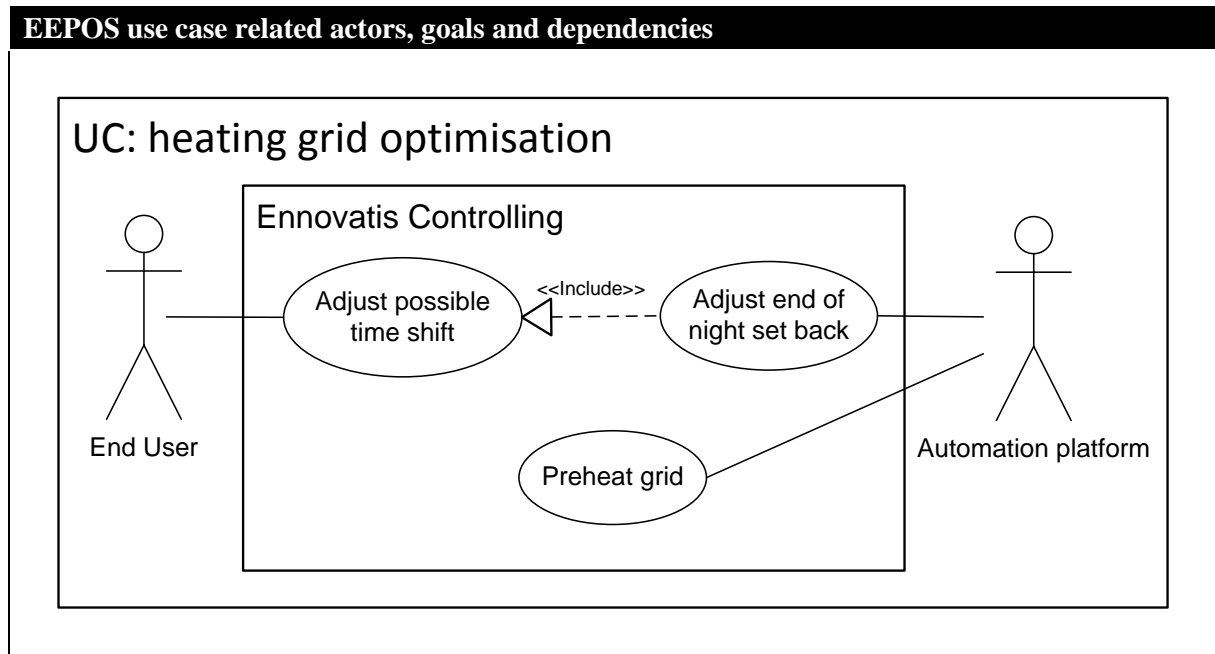


Figure 12. UML based diagram for related use case “heating grid optimisation in German demonstration”

5.7 UC7: Saving energy by end-user collaboration

The main use case in Finnish demonstration for end user collaboration tool is “saving energy by end-user collaboration”. The narrative description of the use case is shown on *Table 35*.

Table 35. Narrative description of the use case “saving energy by end-user collaboration”

Narrative description of the use case
Short description
Saving energy by end-user collaboration (VTT)
Complete description
<p>The saving energy by end-user collaboration use case is based on visualized 3D virtual neighbourhood including the landscape, buildings and energy production units with navigation and limited social media and reporting support.</p> <p>The flesh out use case from D1.1 scenario is as follows. The end user/tenant can navigate and click target entities in this 3D game engine based neighbourhood and get related energy use reports (by means of performance monitoring and operations planning tool) including main KPI's like energy consumption (heat and electricity), costs, RES part of the used energy and load shifting (moved demand from peak hours to off-peak hours of the day) relating year, month, week and day level. Optionally the user can access the right information / feedback without navigation by QR code based smart phone application.</p> <p>The user can also do benchmarking (by means of performance monitoring and operations planning tool) between his / hers apartment / building level KPI's to the corresponding KPI's of other end users. This KPI benchmarking allows the end user gets information of the energy saving issues (KPI's) which are not as good as others. The end-user collaboration tool can be used for asking advice from those whose KPI's are the best. And the improvement on energy saving (apartment / building related KPI's) can be published with few comments (how this was done) in the end-user collaboration tool related forum.</p>

The list of the use case related actors are shown in *Table 36*.

Table 36. List of the Finnish demonstration use case “saving energy by end-user collaboration” related actors

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
End user	«Person»	See Table 16	In most cases the end user is tenant.
End user collaboration tool	«Software»	See Table 16	3D game engine based UI which can visualize 3D virtual neighbourhood including the landscape and buildings with navigation, social media and reporting support.
Performance monitoring and operations planning tool	«Software»	See Table 16	A software that monitors and performs cross-building analysis and defines the energy usage and efficiency related KPI's of one apartment / building in relation to other apartments / buildings.
Social media	«Software»	See Table 16	Software platform for discussion and publishing the personal energy saving results.

The use case related preconditions, events and assumptions are shown in *Table 37*.

Table 37. Finnish demonstration use case “saving energy by end-user collaboration” related preconditions, events and assumptions

Actor/System/Information/Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
End user collaboration tool	Command “Get KPI’s”	Performance monitoring and operations planning tool with relevant API’s must be installed and running.	
End user / tenant	Navigation and selecting items in the 3D virtual neighbourhood	3D model of the neighbourhood must be installed.	Landscape and building 3D models exist. End user is participant of the EEPOS network.
End user collaboration tool	Command “publish in social media” or “read/write comment in social media”	Social media must have suitable API and support for creating social media based groups for people living in the neighbourhood.	

The UML based diagram for the use case is shown in Figure 13.

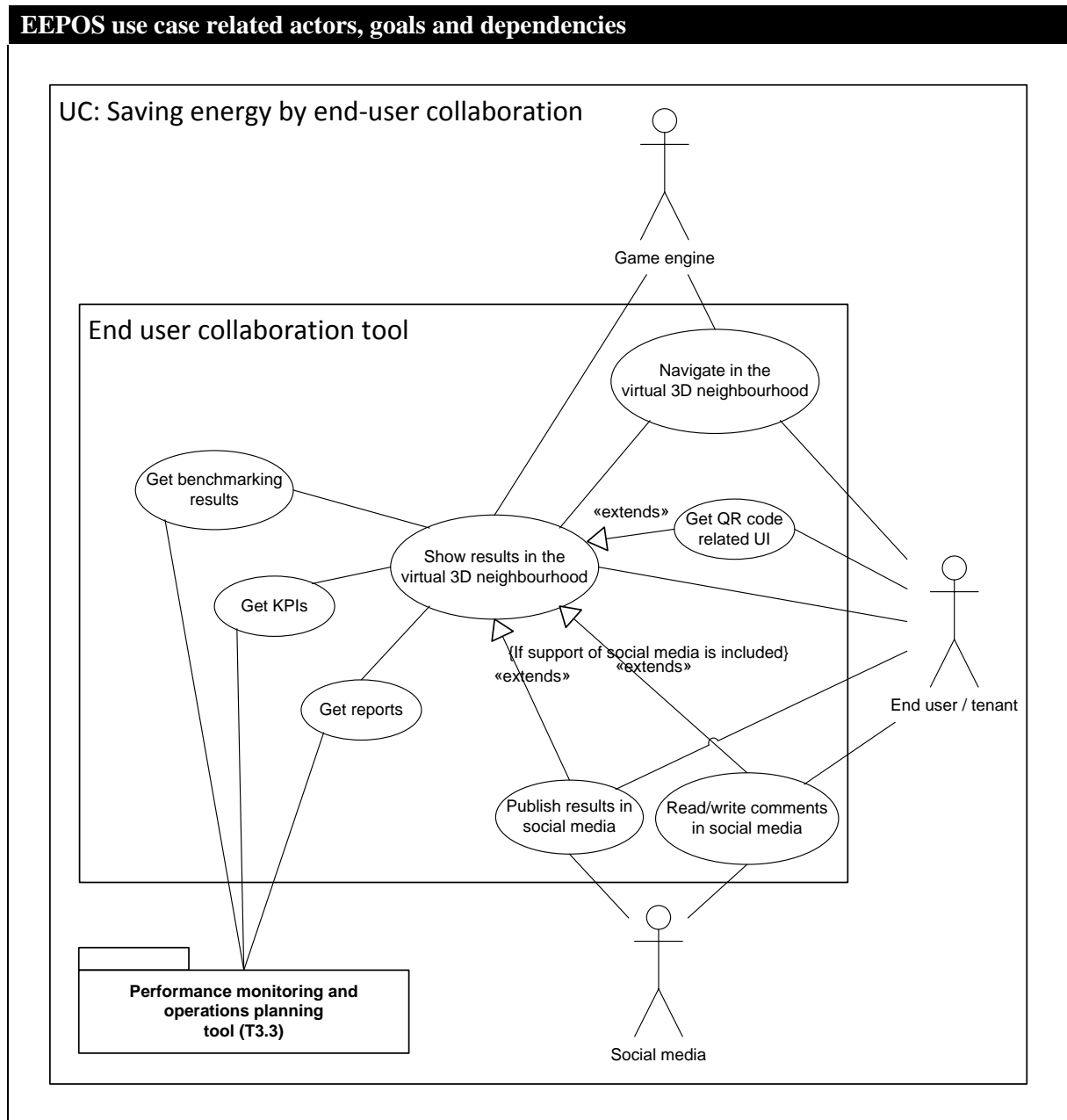


Figure 13. UML based diagram for the Finnish demonstration related use case “saving energy by end-user collaboration”

5.8 UC8: End user collaboration in German demonstration

The narrative description of the German demonstration related use case “end user collaboration” is shown on Table 38.

Table 38. Narrative description of the German demonstration related use case “end user collaboration”

Narrative description of the use case
Short description
End user collaboration (ENO)
Complete description
For the tenant who participates in the EEPOS project the end user collaboration tool is the

main tool, which connects him to the EEPOS system. The tenant can use e.g. a Tablet-PC to access the EEPOS end user platform. He will see information about the energy consumption in his home provided by different types of easy-to-understand diagrams and numbers. The tool will also show historical energy consumption data in order to have a baseline to compare with current data. Furthermore the tenant can be informed about current energy prices and opportunities to shift load to valley times, where the price of energy is lower. He will receive permanent information about the status of RES production in his neighbourhood. In some ways the end user collaboration tool may be used also for interacting with the tenants and involve him in serious games, like e.g. an “Eco-Points program”. The end-user collaboration tool plays a significant role to involve the end-user in the project. It is necessary to increase the awareness and the interest to use the EEPOS tools to ensure a continuous collaboration of the tenants in the project.

The list of the use case related actors are shown in Table 39.

Table 39. List of the German demonstration use case “end user collaboration” related actors

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
End user	«Person»	See Table 16	End user shall be a “prosumer”.
Performance monitoring and operations planning tool	«Software»	See Table 16	
Automation platform	«Software»	See Table 16	

The use case related preconditions, events and assumptions are shown in Table 40.

Table 40. German demonstration use case “end user collaboration” related preconditions, events and assumptions

Actor/System/Information/Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
End user	End user interactions	Participant of the EEPOS system (network).	End user shall be a “prosumer”.
End user collaboration tool	Get data	Performance monitoring and operations planning tool software must be up and running.	Needed sensors and measurements devices are installed.

The diagram for the use case is shown in Figure 14.

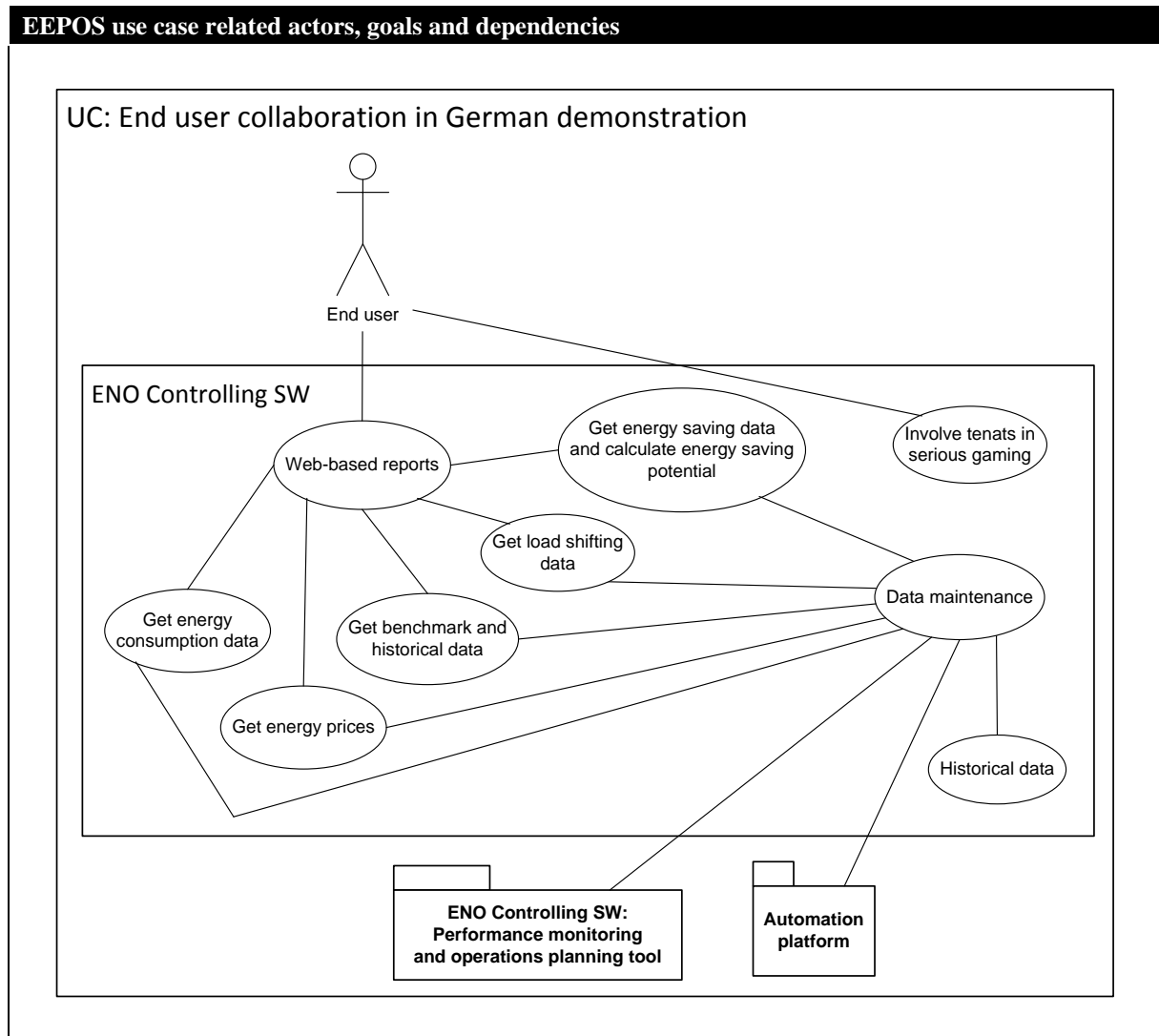


Figure 14. German demonstration use case “end user collaboration”

5.9 UC9: The Trading (Agent-Based) approach

The narrative description of the use case “The Trading (Agent-Based) approach” is shown in Table 41.

Table 41. Narrative description of the use case “The Trading (Agent-Based) approach”

Narrative description of the use case
Short description
“The Trading (Agent-Based) approach” (ENO)
Complete description
<p>With more and more PROSUMER try to deliver energy to the Main Grid (MAG) it is especially a critical task to consider the limited capacity of transmission lines. When these lines are overloaded, they may break down and cause, in the best case, damage to the system and a minor blackout or, in the worst case, a massive blackout. These significant challenges call for the need to build decentralized autonomous systems that are self-organizing and achieve high levels of efficiency. We call such a decentralized autonomous system a “Neighbourhood Area Grid” (NAG). The general target is an architecture with a high level of surplus which ensures that transmission lines are never overloaded.</p>

The flesh out use case from the D1.1 scenario is as follows. Each Energy PROsumer (EPRO) is represented by an agent who manages the self-interested actions of the EPRO. In this context “self-interested” means, that the agent represents the individual interest of the EPRO and not the interests of the complete neighbourhood in general which can be quite different. The NAG offers a balancing mechanism in form of a market place, where buyers and sellers of energy do the trading. The trading is limited to a given trading period which is divided into time frames.

The list of the use case related actors are shown in Table 42.

Table 42. List of the use case “The Trading (Agent-Based) approach” related actors

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
End user	«Person»	See Table 16	End user shall be a “prosumer”
Buyers	«Person»	See Table 16	End user shall be a “prosumer”
Sellers	«Person»	See Table 16	End user shall be a “prosumer”
Service Provider	«Organization»	See Table 16	Manages the relation between the main grid and the EEPOS system.
EnMS operator	«Organization»	See Table 16	Manages the relationships of the energy traders (buyers, sellers) in the EEPOS system especially with the end-user (prosumer).
Main grid	«System»	See Table 16	
Local energy production unit	«Device»	See Table 16	
Energy consumption component	«System»	See Table 16	e.g. building

The use case related preconditions, events and assumptions are shown in Table 43.

Table 43. use case “The Trading (Agent-Based) approach” related preconditions, events and assumptions

Actor/System/Information/Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
End user	End user interactions	Participant of the EEPOS system (network)	End user shall be a “prosumer”
Performance monitoring and operations planning tool	Get data	Performance monitoring and operations planning tool software must be up and running	
Buyers (at the market place)	Signal buy (e.g. email)	Byers are registered in EEPOS system	B, !S
Sellers (at the market place)	Signal sell (e.g. email)	Sellers are registered in EEPOS system	S, !B

Local energy production unit	Signal “more electricity to sell” (e.g. email)	Metering of energy production	$E_{Sellers} > E_{Buyers}$ at a given time frame
Energy consumption component	Signal “more electricity to buy” (e.g. email)	Metering of energy consumption	$E_{Sellers} < E_{Buyers}$ at a given time frame

The diagram for the use case is shown in Figure 15.

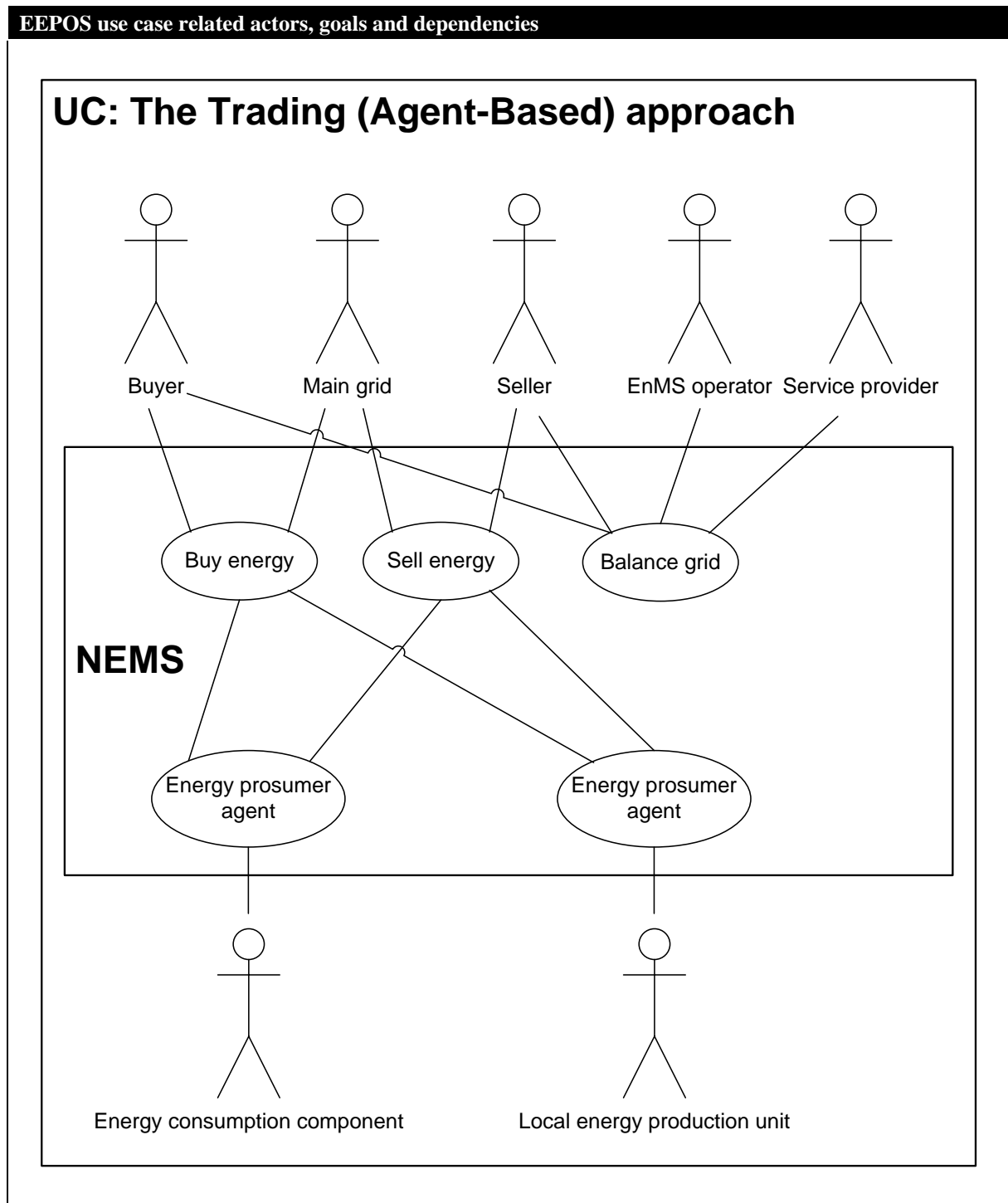


Figure 15. Use case “The Trading (Agent-Based) approach”

5.10 UC 10: Calculation of neighbourhood level PV generation by the Neighbourhood Automation System

The narrative description of the monitoring tool related use case “PV generation forecast calculation” is shown in *Table 44*.

Table 44. Narrative description of the use case “PV generation forecast calculation”

Narrative description of the use case
Short description
PV generation forecast calculation by the Neighbourhood Automation System (DERlab)
Complete description
The PV generation forecast application runs on the Neighbourhood Automation System (Automation Platform) which is a part of the EEPOS Neighbourhood EnMS. It calculates generation forecast profiles for those PV systems in the neighbourhood, which are not controlled by individual Building EnMS. The calculated generation forecast profiles for the PV systems serve as input data for other applications of the Automation Platform (e.g. the optimal load shifting planning application) or EEPOS tools (e.g. energy brokering tool).

A list of the use case related possible actors is shown in *Table 45*.

Table 45. List of the use case “PV generation forecast calculation” related actors

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
Weather forecast service	«Organization»	See <i>Table 16</i>	External data source provides the ICT platform with solar irradiance forecast and ambient temperature forecast. Solar irradiance and ambient temperature forecast is required as input data for the PV generation forecast application of the Automation Platform.
ICT platform	«System»	See <i>Table 16</i>	The ICT platform provides the Automation Platform with (i) solar irradiance forecast and (ii) ambient temperature forecast update.
Automation Platform	«System»	See <i>Table 16</i>	The Automation Platform informs the PV generation forecast application about updates in (i) solar irradiance forecast and (ii) ambient temperature forecast. Update in solar irradiance or ambient temperature forecast triggers the execution of PV generation forecast application.
PV generation forecast application	«Software»	See <i>Table 16</i>	The PV generation forecast application runs on top of the Automation Platform. The application calculates the PV generation forecast profiles for those PV systems in the neighbourhood, which are not controlled by individual Building EnMS. The outcome of the application is required input data for Optimal load shifting planning application and Energy brokering tool. The PV generation forecast application updates PV generation forecast in the Automation Platform.

The use case related preconditions, events and assumptions are shown in *Table 46*.

Table 46. Use case “PV generation forecast calculation” related preconditions, events and assumptions

Actor/System/ Information/ Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
Weather forecast service	Solar irradiance forecast update is provided or ambient temperature forecast update is provided	EEPOS Neighbourhood EnMS is running	

The UML based diagram for the use case “PV generation forecast calculation” is shown in *Figure 16*.

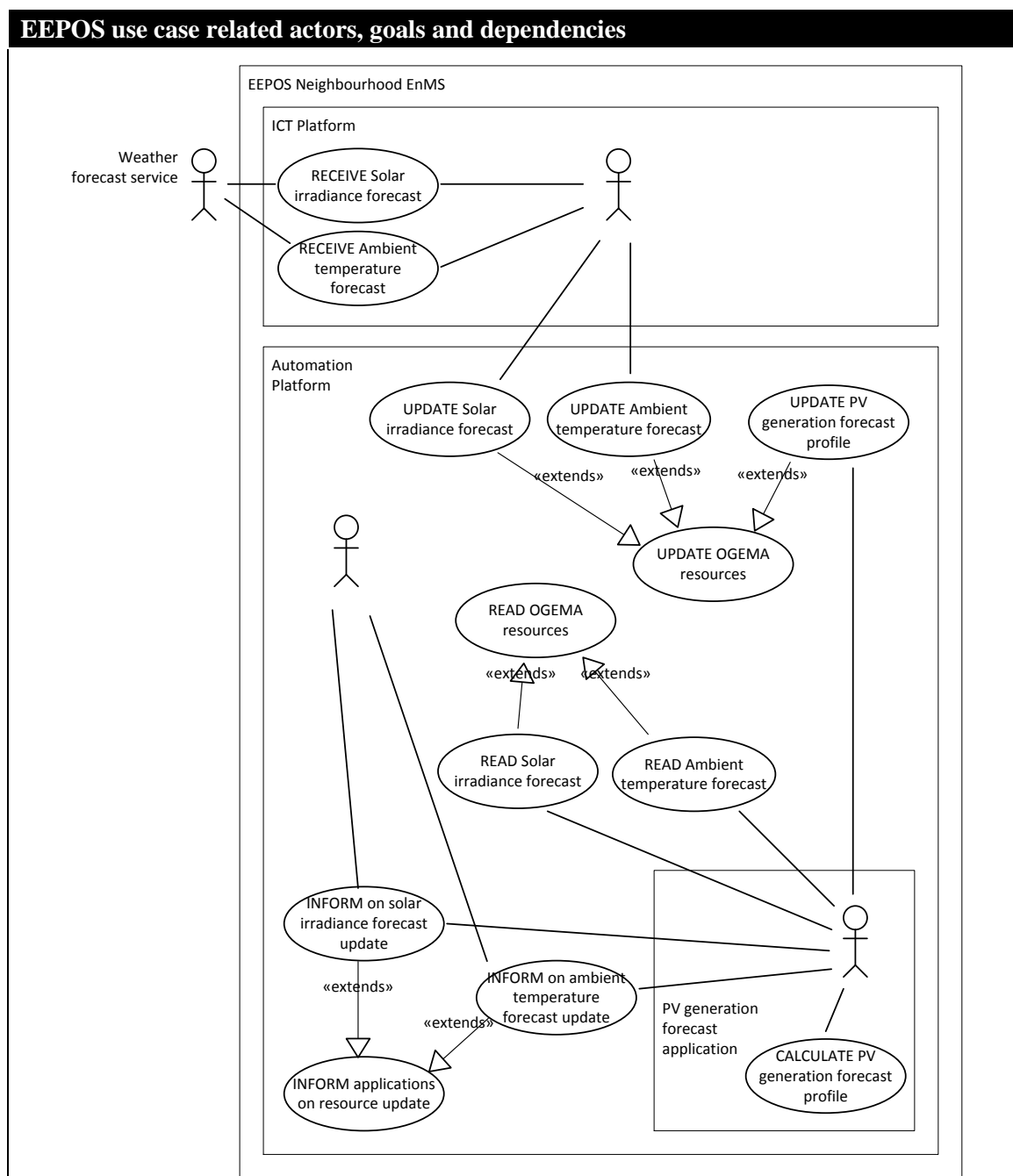


Figure 16. UML based diagram for related use case “PV generation forecast calculation”

5.11 UC 11: Optimal load shifting planning on the neighbourhood level by the Neighbourhood Automation System

The narrative description of the monitoring tool related use case “Optimal load shifting planning” is shown in *Table 47*.

Table 47. Narrative description of the use case “Optimal load shifting planning”

Narrative description of the use case
Short description
Optimal load shifting planning on the neighbourhood level (DERlab)
Complete description
<p>The load shifting planning application runs on the Neighbourhood Automation System (Automation Platform) which is a part of the EEPOS Neighbourhood EnMS. It calculates optimal load shifting profiles for grid user EnMS following management priorities:</p> <ol style="list-style-type: none"> 1) local DER surplus compensation in the neighbourhood, 2) cost effective load shifting following electricity price and 3) peak load shaving in the local electricity grid.

The list of the use case related possible actors are shown in *Table 48*.

Table 48. List of the use case “Optimal load shifting planning” related actors

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
Price forecast service	«Organization»	See <i>Table 16</i>	Electricity price forecast (by means of ICT platform) is required as input data for the optimal load shifting planning application of the Automation Platform.
PV generation forecast application	«Software»	See <i>Table 16</i>	The PV generation forecast application runs on top of the Automation Platform. PV generation forecast is required as input data for the optimal load shifting planning application.
Energy brokering tool	«Software»	See <i>Table 16</i>	Electricity load forecast on the neighbourhood level is required as input data for the optimal load shifting planning application.
ICT platform	«System»	See <i>Table 16</i>	The ICT platform provides the Automation Platform with (i) electricity price forecast and (ii) electricity load forecast on the neighbourhood level. Electricity price forecast and electricity load forecast on the neighbourhood level are required as input data for the optimal load shifting planning application of the Automation Platform
Automation Platform	«System»	See <i>Table 16</i>	The Automation Platform informs the optimal load shifting planning application about updates in (i) electricity price forecast, (ii) PV generation forecast and (iii) electricity load

			forecast. Update in electricity price, PV generation or electricity load forecast trigger the execution of optimal load shifting planning application.
Optimal load shifting planning application	«Software»	See <i>Table 16</i>	The optimal load shifting planning application runs on top of the Automation Platform. The outcome of the optimal load shifting planning application is required as input data for grid users equipped with EnMS and connected to the EEPOS Neighbourhood EnMS. Such grid users can be electricity consumers as well as electricity generators with ability to change their electricity consumption/generation patterns up to some grade.

The use case related preconditions, events and assumptions are shown in *Table 49*.

Table 49. Use case “Optimal load shifting planning” related preconditions, events and assumptions

Actor/System/Information/Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
Price forecast service	Electricity price forecast update is provided	EEPOS Neighbourhood EnMS is running	
PV generation forecast application	PV generation forecast is updated	EEPOS Neighbourhood EnMS is running	
Energy brokering tool	Electricity load forecast on the neighbourhood level is provided	EEPOS Neighbourhood EnMS is running	

The UML based diagram for the use case “Optimal load shifting planning” is shown in *Figure 17*.

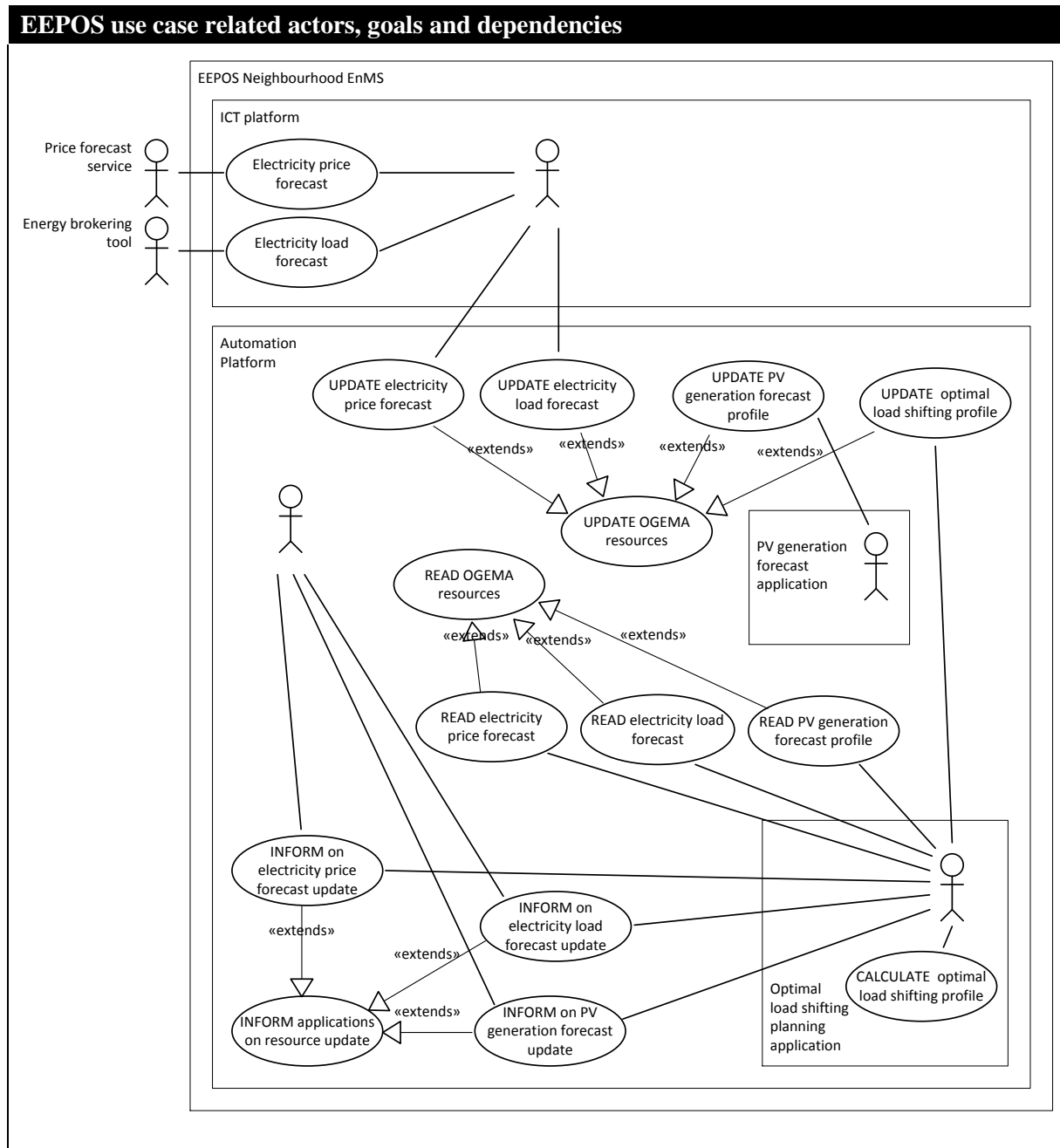


Figure 17. UML based diagram for related use case “Optimal load shifting planning”

5.12 UC 12: Storage of neighbourhood level historic electric energy consumption and generation rates

Narrative description of the use case “storage of neighbourhood level historic electric energy consumption and generation rates” is shown in Table 50.

Table 50 Narrative description of the use case “storage of neighbourhood level historic electric energy consumption and generation rates”

Narrative description of the use case
Short description
Storage of neighbourhood level historic electric energy consumption and generation rates (AIT)
Complete description
Various components of the NEMS rely on forecasts of the behaviour of the neighbourhood for controlling various systems present in the neighbourhood. This forecast need historic data to be computed, which may also be pseudonymized for privacy reasons.

The list of the use case related possible actors are shown in *Table 51*.

Table 51. List of the use case “storage of neighbourhood level historic electric energy consumption and generation rates” related actors

Actor name	Actor Type	Actor Description	Further information specific to this Use Case
Meter	«Device»	See Table 16	Energy meter
Automation platform	«Software»	See Table 16	API for reading/receiving any form of energy data must exist.
ICT platform	«Software»	See Table 16	API for reading/receiving any form of energy data must exist.
Performance monitoring tool’s database	«Software»	See Table 16	

The use case related preconditions, events and assumptions are shown in *Table 52*.

Table 52. Use case “storage of neighbourhood level historic electric energy consumption and generation rates” related preconditions, events and assumptions

Actor/System/Information/Contract triggering the use case	Triggering Event	Pre-conditions	Assumption
Meter	Data transfer is needed		
Performance monitoring tool’s database	Data is transferred		

The UML based diagram for the use case “storage of neighbourhood level historic electric energy consumption and generation rates” is shown in Figure 18.

EEPOS use case related actors, goals and dependencies

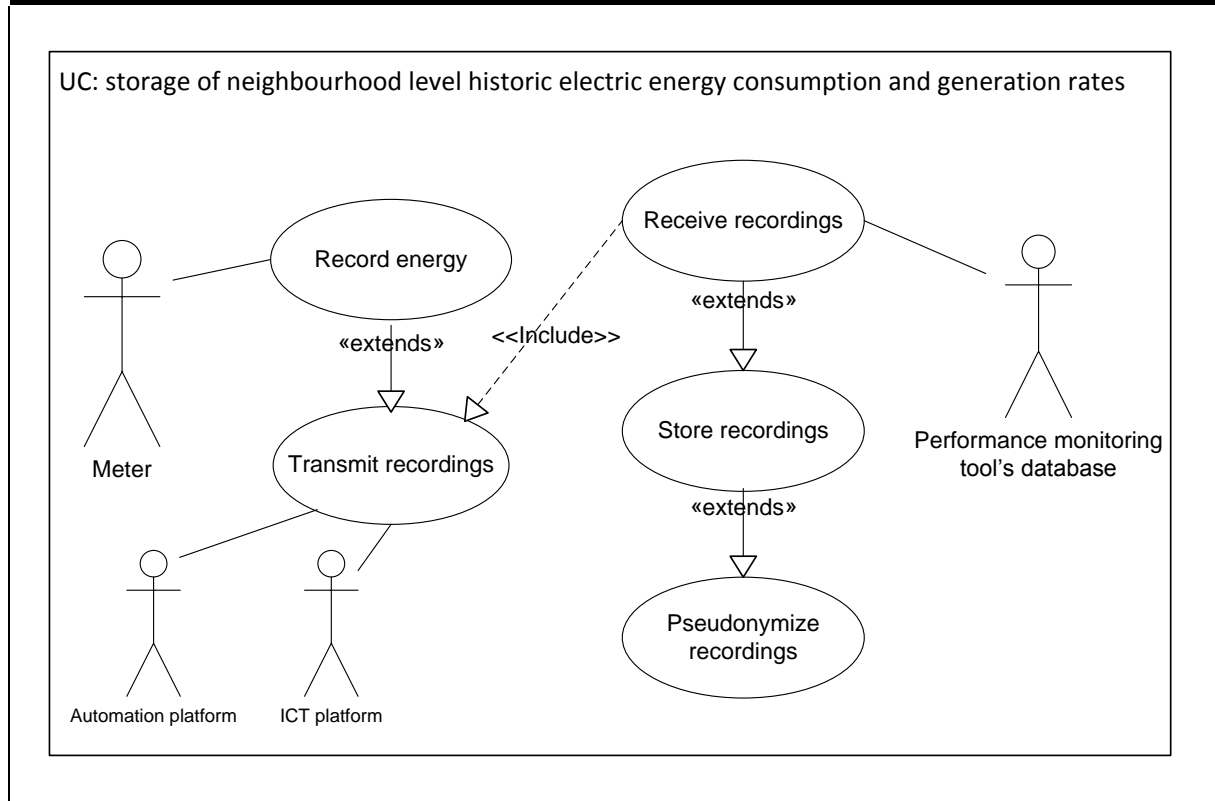


Figure 18. UML based diagram for related use case “storage of neighbourhood level historic electric energy consumption and generation rates”

6. CONCLUSIONS

The final goal of this task is the EEPOS information model which is in the core of the EEPOS tool development utilised in Finnish and German demonstrations. The purpose of this first phase of the modelling work was to describe the information modelling approach and to identify the requirements for the EEPOS information modelling.

The main results are

- Description of the EEPOS information modelling approach
- Requirements for EEPOS information models

This document is an intermediate document and some of the needed inputs (use case descriptions) are moved to the updated version of the document.

6.1 Summary of achievements

The main results presented in this report are the description of the EEPOS information modelling approach and the requirements for EEPOS information models including

- Description of the EEPOS information modelling approach including use case templates based on templates provided by CEN/CENELEC/ETSI
- Listing of the standards which should be considered when developing the EEPOS information models
- Description of the OGEMA data model concept as relevant for EEPOS
- Description of the EEPOS relevant communication between building and neighbourhood levels
- Description of the communication between the EEPOS Neighbourhood Automation System and the EEPOS ICT platform
- Description of several use cases for EEPOS tools by using EEPOS use case templates. Rest of the needed use case descriptions are moved to the updated version of the document.

6.2 Relation to continued developments

This document describes the basis for the EEPOS information model development. The final information model will be developed later in this task. This intermediate document includes some general info of EEPOS information model to T2.3, T3.2, T3.3 and T3.4. And it is the most important document when developing the final version of d2.2 deliverable.

On the other hand the final information models has output to T2.3, T3.2, T3.3 and T3.4. In other words the final data models are in the core of the EEPOS project affecting EEPOS tools development and related Finnish and German demonstrations. And if possible these models can have a role when developing EEPOS related European level information model standards.

6.3 Other conclusions and lessons learned

The using of all CEN/CENELEC/ETSI based use case templates is a rather heavy process and is not very effective in the case when the substance is well known by the information modellers. It is more suitable for standardisation and for very big projects where the domain experts, information modeller and the software developers are different peoples. There have been some challenges in UML based use case diagrams which are not common for everyone.

And it is also challenging to harmonise the descriptions of our use cases because all partners are not familiar with this kind of approach.

7. ACRONYMS AND TERMS

3D	Three Dimensional.
Actor	A participants in Application.
Ambassador	Project name (Autonomous Management System Developed for Building and District Levels, http://ambassador-fp7.eu/).
API	Application Programming Interface.
AS1	Alternative scenario 1.
AS2	Alternative scenario 2.
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers.
BACnet	Building Automation and Controls Networks.
BIM	Building Information Model.
buildingSMART	A neutral, international and unique non for profit organisation supporting open BIM through the life cycle.
CEM	Customer Energy Manager.
CEN	European Committee for Standardization.
CENELEC	European Committee for Electrotechnical Standardization.
CHP	Combined Heat and Power.
CIM	Common Information Model.
COSEM	Companion Specification for Energy Metering.
DER	Distributed Energy Resources.
DLMS	Device Language Message Specification, originally Distribution Line Message Specification.
DSM	Demand Side Management.
EBT	Energy Brokering Tool.
EEBus	E-Energy Bus (www.eebus.org).
EEPOS	Energy management and decision support systems for Energy POSitive neighbourhoods.
ESCO	Energy Service Contractor/Company.
ETSI	European Telecommunications Standards Institute.
EU	European Union.
FSGIM	Facility Smart Grid Information Model.
HBES	Home and Building Electronic Systems.
ICT	Information and Communication Technology.
IDEAS	Project name (Intelligent neighbourhood Energy Allocation & Supervision, http://www.ideasproject.eu/wordpress/).

IEC	International Electrotechnical Commission.
IEEE	Institute of Electrical and Electronics Engineers.
INTrePID	Project name (INTElligent systems for Energy Prosumer buildIngs at District level, http://www.fp7-intrepid.eu/).
ISO	International Organization for Standardization.
JACE	Java Application Control Engine.
JSON	JavaScript Object Notation.
KPI	Key Performance Indicator.
LNAP	Local Network Access Point.
LON.....	Local Operating Network.
M-BUS	Meter-Bus.
MCF	Meter Communication Functions.
MSCONS	Meter data related messages for market communication.
NEMA	National Electrical Manufacturers Association.
NEMS.....	Neighbourhood Energy Management System.
NNAP.....	Neighbourhood Network Access Point.
OASIS	Organization for the Advancement of Structured Information Standards.
oBIX.....	Open Building Information Xchange.
Odysseus.....	Project name (Open Dynamic System for Holistic energy Management of the dynamics of energy supply, demand and storage in urban areas, http://www.odysseus-project.eu/).
OGEMA	Open Gateway Energy Management Alliance.
OpenADR.....	Open Automated Demand Response.
prEN	Proposed European Standard.
PS1	Primary scenario 1.
PS2	Primary scenario 2.
PV	Photovoltaic.
QR code.....	Quick Response code.
SunSpec.....	Open information standards that solar PV manufacturers use to achieve plug-and-play interoperability between solar PV power plant components and software applications, http://www.sunspec.org/ .
UML.....	Unified Modeling Language.
WAGO-I/O.....	A modular, fieldbus independent I/O system.
Z-Wave.....	A wireless communications protocol designed for home automation (http://www.z-wavealliance.org/).
ZigBee	A low-cost, low-power, wireless mesh networking standard.

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