Reports on pre-standardization activities and patent survey

Document ID:	SEMIAH-WP2-D2.2-v1.01
Document version:	1.01
Document status:	Final
Dissemination level:	PU
Deliverable number:	D2.2
Deliverable title:	Reports on pre-standardization activities and patent survey
WP number:	2
Lead beneficiary:	6
Main author(s):	J. Ringelstein, Patrick Selzam (Fraunhofer IWES), Dominique Gabioud (HES-SO), Pierre-Alain Alet (CSEM), Poul Møller Eriksen (Develco), Fabian Schmidhalter (ENALP), Nils Ulltveit-Moe (UiA), Rune Hylsberg Jacobsen (AU), Karl Werlen (Misurio)
Nature of deliverable:	R
Delivery date from Annex 1:	M24
Actual delivery date:	M24
Funding scheme / call:	STREP-FP7-ICT-2013-11
Project / GA number:	619560
Project full title:	Scalable Energy Management Infrastructure for Aggregation of Households
Project start date:	01/03/2014
Project duration:	36 months

Funded by the
European Union

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 619560.

Executive Summary

The document at hand reports the outcome of SEMIAH working task 2.5 on pre-standardization and patent screening activities.

Standards may define technical design, methods, processes and practices. Standardized coordination between business actors and technical systems is required for successful deployment of smart grid systems and services in the mass market. Standards can be understood as key enablers for interoperability of products manufactured by different vendors, and also interoperability of (energy) market actor's business processes. Since many smart grid subsystems rely on software-driven operations, data processing, and data transmission, information technology standards play a key role. With respect to energy systems, and especially Smart Grids, there is a vast multitude of standards which span different areas from customer level (e.g. ZigBee for Home Automation) to enterprise and business process level (e.g. DLMS/COSEM for Metering and Billing). Online tools, e.g. the "Smart Grid Standards Map" operated by the International Electrotechnical Commission (http://smartgridstandardsmap.com), or the public database displaying the result of the European frame program 7 project STARGRID (http://stargrid.iwes.fraunhofer.de), are available for standards classification and lookup. SEMIAH generally aims at influencing standardization by successfully demonstrating the benefits of residential automated demand response and by disseminating the obtained benefits. Amongst the most important standards for project SEMIAH are ZigBee for wireless in-building sensor, actor, and control networks, and the common information model (CIM) for representation of information communicated between the front-end (home energy gateway level) and back-end systems (virtual power plant level).

The patent survey was conducted in order to find SEMIAH related property rights using different online patent databases. In total, 32 patents were reviewed, summarized and classified with regards to relevance to the SEMIAH project. The property rights found concern different levels of the SEMIAH system, e.g. the virtual power plant, information technology and digital electronics, energy supply, demand response, and home energy management systems. Many aspects of virtual power plant systems, demand response and home energy gateways are already disclosed today. However, inventions that combine two or more of the named levels with specific scope and in-detail claims of solutions for concrete problems are rarely found, thus defining gaps in innovation.

Abbreviations

ADR	Automated Demand Response
AES	Advanced Encryption Standard
CEN	Comité Européen de Normalisation
CENELEC	Comité Européen de Normalisation Électrotechnique
CIM	Common Information Model
COSEM	COmpanion Specification for Energy Metering
D	Deliverable
DER	Distributed Energy Resource
DG	Distributed Generation
DLMS	Device Language Message Specification
DR	Demand Response
DRAS	Demand Response Automation Server
DSO	Distribution System Operator
EC	European Commission
EPS	Electric Power System
ETSI	European Telecommunications Standards Institute
EU	European Union
GVPP	Generic Virtual Power Plant
HEMG	Home Energy Management Gateway
HEMS	Home Energy Management System
HTTP	Hyper Text Transfer Protocol
IAP	Interoperability Architectural Perspective
ICT	Information and Communication Technology
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IT	Information Technology
JSON	JavaScript Object Notation
MMS	Manufacturing Messaging Specification
OGEMA	Open Gateway Energy MAnagement
REST	REpresentational State Transfer
RSA	Rivest-Shamir-Adleman cryptosystem
SAREF	Smart Appliances REFerence
SCADA	Supervisory Control And Data Aquisition
SGAM	Smart Grid Architecture Model
SG-CG	Smart Grid Coordination Group
SGIRM	Smart Grid Interoperability Reference Model
TCP	Transmission Control Protocol
VPP	Virtual Power Plant
Wi-Fi	Wireless Fidelity
WP	Work Package
WT	Work Task
XML	eXtensible Markup Language

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Introduction

1.1 Scope and motivation

Successful deployment of smart grid systems and services in the mass market requires standardized coordination between business actors and technical systems. Such coordination requires common interfaces well-defined by standardization bodies. Since many smart grid subsystems rely on software-driven operations, data processing, and data transmission, information technology standards play a key role here. Also, such standards often take into account physical conditions by including informational and data modelling of physical units and entities found in smart grid systems, such that they can be represented by data elements.

This deliverable reports the outcome of SEMIAH working task 2.5 on pre-standardization and patent screening activities. It focuses on early developments in the project consortium with regards to standardization as well as the result of a patent screening.

1.2 Content

The document at hand contains two main chapters. In chapter 2 we highlight the general role of standardization in the smart grid sector and shortly summarize standards and norms that are deemed most relevant in the context of project SEMIAH today. Also, we highlight the role of standardization in the context of SEMIAH specific developments and technical components.

In chapter 3 we present the result of a patent survey conducted in order to find SEMIAH related property rights. In total, 32 patents are reviewed, summarized and classified. The chapter concludes with a short summary of innovation gaps.

2 Smart grid standardization in the SEMIAH context

2.1 Overview of relevant standards

According to common understanding, the term “standard” refers to a norm or requirement regarding technical systems. Standards are formally documented following a well-defined standardization process. A standard may define technical design, methods, processes and practices. In the context of energy systems, standards and regulation often influence each other and may also refer to organizational or business related processes. The IEEE standards association defines standards as *“published documents that establish specifications and procedures designed to maximize the reliability of the materials, products, methods, and/or services people use every day […] establishing consistent protocols that can be universally understood and adopted.”* [2]

Hence, standards can be understood as key enablers for interoperability of products manufactured by different vendors, and also interoperability of (energy) market actor’s business processes.

With respect to energy systems, and especially Smart Grids, there is a vast multitude of standards referring to the following aspects:

- Smart Grid architecture and modelling
- Smart Metering
- Energy Management, Home and Building Automation
- Automated Demand Response
- Energy Efficiency (in buildings)
- Distributed Energy Generation and (Virtual) Power Plants
- In-Home and Wide Area Communication protocols and interfaces for Smart Grids
- Distribution Grid Operation, Automation and Communication
- Data Security and Privacy
- Wholesale energy markets, Trading and Billing
- Electric Mobility

The International Electrotechnical Commission (IEC) is operating an online tool for Smart Grid standard research, the “Smart Grid Standards Map” (http://smartgridstandardsmap.com/). It provides a comprehensive overview of standard documents attributed to Smart Grid technical levels and domains, arranged in an interactive view (cp. Figure 1).

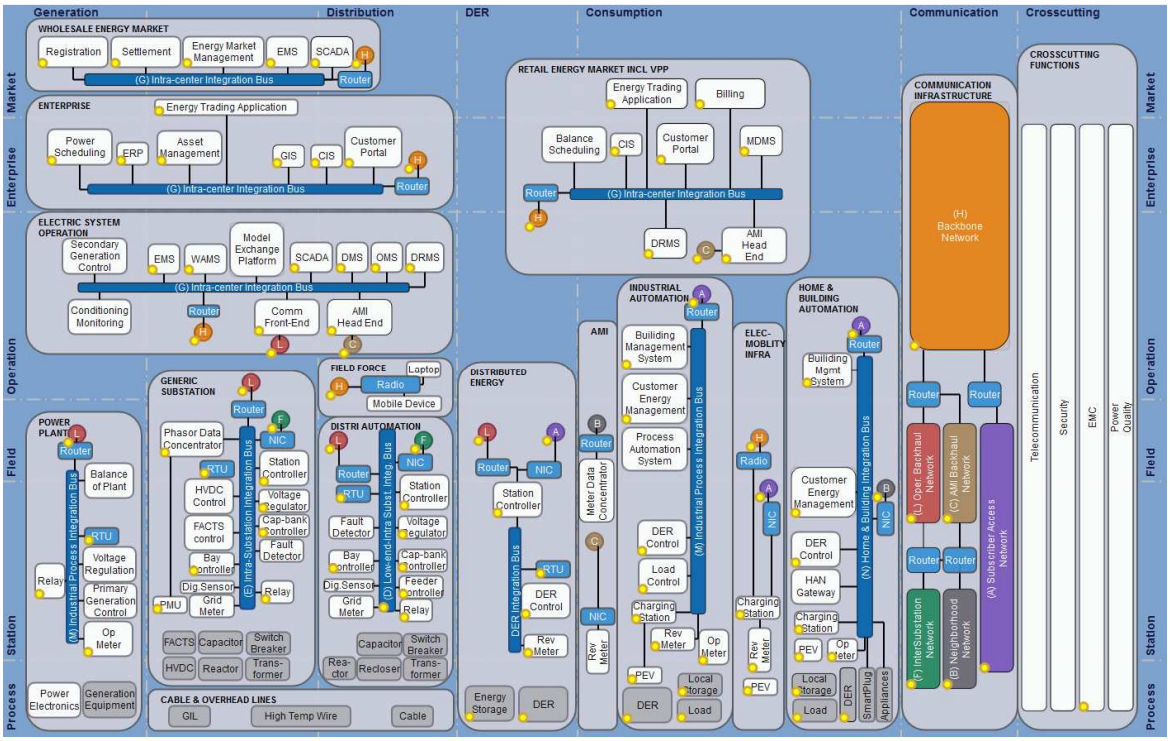

Figure 1: Architecture view of smart grid standards map [3]

The European frame program 7 project STARGRID has performed a thorough assessment and analysis of Smart Grid related standards. The result has been made public through a web-based database accessible at http://stargrid.iwes.fraunhofer.de which contains over 1100 documents (as of January 2016), including standards, standard series, technical specifications and reports, roadmaps, guidelines and others. The project also derived a set of six recommendations on Smart Grid standardization and regulation, aiming at enabling large scale deployment of according technologies [1]. The recommendations refer to alignment of standards with national regulations, system interfaces, interoperability test and certification, security and privacy, the standardization process and DER integration rules and specifications. The recommendations are shortly summarized in the following.

The first recommendation calls for improving the alignment between regulation and standardization. This is due to the fact that regulation in the energy system sector often prescribes technical features. Harmonization of national frameworks and rules, e.g. for DER interconnection, is also called for.

The second recommendation calls for regulated and uniform definition of communication channels between market actors using standardized interfaces.

The third recommendation calls for introducing testing and interoperability procedures in standards, pointing out that such procedures should not only cover testing for individual standard compliance, but also involve tests in a complex integrated environment. This is of importance since Smart Grid systems tend to be highly interconnected.

The forth recommendation considers privacy and security, referring to the Smart Grid as a critical infrastructure threatened by cyber-attacks and data abuse. It calls for a coordinated approach for information security promoting the “privacy by design and by default” paradigm.

The fifth recommendation considers the standardization process, pointing out that it is a big challenge for actors to follow the developments. It calls for improving dissemination of standardization committees using examples of good practice.

The sixth recommendation emphasizes the importance of harmonization of grid codes and interconnection rules for DER.

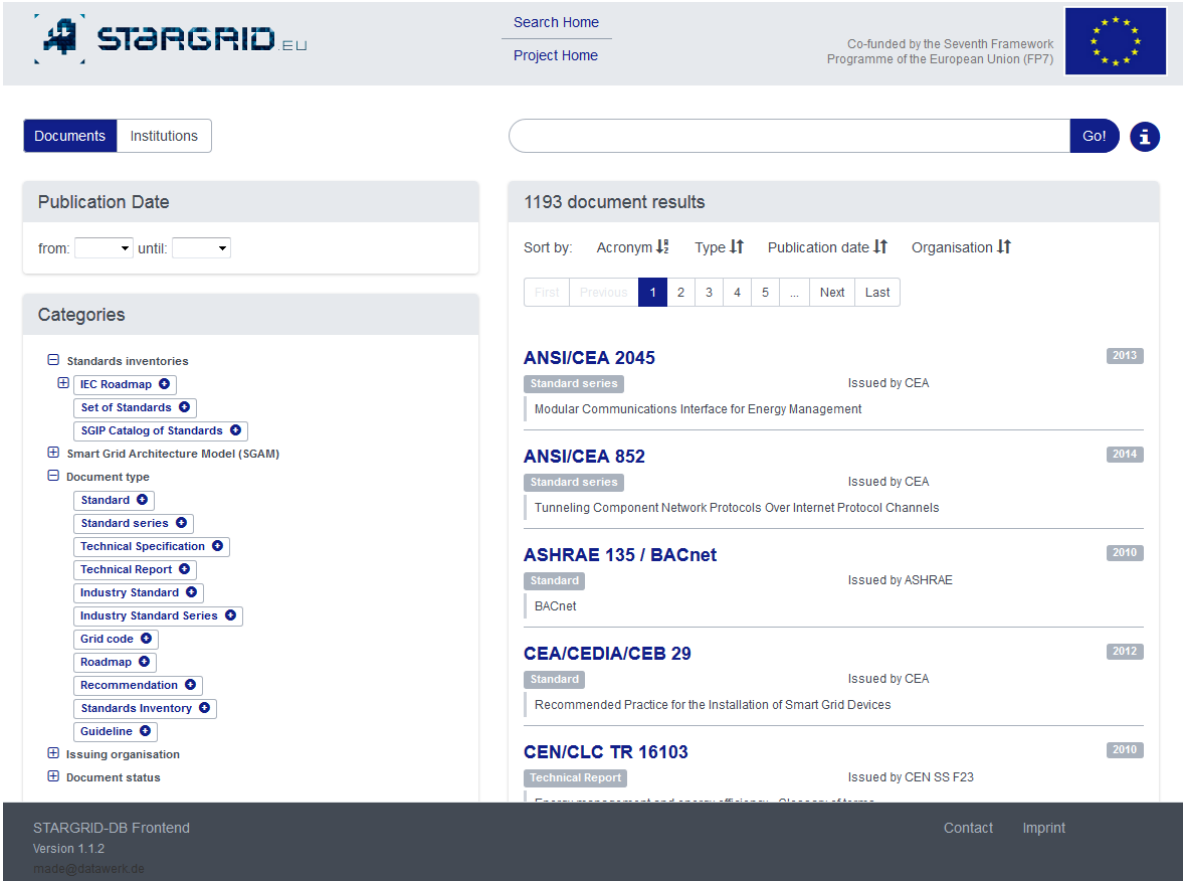

Figure 2: The Stargrid search engine
(http://stargrid.iwes.fraunhofer.de accessed at Jan 27th 2016)

The currently active Horizon 2020 project NOBEL Grid aims at providing advanced tools and ICT services for Smart Grid actors, focusing on applications for enabling active market participation of residential private end customers. The project recently published a deliverable summarizing an analysis on European energy policies and regulation frameworks (D2.2, [NG2016]) which also contains considerations on standardization. The document explicitly mentions the following standard-related topics:

- The General Data Protection Regulation (GDPR), which will probably affect future Smart Grid data protection standards.
- Open standards for smart meter communication that guarantee interoperability of components of different suppliers; the Dutch DSRM standard is specifically mentioned.
- The international information security standard ISO 27001
- ISO 37120 as a standard on smart cities

The following sections contain a short introduction of relevant and widely used standards with respect to the aspects named above, as far as relevant to project SEMIAH.

2.1.1 Smart Grid architecture and modelling

2.1.1.1 IEEE Std 2030-2011

This standard is named “IEEE Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), End-Use Applications, and Loads” and provides alternative approaches and best practices for achieving smart grid interoperability. It establishes the “Smart Grid Interoperability Reference Model” (SGIRM) as a design tool that inherently allows for extensibility, scalability and upgradeability. Furthermore the standard provides understanding and definitions of smart grid components and the knowledge base of this guide contributes to a basis for future certification and testing of smart grid components and subsystems.

In chapter 4.2 of IEEE 2030-2011 the smart grid is defined as “… a complex system made up of interrelated systems. As the power system is upgraded with more flexibility, integrated communications, and advanced controls, it will enable large-scale integration and interoperability of a greater diversity of technologies and end-use applications.”

The key competence of a complex system as a smart grid is interoperability, which is in general the capability of two or more networks, systems or devices to externally exchange and readily use information securely and effectively. Smart grid interoperability is in the standard associated with hardware/software components that enable machine-to-machine communication, data formats with a well-defined syntax and a common understanding of the meaning of the content being exchanged.

Also very important for a smart grid is to fulfill the key requirements privacy, security and reliability, which are described in the standard IEEE Std 2030-2011 in the chapters 4.4 - 4.6.

The main feature of the standard is the establishment of the smart grid interoperability reference model including three high-level “Interoperability Architectural Perspectives” (IAP):

1. Power Systems IAP (PS-IAP)
2. Communications Technology IAP (CT-IAP)
3. Information Technology IAP (IT-IAP)

Each of these perspectives consist of several domains, entities and either interfaces or data flows.

Domains common to all IAPs are: bulk generation, transmission, distribution, service providers, markets, control/operations and customers.

Entities are devices, communication networks, computer systems, software programs, etc. which are generally located inside a domain and connected to each other through interfaces.

Interfaces are logical connections from one entity to another that support data flows implemented with data links.

Data flows are used instead of interfaces in the IT-IAP.

The standard provides a table to identify a set of characteristics for the data at each interface in the SGIRM. It is a starting point to determine appropriate classifications for the data. The data characteristics of the table are: reach, information transfer time, latency, synchronicity, information reliability, data volume and security.

Data characteristic	Classification/Value range			
Data use category	To be determined by the user of the table based on the intended use of the data (i.e., control data, protection data, and/or monitoring data)			
Reach	meters (feet)		kilometers (miles)	
Information transfer time	<3 ms	Between 3 ms and 10 s	Between 10 s and minutes	hours
Data occurrence interval	milliseconds	seconds	minutes	hours
Method of broadcast	Unicast	Multicast	Broadcast	All
Priority	Low	Medium	High	
Latency	Low-low (<3 ms)	Low (<16 ms)	Medium (<160 ms)	High (≥160 ms)
Synchronicity	Yes		No	
Information reliability	Informative	Important	Critical	
Availability (information reliability)	Low (limited impact)	Medium (serious impact)	High (severe or catastrophic impact)	
Level of assurance	Low	Medium	High	
HEMP, IEMI	Hardened, yes		Hardened, no	
Data volume	bytes	kilobytes	megabytes	gigabytes
Security	Low (limited impact)	Medium (serious impact)	High (severe or catastrophic impact)	
Confidentiality	Low (limited impact)	Medium (serious impact)	High (severe or catastrophic impact)	
Integrity	Low (limited impact)	Medium (serious impact)	High (severe or catastrophic impact)	
Availability (security)	Low (limited impact)	Medium (serious impact)	High (severe or catastrophic impact)	

[a] Table 5-1 is to be read from left to right, and each data characteristic listed in the left column is to be assigned one classification/value range.

Figure 3: The SGIRM data classification reference table (source: IEEE Std 2030-2011)

The standard describes all the relevant entities and interfaces respective data flows for the three interoperability architectural perspectives in the chapters 6 - 8.

The domains are explained in the PS-IAP, which represents the view of the electric power system.

The CT-IAP is not meant to give the level of details required for the designer of the lower communications protocol layer, but it provides the generic and standard framework elements. The three most important uses of the CT-IAP are (emphasized in the standard):

- map existing and next-generation utilities´ smart grid architectures
- map use cases and data flows
- use as a coded design framework for more specific design needs

The IT-IAP views the smart grid from the perspective of the IT applications and the data flows exchanged with other applications. The objective of the standard is not to define new information exchange architecture but rather to work with the current best practices and technologies and to identify and fill the gaps for information exchange between the seven domains as necessary.

2.1.1.2 Smart Grid Architecture Model (SGAM)

In order to fulfill tasks defined by the EC mandate M/490, CEN, CENELEC and ETSI have established the Smart Grid Coordination Group (SG-CG) who worked out the SGAM as a technical reference architecture representing and integrating Smart Grid related domains,

subsystems and information data flows [5]. SGAM essentially models the architecture of physical smart grid systems to planes, where each such plane is a two-dimensional matrix-like arrangement of domains and zones. Domains defined by SGAM are Generation, Transmission, Distribution, DER and Customer Premises. Zones are Market, Enterprise, Operation, Station, Field, and Process. These planes are merged with the concept of interoperability layers. Here, SGAM defines component, communication, information, function and business layers. This paradigm allows for representation of complex business use cases using physical elements in a model which spans three dimensions. The top-level business layer would there contain business related objectives and business actors, e.g. the DSO. The lowest-level component layer would contain physical elements, like e.g. the DSO distribution management system, located at the component layer plane in the Distribution Domain and the Operation Zone, or a home energy management gateway at the Customer Premise Domain in the Process Zone. The intermediate layers would then describe logical functions and actors (Function Layer), data flows and data models (Information Layer), and ICT technology and protocols used for data transmission (Communication Layer).

This may be used for an abstract, but formalized model representation of a Smart Grid architecture. The task of using SGAM is supported by a toolbox for the software “Enterprise Architect”. This “SGAM-toolbox” is free to use and was developed by Salzburg University of Applied Sciences [6].

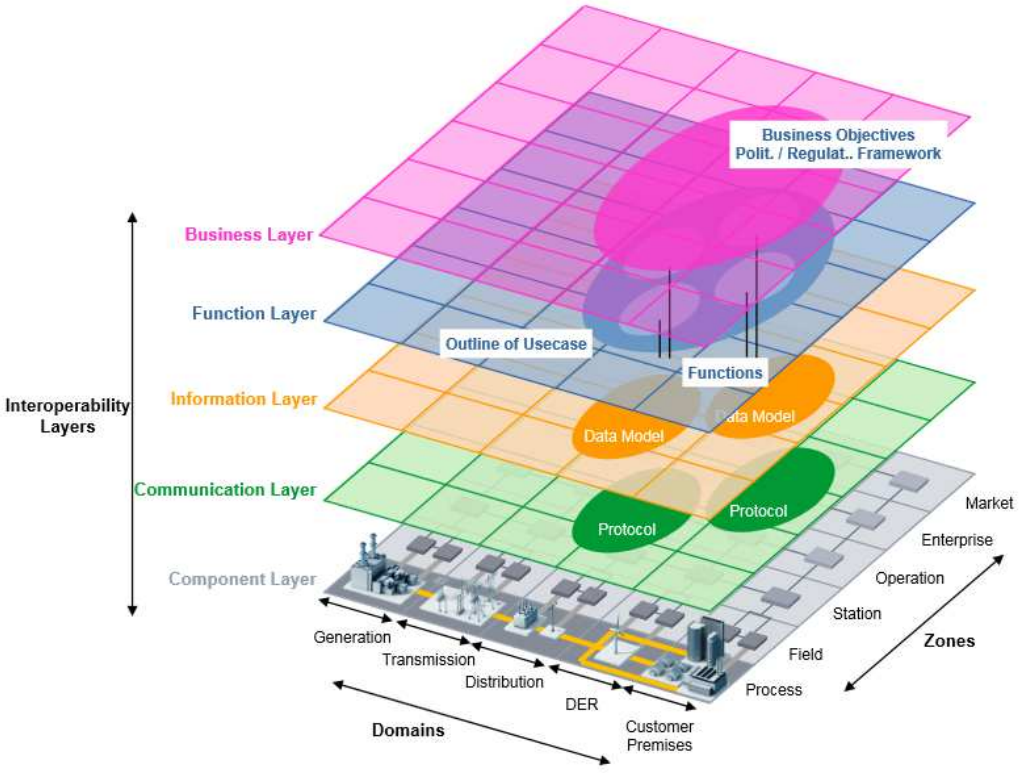

Figure 4: Three-dimensional SGAM framework [5]

2.1.2 Automated Demand Response

2.1.2.1 OpenADR

OpenADR [7] defines an open and interoperable message format and information exchange model for automatic demand response. It was originally developed by the Demand Response Research Center of Lawrence Berkeley National Laboratory (Berkeley Lab). The first specification was released in 2009. OpenADR is being further developed through the US National Institute of Standards and Technology (NIST), the Organization for the Advancement of Structured Information Standards (OASIS), the Utilities Communications Architecture International User's Group (UCAlug), and the North American Energy Standards Board (NAESB). It is intended for standardized exchange of dynamic price and reliability signals between utilities, system operators, energy management and control systems and can be applied to commercial, industrial and residential market areas. It is driven by an alliance of over 100 members. OpenADR is claimed to provide a reliable means for providing DR services towards utilities, supporting the goals of peak load and grid stress reduction. Towards customers, dynamic price control and convenient participation in DR programs is enabled. Towards original equipment manufacturers, it is claimed that by using OpenADR, highly competitive systems can be developed which still are quicker and easier to install and operate.

OpenADR 2.0 supports state of the art information security technologies (EXX and RSA server and client certificates). The specification defines a Demand Response Automation Server (DRAS) enabling for automation of customer responses to demand response programs and dynamic pricing. The utility provides information to the DRAS during the demand response event, indicating e.g. a change of price or a percentage of load to shed or shift. The DRAS relays this information to the individual customer sites. OpenADR 2.0a includes services for registration of actors, demand response events, distribution of complex dynamic prices, and communicating constraints on availability of resources [8]. Simple HTTP is the mandatory transport mechanism, XMPP is optional. There are open source implementations for OpenADR 2.0 communication end nodes (e.g. EnerNOC, cp. https://github.com/EnerNOC/oadr2-ven (accessed Jan 29th 2016)), but it seems questionable if efficient product implementation will be possible without an alliance membership.

The OpenADR 2.0 Profile Specification was approved by IEC as publicly available specification IEC/PAS 62746-10-1.

2.1.3 Home and building automation, indoor communication protocols

2.1.3.1 ZigBee

ZigBee (www.zigbee.org, accessed Jan 29th 2016) is a local-area communication specification defining a framework for wireless in-building sensor, actor, and control systems with low data bandwidth. The ZigBee Alliance currently has approx. 450 members. The first version specification was introduced in 2004.

ZigBee End Devices are typically battery operated sensors or actors which can enter a sleep mode and do not take part in message routing. ZigBee Routers are devices, eventually providing sensor, actor or control functions, acting as message routers and repeaters. The ZigBee Coordinator is a network device handling the network start-up process. In 2012, a specification for connection of ZigBee networks to the Internet was published (ZigBee IP).

In late 2015, the German IT journal Heise published an article about a security leak which can be exploited by listening to the exchange of security keys performes during inclusion of a

new device into the ZigBee network. An attacker may even trigger this device inclusion himself by sending a rejoin request on behalf of the device. The needed information for this may be obtained by listening to standard network traffic. An alternative attack scenario would use a jamming transmitter temporarily disturbing network traffic such that devices need to automatically rejoin the network. The attacker hence may decrypt all communication to and from that device and also send commands. This may lead to controlling devices having inaccurate information about an actor's state.

2.1.3.2 Smart Appliances Reference ontology (SAREF)

SAREF is a new reference language for formalized description of data for homes, public buildings and office devices, enabling them to seamlessly communicate with local or cloud-based energy management systems. It is now referenced in the ETSI technical specification TS 103 264 about Smart Machine to Machine interfaces and appliances which was published in November 2015 [4]. SAREFs main intended user group is the smart appliance industry; SAREF is not intended for modelling physical elements outside of a building or not directly related to a building.

Examples for supported devices are light switches, temperature sensors, meters, and white goods. For device functions, tasks and other properties, SAREF defines building blocks that an individual device can be described with. An example for a task assigned to a washing machine would be *saref:Washing*. Devices can also be categorized in function related, energy related and building related classes, where each of those again contains more specific sub-classes; also, additional new categories may be defined to suit the asset owners' requirements and a single device may belong to one or more categories. The ontology provides defined ways of expressing that a device consists of other devices, has a certain function, or accomplishes a task. A building contains devices or building objects, which can be controlled by devices. An example for that would be a window shutter that can be opened or closed by an actuator.

Similar to devices, also functions may belong to function categories, where the according category classes may again be extended openly. Furthermore, a function is associated to at least one command. Commands again may act upon and change a state of a device.

Devices may offer services for exposing functions to other devices in a network, where a single service represents at least one function. Different devices may offer the same service. E.g. a light switch may offer the function of switching the lights to smart mobile phones that are connected to the in-home network. Furthermore, there is a *Profile* class that allows describing devices producing or consuming energy or power which may even be associated to prices in order to express cost. All the relations and properties named above may be represented and modeled with information elements defined by the SAREF ontology.

The ETSI Technical Specification points out that SAREF does not introduce a hierarchy for device types (e.g. a generalized "sensor" class), but uses a flat classification. This simplifies the addition of new device types by removing the need to place them in a complex type hierarchy. However, it also yields a somehow weaker classification scheme.

The original SAREF was apparently developed by TNO (Netherlands, cp. http://ontology.tno.nl/saref/) and extended by ETSI in order to strengthen the support of services as an important concept for M2M interfacing, especially enabling smart appliance communication with remote applications. The ontology seems to be influenced by results from the European frame program 7 project FIEMSER ("Friendly Intelligent Energy Management Systems in Residential Buildings"). Although the ontology is quite new and yet to be used in commercial products, the EC expects that SAREF will facilitate demand-response and energy and cost savings for building owners and users.

2.1.4 Distributed energy generation and (virtual) power plants

2.1.4.1 Common Information Model

The Common Information Model (CIM) is an IEC standard (IEC 61970, IEC 61968) developed by the electric power industry. CIM is an open standard that defines how managed elements in an information technology environment are represented as a common set of objects and relationships between them. Within the energy domain CIM can be used for representing power system components and networks. It has been primarily developed by the Electric Power Research Institute (EPRI). The core package of CIM is defined by the standard IEC 61970-301. The core classes of CIM are shown in Table 1.

Facility	A facility may contain buildings, storage facilities, switching facilities, power generation, manufacturing facilities, maintenance facilities, etc.
PowerSystemResource	A power system resource can be an item of equipment such as a switch, an equipment container containing many individual items of equipment such as a substation, or an organizational entity such as sub-control area. Power system resources can have measurements associated.
GeneratingUnit	A single or set of synchronous machines for converting mechanical power into alternating-current power. For example, individual machines within a set may be defined for scheduling purposes while a single control signal is derived for the set. In this case there would be a GeneratingUnit for each member of the set and an additional GeneratingUnit corresponding to the set.
Measurement	A Measurement represents any measured, calculated or non-measured non-calculated quantity. Any piece of equipment may contain Measurements, e.g. a substation may have temperature measurements and door open indications, a transformer may have oil temperature and tank pressure measurements, a bay may contain a number of power flow measurements and a circuit breaker may contain a switch status measurement.
Analog	Analog represents an analogue Measurement.
Asset	Tangible resource of the utility, including power system equipment, various end devices, cabinets, buildings, etc. For electrical network equipment, the role of the asset is defined through PowerSystemResource and its subclasses.
AssetContainer	Asset that is aggregation of other assets such as conductors, transformers, switchgear, land, fences, buildings, equipment, vehicles, etc.
ActivityRecord	Records activity for an entity at a point in time; activity may be for an event that has already occurred or for a planned activity.

Table 1: Core classes of the Common Information Model

The data models of the SEMIAH back-end, namely the GVPP component, are based on CIM. Details about this are documented in D4.2 on SEMIAH data models.

2.1.5 Distribution grid operation, automation and communication

2.1.5.1 IEC 61850

The IEC 61850 communication and data model standard series is a worldwide accepted standard for communication within power substations. Today, it features a wide set of subdocuments which extend the application areas and enable for general use of the series. The root of this standard is automation in energy network substations. The original edition from 2003 entitled “Communication networks and systems in substations” considers communication between intelligent electronic devices in substations, e.g. power switches, circuit breakers, and voltage and current sensors, for supervisory control and data acquisition (SCADA) purposes. With the standard framework getting broader, the title changed to “Communication network and systems for power utility communication”. The current edition includes smart grid considerations, e.g. distributed generation monitoring and automation (61850-7-420). Testing possibilities, interoperability and design processes, and possibilities to extent the norm series application areas were also improved.

IEC 61850 includes an information model for description of substations, the Abstract Communication Service Interface (ACSI) and Substation Configuration Language (SCL). These allow for high-detailed, manufacturer independent description of energy system components. The data model is defined as a tree-like structure where Intelligent Electronic Devices (IEDs) are decomposed into Logical Devices (LD), which again are decomposed into Logical Nodes (LN) representing physical features and containing data objects of predefined types.

The data transmission uses TCP/IP as basic transmission protocol. The standard transmission way foresees a mapping to the Manufacturing Messaging Specification (MMS) which provides a classic Client-Server Communication. For high-priority information transmission, special services are defined (e.g. “GOOSE” according to IEC 61850-8-1).

There are various commercial IEC 61850 software stacks, but also the open stack OpenIEC61850, developed in Java by Fraunhofer ISE and freely available at www.openmuc.org .

2.1.6 Smart metering

2.1.6.1 DLMS / IEC 62056

DLMS was defined first by an ad hoc association and later on standardised by the IEC as the standard IEC 62056.

A DLMS smart meter (which is in fact a meter with a remote read and writes access) manages a set of objects (in the sense of the object oriented programming) that can be remotely read and/or written.

These objects belong to so-called COSEM classes (about 50 of them are defined). They are defined by an identifier called “OBIS code”. Smart manufacturers use mostly – but not always – the same OBIS code for the same semantic concept.

The DLMS protocol enables remote operation on the objects. Operations – mostly read and write – are defined by the COSEM classes. It defines also security mechanisms to get connected remotely with a smart meter.

In DLMS protocols, security mechanisms are no more up to date and integration with TCP/IP is the result of quick fixes and is not optimal.

2.1.7 Data Security and Privacy

Data Security and Privacy are topics especially covered in SEMIAH WP8. D8.1, “Specification of Security and Privacy Handling”, presents an overview of relevant standards in subsection 2.1.

Some of the most prominently named standards are:

- ISO/IEC 27001, which describes security techniques for information security management systems, using a top-down, risk-based and technology-neutral approach
- ISO/IEC 27002, which describes a code for practice for information security management within an organization, establishing guidelines and general principles
- ISO 27019, which describes according guidelines for process control systems specific to the energy utility industry
- ISO 15408, which describes common criteria for IT security evaluation
- IEC 62443 covering industrial network and system security, defining procedures for electronically secure industrial automation and control systems

Also, in subsection 4.4 of SEMIAH D8.1, the Security Assertion Markup Language (SAML) standardised by OASIS as well as OpenID, which is being standardized by OpenID Foundation are introduced for authenticating and authorizing users or services in the SEMIAH context.

2.2 Role of standardization in project SEMIAH

2.2.1 Standardization for the SEMIAH system

The roadmap for the mass deployment of technical innovative systems is well-known: scientists invent a new process, engineers develop and test early products or services, companies release first products or services. If the products or services are made up of several components or if they must interface other systems, interoperability becomes a key issue for mass deployment. At this stage, industry promotes the development of standards as enablers for interoperability, which is seen as a requirement for widening the market.

SEMIAH covers the two first steps of the above mentioned roadmap, i.e. it aims to influence later standardization and not to comply with existing standards.

The project aims at influencing standardization by successfully demonstrating the benefits of residential DR and by disseminating the obtained benefits.

2.2.2 Standardization for SEMIAH components

If SEMIAH as system does not comply with a DR standard, the SEMIAH individual components and subsystems use state-of the art standards to speed up development and reduce risks.

The gateway hardware manufactured by Develco Products is named Squid.link and is supporting several wireless communication standards: ZigBee HA and SE, Wireless M-Bus, WiFi, Z-Wave. Develco Products is an active and voting member of the ZigBee alliance, taking part in all regular ZigBee alliance meetings (quarterly). They have primarily been working in the Smart Energy group, standardizing e.g. demand response management units. A great part of this work is also related to security in the ZigBee network, both under commissioning (authentication and exchange of keys) and communication (encryption and change of keys). At Feb 22nd 2016, the Squid.link gateway has been certified with ZigBee

Home Automation 1.2.1 and ZigBee Smart Energy 1.2a standards. Also, the Develco SmartPlug, a device providing remote, instant on-off functionality and accurate power consumption measurement for household electric appliances, is now deemed compliant to ZigBee Home Automation 1.2.1.

An important aspect of standardization refers to controllable applications in buildings. New buildings or households and new complex installations often come already equipped with more or less standardized device drivers or bus connectors. Examples would be heat pumps or smart home environments. As most of the buildings for the SEMIAH pilot are preexisting ones, we face a variety of installations without standardized access, no standardized measurement of exterior and interior temperature levels. The solution to this problem is equipping the installations with a limited amount of ZigBee-enabled sensors and actors, namely remotely switchable smart plugs which also measure the connected device's power as well as temperature, occupancy, and window sensors. For equipping or upgrading households beyond the limited number used in the pilot, further development and device integration of interfaces and standards is deemed absolutely necessary. Such need is currently being addressed by industrial standardization activities such as the "Smart Grid Ready" label for heat pumps, which but only provides a very basic interface. However, standardization activity in this area is not fostered in SEMIAH as this is out of the project's scope.

The front- and back end systems developed by Fraunhofer IWES are using several IT related standards, namely CIM for data transmission in the GVPP and REST, JSON and XML for man-to-machine interfacing between the OGEMA-based home energy management gateway (HEMG) and the back-end components.

The front-end server is based the IoT framework developed by HES-SO named Cloud.iO (cloudio.hevs.ch). Cloud.iO is nothing but a customized version of Message Queue Telemetry Transport (MQTT) and Advanced Message Queuing Protocol (AMQP) message brokers with a limited set of micro-services. The SEMIAH front-end server and the communication between the gateways and the front-end server can be seen as a specialized usage of Cloud.iO.

Technical details on this are given in WP4 documents.

2.2.3 Assessment on existing ICT standards for energy

The legacy ICT standards for energy have been defined before the advent of internet and TCP/IP (e.g. IEC 62056 - DLMS) or have "recycled" protocols of the pre-internet area (e.g. MMS protocol as part IEC 61850 protocol series). At the time of their definition, these protocols were at the leading-edge of the technology.

However, the connection of "things" to the Internet has made major progress over the past decade: internet access has become ubiquitous and its price has sunk, plug-and-play mechanisms have been proposed, frameworks for distributed services have been defined, ways to express application domain specific semantic concepts have emerged.

In the energy domain, ICT systems have much longer life duration than in legacy informatics (often several decades). Hence the speed of evolution of ICT technology poses a double problem to managers of energy automation systems:

1. Older components (e.g. Windows NT operating systems) are still in operation but are no more supported by their manufacturers.
2. Updates and Changes cost money and compatibility with existing infrastructure needs to be ensured, which is why automation managers are reluctant to adopt new appealing standards.

2.2.4 Legacy ICT technology for the energy world

The requirements of the energy world for automation are covered by two main sets of technologies:

A. When real-time behavior and high reliability are required, legacy distributed control systems as they are used in manufacturing for example can be deployed.
B. With moderate requirements for real-time (order of magnitude: one second) and reliability (> 99.99 %), Internet of Things (IoT) technologies are appropriate.

DR at residential customers belongs clearly to the second category. Hence, DR could be implemented as a specific profile of legacy IT systems. In this context, a profile specifies how a generic standard should be used for a particular purpose (for example, the ZigBee Smart Energy Profile defines the ZigBee objects to be used to encode a three phase instantaneous power).

In the long term, DR technologies will most probably be based on legacy ICT systems. However the standardization path is not clear, as of today:

- Most technologies are still evolving. They do not have the maturity level of Ethernet and HTTP, two references for stability in the ICT world. Hence the energy domain is still reluctant to embrace them.
- Solutions to integrate existing systems into novel architectures must be provided.

Of course, the energy domain has some properties that make it different from other application domains: the covered zone – even for a distribution system – is large, the number of connected points is large, often several entities (like neighbor system operators) are involved and the semantic is complex. But state-of-the-art ICT and automation technologies are most probably performing and flexible enough to cope with such requirements.

Energy domain specific profiles mostly encode semantic concepts of the energy domain. Semantic concepts have already been defined in electricity standards like CIM, IEC 61850 and DLMS. However, the concepts are defined in a way that is not extensible and sometimes not consistent or redundant.

For a maximum of flexibility, it is advisable to separate the semantic level and the communication / security level, so that both can evolve independently, and that the same semantic concepts can pass seamlessly from a particular network technology to another network technology.

3 Patents and innovation gaps

3.1 Overview of patents relevant to the SEMIAH context

Using different patent databases, namely https://www.epo.org/index.html, www.patbase.com, http://worldwide.espacenet.com, as well as free Google search, a patent research was conducted during December 2015 in order to find SEMIAH related property rights. Amongst the keywords used for the search were:

- Virtual Power Plant
- (Decentralized) Energy Management
- Building Automation
- Building (Energy) Management
- Demand Response
- Smart Home

- Smart Grid

The patent survey resulted in a list of 32 patents as given in the following table. Each of them was reviewed, classified and judged by relevance for the project. The results of this are also given in the following tables, using a scale for the relevance from 1 (highly relevant) to 6 (not at all relevant). Note that the list does not claim to be complete, but shall rather demonstrate the high number of patents with relation to SEMIAH topics.

Patent Number	Title	Class	Legal Status	Relevance
US6757591	Energy Management System and methods for the optimization of distributed generation	Energy supply system	Expired	4
Scope				
Claims a method of distributing energy for a building, comprising a variety of steps. The steps include energy generation with by-product heat recovering (the energy source being e.g. natural gas), routing electric and heat streams to the building, establishing target and actual total energy costs, as well as optimizing the usage of the energy maintaining the desired building environment. Also, an energy management system comprising a common heat and power (CHP) energy generator, a heat recovery unit, a cooling unit and a heating unit. Also, a system for carrying out named method. Also, a micro-CHP system that can be used as generator according to the method. Also, a method for selecting one out of two energy source options based on current energy cost, availability and an energy model.				
Rationale for relevance rating				
There is no heat energy routed to the buildings in SEMIAH; there is no target cost.				

Patent Number	Title	Class	Legal Status	Relevance
US7231281	Dynamic power control system	VPP	Granted	1
Scope				
Describes a system where a multitude of switchable power nodes are switched on and off according to information from an energy providing utility. The utility shall thus be enabled to influence operation of electric loads in order to avoid grid overloads. The power nodes are switched by a master controller unit with regards to load priority and information from the utility according to a locally stored set of policies. The information sent by the utility is not exactly specified, but may include indirect control information (e.g. variable tariff) or direct control commands.				
Rationale for relevance rating				
Not precisely describing the SEMIAH full front-end approach, but strongly related. The squid.link gateway[1] may be considered master controller, the switchable power nodes are represented by ZigBee switches. The VPP could be operated by the utility, and the information sent by the utility would be the target load ranges for the household.				

Patent Number	Title	Class	Legal Status	Relevance
US8250163	Smart Coupling Device	ICT&Digital Electronics	Granted	2
Scope				
Describes a technical component ("smart coupler") connecting two data networks, equipped with a microprocessor and data storage. One of the networks shall contain a client which needs information from the storage of the smart coupler device in order to provide a function related to the second network. Basically the smart coupler is working as an ICT router or bridge, but the description is very generic, such that even a smart card reader could be considered a smart coupler. In an application scenario, an electricity provider central control station is described to use multiple smart couplers in order to send demand response signals to electricity customers.				
Rationale for relevance rating				
The squid.link gateway could be considered a smart coupler, connecting the home LAN with the ZigBee network.				

[1] Residential gateway hardware manufactured by Develco and used in project SEMIAH as HEMG

Patent Number	Title	Class	Legal Status	Relevance
US7930070	System, method, and module capable of curtailing energy production within congestive grid operating environments	Energy supply system	Grant	3
Scope				
Method for managing power generation of a power generation site coupled to a transmission line, detecting the line operation characteristic and curtailment action, and determining a forecast for curtailment probability level.				
Rationale for relevance rating				
Curtailment of generation caused by limited transmission line transport capacity is no primary focus in SEMIAH. However, similar considerations might be taken in the development of SEMIAH algorithms for distribution grid operation.				

Patent Number	Title	Class	Legal Status	Relevance
US8390473	System, method and apparatus for advanced utility control, monitoring and conservation	Home gateway	Grant	2
Scope				
Utility meter which sends usage data to an IP multi-media device, which in turn is communicating in real-time with a central monitoring station, to which usage data is transmitted and from which control signals, data or information is received. The communication link between the IP device and the control station may use the Internet. The IP device may transmit instructions to appliances and may be equipped with Wi-Fi, Ethernet, ZigBee etc.				
Rationale for relevance rating				
The squid-link can be considered the multi-media device, the VPP the central control station.				

Patent Number	Title	Class	Legal Status	Relevance
US20120125559	Temperature controller with time to target display	HVAC	Published	6
Scope				
Claims a method for controlling air temperature in a building using an HVAC system including a thermostat which uses a processing system to estimate the amount of time until the temperature reaches a target temperature				
Rationale for relevance rating				
Not in the scope of SEMIAH				

Patent Number	Title	Class	Legal Status	Relevance
US2012259749	Demand Response System and Method Using a Smart Portal	DR and DER control	Published	6
Scope				
Claims a demand response system comprising an automatic meter reading unit, an utility complex unit providing demand response information, an eco-index calculation unit, a demand response unit and a smart portal unit for providing the user with a calculated demand response bill.				
Rationale for relevance rating				
Not in the scope of SEMIAH				

Patent Number	Title	Class	Legal Status	Relevance
US8401779	Seg (smart Energy Gateway) for Optimized Energy Flow Control	Automotive	Grant	6
Scope				
A controller for managing distribution of electrical energy within a vehicle having a solar energy source or a plurality of energy sources and a plurality of loads. Also a smart energy gateway for use in such vehicle.				
Rationale for relevance rating				
Not in the scope of SEMIAH				

Patent Number	Title	Class	Legal Status	Relevance
US8391496	Smart Energy Network Configuration Using an Auxiliary Gateway	ICT&Digital Electronics	Grant	6
Scope				
An auxiliary gateway communicating with an energy services interface. The gateway receives communication originated from a smart energy device, from which a unique device identifier is obtained. The identifier is used to retrieve information about the device from a database. This information is in turn given to the energy services interface to facilitate direct communication between the energy services interface and the smart energy device.				
Rationale for relevance rating				
Not in the scope of SEMIAH				

Patent Number	Title	Class	Legal Status	Relevance
US20130198552	Power consumption monitoring	ICT&Digital Electronics	Published	6
Scope				
Method implemented on a microelectronic computing device for monitoring power consumption of an activity executed on the device				
Rationale for relevance rating				
Not in the scope of SEMIAH				

Patent Number	Title	Class	Legal Status	Relevance
US8528345	Managed virtual power plant utilizing aggregated storage	VPP	Grant	3
Scope				
A system for temporarily shifting demand for electrical power at an end user site comprising a chemical energy storage or battery which provides power to the end user, a controller for operation of the storage, and a communication link to a utility manager such that the utility manager can control storage and supply of stored energy to the end user. Also, a method for temporarily supplementing the electrical energy demand of the end user by controlling the storage operation.				
Rationale for relevance rating				
Buildings and water storages could be considered thermal energy storages				

Patent Number	Title	Class	Legal Status	Relevance
US6181985	Rate-based load shed module	DR and DER control	Grant	3
Scope				
The invention described is comprised of a system for switching electrical loads using a load shed module, which is connected to a building gateway by a bidirectional communication link. The gateway is in turn connected to the energy utility. The load shed module is receiving an electrical power rate from the gateway and may measure and transmit status information, e.g. voltage and current at the load connection point, to the energy utility. The load shed module is equipped with a mechanical switch with which the user can adjust the electrical power rate (obviously an energy price) at which the load is switched off. The load may also be switched off if the measurement values taken by the module leave predefined tolerance ranges.				
Rationale for relevance rating				
Generally related, but SEMIAH is not providing load shed modules as described in the patent.				

Patent Number	Title	Class	Legal Status	Relevance
WO2014090285	Method for control of operation of electric energy generators and control system for implementation of the method	VPP	Published	2
Scope				
Claims method for control of electric generator operation connected to an electric energy supply network by a common control unit. The control unit operates the generators such that the generated energy matches the planned demand. A correction signal is fed to the control unit which indicates deviation of actual and planned demand. Using this, the control unit calculates a balancing energy amount to be provided by the totality of the generators, sequentially selects generators to provide balancing energy, and gives control signals to the selected generators. Sequential selection of generators delivering balancing energy is claimed a specific advantage because by doing so, there would be no need for parallel optimization with high computational effort. Hence, it is claimed that the method can be applied through moderate computing power and simple algorithms. Innovation grade is questionable, however the inventor is also manufacturer of a known VPP management system (Siemens Decentralized Energy Management System DEMS).				
Rationale for relevance rating				
SEMIAH is not focusing on control of distributed generators, but the patent principally describes the function of a centrally controlled VPP where generators provide balancing power.				

Patent Number	Title	Class	Legal Status	Relevance
WO2014108209	Energy Management Gateway	Home gateway	Published	3
Scope				
Method of an energy management gateway for load scheduling. Loads are categorized as "constant" or "sporadic". Each load is scheduled differently depending on the category based on information obtained from an external service provider and/or information inputted via a user interface of the gateway. Also, a computer program causing an energy management gateway to perform said method. Also, a gateway configured for carrying out said method.				
Rationale for relevance rating				
SEMIAH does not exactly "categorize" loads being constant or sporadic; instead, only heating loads which are considered by the patent to be "constant" loads are considered. Also, it must be doubted that the patent will prevail because of low innovation level at the time of submission (2013). The authors claim that the main part of the patent is to have recognized that constant and sporadic loads are preferably scheduled differently. According scheduling method is not part of the claims, though.				

Patent Number	Title	Class	Legal Status	Relevance
WO2015071202	Method for the Communication of System Control Units with a Plurality of Energy Generating Systems Via a Gateway, and Correspondingly Configured and Programmed Data Server	VPP	Published	2
Scope				
Intl. Application of German patent. Claims method for communication between system control units with a multitude of distributed energy generators which employs a common gateway. The gateway receives requests from the system control units and device status data from the DG, each of those being received in at least two different data models. The gateway translates these into a common meta data model, processes the data in order to generate request replies and DG control commands, which are accordingly translated back into the original data models and sent to the system control respective DG units.				
Rationale for relevance rating				
Innovation grade questionable because there multiple gateways using the claimed method were already demonstrated before the priority date (Nov 12th 2013). Also, the solution seems obvious for the technical expert. Nevertheless, the claims would probably apply to the SEMIAH solution if distributed energy generators were connected to the full front-end HEMS, being considered the gateway. The OGEMA data model would be the meta data model. The VPP would be a system control unit. However, there is only one VPP, whereas the patent claims state multiple system control units.				

Patent Number	Title	Class	Legal Status	Relevance
WO2015141413	Control System, Hems Controller, and Control Method	Home gateway	Published	3
Scope				
Control System with HEMS controller acquiring and storing state of electrical devices and a server which is notified when device state changes. No detailed information available (missing translation from Japanese).				
Rationale for relevance rating				
Estimation based on limited information available				

Patent Number	Title	Class	Legal Status	Relevance
EP1185030	Method and system for remote control of household devices over the internet	Home gateway	Grant	1
Scope				
System connecting a multitude of remotely controllable devices, which are connected to a central PC over Intranet or Telephone connection, where the central PC is accessible by a public network by means of an internet protocol. The central PC is checking access rights and, if the check is positive, grants access from the internet communication end device to a remotely controllable device. The central PC also carries out protocol translation. It may also carry out authorization check, check for correctness, documentation and registration of the data transfer.				
Rationale for relevance rating				
The squid.link can be considered a central PC; the frontend server can be considered the internet communication end device.				

Patent Number	Title	Class	Legal Status	Relevance
EP0886362	Power distribution control system	DR and DER control	Grant	6
Scope				
Power distribution control system with a plurality of customer communication terminals and a central communication terminal, the latter communicating load reduction requests with incentive payments to the customer terminals. The terminals hence calculate offers for power reduction which are communicated back to the central terminal, which selects offers and communicates the selection result back to the customer terminals. The customer terminals finally reduce power of a group of connected loads according to the selection.				
Rationale for relevance rating				
The SEMIAH approach does not use price-based demand response with offers from distributed customer terminals.				

Patent Number	Title	Class	Legal Status	Relevance
EP2685600	Energy management gateway and method thereof	ICT&Digital Electronics	Published	6
Scope				
Method of an energy management gateway for association between an electrical outlet socket and an electrical load type of the device connected to that socket. The method comprises detection of the device consumption pattern and input of the according load type via a user interface. Also, computer programs which cause an energy management gateway to perform the method and energy management gateways equipped with the means of doing so.				
Rationale for relevance rating				
Device type association is done solely based on user inputs in SEMIAH. There is no automatic or semi-automatic association process.				

Patent Number	Title	Class	Legal Status	Relevance
EP2760097	System for Preventing Disasters Caused by Power Supply and Demand Mismatches	DR and DER control	Published	6
Scope				
Claims are not understandable due to poor translation. However, the scope seems to be a demand management system used for balancing power supply and demand in a wide area electricity supply network. Here for, the power quality seems to be used for control of distributed loads: if the power reserve margin in the network gets critical, the power quality - namely mentioned are voltage, frequency, and distortion - is intentionally influenced by the power supply side. This is detected at the customer demand side and according actions, e.g. load deration or cut-off are carried out.				
Rationale for relevance rating				
SEMIAH does not employ a method similar to the one described. Specifically, power quality is not influenced intentionally in the SEMIAH project.				

Patent Number	Title	Class	Legal Status	Relevance
EP2775667	Modular multi-energy management gateway	Home gateway	Published	3
Scope				
EU application of German patent DE102013003971. Describes a "multi-modular" gateway, consisting of at least one base module and at least two communication modules. All modules are equipped with an internal computing unit, a first communication connection, to which external communication peers are connected, and a second communication connection, which is used for gateway internal communication between the modules. The arrangement is particularly intended to be used for energy management or monitoring purposes.				
Rationale for relevance rating				
Innovation grade seems non-existing. Every standard PC employs the architecture described in the claims; using it for energy management purposes is obvious. Hence, the claims would apply to the Squid.link hardware, but the likeliness of the patent application being granted seems negligible.				

Patent Number	Title	Class	Legal Status	Relevance
DE50015948	Switching system for power and control method thereof	VPP	Grant	2
Scope				
Claims a switching / conveying system for controlling provision of a circuit-transportable good (in particular electrical energy) to at least one consumer, where at least one computing unit manages data or a multitude of connected generators, providers and/or transport utilities. The data comprises information about transport capacities of lines, generation capacity of generators, and/or cost for provision or transport services.				
Rationale for relevance rating				
This patent would possibly relate to any VPP where a central control system would implement energy management with consideration of transport capacity of electrical lines.				

Patent Number	Title	Class	Legal Status	Relevance
DE000019842043	Method for automatic and consumer-oriented minimization of the total electricity consumption and peak power of a group of single electric devices connected to a power supply network	DR and DER control	Grant	5
Scope				
Claims method for automatic minimization of power consumption and peak power of a group of loads which can be de-rated or switched off. Loads are interconnected by associated control units that supervise operation state and power demand of the loads. Control units receive a total power demand and automatically control the load's operation states according to dynamic prioritisation of the associated load.				
Rationale for relevance rating				
In SEMIAH, there is no load switching depending on priorities.				

Patent Number	Title	Class	Legal Status	Relevance
DE102009050170	House automation- and house information system	ICT&Digital Electronics	Grant	1
Scope				
Claims a system for house automation comprising a central control unit (eventually split into an apartment central unit and a building central unit) bidirectionally communicating with at least one control unit. Each control unit is again communicating over radio-based interconnection with at least one component associated to that control unit.				
Rationale for relevance rating				
Claim seems quite broad, but is narrowed by several dependent claims. Possible infringement could apply to the squid.link being connected to ZigBee devices, but the central control unit seems to be missing. Would need to be thoroughly checked.				

Patent Number	Title	Class	Legal Status	Relevance
DE102008057563	Method and system for grid conformant operation of a multitude of decentralised units connected to an electric low-voltage network and electric energy consumers/producers	DR and DER control	Published	5
Scope				
Claims a method and system for grid conformant operation of distributed loads and generators by incentive based control by an energy provider using multiple distributed and one higher-order central control unit. The distributed units detect grid parameters leaving allowed ranges at the distributed loads and generators connection points, eventually alarming the central control unit. In turn, this unit is requesting offers for tariff-incentivized change of operation of the loads or generators from the distributed control units. Replies are gathered by the central unit and are used to calculate a tariff incentive suited to change operation of loads and generators in order to normalize grid operation parameters at the connection points.				
Rationale for relevance rating				
SEMIAH does not aim at grid service oriented operation of DER.				

Patent Number	Title	Class	Legal Status	Relevance
CN102075373	Ubiquitous intelligent gateway based energy-saving and emission-reducing control system and method	VPP	Grant	2
Scope				
Lacking translation from Chinese. Considering available information, a system with a gateway and an energy-saving and emission-reducing control platform is described, where the gateway carries out information acquisition and remote control using sensor and control equipment. The control platform is acquiring this information in order to form a control method for energy saving and emission reduction.				
Rationale for relevance rating				
Seemingly relevant, but scope, claim and innovation grade are unclear. Would need further check / supervision.				

Patent Number	Title	Class	Legal Status	Relevance
CN102122843	Abnormal operation early warning technology for gateway electric energy metering device	ICT&Digital Electronics	Grant	5
Scope				
Lacking translation from Chinese. Considering available information, a method for early warning about abnormal operation for a gateway electric energy metering device is described.				
Rationale for relevance rating				
SEMIAH does not specifically aim at methods for early warning about metering gateway failures.				

Patent Number	Title	Class	Legal Status	Relevance
CN104378285	Energy consumption data collection gateway system based on wireless microcellular networking technology	ICT&Digital Electronics	Published	4
Scope				
Lacking translation from Chinese, scope unclear. Describing a gateway system used for energy consumption data collection, particularly comprising a microcontroller module, a wireless radio frequency network, a radio-frequency identification (RFID) module, and voice communication module. The functionality remains unclear.				
Rationale for relevance rating				
Seems not too closely related; SEMIAH does not use RFID.				

Patent Number	Title	Class	Legal Status	Relevance
CN103618610	Information safety algorithm based on energy information gateway in smart power grid	ICT&Digital Electronics	Published	5
Scope				
Lacking translation from Chinese. Describes information safety algorithm based on an energy information gateway, combining RSA and AES encryption, and digital signatures.				
Rationale for relevance rating				
Creation of information safety methods not in scope of SEMIAH				

Patent Number	Title	Class	Legal Status	Relevance
CN202135153	Wireless sensor network gateway with electric energy metering function	Home gateway	Grant	3
Scope				
Lacking translation from Chinese. Seems to relate to a wireless sensor network gateway, controlling the state of intelligent outlet sockets at electricity user premises, particularly providing metering. Electricity use information as collected by each intelligent socket is transmitted to the gateway with a wireless sensor network, there converted and transmitted to a server through the internet. Also, control commands are received by the gateway from the internet server and relayed to the intelligent sockets.				
Rationale for relevance rating				
Generally related to SEMIAH; ZigBee switching devices could be interpreted as intelligent outlets and the front-end server as internet server. However, innovation grade of the patent is unclear and there seems to be no European application.				

Patent Number	Title	Class	Legal Status	Relevance
CN204214947	Remote maintenance and analysis platform for detecting and monitoring gateway electric energy meter online	Metering	Grant	5
Scope				
Seems to relate to a platform for monitoring electric energy metering gateways, including parameters like current, voltage, power etc. Scope of innovation unclear.				
Rationale for relevance rating				

Patent Number	Title	Class	Legal Status	Relevance
JP2014150617	Hems Controller	Home gateway	Unknown	5
Scope				
Lacking translation from Japanese. Seems to relate to a HEMS controller able for stable operation in conditions of receiving power supply from a battery.				
Rationale for relevance rating				
SEMIAH does not consider adapted operation of loads in case a building is supplied by a battery system.				

3.2 Innovation gaps and patent activity in SEMIAH

The patent survey demonstrates that there is a very high number of patents and patent applications describing inventions related to the SEMIAH approach. Many aspects of VPP systems, DR and home energy gateways are already disclosed due to recent developments. Particularly, ICT systems, computer-driven control systems and smart home appliances are booming since several years, making it hard to find inventions with high innovation grade. However, inventions that combine two or more of the classes defined above with specific scope and in-detail claims of solutions for concrete problems are rarely found, thus defining gaps in innovation.

According to consortium feedback available at the time of writing this document, there is no known intention of patent protecting any inventions made in the SEMIAH project by any partner. From the patent survey it is obvious that any such action would need very thorough analysis of possible patent infringements. The same is valid for exploitation of SEMIAH results towards a mass market product.

4 Literature

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