



Use Cases

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1 Introduction

Energy@home is a no-profit association that aims to develop & promote technologies and services for energy efficiency in the home, for the benefit of the environment, based upon device to device communication. Its goal is to promote the development and widespread of products and services based on the collaboration of the appliances within the household and their integration with the Smart Grid.

This document is going to be submitted by Energy@Home Association to Working Group 21 of IEC-TC 57 as a contribution to the technical report IEC 62746-2 TR through the Italian CEI (Comitato Elettrotecnico Italiano). Where, for the sake of completeness, it is here reminded that WG21 of IEC-TC57 is responsible for “Interfaces and protocol profiles relevant to systems connected to the electrical grid”, while the technical report IEC 62746-2 TR is entitled “Systems interface between customer energy management system and the power management system – Part 2: Use cases and requirements” and is intended to provide use cases and requirements for the interface between the power management system of the electrical grid and customer energy management systems for residential and commercial buildings and industry.

The Association was founded on July 2012 by Telecom Italia, Electrolux, Enel Distribuzione, and Indesit Company and it is open to new members. At the time of writing, the Association counts 22 members from different industries: the electrical system industry (Enel and Edison), household appliances manufacturers (Electrolux, Indesit Company, Whirlpool, and Ariston Thermo), telecommunications (Telecom Italia and Vodafone), ICT companies (Altran, Flash Reply, and Intecs), micro-electronics vendors (Freescale, Renesas, and ST Microelectronics) and a company for the inverter and storage systems (Power-One), as well as research institutes (Istituto Superiore Mario Boella) and small/medium-sized companies (i-em, Flexgrid, Eurotherm, MAC, Gemino, and Urmet).

The Energy@home aims to use the new information technologies and electronic equipment's to transform the home environment in an eco-system of devices that communicate with each other's: the electric meter, household appliances, electrical system, and the network of broadband telecommunications, small renewable power plant and energy storage. Communication allows these devices to be integrated in a smart way, increasing energy efficiency, reliability and security of the domestic energy system, and giving consumers more information and power of choice.

The activities of the Association are organized into working groups and, in addition to the definition of architectures and technical specifications, include the analysis of the use cases and the impact on the regulatory environment, experimenting with pilot projects and the dissemination of the specifications.

Energy@home is an acknowledged contributor to the ZigBee Home Automation 1.2 standard that integrates devices, functionalities and use cases of Energy@home.

Information in this document is preliminary and subject to change, however anyone is encouraged to review and provide comments at the following e-mail addresses:

comments@energy-home.it

Energy@home reserves the right to publish future versions of these specifications without any prior notice.

Founding Members:



Ordinary Members:



Aggregate Members:



2 System Architecture

Following the European roadmap for the implementation of the Smart Grid¹, where concepts like flexible demand and generation are taken into account, one of the cornerstone requirement for the support of an efficient integration of renewable energy sources into the energy system is the flexibility that a customer could offer to the Smart Grid actors through a so called “Smart Grid Connection Point”, that represents the physical and logical interface from the customer to the grid. The generic architecture that describes the functions involved in the interactions between the Customer and the Grid actors is reported in Figure 1

¹ Developed by the “Smart Grid Coordination Group” as requested by the European Commission, mandate M/490. Reference: http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/xpert_group1_sustainable_processes.pdf

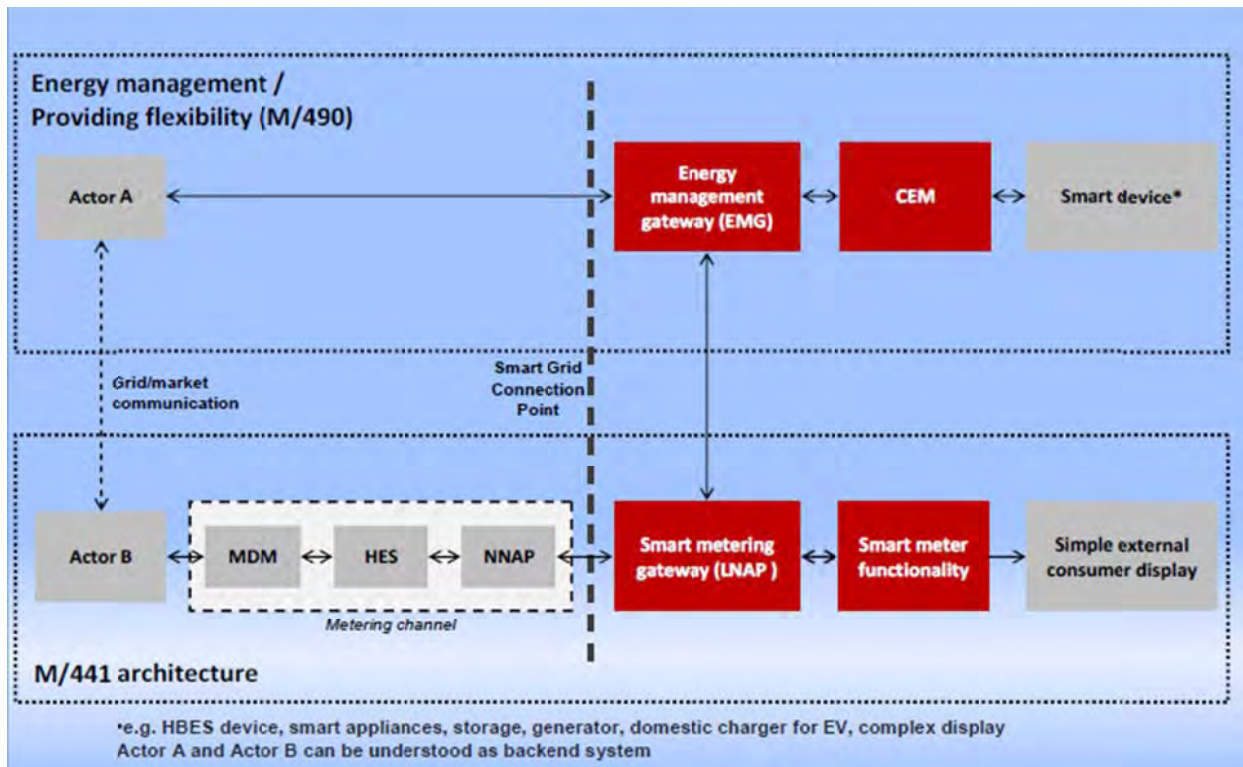


Figure 1: Flexibility functional architecture

The functional components represented in this figure could be implemented/aggregated in different systems and devices. In this document it will be shown how this generic functional architecture can be mapped in the Energy@home architecture. The Association adopted the system architecture shown in Figure 2, providing to the customers new value added services ranging from simple energy consumption awareness, up to a fully integrated energy management system. The architecture is expected to increase in scope as a result of the ongoing collaboration activities and interests of the Energy@home members.

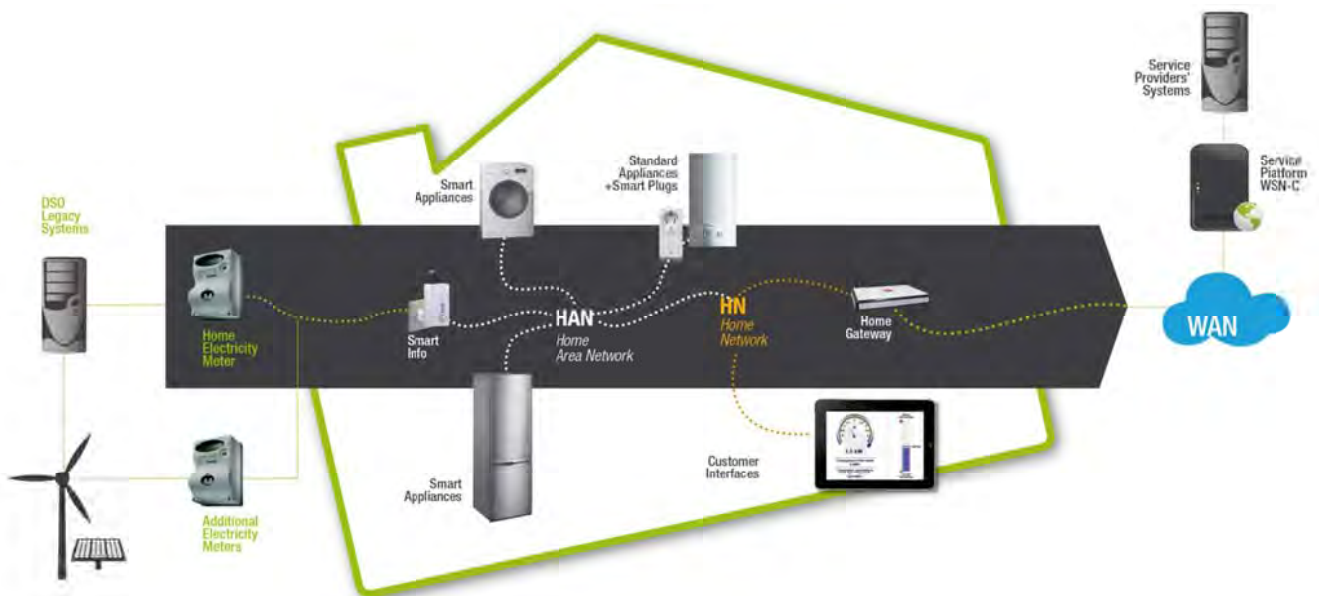


Figure 2: Energy@home architecture

In a Home Domain, that includes both the HAN (Home Area Network) and the HN (Home Network), all the actors (home devices, CEMS, Smart Info and Customer Interfaces) can cooperate through communication mechanism. The aim of Energy@home is to identify and describe the requirements of indoor platform and it is expressly out of the scope the definition of the other interfaces and services provided outside the Home Domain.

Devices in the HAN communicate with each other via the wireless protocol ZigBee Home Automation version 1.2 developed in collaboration between the ZigBee Alliance and Energy@home and officially ratified in July 2013. These international specifications define all levels of communication including the syntax and semantics of application messages exchanged between the user devices. This ensures full interoperability between systems and devices from multiple vendors.

The HAN will interface with the DSO meter using a smart metering gateway (Smart Info) that provides measurement data recorded by the electronic meter communicating with it via the DSO (Enel Distribuzione) power-line protocol. On the other side, this device is part of the Home Area Network and it communicates using the ZigBee protocol: it can be configured to send push data received from the all the DSO meters and can be queried in polling to acquire on-demand data.

The HAN devices are divided into "legacy devices" and " smart devices". The first are traditional devices that do not implement any communication skills and can only be controlled through a Smart Plug. In Energy@home have been defined all the messages needed to configure these smart plugs, to receive energy data and instantaneous power, and where the load permits, to control the switch on/off remotely. Smart devices are connected devices for which the messages are defined to identify the type of load (e.g., type of appliance, supplier name, firmware version, etc.) as well as to monitor and control the start and the status of operation, to communicate information to diagnose problems as well as the transmission of statistical information and the tunneling of manufacturer proprietary information of the appliance. Every electrical load of a smart device can be planned through a scheduling algorithm that uses the data structure defined in Power Profile.

The Power Profile is a vector which represents the energy needs of a device, in the case of a washing machine each element of the vector represents a phase of the washing. Each element is a schedulable phase not interruptible described by 4 fields: the maximum power required, the estimated time required, the expected energy consumed and, finally, the maximum delay allowed scheduling the phase. The CEMS collects the Power Profile of all devices connected and performs a scheduling algorithm to calculate the delay of each stage for each device; this permits to optimize the total demand in terms of maximum power and hourly cost of energy that, of course, is always subject to any restriction set by the client (such as the time of termination of a wash) and to the availability of energy from power plants and storage systems in the home.

The main actors in the Home Domain are the following ones:

- **Smart Appliances:** an evolution of the actual and standard white goods; see hereunder some of their possible new functionalities:
 - Display to the customer information on their energy consumptions (e.g. used energy, instant power, etc.)
 - Dispatch in the HAN information on their energy consumptions
 - Autonomously adapt their behavior according to information on energy consumptions coming from the house. (e.g. reduce their load when global house consumptions goes beyond a threshold)
 - Cooperatively operate with other entities in order to optimize the energy usage through load shifting and load shedding

In any case, the load control operations either performed autonomously or under an external supervision, shall be performed under the complete control of the appliance, which assures the correct execution of its working procedure and its results and performances. For example, a smart washing machine, when requested to modify its consumption behavior, shall assure the result of the washing cycle.

Smart plugs (able to provide remote metering and to be remotely controlled) could be somehow included in the Smart Appliances category although they can provide no direct control over the effect of remote control activities. In particular, Smart Appliances will not be controlled by Smart Plugs

- **Customer Interfaces:** see hereunder some of their possible functionalities:

- Display information on energy usage like instant power, historical data, contractual information and similar, from the whole house (coming from the Smart Info) and from every single smart appliance. The level of details and graphical layout of their user interface is freely defined by every device
- Transmit control message to Smart Appliances to request a modification of their behavior
- Configure Smart Appliances to modify their power consumption profile (e.g. a personal computer used to configure a thermostat to activate the controlled load only in certain time slots)

The Customer Interface, from this perspective, is connected in the HN/HAN; it is foreseen the possibility to have Customer Interfaces accessing the house from the WAN through a specific interface, but the definition of this interface is out of the scope of the Energy@home project as previously stated.

Typical Customer Interfaces are personal computers, Smart Phones, PDAs, ad hoc displays, entertainment systems, in-house monitor and similar. The software application, which implements the user interface, could be local in the device or remotely hosted in another device (e.g. the Home Gateway) and accessed through web-services.

- **Customer Energy Manager System (CEMS)** The CEMS is CEM integrated with communication functionalities, it is the gateway between the HAN, the HN and the WAN (e.g. internet). The CEM is a logical function optimizing energy consumption and or production based on signals received from the grid, consumer's settings and contracts, and devices minimum performance standards. The Customer Energy Manager collects messages sent to and received from connected devices; especially the in-home/building sector has to be mentioned. It can handle general or dedicated load and generation management commands and then forwards these to the connected devices. It provides vice versa information towards the "grid / market". Note that multiple loads/generation resources can be combined in the CEM to be mutually controlled.
- **Smart Info:** it is the element, provided by the DSO, which dispatches energy related information into the HAN. Published data are a sub-set of those already available inside the Home Electricity Meter, hence the Smart Info acts like a proxy of the meter. Additional data could be possibly generated by the Smart Info itself. Noticeably, near real-time instant power (sampled at of about 1 Hertz frequency or higher) should be acquired by another metering device, likely embedded inside the Smart Info. Additional elements (SI') can also be provided by third parties and used to dispatch data generated by other meters into the HAN.

Outstanding components outside the Home Domain are:

- **WSN-C:** Wireless Sensor Network Center: it manages, together with the Home Gateway, the HAN devices and provides service oriented interfaces for the development of third-party applications.
- **Electricity Meter:** An electric meter, able to measure and record usage data in time differentiated registers, and capable of transmitting such data to central utilities system. Moreover, the meter should provide bi-direction communication to allow remote management of the meter.
- **Aggregator:** mediator between consumers and AD buyers, collects requests and signals from the AD buyers, pools flexibilities of consumers to build Active Demand services and makes offers to the markets.

Please note that the proposed classification is mainly intended to identify the main categories of devices in the Home Domain, without any limitation to the possibility for a device to implement functionalities from more than a category. As an example, an advanced Smart Appliance, provided with a rich user interface, could also implement functionalities typical of a Customer Interface. In the same way, while typical smart appliances are smart white goods, also a personal computer, able to perform such operations, should be considered an appliance from this perspective.

1 Visualization of current energy and power data

Name of Use Case

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
1.1		Visualization of current energy and power data

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
1		Stella Di Carlo		

Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	The aim of following use cases is to provide customer with information on the current situation of the customer consumptions
Objective(s)	Visualization of global current metering data from Smart Meter and DSO
Related business case(s)	A.2.19 pag 215 v. 069

Narrative of Use Case


Narrative of Use Case	
Short description	
The customer is presented with information about the global current energy consumption of his/her house. Data are provided by the Smart Info, which retrieved them from the Meter and, possibly, integrates those data with near real-time power, measured by an extra module.	
Complete description	
Among the data coming from the Meter no information about costs are provided, hence any reference to the current tariff shows just which is the active tariff at the moment, but not the pricing. In this context "current" means near real time data and the consumptions of last few hours or days. Data can be presented in different formats (plain numbers, graphics, tables, etc.) in the Smart Appliance or in the Customer Interface. In this Use Case the CEMS is not strictly necessary; its presence would allow a number of extra functionalities described in the CEMS column.	
Diagram(s) of Use Case	
No Diagram is available for this use case	

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name see Actor List	Actor Type see Actor List	Actor Description see Actor List	Further information specific to this Use Case
Smart Info		Provides a sub-set of data contained in the Smart Meter and, eventually, instant power, calculated by the SI itself or another device connected to it. Data are dispatched upon request and in case of transition (only for slowly changing data). The Smart Info	

		<p>performs no elaboration over the data retrieved by the Meter, except the basic processing required to retrieve, validate, memorize and dispatch them. For example, load profile shall be dispatched with the same level of resolution available in the meter (e.g. 15 minutes). Any operation needed to change Meter data resolution or to integrate them with instant power, shall be performed by the device which displays data to the customer.</p>	
CEMS		<p>Hosts a Web application that collects data from HAN devices and organizes them for a user-friendly presentation.</p> <p>Exposes a web-based API over IP HN that can be used by 3rd party applications that wishes to elaborate current data and provides a different visualization.</p> <p>Implements an Execution Environment (e.g. OSGi framework for Java) to host 3rd party applications that wishes to elaborate current data and provides a different visualization.</p> <p>Implements a Trust Agent to manage all security keys of the HAN; this functionality can be implemented via collaboration with the WSN-C Service Platform</p> <p>Implements the communication with the WSN-C Service Platform and provides APIs to mediate communication between local bundles and WSN-C Service Platform.</p>	
Smart Appliances		<p>Receive over the HAN (from Smart Info) global current metering data and total in-house energy consumption. Display a sub-set of available data, depending on the richness of its user interface</p>	

Steps – Scenario Name

Scenario Conditions					
No.	Scenario	Primary Actor	Triggering	Pre-Condition	Post-
		Use Cases			9 / 89

	Name		Event		Condition
1	Visualization of global current metering data + cost information	Smart Info – CEMS – Smart appliances			This scenario add also information about the cost of the used energy. According to rules imposed by the Authority, the DSO could not be allowed to provide such information, being the Energy Retailer the only subject entitled to define final rates for clients.
2	Visualization of current energy consumptions and power of Smart Appliances+ global current metering data	Smart Info – CEMS – Smart appliances			In this scenario, the customer is also informed on the current energy consumptions of the single appliance. The level of detail, frequency and quality of data could be different among different devices. It should be possible for clients to display such disaggregated data together with total house consumptions; such functionality shall be performed by Customer Interfaces
3	Visualization of current energy consumptions and power of Smart Appliances + global metering data + cost information				Similar to the previous scenario with information on costs
4	Visualization of estimated energy consumption of Smart				One of the most important goals of this use case is to educate the consumer in

	Appliances and its cost before starting to run			<p>selecting the parameters of the cycles feedbacking her/him their costs and energy consumption, before the start button will be pressed. Many studies show that, only by displaying this information, a energy consumption saving of 10-15 % could be achieved on the single appliance. The Smart Appliances estimate the energy that will be consumed during its next operation (ex: cycle). If possible, they give information also about the energy cost and the next operation cost by requiring to the CEMS to perform energy cost evaluation. Moreover, in case of time-of-use (TOU) pricing, the appliance receives information about which tariff is currently in use.</p>	
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2. Visualization of current home energy consumption

Name of Use Case

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
1.2	Customer/Market	Visualization of current home energy consumptions and power of Smart Appliances with cycle cost information

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
	9/5/2014	Marco Signa		

Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	The aim of following use cases is to provide customer with information on the current situation of her/his home consumption and in particular the one of Smart Appliances
Objective(s)	Visualization of current energy and power data
Related business case(s)	A.2.19 pag 215 v. 069

Narrative of Use Case

Narrative of Use Case
Short description
The customer is presented with information about the global current energy consumption of his/her house and Smart Appliance on a selected user interface, that could be on the appliances themselves or on another device.
Complete description
The customer is presented with information about the global current energy consumption of his/her house. Data are provided by the Smart Info, which retrieved it from the Meter and, possibly, integrates those data with near real-time power, measured by an extra module. Meter cannot provide information about energy cost, hence any reference to the current tariff would just relate to the active tariff at the moment, but no pricing. In this context "current" means near real time data and the consumptions of last few hours or days. Data can be presented in different formats (plain numbers, graphics, tables, etc.) either on the Smart Appliance display or on another Customer Interface. In this Use Case the CEMS is not strictly necessary; its presence would allow a number of extra functionalities described in the CEMS column. In addition, the customer is also informed on the current energy consumptions of the single Smart appliances. The level of detail, frequency and quality of data could be different among different devices. It should be possible for users to display such disaggregated data together with total house consumptions; such functionality shall be performed by Customer Interfaces.

General Remarks

General Remarks
Consumption of Smart Appliance can be an estimate based on the phase of the cycle or the functionality the appliance is performing, not necessarily the consumption value comes from measurement.

Diagrams of Use Case

Diagram(s) of Use Case

No Diagram available for this Use Case

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name <i>see Actor List</i>	Actor Type <i>see Actor List</i>	Actor Description <i>see Actor List</i>	Further information specific to this Use Case
Smart Info	TBD	Provides a sub-set of data contained in the Smart Meter and, eventually, instant power, calculated by the SI itself or another device connected to it. Data are dispatched upon request and in case of transition (only for slowly changing data). The Smart Info performs no elaboration over the data retrieved by the Meter, except the basic processing required to retrieve, validate, memorize and dispatch them. For example, load profile shall be dispatched with the same level of resolution available in the meter (e.g. 15 minutes). Any operation needed to change Meter data resolution or to integrate them with instant power, shall be performed by the device which displays data to the customer. In addition, near real time instant power information is to be provided in order to allow Smart Appliances to calibrate its energy consumptions.	
CEMS	TBD	<p>Hosts an application that collects data from HAN devices and organizes them for a user-friendly presentation.</p> <p>Exposes a web-based API over IP HN that can be used by 3rd party applications that wishes to elaborate current data and provides a different visualization.</p> <p>Implements an Execution Environment (e.g. OSGi framework for Java) to host 3rd party applications that wishes to elaborate current data and provides a different visualization.</p> <p>Implements a Trust Agent to manage all security keys of the HAN; this functionality can be implemented via collaboration with the WSN-C Service Platform</p> <p>Implements the communication with</p>	

		<p>the WSN-C Service Platform and provides APIs to mediate communication between local bundles and WSN-C Service Platform.</p> <p>Provides to user appliances a single point of contact to publish their respective current energy consumption information.</p>	
SMART APPLIANCE	TBD	<p>Receive over the HAN (from Smart Info) global current metering data about total in-house energy consumption.</p> <p>Each Smart Appliance may display a sub-set of available data, depending on the richness of its user interface, like:</p> <ul style="list-style-type: none"> ▪ its own energy consumption/power drawn data ▪ the total house energy consumption <p>In addition, each Smart Appliance dispatches its own energy consumption data over the HAN for possible use by the CEMS for overall energy management or visualization to the end user on specific interfaces.</p>	

3. Visualization of current home energy consumption with energy cost information

Name of Use Case

<i>Use Case Identification</i>		
<i>ID</i>	<i>Domain(s)/ Zone(s)</i>	<i>Name of Use Case</i>
1.3	Customer\Market	Visualization of current home energy consumptions and power of Smart Appliances with energy cost information

Version Management

<i>Version Management</i>				
<i>Version No.</i>	<i>Date</i>	<i>Name of Author(s)</i>	<i>Changes</i>	<i>Approval Status</i>
	9/5/2014	Marco Signa		

Scope and Objectives of Use Case

<i>Scope and Objectives of Use Case</i>	
Scope	The aim of this use cases is to expand Use Case ID xxx (Visualization of current home energy consumptions and power of Smart Appliances) to provide customer with information on the energy cost at any point in time during the day and specifically the cost of running Smart Appliance with selected cycle at a certain time of the day.
Objective(s)	Provide information to consumers on energy cost during the day and specifically on appliance cycle cost to educate them on a more efficient and rationale use of the energy
Related business case(s)	A.2.19 pag 215 v. 069

Narrative of Use Case

<i>Narrative of Use Case</i>
Short description
The customer is presented with information about the global current energy consumption of his/her house and Smart Appliance on a selected user interface, that could be on the appliances themselves or on another device. In addition, the consumer can see the cost of the energy during the day as well as the energy cost of selected cycles for Smart Appliances
Complete description
The customer is presented with information about the global current energy consumption of his/her house and energy cost information throughout the day. Energy data are provided by the Smart Info, which retrieved it from the Meter and, possibly, integrates those data with near real-time power, measured by an extra module. Meter cannot provide information about energy cost, according to rules imposed by the Authority, so the DSO is not allowed to provide such information, that will be provided instead by the Energy Retailer who is the only subject entitled to define final rates for clients. Energy Retailer would provide energy cost information through different media (like internet for example). In this context "current" means near real time data and the consumptions of last few hours or days. Data (energy and cost) can be presented in different formats (plain numbers, graphics, tables, etc.) either on the Smart Appliance display or on another Customer Interface. In addition, the customer is also informed on the current energy consumptions of the single Smart appliances. The level of detail, frequency and quality of data could be different among different devices. It should be possible for users to display such disaggregated data together with total house consumptions; such functionality shall be performed by Customer Interfaces. One of the most important goals of this use case is to educate the consumer in selecting the parameters of the cycles by providing her/him feedback on the costs and energy consumption, before the start button will be pressed. Many studies

show that, only by displaying this information, a energy consumption saving of 10-15 % could be achieved on the single appliance.
 The Smart Appliances estimate the energy that will be consumed during the selected operation (ex: cycle). The CEMS will perform the energy cost evaluation based on data received by Energy retailer. Final cost information will be displayed either on the Smart Appliance display or on a specific user interface. Moreover, in case of time-of-use (TOU) pricing, the appliance receives information about which tariff is currently in use.

General Remarks

General Remarks
Consumption of Smart Appliance can be an estimate based on the phase of the cycle or the functionality the appliance is performing, not necessarily the consumption value comes from measurement.

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name <i>see Actor List</i>	Actor Type <i>see Actor List</i>	Actor Description <i>see Actor List</i>	Further information specific to this Use Case
SMART INFO	TBD	<p>Provides a sub-set of data contained in the Smart Meter and, eventually, instant power, calculated by the SI itself or another device connected to it. Data are dispatched upon request and in case of transition (only for slowly changing data). The Smart Info performs no elaboration over the data retrieved by the Meter, except the basic processing required to retrieve, validate, memorize and dispatch them. For example, load profile shall be dispatched with the same level of resolution available in the meter (e.g. 15 minutes). Any operation needed to change Meter data resolution or to integrate them with instant power, shall be performed by the device which displays data to the customer.</p> <p>In addition, near real time instant power information is to be provided in order to allow Smart Appliances to calibrate its energy consumptions. In addition, in case of time-of-use (TOU) pricing, the Smart Info can emit signal in the HAN, whenever a tariff change is taking place.</p>	
CEMS	TBD	<p>Hosts an application that collects data from HAN devices and organizes them for a user-friendly presentation.</p> <p>Exposes a web-based API over IP HN that can be used by 3rd party applications that wishes to elaborate current data and provides a different visualization.</p> <p>Implements an Execution Environment (e.g. OSGi framework for Java) to host 3rd party applications that wishes to elaborate current data and provides a different visualization.</p>	

		<p>Implements a Trust Agent to manage all security keys of the HAN; this functionality can be implemented via collaboration with the WSN-C Service Platform</p> <p>Implements the communication with the WSN-C Service Platform and provides APIs to mediate communication between local bundles and WSN-C Service Platform.</p> <p>Provides to user appliances a single point of contact to publish their respective current energy consumption information.</p> <p>The CEMS hosts a dedicated algorithm, the <i>Energy Cost Algorithm</i>, to evaluate energy costs obtaining (either via a proper code or a proper form to be filled by user or a remote web site to gather the information) the cost information. Moreover, implements a proper web application to display both cost and energy consumption, including cost for running Smart Appliances with selected cycles. In addition, this interface shall also provide a way to obtain the cost per kWh. The exact moment when a tariff change occurs can be obtained by the Smart Info (this operation could also require to evaluate the possible difference between CEMS and Meter real-time clocks)</p> <p>Distributes over the HAN network the cost information to interested devices.</p>	
SMART APPLIANCE	TBD	<p>Receive over the HAN (from Smart Info) global current metering data about total in-house energy consumption and information about energy cost. It estimate the energy to be consumed to perform the next operation and may provide it to the CEMS.</p> <p>Each Smart Appliance may display a sub-set of available data, depending on the richness of its user interface, like:</p> <ul style="list-style-type: none"> ▪ its own energy consumption/power drawn data ▪ The estimated energy consumption of selected cycle and its cost based on ToU or current tariff. ▪ the total house energy consumption 	

4. Visualization of historical data for the single customer (Global in house and Smart Appliances)

Name of Use Case

Use Case Identification		
ID	Domain(s)/Zone(s)	Name of Use Case
1.7	Customers/Process	Visualization of historical data for the single customer (Global in house and Smart Appliances)

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
01		Sergio Brambilla (Enel Distribuzione)		
		Stella Di Carlo (Enel Distribuzione)		

Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	Customer awareness.
Objective(s)	Energy efficiency focuses on energy saving –“doing more with less”; a permanent and long-term reduction of electricity usage.
Related business case(s)	Partially covered by WGSP 2111 A.2.19.2 pag 217 v. 069 JWG10

Narrative of Use Case

Narrative of Use Case	
Short description	The customer access the historical data and verify how he used energy during time.
Complete description	Provide customers historical and statistical information on their energy consumption, disaggregating the global energy time variations with the one coming from the Smart Appliances and other devices.

2 Diagrams of Use Case

Diagram(s) of Use Case
No Diagram available for this Use Case

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name see Actor List	Actor Type see Actor List	Actor Description see Actor List	Further information specific to this Use Case
Smart Info		It is the element, provided by the DSO, which provides energy information into the HAN. Published data are a subset of those already available inside the Home Electricity Meter, hence the Smart Info	Retrieves, from the Meter, available historical data (i.e. the in-house power profile) and possibly internally generated instant power

		acts like a proxy of the meter	samples. Data resolution and number of samples could vary, according to meter configuration. The Smart Info itself does not perform operations to change time resolution of data coming from the Meter. Any needed operation, or integration with additional data, shall be performed by the Customer Interface device.
CEMS		Customer Energy Manager System. The CEMS is CEM integrated with communication functionalities, it is the gateway between the HAN, the HN and the WAN (e.g. internet). The CEM is a logical function optimising energy consumption and or production based on signals received from the grid, consumer's settings and contracts, and devices minimum performance standards. The Customer Energy Manager collects messages sent to and received from connected devices; especially the in-home/building sector has to be mentioned. It can handle general or dedicated load and generation management commands and then forwards these to the connected devices. It provides vice versa information towards the "grid / market". Note that multiple loads/generation resources can be combined in the CEM to be mutually controlled.	The access to the network platform, allows the storage of the total and single appliance's energy consumption. The CEMS can access and aggregate those data to present them to the user through a Browser. The CEMS allows external applications in the HN to retrieve the stored data
Smart Appliances		It is an appliance connected in the HAN and equipped with some intelligence to cooperate with the other home actors in order to provide new services to the consumer, like for instance energy consumption awareness, demand response. The Smart Appliance plays an active role in the home system complying with the system	The Smart Appliances can display some specific data concerning their energy usage, considering the intrinsic limitations of their User Interface It will provide to the

		<p>policies, satisfying the user wishes and always assuring its best performance. Most of these technologies imply some information transfer from the Smart Grids to the Smart Appliance (thus a communication channel within the HAN and outside the Home Domain) and an additional control and supervision logic (inside and/or outside the appliance).</p>	<p>HAN its information on energy consumption.</p>
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5. Visualization of historical data compared with a benchmark

Name of Use Case

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
2.2	Customers/Process	Visualization of historical data compared with a benchmark

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
01		Sergio Brambilla (Enel Distribuzione)		
		Stella Di Carlo (Enel Distribuzione)		

Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	Customer awareness.
Objective(s)	Energy efficiency focuses on energy saving –“doing more with less”; a permanent and long-term reduction of electricity usage.
Related business case(s)	

Narrative of Use Case

Narrative of Use Case	
Short description	The customers may compare their own energy consumptions with other customers to be able to check their behavior against virtuous references.
Complete description	Provide customers historical and statistical information on their energy consumption, disaggregating the global energy time variations with the one coming from the Smart Appliances and other devices. Compare these data with a benchmark available in the network.

Diagrams of Use Case

Diagram(s) of Use Case
No Diagram available for this Use Case

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name see Actor List	Actor Type see Actor List	Actor Description see Actor List	Further information specific to this Use Case
Smart Info		It is the element, provided by the DSO, which provides energy information into the HAN. Published data are a subset of those already available inside the Home Electricity Meter, hence the Smart Info	Same as UC 2.1

		acts like a proxy of the meter	
CEMS		<p>Customer Energy Manager System. The CEMS is CEM integrated with communication functionalities, it is the gateway between the HAN, the HN and the WAN (e.g. internet). The CEM is a logical function optimising energy consumption and or production based on signals received from the grid, consumer's settings and contracts, and devices minimum performance standards. The Customer Energy Manager collects messages sent to and received from connected devices; especially the in-home/building sector has to be mentioned. It can handle general or dedicated load and generation management commands and then forwards these to the connected devices. It provides vice versa information towards the "grid / market". Note that multiple loads/generation resources can be combined in the CEM to be mutually controlled.</p>	<p>Guarantee a simple access to the application in the network in order to enable comparison with other users.</p>

6. Visualization of historical data compared with a user community

Name of Use Case

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
2.3	Customers/Process	Visualization of historical data compared with a user community

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
01		Sergio Brambilla (Enel Distribuzione)		
		Stella Di Carlo (Enel Distribuzione)		

1.3 Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	Customer awareness.
Objective(s)	Energy efficiency focuses on energy saving –“doing more with less”; a permanent and long-term reduction of electricity usage.
Related business case(s)	

1.4 Narrative of Use Case

Narrative of Use Case
Short description The customers may compare their own energy consumptions with user communities
Complete description Provide customers historical and statistical information on their energy consumption, disaggregating the global energy time variations with the one coming from the Smart Appliances and other devices. Compare these data with a with a user community available in the network.

2 Diagrams of Use Case

Diagram(s) of Use Case
No Diagram available for this Use Case

3 Technical Details

3.1 Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name see Actor List	Actor Type see Actor List	Actor Description see Actor List	Further information specific to this Use Case
Smart Info		It is the element, provided by the DSO, which provides energy information into the HAN. Published data are a subset of those already available inside the Home Electricity Meter, hence the Smart Info	Same as UC 2.1

CEMS		<p>acts like a proxy of the meter</p> <p>Customer Energy Manager System. The CEMS is CEM integrated with communication functionalities, it is the gateway between the HAN, the HN and the WAN (e.g. internet). The CEM is a logical function optimising energy consumption and or production based on signals received from the grid, consumer's settings and contracts, and devices minimum performance standards. The Customer Energy Manager collects messages sent to and received from connected devices; especially the in-home/building sector has to be mentioned. It can handle general or dedicated load and generation management commands and then forwards these to the connected devices. It provides vice versa information towards the "grid / market". Note that multiple loads/generation resources can be combined in the CEM to be mutually controlled.</p>	<p>Guarantee a simple access to the application in the network to compare the energy usage with a community of users.</p>
Smart Appliances		<p>It is an appliance connected in the HAN and equipped with some intelligence to cooperate with the other home actors in order to provide new services to the consumer, like for instance energy consumption awareness, demand response. The Smart Appliance plays an active role in the home system complying with the system policies, satisfying the user wishes and always assuring its best performance. Most of these technologies imply some information transfer from the Smart Grids to the Smart Appliance (thus a communication channel within the HAN and outside the Home Domain) and an additional control and supervision logic (inside and/or outside the appliance).</p>	

7. Multi-tariff energy use optimization in case of smart and non-smart appliances

Multi-tariff energy use optimization in case of smart and non-smart appliances

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
1.10	Customers/Process	Multi-tariff energy use optimization in case of smart and non-smart appliances

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
1.0	09/05/2014	Lucio Bianchi (Indesit Company)		

Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	Energy@home system provides an optimization of appliances usage in order to optimize energy cost according to the variable energy tariffs.
Objective(s)	Energy@home system performs actions in order to reduce and optimize the energy cost. The optimization of energy cost can leverage both on coordinated and self-management regulation.
Related business case(s)	a.2.4. pag 76; JWG-spuc 1.2; a.2.2 JWG 1100 pag 63

Narrative of Use Case

Narrative of Use Case
Short description
-
Complete description
<p>Coordinated management:</p> <p>The customer can define/modify the house rules for the energy costs optimization in case of single or multiple appliances. For any appliances the customer can set parameters like the operational time interval allowed for the device (e.g. from 6:00 to 24:00). Smart Plugs could be used to manage operational time interval for a set of non-smart appliances (e.g. a boiler). In order to simplify the process, default configurations could be considered.</p> <p>The Smart Appliances can activate enhanced features that guarantee to the whole set of devices to minimize user cost according to the variable tariffs.</p> <p>Self management:</p> <p>The customer prepares the Smart Appliance for its operating cycle (i.e. a washing program) and sets the needed condition for activation, e.g. the lowest energy price time. The Smart Appliance automatically waits until the given condition is met.</p>

General Remarks

General Remarks
This Use Case is meaningful for all those appliances which are activated by the customer and perform a specific operating cycle, such as a washing machine, oven and dishwasher. The most important exception is the fridge, which operates continuously

Diagrams of Use Case

Diagram(s) of Use Case
No Sequence Diagram available yet for this Use Case

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name <i>see Actor List</i>	Actor Type <i>see Actor List</i>	Actor Description <i>see Actor List</i>	Further information specific to this Use Case
Smart Info		<p>Provides a sub-set of data contained in the Smart Meter and, eventually, instant power, calculated by the SI itself or another device connected to it. Data are dispatched upon request and in case of transition (only for slowly changing data). The Smart Info performs no elaboration over the data retrieved by the Meter, except the basic processing required to retrieve, validate, memorize and dispatch them. For example, load profile shall be dispatched with the same level of resolution available in the meter (e.g. 15 minutes). Any operation needed to change Meter data resolution or to integrate them with instant power, shall be performed by the device which displays data to the customer.</p> <p>In case of time-of-use (TOU) pricing, the Smart Info can emit signal in the HAN, whenever a tariff change is taking place. (see notes below).</p> <p>In addition, near real time instant power information is to be provided in order to allow Smart Appliances to calibrate its energy consumptions.</p>	
CEMS		<p>Coordinated management:</p> <p>The CEMS hosts the application that allows the Customer to optimize the energy use. The macro functionalities could be:</p> <ul style="list-style-type: none"> • Allow the Customer to define for each time interval the priority appliances list (i.e. from 19:00 to 23:00 priority 	

		<p>to the washing machine)</p> <ul style="list-style-type: none"> • Allow the user to associate to the Smart Plug a non-smart appliance (not yet connected to the HAN) • Receive from Smart Appliances info's about the estimated appliance power profile of the program activated by the Customer. • Control the appliances in order to optimize energy costs and life quality <p>The CEMS also provides a web customer interface for these functionalities.</p> <p>Self-regulation:</p> <p>Provide the HAN with information about energy tariff profiles, energy costs and clock time.As a function of the complexity of the optimization algorithm and of the Smart Appliance, some specific software in the CEMS could help the determination of the optimal start time.</p>	
Smart Appliances		<p>Coordinated regulation:</p> <p>The appliance before starting informs the central unit about its estimated power profile: the received appliance power profile data are used by the central unit to calculate the time when the appliance can start (according to the user desiderata, the total power availability and the tariff policy).</p> <p>Self-regulation:</p> <ul style="list-style-type: none"> • estimate the energy to be consumed to perform the next operation • display the estimated energy value • receive the information of energy cost through HAN • display this cost <p>Implements or delegates to the CEMS</p>	

		<p>the implementation of the delay determination logic</p> <ul style="list-style-type: none"> • Offer to the customer the possibility to activate a delayed start. This operation can be performed in several ways and with different level of complexity according to the built-in User Interface capabilities. For example, a simple appliance can have just a button for starting when the lowest tariff is used. A more complex appliance can offer a rich interface showing the tariff profile in time and letting the customer to choose when to start. • If the customer accepts the delayed start, the Smart Appliance waits until the required condition is met. • Display the actual cost of the required cycle and the relevant "delayed start" economical saving (depending on the richness of its User Interface) 	
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8. Visualization of estimated energy consumption of Smart Appliances and its cost before starting to run

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
1.4	Customers/Process	Visualization of estimated energy consumption of Smart Appliances and its cost before starting to run

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
1.4	09/05/2014	Lucio Bianchi (Indesit Company)		

Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	One of the most important goals of this use case is to educate the consumer in selecting the parameters of the cycles feedbacking her/him their costs and energy consumption, before the start button will be pressed.
Objective(s)	Dispatch and visualization of the estimated energy consumption and cost of the selected program
Related business case(s)	A.2.3 pag 73 v0.6.9

Narrative of Use Case

Narrative of Use Case	
Short description	
The Smart Appliances estimate the energy that will be consumed during its next operation (ex: cycle). If possible, they give information also about the energy cost and the next operation cost by requiring to the CEMS to perform energy cost evaluation.. Moreover, in case of time-of-use (TOU) pricing, the appliance receives information about which tariff is currently in use	
Complete description	

Diagrams of Use Case

Diagram(s) of Use Case
No Sequence Diagram available yet for this Use Case

Technical Details

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name see Actor List	Actor Type see Actor List	Actor Description see Actor List	Further information specific to this Use Case
Smart Info		Provides a sub-set of data contained in the Smart Meter and, eventually, instant power,	

		calculated by the SI itself or another device connected to it. Data are dispatched upon request and in case of transition (only for slowly changing data). The Smart Info performs no elaboration over the data retrieved by the Meter, except the basic processing required to retrieve, validate, memorize and dispatch them. For example, load profile shall be dispatched with the same level of resolution available in the meter (e.g. 15 minutes). Any operation needed to change Meter data resolution or to integrate them with instant power, shall be performed by the device which displays data to the customer.	
CEMS		Provide the HAN with information about energy tariff profiles, energy costs and clock time.	
Smart Appliances		<ul style="list-style-type: none"> • estimate the energy to be consumed to perform the next operation • display the estimated energy value • receive the information of energy cost through HAN • display this cost 	

9. Visualization of a warning if available total power (in the home) is not sufficient to run a Smart Appliance

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
1.5	Customers/Process	Visualization of a warning if available total power (in the home) is not sufficient to run a Smart Appliance

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
1.0	06/05/2014	Andrea Ranalli (Telecom Italia)		

Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	Customer awareness: the goal of this level of functionalities is to enhance customer awareness about her/his energy consumption by displaying some useful energy related data. The appliance will not suggest directly to the customer any related action
Objective(s)	Visualization of current energy and power data
Related business case(s)	

Narrative of Use Case

Narrative of Use Case
Short description The aim of following use cases is to provide customer with information on the current situation of her/his consumptions
Complete description The Smart Appliance estimates the maximum power that will be consumed during its next operation (ex: cycle). If the total available power in the home is not sufficient to run, the Smart Appliance notifies the user

Diagrams of Use Case

Diagram(s) of Use Case
No Sequence Diagram available yet for this Use Case

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name see Actor List	Actor Type see Actor List	Actor Description see Actor List	Further information specific to this Use Case
SmartInfo	TBD	Provides a sub-set of data contained in the Smart Meter and, eventually, instant power, calculated by the SI itself or another device connected to it. Data are dispatched upon	

		<p>request and in case of transition (only for slowly changing data). The Smart Info performs no elaboration over the data retrieved by the Meter, except the basic processing required to retrieve, validate, memorize and dispatch them. For example, load profile shall be dispatched with the same level of resolution available in the meter (e.g. 15 minutes). Any operation needed to change Meter data resolution or to integrate them with instant power, shall be performed by the device which displays data to the customer.</p> <p>In addition, near real time instant power information is to be provided in order to allow Smart Appliances to calibrate its energy consumptions.</p>	
Smart Appliances	TBD	<p>The Smart Appliances:</p> <ul style="list-style-type: none"> ▪ estimate the maximum power to be consumed to perform the next operation ▪ receive the information of total available power in the home through HAN ▪ display a warning to the user if it is not possible to run <p>eventually send the information that it is not possible to run through the HAN</p>	

10. Request of confirmation to start if available power (in the home) is not sufficient to run a Smart Appliance

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
1.6	Customers/Process	Request of confirmation to start if available power (in the home) is not sufficient to run a Smart Appliance

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
1.0	06/05/2014	Andrea Ranalli (Telecom Italia)		

Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	Appliance regulation
Objective(s)	
Related business case(s)	Not covered

Narrative of Use Case

Narrative of Use Case
<p>Short description</p> <p>The Energy@home system may require explicit confirmation from the Customer if the use of a Smart Appliance may lead to power overload.</p> <p>1) Coordinated management: The Energy@home system checks if the total available power in the home is not sufficient to run the Smart Appliance, depending on its power profile estimation, on other Smart Appliances estimated power profile and on the current total in house consumption. The Smart Appliance notifies the Customer and asks the confirmation to start.</p> <p>2) Self-management: The Smart Appliance estimates the appliance power profile about its next operation (ex: cycle). If the total available power in the home is not sufficient to run, the Smart Appliance notifies the user and asks to the customer the confirmation to start</p>
<p>Complete description</p> <p>The appliance regulation can be performed according to 2 increasing levels of performance and system complexity: a coordinated regulation among the devices of the HAN or a self-regulation operated autonomously by the Smart Appliances. The goal of both approaches is to provide the customer automatically with suggestions and assistance on how to improve the energy management of the house.</p> <p>1) Coordinated Management appliances regulation In this configuration, all the Smart Appliances in the house cooperate together to regulate their behavior according to global energy information of the house, their current state and priority when the regulation is needed. The type of regulation performed by the appliance could vary according to the type of appliance. The regulation logic could be centralized or distributed but in any cases coordinated and harmonized. Only knowing the entire energy and power status of the Home Domain System, the full performances of the system could be guaranteed; on the other side, the involved algorithms will be the most complex, having to take into consideration the different and time variable energy states of the Smart Appliances and standard electrical loads in the house.</p> <p>2) Self-Management appliances regulation In this configuration, the single Smart Appliance regulates its behavior according to global energy information of the house, such as current instant power and energy price. The type of</p>

regulation performed by the appliance could vary according to the type of appliance and its current state when the regulation is needed. No cooperation with other appliances is involved. Since in this level there is no coordination with other Smart Appliances and thus knowledge of their power consumption (and of other independent electrical loads of the house), the full performances of the system could not be guaranteed; this is why the output of the use cases of this scenario should be considered as suggestions: the customer nevertheless will be in charge of coordinating the use of other Smart Appliances and independent electrical load of the house. She/he will always decide if accepting or not the suggestions from the system

Diagrams of Use Case

<i>Diagram(s) of Use Case</i>
No Sequence Diagram available yet for this Use Case

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name <i>see Actor List</i>	Actor Type <i>see Actor List</i>	Actor Description <i>see Actor List</i>	Further information specific to this Use Case
Smart Info	TBD	Provides a sub-set of data contained in the Smart Meter and, eventually, instant power, calculated by the SI itself or another device connected to it. Data are dispatched upon request and in case of transition (only for slowly changing data). The Smart Info performs no elaboration over the data retrieved by the Meter, except the basic processing required to retrieve, validate, memorize and dispatch them. For example, load profile shall be dispatched with the same level of resolution available in the meter (e.g. 15 minutes). Any operation needed to change Meter data resolution or to integrate them with instant power, shall be performed by the device which displays data to the customer. In addition, near real time instant power information is to be provided in order to allow Smart Appliances to calibrate its energy consumptions	
CEMS	TBD	<p><u>Coordinated management:</u> The CEMS hosts the application that allows the Customer to coordinate the Smart Appliances according to the available power and to knowledge of the potential activity schedules of other Smart Appliances in the HAN (e.g. due to pre-programmed schedules).</p> <p><u>Self management:</u> The CEMS should be notified of the state of the Smart Appliance.</p>	<p><u>Coordinated management:</u> The Smart Appliance:</p> <ul style="list-style-type: none"> ▪ sends the estimated appliance power profile to the central unit and receives from it the information about the power overload risk ▪ interacts with the customer to avoid starting the cycle in case of potential overload by asking for confirmation <p><u>Self management:</u></p>

			<p>The Smart Appliances:</p> <ul style="list-style-type: none"> ▪ estimate the maximum power to be consumed to perform the next operation ▪ receive the information of total available power in the home through HAN ▪ display a warning to the user if it is not possible to run eventually send the information that it is not possible to run through the HAN. <p>Interacts with the customer to avoid starting the cycle in case of potential overload by asking for confirmation.</p>
Smart Appliances	TBD		

11. Home Domain Overload Management - The CEMS wants to optimize the use of power in order to avoid Home Domain Overload.

The customer can define/modify the load shedding priorities and strategies in case of a Home Domain Overload, to be applied to smart and non-smart appliances (Smart Plugs could be used to manage power disconnection priorities for non-smart appliances). A central unit located inside the house will implement the coordination logic. An alarm (e.g. acoustic) can be generated to notify to the customer the critical condition. In order to simplify the process, default configurations could be considered.

The Smart Appliances can activate enhanced features that guarantee to the whole set of devices a maximum energy consumption (peak limit). In case of self management, while working, the Smart Appliance can perform load shedding, modifying its behavior in order to reduce or adapt its power consumption to the overall status of the house.

The purpose of this user story is to manage a peak overload in order to take any appropriate action such as alerting the user, reducing peak consumption of residential electrical loads, providing a report to the user related to this event. As a matter of fact, we can distinguish among the following sub-cases:

Ex-ante. This is the case when the system exploits a forecast algorithm to prevent an overload situation or the case when there is enough time between the overload warning notification event (when any component/device of the overall system notices that the maximum contracted power is being exceeded) and the breaker disconnection, i.e. there is time sufficient to react to this event, be it the user, or the Home Energy Management System, or a smart appliance to react. In order to better understand the sequence diagrams in the following pages, it is worth to remind how the overload is regulated in Italy by using as an example a typical contract with 3 kW contracted peak power:

The meter allows for an excess of 10% of the contracted peak for an unlimited amount of time, i.e. no warning up to 3.3kW of absorbed power.

The meter allows for a current absorption between 3.3 kW and 4.1 kW (i.e. +25%) for a limited amount of time (usually 2 hours), after this time the breaker disconnects

The meter allows for a current absorption between 4.1 kW and 14 kW for a very short amount of time (usually 2 minutes), after this time the breaker disconnects

Finally, if the meter measures a current absorption higher than 14 kW, for safety reasons, the breaker immediately disconnects.

The use case intends to adopt an approach where a combination of consumption forecast methods and notifications directly sent by the meter is used in order to prevent as well as to notify the overload warning.

Ex-post. This scenario deals with what happens after the breaker disconnection happened, when the system notifies the user and the devices in the HAN that this event happened.

Post-mortem. In this scenario the Home Energy Management System makes a post-mortem analysis in order to estimate why the event happened, e.g. the contracted power was exceeded because the washing machine and the hair dryer were running at the same time. This type of analysis is useful both to educate the users as well as to train an automatic learning system in order to avoid it can happen again in the future. This scenario seems not to require so far any specific specification for new message exchanges between user devices

11.1 Power Loss Notification and Analysis - The user wants to understand the cause of a power loss event (e.g. a blackout on the external grid or a trip of the circuit breaker)

The Customer Energy Management System, if it has UPS capabilities, switches to UPS and sends an SMS to the customer to inform him that a power loss event occurred.

If UPS capability is not available or fail, power loss detection could be performed by an external server after ½ hour of gateway inactivity.

At the end of the event the CEMS restarts sending to the customer a report about home and appliances consumption before the event; the user can eventually choose to do something to reduce the loads.

11.2. Overload management ex-ante

Name of Use Case

<i>Use Case Identification</i>		
<i>ID</i>	<i>Domain(s)/ Zone(s)</i>	<i>Name of Use Case</i>
1.9	Customers/Process	Home Domain Overload management ex-ante

Version Management

<i>Version Management</i>				
<i>Version No.</i>	<i>Date</i>	<i>Name of Author(s)</i>	<i>Changes</i>	<i>Approval Status</i>
1.0	08/05/2014	Stefano Ginocchio (Edison)		
1.1	12/06/2014	Andrea Ranalli (Telecom Italia)		

Scope and Objectives of Use Case

<i>Scope and Objectives of Use Case</i>	
Scope	In this scenario, the single appliance regulates its behaviour upon home power availability. The power peak management can leverage both on coordinated and self-management regulation as indicated in the use cases. Also, The customer is promptly informed if the overall power drawn exceeds the maximum available power, hence causing a Home Domain Overload. The notification shall be notified local alarms (e.g. acoustic). The customer can also access to an historical view of any alarm.
Objective(s)	The aim of following use cases is to foster the use the appliances when there is enough power in order to avoid overloading.
Related business case(s)	WGSP 21 22-2121 , JWG1100* → to be implement a new UC for emergency situation

Narrative of Use Case

<i>Narrative of Use Case</i>
Short description
<p>The Energy@home system can optimize the use of power in order to avoid Home Domain Overload.</p> <p>Coordinated management:</p> <p>The customer can define/modify the load shedding priorities and strategies in case of a Home Domain Overload, to be applied to smart and non-smart appliances (Smart Plugs could be used to manage power disconnection priorities for non-smart appliances). A central unit located inside the house will implement the coordination logic. An alarm (e.g. acoustic) can be generated to notify to the customer the critical condition. In order to simplify the process, default configurations could be considered.</p> <p>The Smart Appliances can activate enhanced features that guarantee to the whole set of devices a maximum energy consumption (peak limit).</p> <p>Self management:</p> <p>While working, the Smart Appliance can perform load shedding, modifying its behaviour in order to reduce or adapt its power consumption to the overall status of the house.</p>
Complete description
At 8:00 AM Mary, the end user of this story, wakes up and switches on the washing machine.

After half an hour, her daughter switches on the hair dryer. The total house consumption exceeds the maximum contracted power and the system notifies this event.

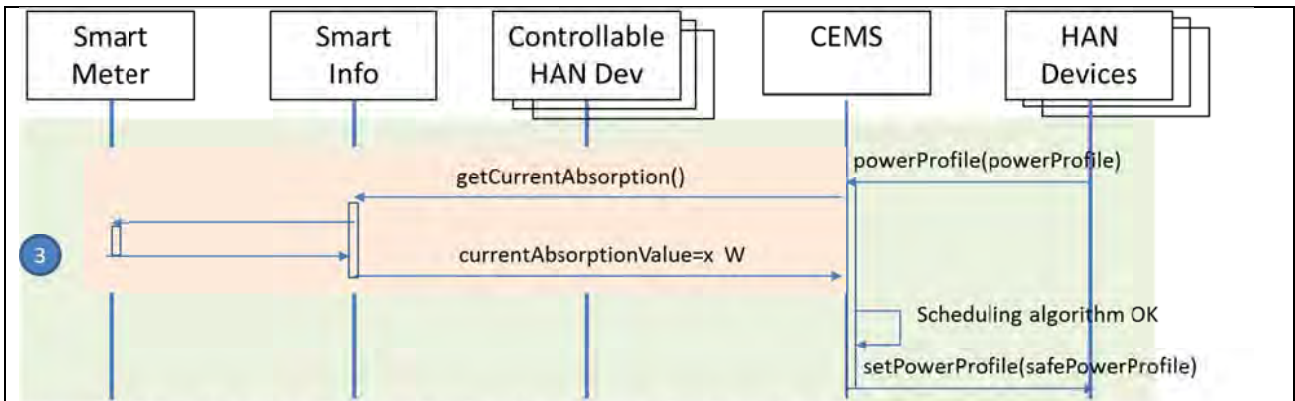
There is no need to get the attention of Mary because fortunately Mary has smart appliances (flexible HAN devices) and thanks to their flexibilities the CEMS is able to automatically reduce their power consumption and/or postpone the starting of high power absorbing phases (e.g. the start of a water heating phase in a washing machine) and prevent the blackout without any user intervention and without degrading the quality of the washing cycle.

When Mary will launch again the CEMS app, the app will tell Mary that the event was well managed automatically thanks to the support of the washing machine.

The same events happened at the John's house premises but John has no smart appliance. Therefore, the Customer Energy Management System of John decides to use the user notification devices (e.g. buzzer, text messaging) in order to get the user attention and ask the user to manually switches off some loads. John was quick enough to see the notification sent by a text message (SMS) on his mobile and switches off the hair drier to prevent the blackout. But, several other times happened that John was not quick enough and he had to switch on again the meter located in the basements; in this case the CEMS app reminds John that a smart appliance would have avoided such a problem.

Diagrams of Use Case

<i>Diagram(s) of Use Case</i>		
The use cases is described through a set of composable phases, each phase is described by a sequence diagram.		
Id	Phase Name	Description
1	Power Profile scheduling	An HAN device requests the CEMS to schedule a power profile This phase shows the case when the CEMS is able to return a safe schedule. When a new cycle is planned, the appliance will provide the cycle power profile where for each block of the cycle is reported if load can be reduced or not. How much the load can be reduced depends on the type of product and the manufacturer choice. NOTE even if the load can be reduced in certain part of the cycle, it does not mean the appliance will comply with the request.
2	Unschedulable Power Profile	An HAN device requests the CEMS to schedule a power profile This phase shows the case when the CEMS is NOT able to return a safe schedule
3	Overload Warning	The Smart Meter notifies the CEMS that there is an overload warning
4	Overload warning cleared up	The Smart Meter notifies the CEMS that the overload warning was cleared up and the situation is now back to the normal functioning
5	User Notification	The CEMS requests the HAN devices with user notification capability to notify the user of a given event (in this case the overload warning). When an HAN device gets the user attention it notifies back the CEMS
Sequence diagram 1:		



- Overload forecast phase (initiated by a powerProfile schedule or change)
 - An HAN device (e.g. a washing machine) sends to the EMS a request to schedule a new load or – alternatively – sends a request to change its scheduled load. The load is described by its powerProfile
 - 3 – The EMS requests to the meter – via the SmartInfo – the current current absorption of the house
 - The EMS uses the powerprofiles received by the HAN devices and, where available, its own proprietary consumption forecast algorithm, in order to estimate if there is a risk of overload in scheduling this new powerProfile
 - The EMS schedules the powerProfile at a time when there is no overload risk

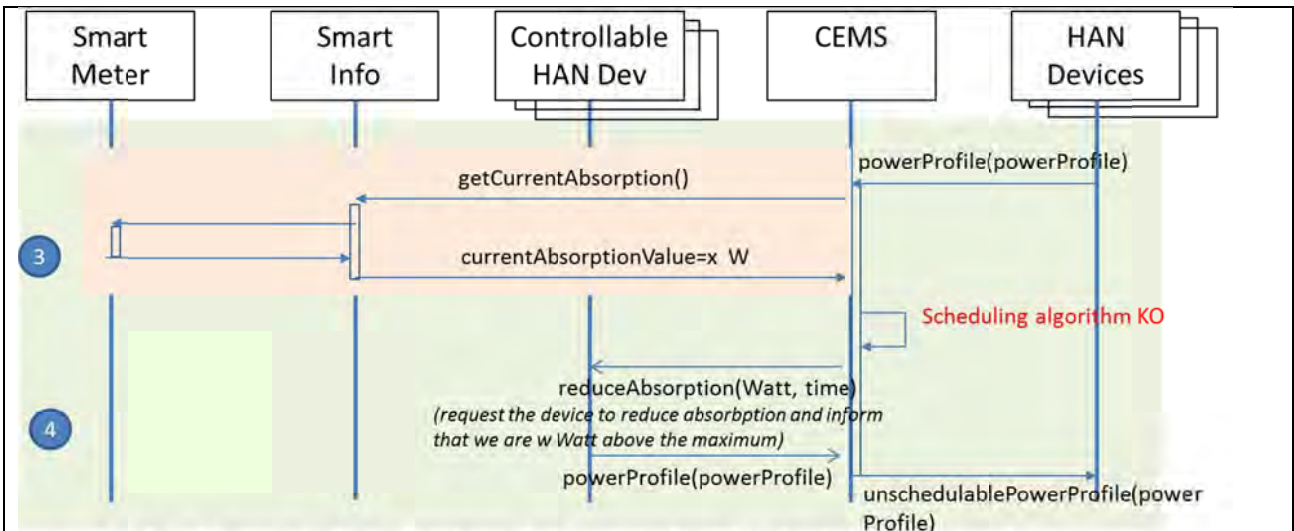
Description of the phase 1:

An HAN device sends to the CEMS a request to schedule a new power profile, or to change its schedule. The CEMS retrieves via the Smart Info the current total house power absorption, eventually uses a forecast algorithm, and returns a safe power profile schedule. When a new cycle is planned, the appliance will provide the cycle power profile where for each block of the cycle is reported if load can be reduced or not. How much the load can be reduced depends on the type of product and the manufacturer choice. NOTE even if the load can be reduced in a certain part of the cycle, it does not mean the appliance will comply with the request.

Message exchange 1:

This use case is already covered by current Energy@home specifications, no new message exchange need to be specified so far.

Sequence diagram 2 (Power profile is unscheduled):

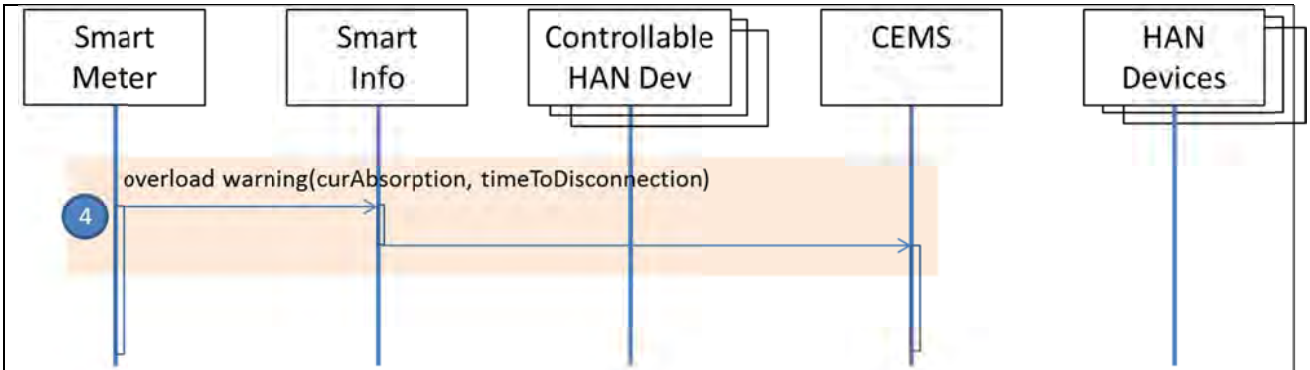


- Overload forecast phase (initiated by a powerProfile schedule or change)
 - An HAN device (e.g. a washing machine) sends to the EMS a request to schedule a new load or – alternatively – sends a request to change its scheduled load. The load is described by its powerProfile
 - The EMS requests to the meter – via the SmartInfo – the current current absorption of the house
 - The EMS uses the powerprofiles received by the HAN devices and, where available, its own proprietary consumption forecast algorithm, in order to estimate if there is a risk of overload in scheduling this new powerProfile
 - The EMS is not able to schedule this powerProfile because of overload risk

Description of the phase 2:

This is a slight variant of the previous phase. In this case the forecast & scheduling algorithm of the CEMS is not able to return a safe schedule for this power profile. Therefore the CEMS requests the flexible HAN devices to change their schedule if possible. If an HAN device accepts to change its schedule, the CEMS runs again the scheduling algorithm and try to find a safe schedule

Sequence diagram 3 (Overload Warning notification sent from the Meter):



- **Overload Warning Notification phase (initiated by the SmartMeter)**
 - The Smart Meter, through the Smart Info, notifies the CEMS that there is an overload warning
 - 4 - Two parameters are here required to be sent to the CEMS:
 - Measured current absorption (in Watt)
 - time before disconnection if the current absorption does not reduce (in sec)
 - N.B. The Smart Meter is requested to use its best effort to notify again the CEMS when:
 - the time before disconnection changes (e.g. when a new power threshold is reached)
 - the overload warning is cleared up

Description of the phase 3:

The Smart Meter, through the Smart Info, notifies the CEMS that there is an overload warning. The Meter is requested to provide two parameters: the measured power absorption, the time before disconnection.

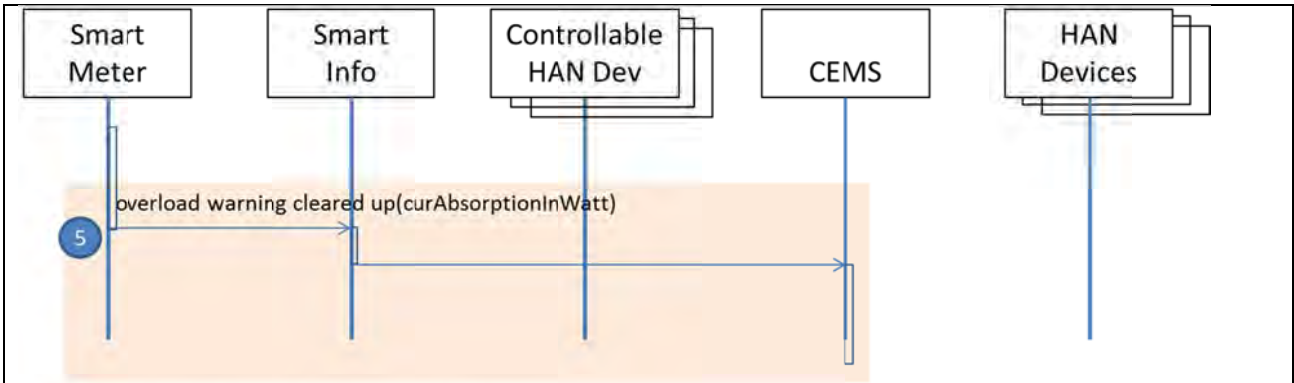
Notice that the Smart Meter is requested to do its best effort to notify again the CEMS when some condition changes:

- The time before disconnection changes because a new alarm threshold was reached
- The overload warning is cleared up and the system can returns to its normal state

Message exchange 3:

ID message	From	to	description	parameters	Acknowledgment message (if any)
1	Smart Meter	CEMS	Overload warning	Watt: measured power Time: time to disconnection (in seconds)	Ack needed

Sequence diagram 4 (Overload Warning ClearedUp notification sent from the Meter):



- Overload Warning is cleared up
 - the Smart Meter is requested to be state-full and recognizes that it passes from an overload warning state to a clearing of this state

Description of the phase 4:

The Smart Meter, through the Smart Info, notifies the CEMS that the overload warning is cleared up and the system is returned to its normal state.

Message exchange 4:

ID message	From	to	description	parameters	Acknowledgment message (if any)
1	Smart Meter	CEMS	Overload warning Cleared Up	Watt: measured power	Ack needed

Sequence diagram 5 (Notification of the Overload Warning Event to the User):



- User Notification phase (this phase is parametric of the event Type)
 - The EMS requests the HAN devices with user notification capabilities to notify the user an Event. In this case the event is overload Warning event which is described through 2 parameters:
 - Measured current absorption (in Watt)
 - time before disconnection if the current absorption does not reduce (in sec)
 - It is implementation-dependant the order in which the EMS selects the notification devices, of course the EMS should try to minimize the user comfort impact by using the most appropriate notification devices
 - The HAN device that got user attention is requested to notify back the EMS about that. Such a notification allows the EMS to avoid scaling-up the means to get the user attention, e.g. by sending an SMS or activating a buzzer

Description of the phase 5:

The CEMS notifies an Event to the user. It is responsibility of the CEMS to select which HAN device (or which set of HAN devices) should be requested to notify the user. It is responsibility of the HAN device, if it gets the user attention, to notify back the CEMS in order to avoid the CEMS scales up the notification to another notification device.

Message exchange 5:

ID message	From	to	description	parameters	Acknowledgment message (if any)
1	CEMS	HAN Device	Notifies an Event to the user	Event. The Warning Event is represented by two parameters: Watt: current power absorption Time: time to disconnection (in seconds)	Ack needed
2	HAN Device	CEMS	The user was notified	None	none

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name <i>see Actor List</i>	Actor Type <i>see Actor List</i>	Actor Description <i>see Actor List</i>	Further information specific to this Use Case
Smart Info	TBD	<p>The Smart Meter provides useful information to the system such as the contracted maximum power and the current absorption. It also notifies a warning event when the total house consumption exceeds the maximum contracted power.</p> <p>The Smart Meter uses the Smart Info as a communication bridge to the user devices in the home premises.</p> <p>Provides a sub-set of data contained in the Smart Meter and, eventually, instant power, calculated by the SI itself or another device connected to it. Data are dispatched upon request and in case of transition (only for slowly changing data). The Smart Info</p>	

		<p>performs no elaboration over the data retrieved by the Meter, except the basic processing required to retrieve, validate, memorize and dispatch them. For example, load profile shall be dispatched with the same level of resolution available in the meter (e.g. 15 minutes). Any operation needed to change Meter data resolution or to integrate them with instant power, shall be performed by the device which displays data to the customer.</p> <p>In addition, near real time instant power information is to be provided in order to allow Smart Appliances to calibrate its energy consumptions.</p> <p>The Smart Info receives from the Meter, or generates itself, a max-power-alarm, indicating that power is beyond a contractual threshold. The Smart Info, consequently, emits an alarm in the HAN to all the Customer Interfaces, Smart Appliances and to the CEMS, providing indication about the percentage of power beyond the threshold (if available). It should be defined whether the alarm is to be sent to all paired devices or only to those which have been previously registered for receiving the alarms. The alarm could be emitted more than once, before the Meter opens the breaker.</p>	
CEMS	TBD	<p>It collects data from HAN devices and organizes them for a user-friendly presentation.</p> <p>Generally speaking, it implements the decision logics of the overall customer system and it takes care of dispatching events to HAN devices. It can exploit forecast algorithms, the implementation of these algorithms are outside the scope of these specifications.</p>	

		<p>Implements a Trust Agent to manage all security keys of the HAN; this functionality can be implemented via collaboration with a Service Platform in the cloud.</p> <p>Implements the communication logics with a Service Platform in the cloud.</p> <p>Coordinated management: The CEMS hosts the application that allows the Home Domain Overload Management. The macro functionalities could be:</p> <ul style="list-style-type: none"> • Allow the Customer to define its own overload rules (i.e. appliances priority) • Allow the Customer to associate to the Smart Plug a non-smart appliance (not yet connected to the HAN) • Receive from Smart Appliances info's about the estimated appliance power profile of the program activated by the Customer • Coordinate the appliances in order to avoid the overload condition • Inform the Customer about any activated action (i.e. acoustic warning) • <p>The CEMS also provides a web customer interface for these functionalities.</p> <p>It can activate the local alarm through an in house TI terminal. It allows the user to set the priorities for the house device/appliance alarm activation (i.e. TI terminal, dishwasher machine, ect.)</p> <p>Self management: The CEMS should be notified of the modified behaviour (appliance power profile change) of the Smart</p>	
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		Appliance.	
Smart Appliances	TBD	<p>They provide to the CEMS information about their load profile.</p> <p>They can also exhibit some degree of flexibility to react to requests from the CEMS to reduce the power absorption at different levels down to 'pause' level.</p> <p>At the startup time, they announce and register their capabilities with the CEMS. At the registration phase they have also to indicate their capability to get the user attention (e.g. via a display, a buzzer, a text message).</p> <p>Coordinated management: The Smart Appliance</p> <ul style="list-style-type: none"> • receives through HAN the coordination signals • executes the relative actions, as a function of its status • displays an information to the user • before starting, informs the central unit about the appliance power profile <p>Self management: The Smart Appliance receives from HAN the available power in the Home Domain. Using this information, it adapts its behaviour by some load shedding actions. In addition, it notifies its appliance power profile change in the HAN and, if possible, in its UI.</p>	

11.3. Power loss notification and ex-post analysis

Name of Use Case

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
1.8	Customers/Process	Power Loss Notification and Analysis

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
1.0	08/05/2014	Stefano Ginocchio (Edison)		

Scope and Objectives of Use Case

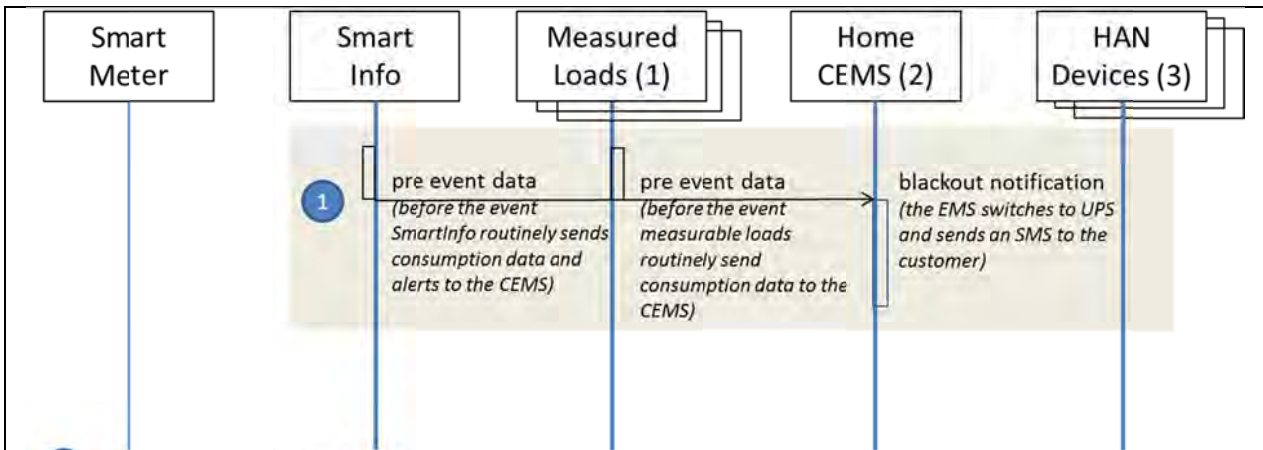
Scope and Objectives of Use Case	
Scope	In case of energy black out the CEMS, equipped with an UPS, is able to guarantee the correct activity for a minimum time (< 60 sec.). It can alert the customer about the event with an alarm (e.g SMS, phone call). If an UPS is not present, this is typically the “ex-post” scenario of the Overload Management use case.
Objective(s)	The aim of following use case is to help the customer to understand the cause of a power loss event and to manage proper load recovery after it.
Related business case(s)	

Narrative of Use Case

Narrative of Use Case
<p>Short description</p> <p>The Customer Energy Management System sends an SMS to the customer to inform him that a power loss event occurred. At the end of the event the CEMS restarts sending to the customer a report about home and appliances consumption before the event; the user can eventually choose to do something to reduce the loads.</p>
<p>Complete description</p> <p>Before the power loss measurable loads routinely send consumption data to the CEMS. Also SmartInfo routinely sends global consumption and alerts. The Customer Energy Management System (so far in E@h this role is implemented by the Smart Gateway) if has UPS capabilities switches to UPS and sends an SMS to the customer.</p> <p>If UPS capability is not available or fail, power loss detection could be performed by an external server, e.g. after ½ hour of gateway inactivity.</p> <p>At the end of the power loss event , the customer has to be informed about the type and cause of the power loss (ex post analysis) and can make appropriate choices to avoid e.g. a new trip of the circuit breaker. The loads restart following their own procedures. Smart Appliances will restart in the same state they were when black out occurred. The CEMS restarts, receives from the SmartInfo the alert occurred before the event, and calculate the duration and type of the event (blackout on the grid/circuit breaker trip) and sends to the customer a report containing also home and appliances consumption before power loss .The user can eventually choose to do something to reduce the loads.</p>

Diagrams of Use Case

Diagram(s) of Use Case
Detection of a power loss event phase

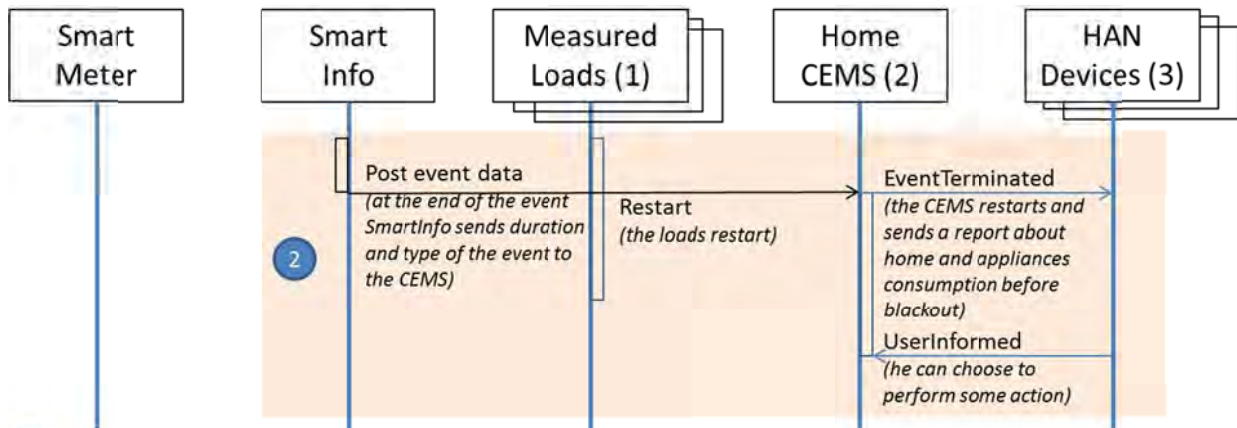


- 1 • Detection of a blackout phase
- before the event measurable loads routinely send consumption data to the CEMS;
 - before the event SmartInfo routinely sends consumption data and alerts to the CEMS;
 - an home Energy Management System (so far in E@h this role is implemented by the Smart Gateway) that has UPS capabilities switches to UPS and sends an SMS to the customer; (otherwise power loss detection could be performed by an external server after ½ hour of gateway inactivity)

(1) Devices that have some load measurement capability, including devices connected to a smart plug

(2) Home Customer Energy Management System

(3) Devices that have user notification capabilities (e.g. display, SMS, buzzer, ...)



- 2 • End of blackout phase
- the loads restart;
 - the CEMS restarts;
 - SmartInfo sends to the CEMS duration and type of the event;
 - the CEMS sends to the customer a report about event type, home and appliances consumption and alerts before power loss;
 - the user can choose to perform some action (e.g. reduce the loads).

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name	Actor Type	Actor Description	Further

<i>see Actor List</i>	<i>see Actor List</i>	<i>see Actor List</i>	information specific to this Use Case
Smart Info	TBD	<p>The Smart Meter uses the Smart Info as a communication bridge to the user devices in the home premises.</p> <p>The Smart Info is not active during the power loss event</p> <p>At the end of the event the Smart Meter, by means of the Smart Info, provides to the CEMS the alert occurred before the event.</p> <p>In case of black out the Smart Info will not be able to reach the Meter, hence it shall not emit any dedicated message toward the HAN.</p>	
CEMS	TBD	<p>The Customer Energy Management System sends an SMS to the customer if it has UPS capabilities otherwise power loss detection could be performed by an external server, e.g. after ½ hour of gateway inactivity.</p> <p>At the end of the event the CEMS will have the possibility to calculate the duration and type of the event (blackout on the grid/circuit breaker trip).</p> <p>CEMS could activate a SMS or a voice call alarm</p>	
Smart Appliances	TBD	<p>The Smart Appliances:</p> <ul style="list-style-type: none"> - before the event routinely send consumption data to the CEMS - at the end of the event return to the status they were before the event. 	

12. Active Demand and Load Shifting to reduce consumption at peak time

Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
1.11	Customers/Market	Active Demand and Load Shifting to reduce consumption at peak time

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
01				

Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	Customer awareness.
Objective(s)	Demand Response as changes in electric usage by end-consumers from their current consumption patterns in response to incentive payments designed to adjust electricity usage in response to the market prices or when system reliability is jeopardized.
Related business case(s)	

Narrative of Use Case

Narrative of Use Case
Short description
The Aggregator provides customer incentives for consuming energy in case of excess of production in the form of energy cost discount, or in order to perform power limitation within a given geographical region and temporal slot.
Complete description
<p>The Aggregator can provide incentives for consuming energy in case of excess of production (for example, higher renewable energy production Vs forecast) in the form of energy cost discount. Alternatively, in order to perform power limitation within a given geographical region and temporal slot, Aggregator may provide incentives to postpone consumption. Special offers or requests for load shifting may vary each day and on a short notice.</p> <p>Case 1: Aggregator is sending a request to reduce household power consumption at peak time.</p> <p>The appliance response can be triggered as Utility sends to the household a request to reduce power consumption on peak time. The appliance is not guaranteed to reduce its consumption, but will have a probability of doing so based on user settings, kind of appliance and its status. The household CEMS will coordinate between the different actors in the house and their needs in terms of power consumption, and will take into consideration the overall power consumption forecast thus better optimizing the energy costs and prevent overloads.</p> <ul style="list-style-type: none"> • Sub case 1: The appliance is already running. Request to reduce consumption arrives when the the product has already started its cycle. In this case it may reduce the power consumption depending on the kind of product, what the product is currently doing and the consumer settings (i.e. consumer has enabled this functionality because of incentives or special contract he may have from utilities or DSOs). Power will be reduced without posing risks of safety or damage to consumers and their belonging. The percentage of power reduction varies product by product and so does the time duration at low power. • Sub case 2: The appliance is in smart start mode. The request to avoid consumption at a certain time is received by the CEMS before the product starts its cycle. The CEMS will then plan the starting of the appliance taking into account the request from the Aggregator or may shift the

start of an already planned appliance in order to avoid taking energy during the peak time and may also shift the activation of certain features (for example: defrost on No-Frost freezers). The possibility to shift loads is dependent on customer settings and on the kind of product.

If the CEMS is able to meet the Aggregator requests, it sends a message of AD fulfillment to the Aggregator. After verification of the data with information coming from DSO, the aggregator will carry out the payment of the incentive to the user.

Case 2: The Aggregator is sending a request to increase household power consumption at a certain time.

The appliance response can be triggered as Aggregator sends to the household a request to increase power consumption due to excess of energy availability. The appliance in 'smart start' mode is not guaranteed to anticipate its starting, but will have a probability of doing so based on user settings and kind of appliance.

The household CEMS will coordinate between the different actors in the house and their needs in terms of power consumption, and will take into consideration the overall power consumption forecast thus better optimizing the energy costs and prevent overloads.

Story case

Today, Thursday morning, the aggregator, based on the consumption profile of its customers, send to a selection of its customers an AD request to reduce electric consumption between 17.30 to 18.00 on Friday.

The CEMS alert Mary and John about the request received.

Mary leave the Energy@home system in automatic mode and it can optimize the power consumption in their house.

On Friday at 17 John realizes that he urgently needs to start the washing machine and forces the manual operation of the washing machine overriding the signal sent by the aggregator. CEMS reassesses the optimization of the electrical loads of the house and optimizes energy consumption taking into account the load curve received by the washing machine.

At 18 Mary and John' CEMS acquire the consumption data from the smart info.

Mary was able to meet the AD service and her CEMS sends a message of AD fulfillment to the aggregator. After verification of the data with information coming from DSO, the aggregator will carry out the payment to Mary.

John fails to meet the AD service request sent by the aggregator. CEMS closes the activity and does not send any signal to the aggregator.

General Remarks

General Remarks

With the development of renewable resources, supply energy is becoming more difficult due to the unpredictability and this could be managed by using the aggregated flexibility offered by small commercial and domestic consumers.

In this context, it is always more plausible in the near future to have the active participation of domestic consumers to balance services.

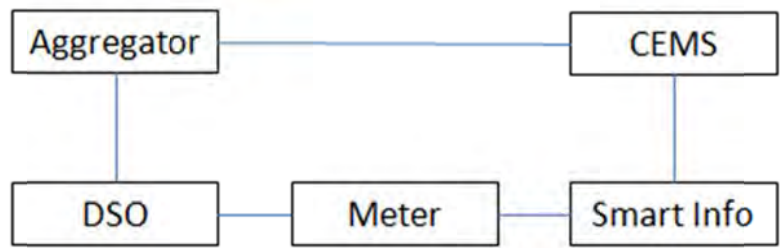
This use case only considers the services offered by the aggregator. It will provide to aggregate the flexibility of small commercial and domestic consumers and sell it in the market for balancing and ancillary services.

This use case doesn't consider the direct management of the electrical equipment by the network operator and it doesn't consider network services that requires real-time answers and even services for the management of the dynamic tariff of electricity.

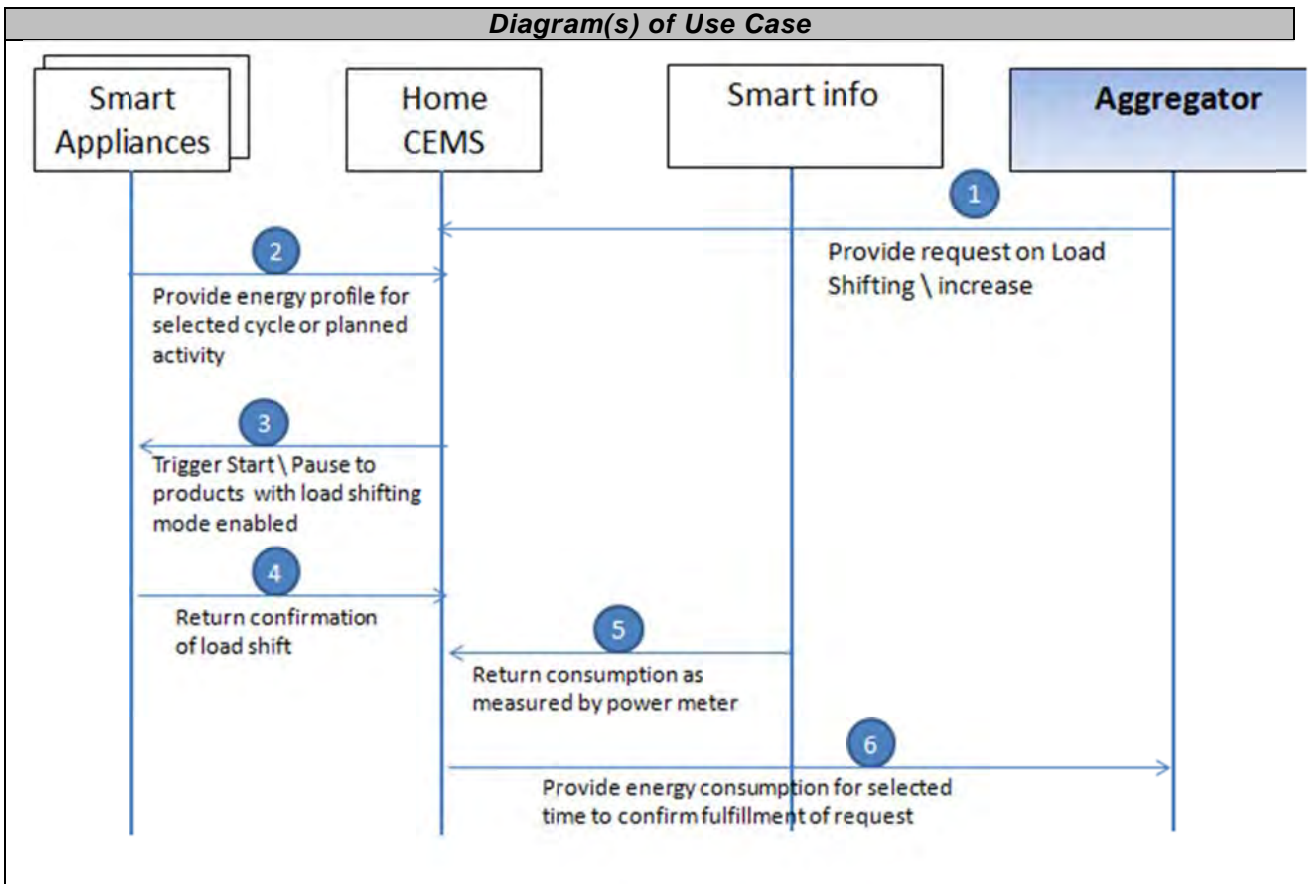
In this use case will be not analyzed the relationship between aggregators and DSO and the way in which the AD programs are generated and sent to the consumers.

We will not consider also the planning and optimization activities carried out within the HAN needed to answer to the aggregator requests. These activities are developed in other use cases.

The figure below shows the actors and their relationships needed to carry out this use case.



2 Diagrams of Use Case



Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name see Actor List	Actor Type see Actor List	Actor Description see Actor List	Further information specific to this Use Case
Smart Info		It is the element, provided by the DSO, which provides energy information into the HAN. Published data are a subset of those already available inside the Home Electricity Meter, hence the Smart Info	

		acts like a proxy of the meter	
CEMS		Customer Energy Manager System. The CEMS is CEM integrated with communication functionalities, it is the gateway between the HAN, the HN and the WAN (e.g. internet). The CEM is a logical function optimising energy consumption and or production based on signals received from the grid, consumer's settings and contracts, and devices minimum performance standards. The Customer Energy Manager collects messages sent to and received from connected devices; especially the in-home/building sector has to be mentioned. It can handle general or dedicated load and generation management commands and then forwards these to the connected devices. It provides vice versa information towards the "grid / market". Note that multiple loads/generation resources can be combined in the CEM to be mutually controlled.	
Smart Appliances		It is an appliance connected in the HAN and equipped with some intelligence to cooperate with the other home actors in order to provide new services to the consumer, like for instance energy consumption awareness, demand response. The Smart Appliance plays an active role in the home system complying with the system policies, satisfying the user wishes and always assuring its best performance. Most of these technologies imply some information transfer from the Smart Grids to the Smart Appliance (thus a communication channel within the HAN and outside the Home Domain) and an additional control and supervision logic (inside and/or outside the appliance).	
Aggregator		it is the key mediators between the consumers on one side and the markets and the other power system participants on the other side:	

		<ul style="list-style-type: none"> - The aggregator collects the requests and signals for Active Demand-based services coming from the markets/AD buyers. - Pools “flexibilities” of consumers to build Active Demand services and makes offers to the market. The aggregator sells a deviation from the forecasted level of demand, and not a specific level of demand. - It sells “flexibilities” to the different power system participants through the markets or bilateral contracts. 	
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Steps – Scenario Name

Scenario Conditions					
No.	Scenario Name	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
1	Request of AD service	Aggregator	Market prices or system reliability		

Steps – Scenarios

Scenario								
Scenario Name :		No. 1 - Request of AD service						
Step No.	Event	Name of Process/Activity	Description of Process/Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchange	Requirements , R-ID
1		Provide request on Load Shifting/increase	The Aggregator sends a request for AD Service.	AD service request	Aggregator	CEMS	AD service request (message ID, Customer ID, Activation time, Duration, Combined volume and prise signal ...)	Acknowledgment message is required; 1-7.1
2		Consumption prediction	CEMS gets information about expected consumptions by all smart products in the home through the cycle's energy		Smart Appliances	CEMS		2-7.1

			profile that is based on consumer selection. This information is required to be able to auto plan best start time to meet end user's needs as well as Utility\Aggregator's ones.					
3		Scheduling phase	Case 1: CEMS elaborates a strategy to minimize consumption for all running products in order to meet the consumption reduction\increase request while still fulfilling consumer's needs. The strategy takes into consideration the appliance availability to respond to such a request which is based on consumer's input and phase of the cycle. Case 2: CEMS elaborates a strategy for running all requested		CEMS	Smart Appliances		Acknowledgment message is required; 3-7.1

			cycles (or product's functions) and sends a signal to the products with the start time or when is time to start.					
4		Product feedback	The smart product returns confirmation that it will fulfill the request from the CEMS		Smart Appliances	CEMS		4-7.1
5		Household power consumption reading	The Smart Info provides to the CEMS the overall energy consumption of the household during the time in which the load shift should take place.		Smart Info	CEMS		5-7.1
6		Consumption confirmation	CEMA sends to the Aggregator an information that the requirements have been fulfilled during the requested time	AD service fulfillment	CEMS	Aggregator	AD service fulfillment (message ID, Customer ID, Activation time, Duration, Measure)	Acknowledgment message is required; 6-7.1

Information Exchanged

Information Exchanged		
Name of Information (ID)	Description of Information Exchanged	Requirements to information data
1-7.1	The Aggregator sends a request for AD Service.. The request may be done well in advance or with a short notice, depending on the case. The request arrives to the CEMS through the home gateway or directly depending on the case.	The request contains the value of the incentives offered to customers if consumption is maintained in a defined time interval within a range of power. The unit of time is multiple of 15 minutes. Power measurement and incentives are calculated in multiples of 15 minutes. The

	<p>Consumers will receive an incentive (€ as a function of actually consumed kW) with no reference to the absolute values if they will follow the signal sent by the aggregator.</p>	<p>power of the 15 minute period is calculated on the energy consumed in that period.</p> <table border="1" data-bbox="869 313 1420 616"> <thead> <tr> <th colspan="2">AD service request</th> </tr> </thead> <tbody> <tr> <td>Message ID</td> <td>xxx</td> </tr> <tr> <td>Customer ID</td> <td>yyyy</td> </tr> <tr> <td>Activation time</td> <td>hh:mi yyyy/mm/dd</td> </tr> <tr> <td>Duration</td> <td>xx min</td> </tr> <tr> <td>Combined volume and price signal</td> <td>Incentive of X € (kW)</td> </tr> <tr> <td>Less than 0,6 kW</td> <td>Incentive of X € (kW)</td> </tr> <tr> <td>0,6 kW ≤ Power < 0,9 kW</td> <td>Incentive of X € (kW)</td> </tr> <tr> <td>More than 0,9 kW</td> <td>No incentive</td> </tr> </tbody> </table>	AD service request		Message ID	xxx	Customer ID	yyyy	Activation time	hh:mi yyyy/mm/dd	Duration	xx min	Combined volume and price signal	Incentive of X € (kW)	Less than 0,6 kW	Incentive of X € (kW)	0,6 kW ≤ Power < 0,9 kW	Incentive of X € (kW)	More than 0,9 kW	No incentive				
AD service request																								
Message ID	xxx																							
Customer ID	yyyy																							
Activation time	hh:mi yyyy/mm/dd																							
Duration	xx min																							
Combined volume and price signal	Incentive of X € (kW)																							
Less than 0,6 kW	Incentive of X € (kW)																							
0,6 kW ≤ Power < 0,9 kW	Incentive of X € (kW)																							
More than 0,9 kW	No incentive																							
6-7.1	<p>At the end of AD service CEMS acquires data consumption about total household consumption from the Smart Info and sends it to the requester of the Load Shift in case that the requirements have been fulfilled during the requested time. Afterwards the aggregator will request to the DSO the consumer consumption during the period of AD request. Looking at the actual consumption of the consumers based on the measurements made by the meter and acquired by the DSO, the aggregator will provide to pay the incentive to the customer.</p>	<p>AD service fulfillment</p> <table border="1" data-bbox="869 683 1420 1019"> <thead> <tr> <th colspan="2">AD service fulfillment</th> </tr> </thead> <tbody> <tr> <td>Message ID</td> <td>xxx</td> </tr> <tr> <td>Customer ID</td> <td>yyyy</td> </tr> <tr> <td>Activation time</td> <td>hh:mi yyyy/mm/dd</td> </tr> <tr> <td>Duration</td> <td>xx min</td> </tr> <tr> <td>Measure:</td> <td></td> </tr> <tr> <td>1-15 minute max power</td> <td>xx W</td> </tr> <tr> <td>2-15 minute max power</td> <td>xx W</td> </tr> <tr> <td>3-15 minute max power</td> <td>xx W</td> </tr> <tr> <td>4-15 minute max power</td> <td>xx W</td> </tr> <tr> <td>5-15 minute max power</td> <td>xx W</td> </tr> </tbody> </table>	AD service fulfillment		Message ID	xxx	Customer ID	yyyy	Activation time	hh:mi yyyy/mm/dd	Duration	xx min	Measure:		1-15 minute max power	xx W	2-15 minute max power	xx W	3-15 minute max power	xx W	4-15 minute max power	xx W	5-15 minute max power	xx W
AD service fulfillment																								
Message ID	xxx																							
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2-15 minute max power	xx W																							
3-15 minute max power	xx W																							
4-15 minute max power	xx W																							
5-15 minute max power	xx W																							

Common Terms and Definitions

Common Terms and Definitions	
Term	Definition
Flexibility	“On an individual level, flexibility is the modification of generation injection and/or consumption patterns in reaction to an external signal (price signal or activation) in order to provide a service within the energy system. The parameters used to characterize flexibility include: the amount of power modulation, the duration, the rate of change, the response time, the location etc.” [source eurelectric, Jan 2014]
Active Demand (AD)	It is the active participation of residential consumers in the power system markets and in the provision of flexibility to the different power system participants by participating in AD service.
AD service:	It is a request sent from the aggregator to the consumers to maintain a certain power level in a period of time. The aggregator will give an incentive (€ as a function of kW actually consumed) for the fulfillment of the program.

13. Tariff-Consumption Information Exchange


Name of Use Case

Use Case Identification		
ID	Area Domain(s)/ Zone(s)	Name of Use Case
JWG-211x	Smart Grid	Exchanging information on consumption, price and warnings with external actors and within the home

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
0.2	01/03/2012	Willem Strabbing - The European Smart Meter Industry Group (ESMIG) Tim Sablon - The European Smart Meter Industry Group (ESMIG) Various contributions from Smart Grid Coordination Group members (version history will be included in the next version).	Initial draft	Draft
0.4	11/07/2012	Tim Sablon - The European Smart Meter Industry Group (ESMIG)	Reviewed version	Version after commenting phase
0.5	12/11/2012	Tim Sablon - The European Smart Meter Industry Group (ESMIG)	Reviewed version	Version for final commenting
0.51	Feb. 3, 2014	Yasuro Shobatake (JPNC TC57/WG21 Expert)	Fit description into IEC/TC8 Format	
0.6	March 24, 2014	Stephan Fertig (TC59x/WG7)	Modified to new JWG Use Case ID	Draft
0.7	May 26, 2014	Marco Signa (Energy@home)	Modified to include E@H part	DRAFT

Scope and Objectives of Use Case

	Use Cases	59 / 89
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Scope and Objectives of Use Case	
Scope	<p>The scope of this use case is the communication between the CEM and "upstream"² actors As well as the communication between CEM, the consumer and (in-home) smart devices. Smart devices cover also smart appliances, generators and storage (see table with actors).</p> <p>When the consumer has a price dependent energy tariff and/or a time dependent distribution tariff, price based demand response is enabled by creating an incentive for load management by consumers or a CEM in response to price changes (RTP, CPP, ToU). Note that multiple loads/generation resources (even from multiple premises) can be combined in the CEM to be mutually controlled.</p> <p>From an architectural point of view the Smart Grid Coordination Group introduced the "Smart Grid Connection Point" (SGCP) entity as an interface between Smart Grid actors (applications and/or organizations) and in-home/building systems or devices. The diagram below shows the SGCP in its environment. NOTE: ENEL's Smart Info is then very close to a Smart metering gateway.</p> <div style="text-align: center;"> </div> <p>Please note that the boxes in the diagram above are functional. The Smart Meter and CEM can be one or two separate physical boxes. The CEM can also be integrated in Smart in-home devices. The communication with the Grid market/applications can be through one or through separate infrastructures.</p>
Objective(s)	<p>The objective of this use case is to exchange information between external actors, the premise and the consumer in order to:</p> <ul style="list-style-type: none"> - Make consumers aware of their energy consumption - Providing external market roles with information on (forecasted) energy consumption - Enable consumers or their Energy Management System to react on (changes in) energy prices, thus supporting consumers to optimize their consumption to use cheaper or greener energy (depending on personal preferences) - Send warnings to the consumer to keep consumption below a certain (contracted) level - Enable external actors to retrieve the state and consumption of in home smart devices
Related business case(s)	<p>A combination of the functions described in this use support "Demand Response", following the definition of Eurelectric, which is referenced in</p>

² Upstream in this context means towards actor A or B (see actor definitions)

Narrative of Use Case

Narrative of Use Case
<p>Short description</p> <p>This use case describes how information regarding price and environmental aspects is sent from upstream actors to CEM and how information regarding energy consumption or generation as well as smart device statuses and consumption are being sent back to the consumer and upstream actors. . Also the case that remote-controllable device is connected to CEM is described.</p>
<p>Complete description</p> <p>This high level use case comprises four different primary use cases:</p> <p>1. <u>JWG 2111: Information regarding power consumption or generation</u></p> <p>The Smart Meter makes available the information on total power consumption or generation in the house. The CEM receives this information but can also receive consumption / generation information per smart device.³ The rate of update of the information must be proportional to the rate of change in the power drawn.</p> <p>This use case scenario consists of two scenarios:</p> <ul style="list-style-type: none"> - Sending information regarding (future) power consumption or generation of individual smart devices. This information is provided by the smart device to CEM, which may aggregate it and use it to forecast consumption/generation and send this to the consumer's display and external actors when required. As the CEM can be a function integrated in smart devices in the customer premises, more than one CEM in the house may execute this scenario. In this case, one CEM does not have the total house consumption, but only partial information. - Sending information regarding total power consumption or generation. This information is provided by the smart meter, sent to the CEM that may use it to make a forecast of consumption/generation and forward this to the consumer's display and external actors. <p>Note that several use case scenarios may work together in an iterative way. E.g. there might be a negotiation which uses the price (WGSP2112) to get a forecast (WGSP2111), then adapting the price, which might be binding from there on.</p> <p>Also note that the consumption information can be transferred via different channels to actor A, B and to the consumer or in-home devices. This implies that the use case could effectively be split up into three sub-use cases, each with its own goal (sending the information to Actor A, sending the information to Actor B and sending the information to the Simple External Consumer Display).</p> <p>In case of Remote-controllable device is connected to CEM, CEM asks information regarding power consumption or generation to individual remote-controllable device if the remote-controllable device has the capability of showing such information.</p> <p>2. <u>JWG 2112: Price and/or environmental information</u></p> <p>Actor A will send information (e.g. price, meteorological, environmental, cost related information, warning messages) to the consumer or his smart devices via the Energy management gateway; Actor B may do the same via the Smart Metering gateway. The goal is to make the consumer or his devices aware of the amount and cost of consumed energy and the amount and income for selling energy back to the grid, or of other elements relevant to energy</p>

³ Note that the CEM may be a function embedded in the Smart device (having thus access to only partial consumption information), in which case the information on total consumption is provided to the CEM by a communication with a gateway or the smart meter

management (e.g.: the percentage amount of green power). The consumer can also receive a notification that the tariff has been changed.

To move out peak loads, an external actor can propose a tariff of electricity higher during certain periods of the day or during certain days in order to invite his customers to delete or shift various uses or lower their consumptions in its housing during these periods. These periods and days may not be fixed in advance, but rather determined on the flexibility needs of the smart grid. When such a higher cost period occurs, the customers are notified in advance, so that they can be ready to react to these price messages. Smart devices can be parameterised or managed by the CEM to start when the energy costs less or when the relative amount of green energy is over a set level or to temporarily lowers its power consumption and/or shifts its operation before or after a peak consumption period. The parameterization of the CEM and smart devices are the responsibility of the consumer.

The price information can be either real-time price, real time combined price and volume messages or a fixed tariff schedule. Note that dynamic pricing requires a metering system that is able to provide the information for, or to calculate the cost of energy based on, a flexible tariff scheme. This implies that price related changes in the CEM by actor A or B may be combined with a tariff update in the smart meter; this is described in use case BI.03. of the Smart Meters Coordination Group use case repository.

The communication functionalities described in this use case may also be used to send warning messages from an external actor to the consumer, warning him that emergency load control will happen within a certain period of time, unless changes in consumption / generation take place.

Note that several use case scenarios may work together in an iterative way. E.g. there might be a negotiation which uses the price (WGSP2112) to get a forecast (WGSP2111), then adapting the price (WGSP2112), which might be binding from there on.

Also note that the information may be provided by Actor A or Actor B alternatively, which implies that this use case could be effectively split up in two sub-use cases.

In case of Remote-controllable device is connected to CEM, CEM interprets the Price and/or environmental information and controls this type of device remotely.

3. JWG 2113: Warning messages from CEM / Smart Device

This primary use case scenario consists of two scenarios:

- A warning message is generated by the smart device after estimating that the power consumed during its next operation will exceed maximum contracted power.

The Smart Device receives information from the CEM on total house consumption and maximum contracted power. The Smart Device estimates the maximum power that will be consumed during its next operation (ex: cycle). If there is a risk to exceed the threshold of the maximum contracted power, a warning is generated and displayed on the smart device or other customer interfaces (e.g. other devices or the simple external consumer display). The threshold is based on limits received from the CEM, which can be limits for instant power or accumulated energy consumption.

In case of Remote-controllable device is connected to CEM, CEM makes the warning message if needed. In order to do this, CEM asks information regarding power consumption to individual remote-controllable device if the remote-controllable device has the capability of showing such information.

- The warning message is generated by the CEM after noticing that contracted power is exceeded, based on information from the smart meter. Note that the CEM may also take action to lower the consumption of smart devices; since these actions are not in scope of this use case and the work of the SG-CG, this scenario only describes how the warning messages are being sent.

The limits (for instant power) can include not only upper limits (for example, when the customer is close to the limit of his contracted power) but also lower limits (for example, the remaining usual instant power consumption when the customer is out or during night time).

4. JWG 2114: Retrieve status of smart devices

The customer is also informed of the current energy consumptions\generation of the single Smart devices. The level of detail, frequency and quality of data could be different among different devices. It should be possible for users to display such disaggregated data together with total house consumptions; such functionality shall be performed by Customer Interfaces. One of the most important goals of this use case is to educate the consumer in selecting the parameters of the cycles by providing her/him feedback on the costs and energy consumption, before the start button is pressed. Many studies show that, only by displaying this information, a energy consumption saving of 10-15 % could be achieved on the single appliance.

The Smart device estimates the energy that will be consumed during the selected operation (ex: cycle). The CEMS will perform the energy cost evaluation based on data received by Energy retailer. Final cost information will be displayed either on the Smart Appliance display or on a specific user interface. Moreover, in case of time-of-use (TOU) pricing, the appliance receives information about which tariff is currently in use.

An external actor can retrieve the state of a smart device directly from the CEM. This real time information may be retrieved by an external actor who has a business relationship to the customer, having guaranteed that some of his smart devices are (exclusively) controlled by the external actor.

In case of Remote-controllable device is connected to CEM, CEM makes the status message if needed. In order to do this, CEM asks status information to individual remote-controllable device if the remote-controllable device has the capability of showing such information.

Notes and open issues	
Nr	Note
1.	This high level use case may in the future be split up in two high level use cases: -upstream communication (consumption, device status) - downstream and within home communication (price)
2.	Where relevant all primary use case (scenarios) may be split up according to external actors
3.	There is not yet a use case covering the situation where there would be multiple CEMs and the aggregation takes place in the grid side of the SGCP. (e.g. how is the user being informed that he is (going to) exceed his contractual power). Closing this gap would be a next step
4.	Next step: define additional use cases using the top down method, considering the functional architecture as a black box and identifying which messages would go in / come out

Actors

Actors			
Grouping		Group Description	
Actor Name see Actor List	Actor Type see Actor List	Actor Description see Actor List	Further information specific to this Use Case

Customer Energy Manager (CEM)	Internal	<p>The CEM is a logical function optimising energy consumption and or production based on messages received from the grid, consumer's settings and contracts, and devices minimum performance standards. The Customer Energy Manager collects messages sent to and received from connected devices; especially the in-home/building sector has to be mentioned. It can handle general or dedicated load and generation management commands and then forwards these to the connected devices. It provides vice versa information towards the "grid / market". CEM Hosts an application that collects data from HAN devices and organizes them for a user-friendly presentation.</p> <p>The CEMS hosts a dedicated algorithm, the Energy Cost Algorithm, to evaluate energy costs obtaining (either via a proper code or a proper form to be filled by user or a remote web site to gather the information) the cost information. Moreover, implements a proper web application to display both cost and energy consumption, including cost for running Smart Appliances with selected cycles. In addition, this interface shall also provide a way to obtain the cost per kWh.</p> <p>Exposes a web-based API over IP HN that can be used by 3rd party applications that wishes to elaborate current data and provides a different visualization.</p> <p>Implements an Execution Environment (e.g. OSGi framework for Java) to host 3rd party applications that wishes to elaborate current data and provides a different visualization.</p> <p>Implements a Trust Agent to manage all security keys of the HAN; this functionality can be implemented via collaboration with the WSN-C Service Platform</p> <p>Implements the communication with the WSN-C Service Platform and provides APIs to mediate communication between local bundles and WSN-C Service Platform.. Note that multiple loads/generation resources can be combined in the CEM to be mutually controlled.</p> <p>When the CEM is integrated with communication functionalities it is called a Customer Energy Management System or CEMS.</p>	
Energy management gateway	Internal	An access point (functional entity) sending and receiving smart grid related information and commands between actor A and the CEM, letting the CEM decide how to process the events. The communication is often	

		<p>achieved through an internet connection of through a wireless connection.</p> <p>This gateway may also provide services including protocol conversion, device management, security and service capabilities.</p>	
Smart Metering gateway (LNAP)	Internal	<p>An access point (functional entity) that allows access to one or more metering end devices and, when equipped with an interface, to advanced display / home automation end devices connected to the local network.</p> <p>A LNAP also may allow data exchange between different functional entities connected to the same LN. The LNAP may act simply as a router transferring messages between the metering end device and/or display/home automation devices and the Neighbourhood network of wide area network.</p> <p>It may also provide services including protocol conversion, device management, security and service capabilities. Services may be provided as functions of the LNAP itself or provide proxy services on behalf of limited capability devices connected to the local network.</p>	
Smart meter	Internal	<p>The metering end device is a combination of the following meter-related functions from the Smart Metering reference architecture:</p> <ul style="list-style-type: none"> • Metrology functions including the conventional meter display (register or index) that are under legal metrological control. When under metrological control, these functions shall meet the essential requirements of the MID; • One or more additional functions not covered by the MID. These may also make use of the display; <p>Meter communication functions.</p>	
NNAP	Internal	<p>The Neighbourhood Network Access Point is a functional entity that provides access to one or more LNAP's, metering end devices, displays and home automation end devices connected to the neighbourhood network (NN). It may allow data exchange between different functional entities connected to the same NN.</p>	
Simple external consumer display	External	<p>Dedicated display screen in connection with the smart meter/SGCP available to the customer to check power consumption, planned load reductions and load reductions historical. Other not dedicated means also exist to deliver consumption information to the customer, such as the personal computer, the mobile phone or the TV set.</p>	

Smart device	External	<p>A smart device may be an appliance, generator or storage device (<i>Local storage devices include direct and functional electricity storages such as electrochemical batteries, heat pumps and micro CHP such as fuel cells with heat buffers, air conditioning and cooling devices with thermal inertia, etc...</i>). The smart device can receive data directly from the grid, though an interface with the CEM and can react to commands and messages from the grid in an intelligent way.</p> <p>Since the smart device is outside the scope of the SGCG, it must be seen as an external actor</p>	
Smart appliance (white goods)	External	<p>An example of a smart device is a <i>smart white goods appliance</i> which is an appliance that has the capability to act in response to a message from the grid and thereby optimize its behaviour towards the energy supply network. The message can be received from a utility or a third party energy service provider directly or via a home energy management system,</p> <p>The message can be information like the cost of energy or the amount of available renewable energy, or it can be a Demand Respond message (delay load message or other related information) that the appliance must receive, interpret and react upon based on pre-set or active consumer input.</p> <p>Each Smart Appliance may display a sub-set of available data, depending on the richness of its user interface, like:</p> <ul style="list-style-type: none"> its own energy consumption/power drawn data The estimated energy consumption of selected cycle and its cost based on ToU or current tariff. the total house energy consumption. <p>The smart appliance is not guaranteed to respond, but will do so based on its status and user settings in order to ensure the expected performance.</p> <p>The consumer has the ultimate control of the appliance and can override any specific mode (e.g. override a delay to allow immediate operation, limit delays to no more than a certain number of hours, or maintain a set room temperature).</p> <p>Any appliance operation settings or modes shall be easy for an average, non-technical consumer to activate or implement.</p>	

Actor A	External	External actor (Smart Grid Market Role) interacting with the system functions and components in the home or home automation network through the energy management communication channel.. Examples of such market roles are the Energy Provider, the Energy Services Provider, the aggregator, etc...	
HES	Internal	<p>Responsible for acquiring the reads from meters and/or from data concentrators</p> <p>Delivers the raw meter reads to MDM</p> <p>Repeats the reading for any missing reads</p> <p>Is the short-term interim data storage (1-3 months) for meter reads</p> <p>Pushes the event information upwards to MDM</p> <p>Supports the specific protocols of the concentrators and meters</p> <p>Contains some topology information and aggregation functionality for plug & play solutions</p>	
MDM	Internal	<p>Is the single meter data repository for all metering data</p> <p>Is the long-term storage for the metering data</p> <p>Ensures the data quality by VEE for the higher level business processes</p> <p>Connects all head-end systems</p> <p>Is the connection point for other systems to reach the smart meters i.e. a gateway to HES and back</p> <p>Delivers the meter reads to other business systems for further usage</p> <p>Acts as the critical security firewall between business and operational systems and the advanced metering infrastructure.</p> <p>Contains some topology information and aggregation functionality</p>	
Actor B	External	External actor (Smart Grid Market Role) interacting with the system functions and components in the home or home automation network through the metering communication channel. This actor is responsible for collecting metering data. Examples of such market roles are the DSO, metering company, etc.	

14. Energy production/storage

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
1.12	Generation/Field	Energy production/storage integration

1.2 Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
1.0	07/05/2014	Luca Wiegand, Ciro Lanzetta (i-EM)	First draft	

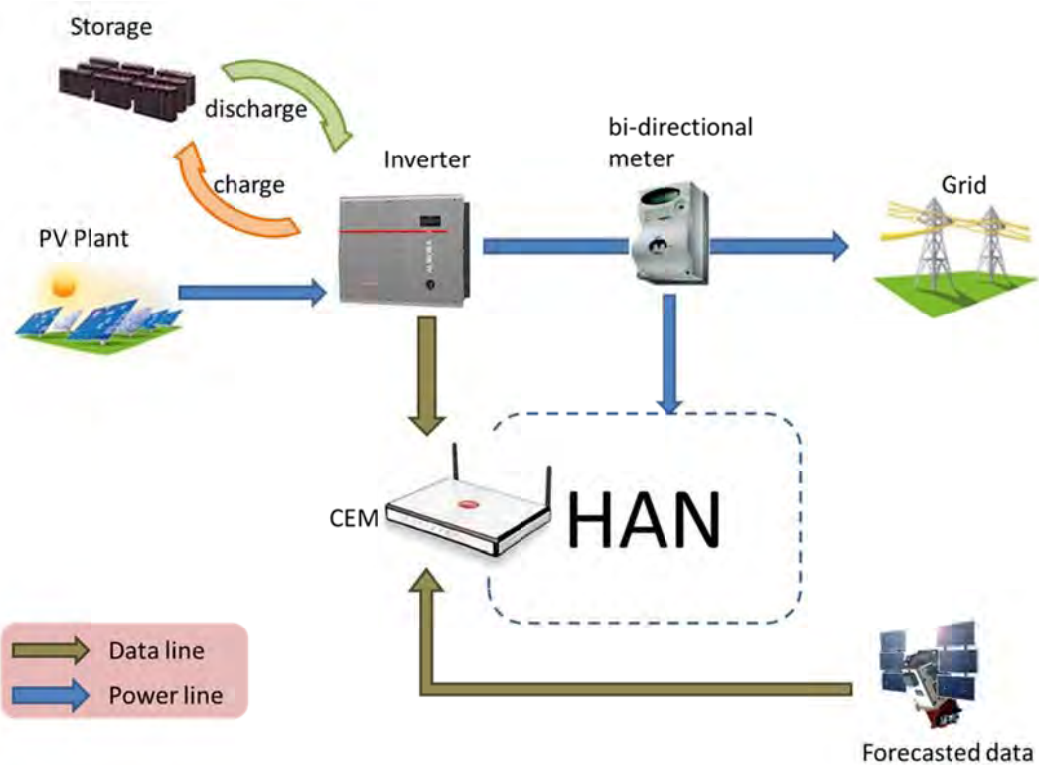
1.3 Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	The goal of this use case is to integrate the production from domestic photovoltaic (PV) plants and the storage systems that could be linked to a PV plant in the Energy@Home architecture.
Objective(s)	<ul style="list-style-type: none"> - Monitoring system for all the significant quantities that regard the production system, through a user-friendly interface - Tuning of the appliances timing algorithms using information about current and forecasted energy production.
Related business case(s)	JWG6/7-10 pag47.--> to include: possibility to sell energy to the grid

1.4 Narrative of Use Case

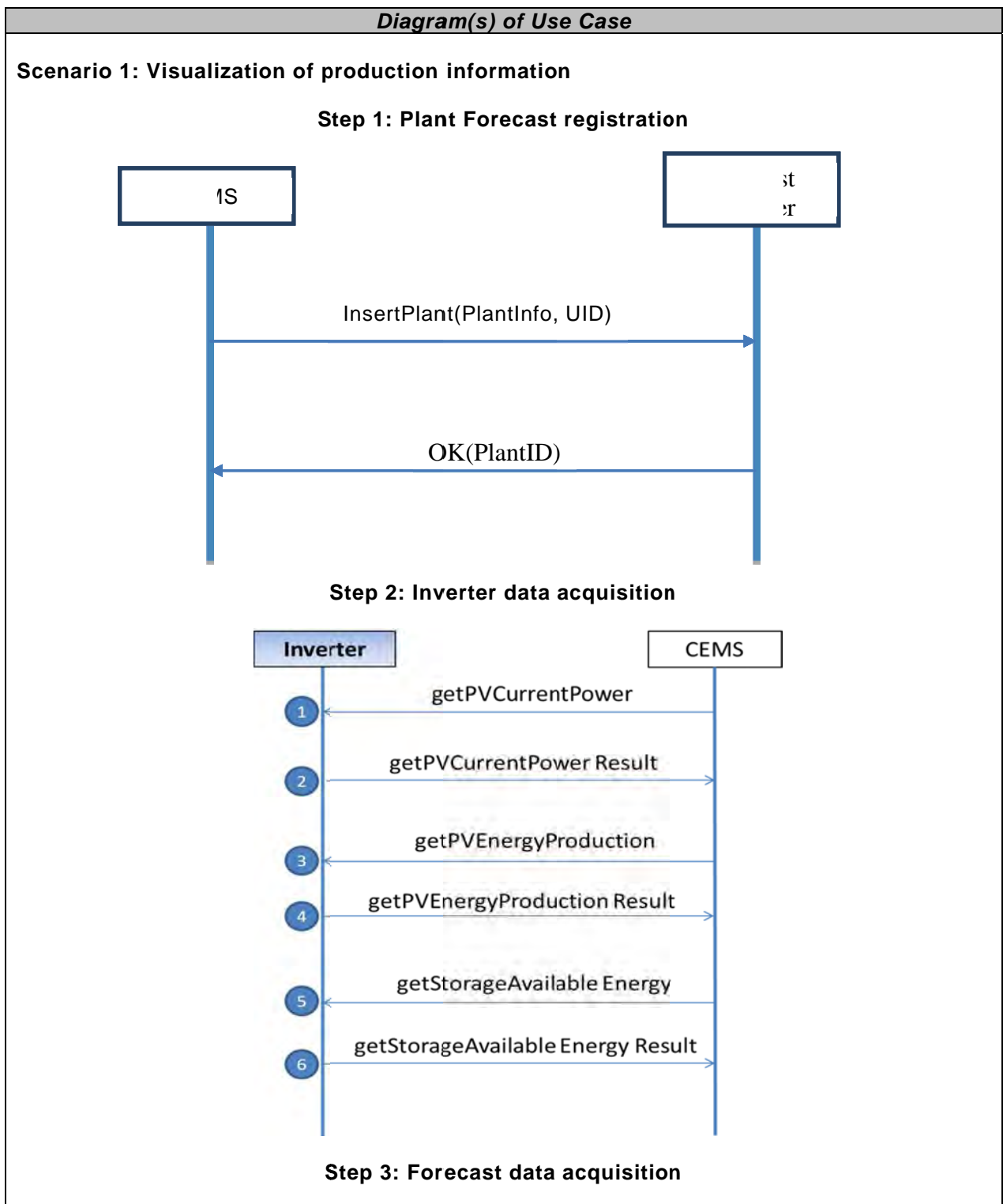
Narrative of Use Case
<p>Short description</p> <p>The aim of this use case is to provide customer with information on the current situation of her/his production plant, including suggestions about when an appliance should be used based not only on the current and forecasted consumptions, but also on the current and forecasted production of the photovoltaic plant</p>
<p>Complete description</p> <p>The goal of this use case is to integrate the production from domestic photovoltaic (PV) plants and the storage systems that could be linked to a PV plant in the Energy@Home architecture.</p> <p>This integration aims to have a dual benefit for the final user: on the one hand user will be able to monitor from a user-friendly interface all the significant quantities that regard the production system: current power, energy production, battery state of charge, forecast data, etc...</p> <p>On the other hand information about current and forecasted energy production will be used inside the algorithm that defines the best execution time in which an appliance should start. Currently this algorithm includes only current and expected consumptions of the other appliances. This integration will produce a more accurate result for users with domestic PV plants.</p> <p>Storing energy in a battery system allow the system to release electric power in a different period and so the system can achieve cost optimization/peak consumption reduction. On the other hand a scenario could be executed where the excess energy from PV plant could be stored into a DHW (Domestic Hot Water) storage, buffer primary water (for heating or cooling) sometimes present into house's hydraulic circuit or directly feed into the circuit. In this case storing energy into a thermal storage allow the system to limit use of electric energy coming from the grid maximizing autoconsumption. For example the CEMS, receiving information about how much electricity is exported into the grid can adopt an algorithm able, as a target, to</p>

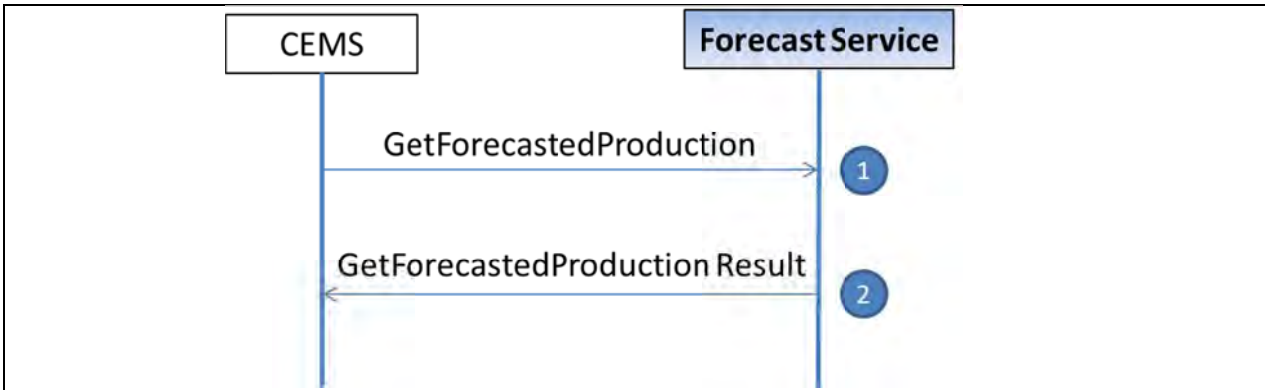
reduce to zero the value of energy given to the grid itself. Electric energy autoconsumption can be allowed according to economic reasons. In fact it could be cheaper to store energy into battery/thermal storage rather than sell electric energy coming from PV plant even if it could reduce the global system energy efficiency.



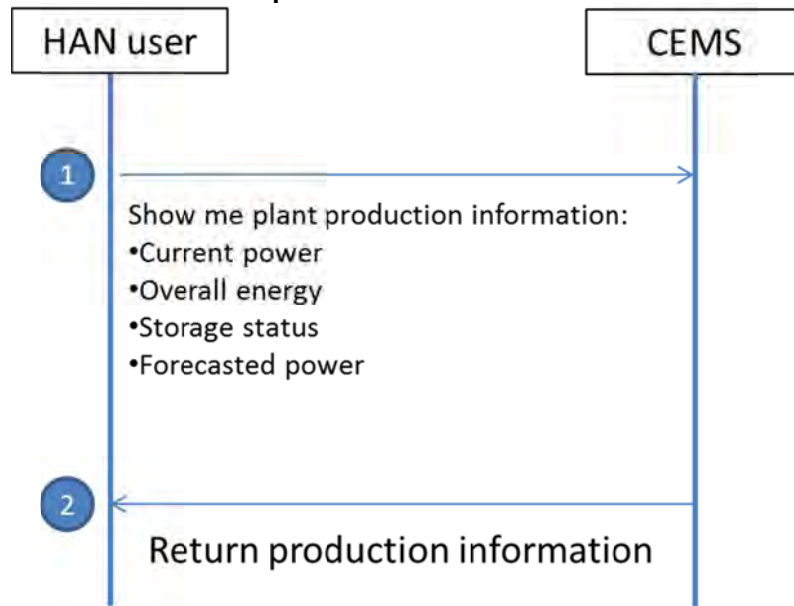
The storage component could be installed, if a battery storage will be used, inside the inverter and it is managed by inverter controller, otherwise could be installed in the hydraulic circuit as DHW buffer or CH/Cooling buffer primary water managed by heating controller. The inverter/storage system will communicate PV plant and storage information to the CEMS through a zigbee module. The CEMS will be able to retrieve forecast information invoking a remote Web Service.

Diagrams of Use Case





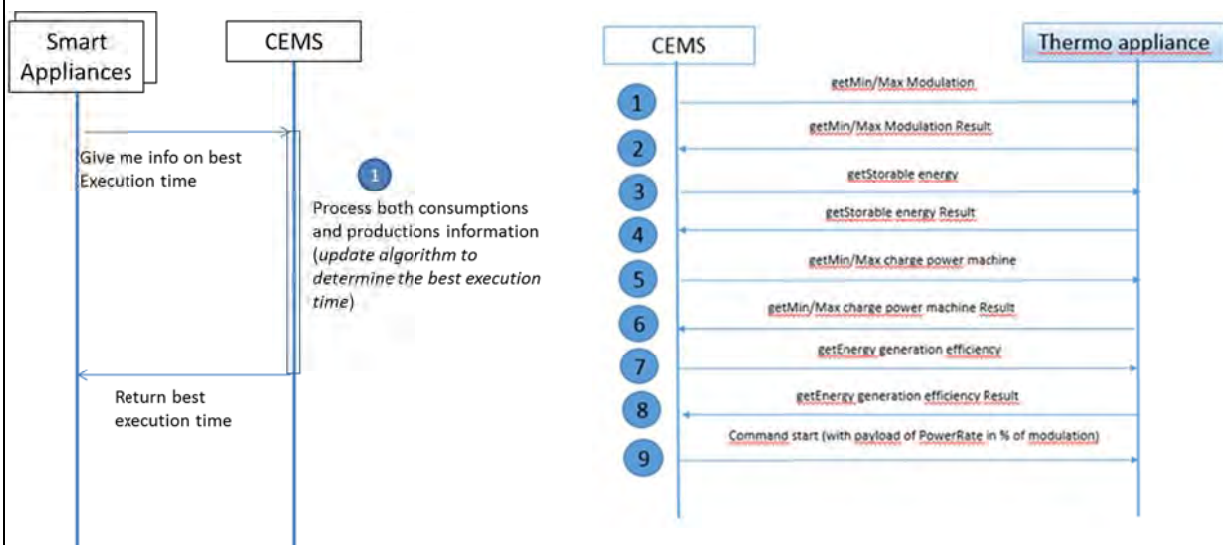
Step 4: User visualization



Scenario 2: peaks/costs optimization

Standard appliance

Thermal storage



Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name <i>see Actor List</i>	Actor Type <i>see Actor List</i>	Actor Description <i>see Actor List</i>	Further information specific to this Use Case
Inverter/Storage_system		Provides a set of data retrieved by photovoltaic plant production status and, possibly, by the storage system. The storage system is could be included inside the inverter or inside the hydraulic circuit, so there is direct communication between the storage and the CEMS. Data are dispatched upon request. Data sent by inverter represents exclusively current values, so CEMS will store these data to keep historical data.	
CEMS		Hosts a Web application that collects data from Inverter and forecast service and organizes them for a user-friendly presentation. Data collection will be triggered by the CEMS periodically every a certain amount of time, depending on the component to query (e.g. once a day for the forecast, once a minute for the inverter).	
Forecast Web Service		Forecast provider makes available a service that, when invoked, returns a collection of expected plant power values for the plant installed in a specific home. The service provides 72 power values, once an hour for the next 72 hours.	
HAN user		It's the home user that interacts with CEMS GUI to get information about production and storage system	

Triggering Event, Preconditions, Assumptions

Use Case Conditions			
Actor/System/Information/Contract	Triggering Event	Pre-conditions	Assumption
Scenario 1: visualization of production information			

Step 1: plant forecast registration			
HAN user	User starts to fill the plant registration form in the CEMS GUI	None	
Step 2: Inverter data acquisition			
CEMS	CEMS periodically starts to request plant production values to the PV inverter	None	Connection between CEMS and inverter has to be established before executing this step
Step 3 :forecast data acquisition			
CEMS	CEMS periodically starts to request plant production forecast to the Forecast Web Service	Step 1	
Step 4: User visualization			
HAN user	User accesses to the CEMS GUI to monitor PV plant variables	Step 2 & 3	
Scenario 2: Peaks/costs optimization			
E@H appliance	An home appliance asks the CEMS for the best execution time	Inverter and forecast data acquisition is running	

3.

Steps – Scenario Name

Scenario Conditions					
No.	Scenario Name	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
1	Visualization of production information	HAN user, CEMS	User accesses to the CEMS GUI to monitor PV plant variables	Inverter and forecast data acquisition is running. PV plant has been registered in the forecast service	User accesses to the plant production and forecast information
2	Peaks/costs optimization	E@H appliance	An home appliance asks the CEMS for the best execution time	Inverter and forecast data acquisition is running	Appliance suggests user its best execution time thanks to CEMS response

Steps – Scenarios

Scenario								
Scenario Name :		No. 1 - Visualization of production information						
Step No.	Event	Name of Process/Activity	Description of Process/Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirements, R-ID
1	None	plant forecast registration	CEMS provides a registration form to the user to fill PV plant data. After submission, data are sent to the forecast web service, that stores them and provides an ID to be used for forecast requests	CREATE	CEMS	Forecast Service	Plant info	
2	None	Inverter data acquisition	Periodically the CEMS starts the inverter data acquisition process: the CEMS makes 4 requests asking for the main four variables. The inverter responds to these requests with 4 values that are stored by CEMS in a database to let them be available by user when	GET	Inverter/Storage system	CEMS	<ul style="list-style-type: none"> •Current PV power •Overall energy produced by the plant •Current energy available in storage (if present) •Instantaneous power available from the battery 	

			he/she requests the plant production information.					
3	Step 1	forecast data acquisition	Periodically the CEMS starts the forecast data acquisition process: the CEMS makes a request to the Forecast Web Service asking for the expected plant power of the next hours. Forecast service returns a sequence of expected powers in a specific date time that is stored by CEMS in a database to let it be available by user when he/she requests the expected plant production information.	GET	Forecast Web Service	CEMS	72 power values, once an hour for the next 72 hours	
4	Step 2/3	User visualization	User requests information about his/her Energy Production	REPORT	CEMS	HAN User	No information exchanged (information about Energy	

			System to the CEMS through the Home Gateway web application . CEMS shows this information in a user-friendly interface.				Production System are only shown)	
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Scenario Name : *No. 2 - peaks/costs optimization (standard appliance)*

Step No.	Event	Name of Process/Activity	Description of Process/Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information Exchanged	Requirements , R-ID
1	Step 2/3 of Scenario 1	Get best execution time	This step is simply an updating of the algorithm that establishes the best appliances execution time. CEMS (due to scenario 1) has already stored in its database the production information required in the algorithm. CEMS has to use these new information in addition to the existing used information, such as appliances current	UPDATE	CEMS	Appliances	This scenario doesn't need any further message in addition of the existing messages (i.e. the best execution time of an appliance) .	

			and expected consumption and overall home consumption.					
Scenario Name :		No. 2 - peaks/costs optimization (thermal storage)						
Step No.	Event	Name of Process/Activity	Description of Process/Activity	Service	Information Producer (Actor)	Information Receiver (Actor)	Information	Requirements , R-ID
1		Get Min/Max modulation	This step simply allows CEMS have information on thermo appliance modulation capabilities in order to know its limits. The minimum/maximum value is not necessary 0/100, in some situations the thermo appliance could have limitations on this values.	GET	Thermo appliance	CEMS	Min/Max Modulation	
2		Get Storable energy	This step enables CEMS to know the quantity of energy actually storable in the thermo appliance.	GET	Thermo appliance	CEMS	Storable energy	
3		Get Min/Max charge power machine	This step allows CEMS have information on the minimum/maximum instantaneous power the thermo appliance	GET	Thermo appliance	CEMS	Min/Max charge power	

			can manage when sinking energy from the PV plant.					
4		Get energy generation efficiency	This step defines the efficiency for thermo appliance useful to let the CEMS able to make choice (possibly the most convenient) among different solutions the whole system is capable of.	GET	Thermo appliance	CEMS	Energy generation efficiency	
5		Get start command with information about power rate	This step enables the thermo appliance to follow CEMS indications about start time and power absorption expressed in terms of % of modulation	GET	CEMS	Thermo appliance	Command start with payload of PowerRate expressed as % of modulation	

Information Exchanged

Information Exchanged		
Name of Information (ID)	Description of Information Exchanged	Requirements to information data
Scenario 1 – Step 1		
Plant info	Vital statistics and general information about PV plant	
Scenario 1 – Step 2		
Total Energy production (kWh)	CEMS queries the Inverter for the PV Energy production. Inverter returns the current PV Energy production	
Storage available energy (kWh)	CEMS queries the Inverter for the Storage available energy. Inverter returns the Storage available energy (if any)	
Peak power from the battery	CEMS Asks for the instantaneous power available from the battery (if	

	any). Inverter returns the Peak power deliverable from the battery	
Scenario 1 – Step 3		
Plant forecast power	CEMS asks the forecast service for the current PV power. Forecast service returns the expected plant power	Must be 72 forecast values, once per hour (3 days)

Common Terms and Definitions

Common Terms and Definitions	
Term	Definition
PV plant	Photovoltaic plant

15. Device remote monitoring

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
1.13	Customers/Process	Devices monitoring

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
1.0	09/05/2014	Lucio Bianchi (Indesit Company)		


Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	Management of the connected devices to monitor their status and functionalities
Objective(s)	The user can receive remotely (inside or outside home) on his PC/mobile the status of his devices to let him monitoring the appliances, the lighting system, the HVAC system, the alarm system.
Related business case(s)	

Narrative of Use Case

Narrative of Use Case
Short description
-
Complete description
<p>The user access remotely the devices information such as:</p> <ul style="list-style-type: none"> • the current status (Running, End, Pause, Delay, ...) • the current phase (e.g. for a washing machine Heating, Rinse, Spin, ...) • the selected program • the selected options (temperature, duration, spin, ...) and special functions (prewash, extrarinse, superfreeze, ...) • the remaining time to end the cycle <p>Furthermore some event/alert can be defined and monitored to inform the user of special events that occurred (e.g. the washing machine has just finished, the fridge door remained open, the oven has reached the heating temperature, some faults occurred on the dish washer)</p> <p>For every subsystem to be monitored (lighting system, HVAC system, alarm system, ...) the available information must be defined even if some basic information are always applicable (the on/off status, the program/option selected, the alarm/event notification...).</p>

General Remarks

	Use Cases	80 / 89
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General Remarks

Before starting any monitoring and controlling activities, the remote user interface must know which are the capabilities that the local remote interface implements in terms of number and type of programs and options and of relationship between them (i.e. compatibility between cycle and options or between 2 options) .

Diagrams of Use Case

Diagram(s) of Use Case



Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name see Actor List	Actor Type see Actor List	Actor Description see Actor List	Further information specific to this Use Case

Smart Appliance		<p>The device is able to provide information about his conditions (device status)</p> <p>The device spontaneously informs the CEMS about any status change.</p> <p>The status change can result from:</p> <ul style="list-style-type: none"> • the interaction of the user with the device • the normal evolution of the functional phases over the time • the alarm/event occurrence <p>Note: the device is also able to respond on-demand on his status</p>	
CEMS		<p>It collects the status notification , events, alarms sent from the devices over the HAN</p> <p>It receives from the Remote GUI the request to start or to stop the device status notification toward the Remote GUI.</p> <p>It sends the device status notification to the Remote GUI when the start request is received and after any status notification received from the device , until it receives the stop request from the Remote GUI.</p> <p>Depending on the adopted technical solution, the CEMS can act as a simple tunnel between the device and the Remote GUI or can implement some type of parsing of the data received</p>	
Remote GUI/Backend		<p>It provides the secure access of the user to the monitoring page</p> <p>It provides to the users a numeric, textual and graphical visualization of the device status, events, alarms</p> <p>It sends to the CEMS the</p>	

		<p>request for monitoring the devices or to stop the monitoring phase.</p> <p>It can adds reacher information on the device usage, help online, user guide online.</p>	
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Information Exchanged		
Name of Information (ID)	Description of Information Exchanged	Requirements to information data
Start Status Notification Request	The Remote GUI asks the CEMS to open the forwarding of the devices status	-
Status Notification	This packet is the mirroring of the Status Notification sent by the device over the HAN. The CEMS has always the update value for the status since the dispatching from the device is always enabled.	<p>The status packet includes all the information related to the condition of the device, e.g. for an appliance can be:</p> <ul style="list-style-type: none"> • Running, End, Pause, Delay, ...) • Heating, Rinse, Spin, ... • selected program • temperature, duration, spin, ... • prewash, extrarinse, superfreeze, ... • remaining time to end the cycle
Stop Status Notification Request	The Remote GUI asks the gateway to close the forwarding of the devices status	-

16. Device remote Control

Use Case Identification		
ID	Domain(s)/ Zone(s)	Name of Use Case
1.14	Customers/Process	Devices control

Version Management

Version Management				
Version No.	Date	Name of Author(s)	Changes	Approval Status
1.0	09/05/2014	Lucio Bianchi (Indesit Company)		

Scope and Objectives of Use Case

Scope and Objectives of Use Case	
Scope	Management of the connected devices to control their status and functionalities
Objective(s)	The user can control remotely (inside or outside home) the status of his devices using his PC/mobile, setting the required functionalities on the appliances, the lighting system, the HVAC system, the alarm system.
Related business case(s)	To be discussed

Narrative of Use Case

Narrative of Use Case
Short description
-
Complete description
<p>The user controls remotely the devices parameters such as:</p> <ul style="list-style-type: none"> • ON/OFF status of the appliance • Required cycle • Required washing/cooking/freezing temperature, spin speed, duration • Required options and functions (superwash, rapid wash, super cooling, ...) • Start, Stop, Pause commands <p>For every subsystem to be controlled (lighting system, HVAC system, alarm system ...) the available information must be defined even if some basic information are always applicable (the on/off status, the program/option selection, ...).</p>

General Remarks

General Remarks
Before starting any monitoring and controlling activities, the remote user interface must know

which are the capabilities that the local remote interface implements in terms of number and type of programs and options and of relationship between them (i.e. compatibility between cycle and options or between 2 options) .

Diagrams of Use Case

<i>Diagram(s) of Use Case</i>			

Actors

Actors			
Grouping (e.g. domains, zones)		Group Description	
Actor Name see Actor List	Actor Type see Actor List	Actor Description see Actor List	Further information specific to this

			Use Case
Smart Appliance		<p>The device is able to modify his status conditions (device status) according with the commands dispatched by the remote GUI and according with the constraints selected by the user (e.g. remote control enabled)</p> <p>The device spontaneously informs the CEMS about any status change.</p> <p>The status change can result from:</p> <ul style="list-style-type: none"> • the interaction of the user with the device, both locally and remotely • the normal evolution of the functional phases over the time • the alarm/event occurrence 	
CEMS		<p>It collects the status notification , events, alarms sent from the devices over the HAN</p> <p>It receives from the Remote GUI the request to modify the status of the devices (e.g. selection of a cycle, ON/OFF of the device, start/stop commands)</p> <p>It sends the modification request to the devices over the HAN</p> <p>It sends the device status notification to the Remote GUI</p> <p>Depending on the adopted technical solution, the CEMS can act as a simple tunnel between the device and the Remote GUI or can implement some type of parsing of the data received.</p>	
Remote GUI/Backend		<p>It provides the secure access of the user to the monitoring page</p> <p>It provides to the users a numeric, textual and graphical</p>	

		<p>visualization of the device status, events, alarms</p> <p>It sends to the CEMS the request for the modification of their status</p> <p>It can adds reacher information on the device usage, help online, user guide online.</p>	
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Further Information to the Use Case for Classification / Mapping

Classification Information		
Relation to Other Use Cases		
Information Exchanged		
Name of Information (ID)	Description of Information Exchanged	Requirements to information data
Select a cycle	The Remote GUI asks the backend to set the required cycle on the device	Type/number of cycle
Change one parameter	The Remote GUI asks the backend to set the required parameter	Type/value of parameter
Send all data & Set start cycle	Once the Remote GUI confirms the selected options with a direct command such as Start cycle (or with a direct confirmation command or after a periodical time basis), all the information related to the required appliance configuration is dispatched from the backend to the CEMS and from the CEMS to the appliance	Type/number of cycle Type/value of parameter Type of command to execute
Status Notification	After the appliance executed the remote request, status change , the updated status is dispatched over the network	The status packet includes all the information related to the condition of the device, e.g. for an appliance can be: <ul style="list-style-type: none"> • Running, End, Pause, Delay, ...) • Heating, Rinse, Spin, ... • selected program • temperature, duration, spin, ... • prewash, extrarinse, superfreeze, ... remaining time to end the cycle

Device configuration (management)

Add a new device

The user buys a Smart Appliance and would like to start it up in the Energy@Home HAN with the simplest human interaction possible. The admission procedure is required to guarantee the interconnection of the Smart Info, Smart Appliances and CEMS owned by the same customer.

If the HAN was previously activated by the CEMS, through a web interface, the user starts the admission procedure, identifies the new ZigBee device checking manufacturer and model and allows the new Smart Appliance to join the Energy@Home solution. The same procedure could be activated for the Smart Info.

In case the CEMS is not available, the admission procedure should be managed by another device, which shall provide user with a user-friendly interface.

Remove a device

In case of both joining of not desired device to the HAN and replacement of broken ones, the customer is provided with this procedure. The user experience could be similar to ADD one.

Maintenance

If the customer experienced some problems with Energy@Home a Web application on the CEMS could present the status of the HAN including the devices list, the devices status (i.e. joined to the HAN but not responding), etc. Also Warning and Alarm could be activated in case of communication problems.

If the CEMS is not available, this functionality is critical to be provided.