State of the art of Smart meters, sub-metering devices and energy management systems in the European Union

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2. **Smart meters in the EU**

1.1. **Smart grids**

Smart grids are electricity networks that make use of the information and communication technologies (ICT) and are able to integrate other advanced technologies (distributed electricity generators, electricity storage, electric vehicles...) to maximize the efficiency, reliability and safety of the power grid, and minimize the costs and environmental impacts. Smart grids are then, energy networks that automatically monitor energy flows and are able to respond to changes in supply and demand. When coupled with smart metering systems, smart grids reach consumers and suppliers by providing information on real-time consumption.

Smart grids can help to integrate renewable energy. While energy production through renewable sources strongly fluctuates, combining information on energy demand with weather forecasts can allow grid operators to better plan the integration of renewable energy into the grid and balance their networks. Furthermore, smart grids open up the possibility for consumers who produce their own energy to respond to prices and sell excess to the grid.

To illustrate this change on the electrical grid, Figure 1 shows the evolution on the electrical grid model.

![Figure 1. Electricity systems are getting smarter, from past to future. Source: IEA. Technology roadmap: Smart Grids.](image)

In Table 1 a summary of the differences between conventional and smart grids are presented:
### Table 1. Characteristics' comparison between Conventional and Smart grids (NCCS, 2011)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Conventional old grid</th>
<th>New smart grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resiliency, reliability and security</td>
<td>Vulnerable to failures and natural disasters</td>
<td>Resilient to attacks and failures with rapid and even automatic restoration, self-healing</td>
</tr>
<tr>
<td>Integration generation and storage</td>
<td>Central generation of large power plants located in few places. Difficulty to integrate distributed energy sources.</td>
<td>Facility to integrate the many distributed energy sources (renewables) with “plug-and-play” as a supplement to the central stations</td>
</tr>
<tr>
<td>Consumer engagement</td>
<td>Consumers have a passive paper, and are under-informed</td>
<td>Are involved, well informed and have an active paper – demand response and possibility to be “prosumers”</td>
</tr>
<tr>
<td>Optimisation and operations efficiency</td>
<td>One direction power flow, far to utilise the whole capacity of the infrastructure, concurring to higher investment and maintenance costs</td>
<td>Two-direction communication and flow. Ability to reduce losses and use the full capacity of the system’s assets.</td>
</tr>
<tr>
<td>Market evolution</td>
<td>Limited choices for the consumer, limited wholesale markets.</td>
<td>More mature, liberalization of the market lead to a growth of market and more options for the consumer</td>
</tr>
</tbody>
</table>

#### 1.2. Smart meters - Need for smart metering

The Smart Meter is the key element for the Advanced Metering Infrastructure (AMI)\(^1\) to work properly, it is placed in the home or building and collects all the energy consumption in intervals of time and notifies the consumer of the current price of electricity. Hence, with smart meters, consumers can adapt – in time and volume - their energy usage to different energy prices throughout the day, saving money on their energy bills by consuming more energy in lower price periods and helping grids to balance supply and demand.

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\(^1\) Advanced metering infrastructure (AMI) is a group of technologies combined together form an architecture that permits a two-way communication between the consumer and the utility (EPRI, 2007).
Smart meters contribute the participants of the grid in the following ways:

- **Customers benefits:**
The consumers will be better informed on how much and when they consume energy. Online and in-home displays help manage their consumption and costs and realize energy/cost savings bill by having access to the price rates. The customer can receive a better and tailored service, as the utility company is able to better profile the behaviour of its customers.

- **Suppliers benefits:**
Estimated and manual read-outs will be avoided; utility companies will obtain (nearly) real time readings and a perceptible cost reduction to obtain therequired data. Customer service will be much better thanks to the massive amounts of energy consumption data. New innovative offers such as the time-of-use tariffs help shift the customer services towards a consumer engagement.

Collaterally, due to the AMI implementation the electrical system will be more efficient, and reliable, bringing a losses and costs reduction. Also, a rapid outage or system faults detection and quick fix of the problem helps reducing interruptions and improve service. In a more open perspective, new business will arise mainly in the IT and data analysis fields due to the large amount of data generated.

### 1.3. EU smart meter’s strategy

The EU aims to replace at least 80% of electricity meters with smart meters by 2020 wherever it is cost-effective to do so. This smart metering and smart grids rollout can reduce emissions household energy consumption in the EU by up to 9%. To measure cost effectiveness, EU countries conducted cost-benefit analyses based on guidelines provided by the European Commission. A similar assessment was carried out for natural gas smart meters.

The European Union has a plan to implement electricity and natural gas smart meters throughout the European countries, a 2014 report on the smart metering deployment (European Commission: Smart grids and meters, 2014) shows that:
Close to 200 million smart meters for electricity and 45 million for gas will be rolled out in the EU by 2020. This represents a potential investment of €45 billion (and shifts the market towards large scale production market players)

By 2020, ~72% of European consumers are expected to have a smart meter for electricity. About 40% should be equipped with a gas smart meter.

The cost of installing a smart meter in the EU is on average between €200 and €250.

On average, smart meters provide savings of **€160 for gas** and **€309 for electricity** per metering point annually (distributed amongst consumers, suppliers, distribution system operators, etc.) as well as an average energy saving of 3%.

'Smart meter’ is a general term typically related to electricity and natural gas (~30%). Future markets will involve water and district heating infrastructure meters.

### 1.4. Most commonly deployed Smart meters

Throughout the EU roll-out, vast numbers of smart meters need to be produced, distributed and installed. Only a handful producers can keep up with that required volume, leaving the market fairly undivided. The main players on the EU market currently are:

- Landis & Gyr  (www.landisgyr.com)
- Itron  (https://www.itron.com/)
- Elster  (www.elster.com/)
- Iskraemeco  (www.iskraemeco.si/)

All four have joined IDIS, the ‘Interoperable Device Interface Specifications’ Industry Association, which publishes yearly reports of the industry and market analysis for smart meters and related technologies ([http://idis-association.com/](http://idis-association.com/)).

### 3. Smart metering deployment in the EU

#### 2.1. Smart meters State-of-the-art

In Europe the first regulation covering the smart metering legislation is found in Annex I.2. Europe – Electricity Directive 2009/72/EC, however each member state must transpose the EU legislation to its national legal order. Each country is, however, free to conduct a Cost-Benefit Analysis or not to perform a smart meter roll-out.
In any case the rollout of smart meters should be completed by 2020. So far, about 16 member states are in the process of wide-scale roll-out by 2020, see Figure 4. If this scenario is carried through, the rollout would achieve more than 80% penetration.
The setup for the countries that are in the process of adoption and rollout is as follows:

![Figure 5. Member States proceeding with large-scale smart metering roll-out by 2020](image)

To have detailed information about each member state, the European Commission’s Joint Research Group (JRC), summarizes the smart meter’s situation in the “Smart Metering Deployment in the European Union” (JRC, 2014) report. The report describes the deployment strategy of each country (mandatory or voluntary), the metering market (regulated or competitive), the responsible party and ownership (DSO, meter operator or supplier) and also the responsible party able to access metering data (DSO or central hub).
2.2. Minimum functionalities

In Europe, the first regulation covering the smart metering legislation is found in Annex I.2. Europe-electricity Directive 2009/72/EC. The EU has set common minimum functionalities for smart meters, included in the Recommendation 2012/148/EU. These functionalities capture the essential elements that a smart meter requires to benefit all stakeholders, and is summarized in Table 2 (Cost-benefit analyses & state of play of smart metering deployment in the EU-27, 2014).

| CONSUMER | a) Provide readings directly to the consumer and/or any third party  
b) Update readings frequently enough to use energy savings schemes |
| METERING OPERATOR | c) Allow remote reading by the operator  
d) Provide two-way communication for the maintenance and control  
e) Allow frequent enough readings for networking planning |
| COMMERCIAL ASPECTS OF SUPPLY | f) Support advanced tariff system  
g) Remote ON/OFF control supply and/or flow or power limitation |
| SECURITY – DATA PROTECTION | h) Provide secure data communication  
i) Fraud prevention and detection |
| DISTRIBUTED GENERATION | j) Provide import/export and reactive metering |

A summary of the recommended functionalities, met per member state, is shown in Figure 6 (classifying if the actual implementations are in correlation with the recommended functionalities, partially or not).
These ten recommended functionalities are the outcome of the Commission consultation. They are based on those proposed under the standardization mandate M/441 (identified in CEN-CLC-ETSI TR 50572:2011 “Functional reference architecture for communications in smart metering systems”). ERGEG has proposed advisory measures concerning the meters for electricity and natural gas. To conform to these requirements, smart meters should at the very least provide the following services:

### Table 3. Smart meter functionalities identified by the M/441

<table>
<thead>
<tr>
<th>M/441 additional functionalities</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F1</strong></td>
<td>Remote reading of metrological register(s) and provision to designated market organisations</td>
</tr>
<tr>
<td><strong>F2</strong></td>
<td>Two-way communication between the metering system and designated market organisation(s)</td>
</tr>
<tr>
<td><strong>F3</strong></td>
<td>To support advanced tariffing and payment systems</td>
</tr>
<tr>
<td><strong>F4</strong></td>
<td>To allow remote disablement and enablement of supply and flow power limitation</td>
</tr>
<tr>
<td><strong>F5</strong></td>
<td>To provide secure communication enabling the smart meter to export metrological data for display and potential analysis to the end consumer or a third party designated by the end consumer</td>
</tr>
<tr>
<td><strong>F6</strong></td>
<td>To provide information via web portal/gateway to an in-home/building display or auxiliary equipment</td>
</tr>
</tbody>
</table>
Besides the proposal of ERGEG, the European Mandate 441 decides on the communication protocols and functionalities of smart meters. The mandate envisages harmonization of the European Standards as to provide interoperability between the different consumption meters (water, natural gas, electricity and heat). The M441 is picked up by standardization bodies and private initiatives such as ESMIG and IDIS that cope with interoperability testing.

2.3. Communication infrastructure and data handling standard

The anatomy of the Advanced Metering Infrastructure (AMI). The Advanced Metering Infrastructure is composed by several elements from the inside of the customer building until the utility. These components are presented in Figure 5: Home display units, Home Area Network, Smart meters, Wide Area Network, Data collection Head-end, Data management systems (DMS) and Data portal to stakeholders systems.

![Advanced Metering Infrastructure diagram, from customer's home to stakeholder's services. Own figure adapted from: (Evans, 2007)](image)

The central part of the AMI:

- **Smart meters:**
  Is the key element for the AMI to work properly; placed in the home or building limits and collects all the energy consumption in intervals of time and provides the electricity price to the consumer. Using communication protocols, the smart meter is able to remotely report data to both consumer and utility.

- **Wide Area Networks (WAN):**
  These networks are capable to cover a broader area, are the medium in which various groups of smart meters from different LANs communicate the data collected to the data concentrator or head end.
- **Data concentrator (DC) or head end:**
  The head end is the responsible to put together all data from a large number and disparate set of smart meters. Most of the EU member states have adopted this Data Concentrator as a middleware, between the smart meter and the Data Management System (DMS). This Data Concentrator is located at the Medium/Low Voltage substations and works as a communication gateway. The communication technology occurs through Power Line Carrier (PLC) and/or GPRS.

- **Data management systems (DMS):**
  DMS is a single repository capable of storing massive quantities of smart meter readings. In most cases, communication between the Data Concentrator and the DMS is done through GPRS. Smart meters are able to record the interval consumption, so they produce a large amount of data, for example a reading per hour can produce around some 8000 readings per year per single meter.

Therefore, the implementation of a common standard on data handling is one of the biggest challenges in the EU smart meter rollout. From the EU point of view, the most common and accepted communication standards between the local components and the Metering Data management software, are found in the CEN/CLC/ETSI/TR 50572:2011 (see ANNEX 1: Smart meter standards applicable in the EU). The more advanced metering infrastructure is well described under CEN/CLC/ETSI/TR 50572 (CEN, 2011).

Below, in Figure 8, a coordination diagram for the Mandate 441 highlighting the standardization area that the Mandate is targeting. Figure 9 shows the EU mandate 441 and relations between standardization committees as well as the communication between local systems and the Head End system.

![Figure 8. Coordination diagram for the M441](image-url)
2.4. Observed problems and risks

Since it concerns a very recent development on a global scale, there are a lot of actions in the field in different stages of development.

**Technically**

So far, no general standard has been adopted to serve as a common way of communications. Existing and new devices need to be compatible with a range of energy management systems for end-users and grid operators as well as the operator of the data infrastructure and energy – the network service supplying operator (NSSO). This problem of compatibility will only increase with demands from governments and the EU on the level/detail of the measured data, increased grid facilities related to renewable energy and new functions such as demand side management.

Communication protocols detail the methodology of data transfer and how the main infrastructure communicates the live situation of the monitored energy consumption. Systems in use are GPRS, G3 and PLC. All of them have their limitations depending on speed of communication and functionalities required.
Soft infrastructure
The exchange of data between all the components of the system needs to cope largely with future issues. Smart meters are installed for expected lifetimes of 15 to 20 years so the way they are conceived today will need to provide a platform for all possible applications in the future. In general, products today offer the following services:

- Meter read-out, synchronization and remote demand reset, ops check and maintenance
- Communication mode internet protocol via GPRS and GSM CSD with protocol TCP/IP or power line (PLC) and radio infrastructure
- Plug and play installation needing no external power supply or wiring software ops; remote firmware upgrade and modem configuration

Non-technical
There is a wide mix of legal issues related to new applications of smart meters:

- Action related data in order to pinpoint a fault location in case of non-compliance to the ESSO (energy service supply operator) contract
- Security of data transfer and protocol compliance, encryption, ...
- Open platform in order to allow actual and future ESSO’s to offer their services in a simple but conform way (for example via Pi-Dongle)
- Privacy compliance and use of data, damage insurance in case of failure on the client side and/or ESSO, Cyber security, ...

2.5. Some examples

Table 4. Overview on the implementation of the smart meters in example countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Size</th>
<th>Technology</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danmark</td>
<td>1.000.000 pcs for period of 10 yrs + extension till 2035</td>
<td>Kamstrup - OMNIA Suite connecting to Energy's new Gridstream meter data management system from Landis+Gyr, and the existing SAP system</td>
<td>Regulatory modification but no business case so far for DONG says Søren Rønnebech – new law will provide services for electricity (follow-up consumption and control – social benefits with RES – grid investments)</td>
</tr>
<tr>
<td>Greenland</td>
<td>46.000 pcs (heat +water +electricity)</td>
<td>Kamstrup – each meter is router for the other one – RF-mesh solutions; concentrator transmitting the data to the energy company via GSM/GPRS</td>
<td>Able to improved energy management and significant financial savings for national grid operator</td>
</tr>
</tbody>
</table>

Dong installs in 50% of the households - complete rollout DK until 2020

We can read, disconnect and reconnect the power automatically and centrally, so that we avoid unpleasant situations out in the small communities where everyone knows everyone.
Some specific, ‘more then required’ smart metering projects have started in several Member States. In the Netherlands, Soest Stedin seeks solutions that comply with the regulatory framework which offer a replacement for the boiler day/night switching service. Stedin recognizes that for the energy transition to be successful, customer adoption of demand-side flexibility will be essential. As a result, Stedin adopted a strategy to facilitate market parties optimally (e.g. aggregator role) to make them successful in delivering demand-side flexibility as a contribution to affordable energy systems. Stedin recognizes the potential of approx. 100k heating systems (average 2 kW per system) in its operating area to contribute to demand-side flexibility (representing 200 MW on the balancing market).

In France, the AMMR SI project will allow users to integrate existing smart meters for equal energy vectors (e.g. electricity: PME / PMI meter, gas meters equipped with communicating such cases Cello …) in one common energy management system. The challenges to be met by the candidates with the new SI AMMR are:

- Identify and remotely monitor gas and electricity meters of all GEG concessions with constraints of reliability, safety and productivity
- Integration into the information system of GEG
- Its ability to integrate new meters after deployment
- Its ability to store a significant amount of varied data and return them synchronously and asynchronously with significant volumes (especially for the needs of future GRD sites)
- Its ability to adapt to regulatory changes (including in connection with the secured exposure of consolidated data to third parties) and trades.

In Germany, the ‘Gemeindewerke Niestetal’ intends to exchange domestic water meters with ultrasonic water meters with integrated radio communication (Open Metering). By the end of 2016, a total of 600 meters should be operational. In 2017, this total should increase to 3000 meters. Ultrasound technology should result in a long-term stable supply of accurate data. All components for the smart metering equipment must comply with the MID OIML R49, EN 14154 standards and directives.

### 4. Sub-metering devices in the EU

#### 3.1. Sub-meters - in general

A sub-metering device is a local measuring equipment within the home network or a general measuring equipment if it is placed in the electric box, the sub-metering device is independent from
the official electricity smart meter that is used to extract the readings and bill the consumers, they are able to provide readings and measurements with a lower period frequency than the smart meters, while the smart meters provide readings from 15 minutes to 1 hour frequency, there are some sub metering devices that provide readings every 1 minute or 3 minutes. Also, the possibility to access the data real time is a competitive advantage of the sub metering devices respect to the smart meters which, not always, its measurements are not available for the user immediately.

However, the sub-metering devices are an alternative for those householders that either (a) does not account for an official smart meter as the country or DSO have not a smart meter rollout strategy, or (b) although they account for a smart meter, for some reason, they are not able to access to the data. Therefore, the installation of a sub-metering device that provides them the real-time data and accomplish (and improve) the functions that the smart meter should do.

There are many option when selecting sub-metering devices, also their communication modules differ largely with a wide range of wired and wireless communication protocols including MV/LV BPL, ZigBee, 3G, Wi-Fi, Ethernet, fiber, serial, Mesh-RF and WAN. Support for ANSI/NMEA C12.18 and IEC 62056 (DLMS/COSEM) 2-way communication protocols for meters exists and is being developed further.

3.2. Sub-metering penetration in EU

In comparison to smart meters, the number of different devices in use in the EU is rather limited, the demanders of this kind of devices are usually:

- Individual people that is close to the energy sector and have some kind of technical background that seek for a major control of its consumption
- Local institutions that offers these devices with the framework of a project to the citizens in order to create a community to engage users to save energy. This is the case of the “Rubí Brilla” project.

It is worth to say that the sub-metering offer has been increased recently, by the suppliers mainly focused in the industry and corporate sector, started offering these products to the residential sector, this is the case of Circutor in Spain offering sub metering devices for residential consumers. Likewise, by those appliance manufacturers which are offering software platforms equipped in their devices. Well known are platforms of local heating devices and electrical appliances that offer system-related services. Laptop/tablet software platforms which enable tracking of the operational condition of the devices, energy used and (a limited form of) reporting are gaining ground at a fast pace.

As in many other fields, the main barrier of the penetration for the sub-metering devices is the price. Depending on the device and the complements, an electric sub metering would cost between 100 to 200€. This is an expensive quantity when it comes to residential consumers, as the savings there could achieve by having more information of their consumption does not pay off the initial cost of purchasing such device, however few people (most of them with a technical background) wouldn’t mind to invest on it.
3.3. Choosing a sub-metering device

There are many sub-metering device options for electricity, gas and heating. See the detailed information of some of them in the Error! Reference source not found.. These solutions offer both a hardware device to be installed in the house and the software platform where to visualize the data, this platform is either a web or a mobile app.

Due to the variety of suppliers it is essential to check their company guarantees program and compatibility for the individual application environment. The major suppliers of household appliances for heating and cooling, electrical and kitchen apparatus offer their own systems. Since they have to comply with general CE-standards aspects of safety, operability but also EMC involving health risks need to be analyzed in order to identify the most suitable device.

EU implemented standards for water meters, gas meters and heat meters that need to be complied with by suppliers (see ANNEX 1: Smart meter standards applicable in the EU).

We would like to mention, that there is a large number of companies that are offering only a software service with a powerful data analytics system with the objective to engage the consumer, without using any sub-metering devices, as they partner with utilities so they are able to get the data from the utility’s smart meter.

3.4. Observed risks and problematic issues (data security, privacy issues)

As mention above, a wide range of different systems comprising different modes of communication exist, in order to send and receive the data. A significant future challenge exists in the compatibility of these individual company set-ups to more commonly used systems such as EIB or S-bus, as well as building monitoring systems².

Communication is key point, as if the communication breaks then the user won’t be able to visualize any data, for instance if the device communicates via Wi-Fi and the user switches it off every night then it is possible that we lose some data, depending on the device, as well as if the Wi-Fi signal is not strong enough no sending of data would be done.

After knowing that the communication works properly, the data quality is also an important issue, the manufacturer or supplier must provide a well-calibrated device as good data is essential for the services associated to the devices.

The other important issue is the data security and data protection rights of the user (EUR-LEX 2014/724/EU, 2014), some suppliers apply systems that use open software offering the advantage of

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² EU developed an Energy performance directive for buildings bringing into relation local building automation functions under EN15232 and VDI 3813
community development, this advantage is countered by the increased risk of abuse, inherent to open source software. So, it should be convenient that the supplier informs the user before registering to its platform the data protection conditions and also asking for its consent.

5. Energy Management Systems (EMS) in the EU

The Energy Management System (EMS) are used to refer to two applications in the energy field. The first one, EMS is a referred to set of computer -aided tools the electric grid operator is using to control, monitor an optimize the grid. This system is used by the Distribution System Operator (DSO) and by the Transmission System Operator (TSO).

However, the Energy Management System is also referred to those systems that individual companies, commercial entities or domestic users to monitor, measure and control their electrical consumption and even control its devices (Personal Energy Management Systems).

4.1. EMS infrastructure

Currently, the market is relatively new, immature and very diffuse. A lot of ESSO’s need to implement and rollout a system while legislation nor technology is ‘finalized’. This study is therefore limited to an overview of the different systems used by the different Distribution Network Operators / ESSO’s.

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Figure 10. Interaction of the metering and electricity infrastructure

Figure 10 presents an overview of the interaction of meters and the household electric system on low and medium voltage level (typically the action field of Distributed System Operators (DSO) working from 400V to about 15kV).
Through all the individual data connection points on the 400V side, the data connections nodes are usually located inside Power Transformer Substations. Downstream, big data becomes available in the enterprise service station or local dispatch of the DSO.

It should be noted that the actual standard IEC 61968-9 is already widespread and capable of dealing with Smart Grid necessities on the DSO level as well as on the Transmission System Operator (=TSO: operator of the transport system typically from above 15kV to 400kV).

The so-called Head End Software (HES) and Meter Data Management (MDM) are under development from a more local scale to a broader area- or country-level.

4.2. Energy management system evolution

In an ever evolving system development and detailing we see that system accessibility and data collection is of major importance.

As Figure 11 shows, energy management platforms are evolving from vertical energy vector handling to an integrated approach, offering end-users an overview of all vectors consumed (as well as detailed statistics and reports). New technology developments and energy-vectors will be integrated not only on the software side, but on the hardware side as well. Most up-to-date and future developing market players focus their research on this evolution. Market players have to act in a different way on their product development and change from solution-solving to what-if product development. This implies to work on business roles of the market players in a broad way including mobile operators, stores, banks and credit card companies.

Figure 11. Evolution of EMS structure
Valorizing data from Smart Meters and Smart Grids requires dealing with Big Data. Big Data analytics in Demand Energy Management includes, among other strategies, load patterns recognition and categorization, predictive analytics, distributed data mining and cloud computing, to assess different aspects of the smart grids that cannot be solved with conventional data processing techniques\(^3\).

These platforms are available today, capable of handling different issues such as Load Management, active switching and limiting local decentralized production such as solar.

These types of energy management software platforms are offered by all major players such as ABB, Siemens, Landis + Gyr or MOXA. An example of the functionalities of the Landis platform:

4.3. Penetration of main market players in EU member states

Studies have been conducted to clarify what functionalities in the platform are need to have and nice to have. The portfolio of energy management system functionalities need to enable a more efficient use of resources in order to comply with the customer’s needs.

The portfolio can contain:

- Load management and communication with the local smart meter
- Interaction with the home energy management system (or even home care services\(^4\))
- Analysis of price fluctuation such as day/night regimes – unbalance – restore – frequency support
- Contractual services for billing, status of consumption etc.

4.4. Energy Management Systems

The market for (building) energy management systems is very divided, with hundreds of small and large suppliers. The key market players here are typically the smart grid networking and solution

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\(^4\) Home Care Services integrate the house-security and protection system as well as electrical keys and other services for lighting or heating
providers, offering a wide range of products related to metering or utilities and the related software as end-user ‘packages’. Some examples of important player EMS software:

- ABB smart grid technologies ‘Ekip Power’
- General Electric ‘Energy Connections’
- Siemens ‘Ecologic Analytics’
- Landis+Gyr – ‘GRIDiant’

6. Personal Energy Management Systems

The energy market is plenty of energy management tools, also it exists a large variety on how these services reach the end consumer, we will analyze in detail the existing energy management systems for residential consumers, the way they reach the end user, if they offer only software product/service or hardware + software product, the functionalities they are offering the user, which are their communication channels and which kind data source are they using.

The companies analysed that offer an Energy Management System are listed in Table 5.

Table 5. Companies’ product analysed offering any kind of energy management system

<table>
<thead>
<tr>
<th>Company name</th>
<th>Company website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enerbyte</td>
<td><a href="http://www.enerbyte.com/">http://www.enerbyte.com/</a></td>
</tr>
<tr>
<td>Opower</td>
<td><a href="https://opower.com/">https://opower.com/</a></td>
</tr>
<tr>
<td>C3 IoT</td>
<td><a href="http://c3iot.com/products/">http://c3iot.com/products/</a></td>
</tr>
<tr>
<td>SilverSpring</td>
<td><a href="http://www.silverspringnet.com/">http://www.silverspringnet.com/</a></td>
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The parameters used to analyse the companies’ solutions are the following:

**Business model**

**B2C:** Residential consumers can contract directly the services and products provided by these companies.

**B2B:** Companies offering their solution to other business companies.

- **Utility:** Companies offering their solution to utilities as an added value service for their customers.
- **Institutions/Smart Cities:** Companies offering their solution to public institutions, city councils, municipalities, etc.
- **Communities/SME’s:** Companies offering their solution to small and medium enterprises (SME’s) or community buildings.

**Channels**

- **Smartphone app:** Energy management platform available to be used through a mobile app.
- **Web portal:** Energy management platform available from the computer in a website.
- **Newsletter/Reports:** Frequent reports that summarize the consumer performance. These can be paper reports or emails and the frequency of delivering such information is varied.
Functionalities

- **Comparison**: Comparison tools are available for the consumer. It is important to distinguish between different levels or quality of comparison.
- **Community**: The platform allows consumers to share their achievements with the community or to interact with other users.
- **Gamification/Rewards**: The solution includes the organization of friendly competitions that can be rewarded with virtual points or badges.
- **Prosumer**: The possibility to monitor energy production from microgeneration sources.
- **Temperature**: Monitoring of the home temperature is included on the platform. In most of the cases, this is linked to the availability of smart thermostats.
- **Remote control**: The platform allows consumers to remotely control heating, appliances or lighting.
- **Notifications**: Possibility to send notifications to consumer for alert purposes, irregularities or events organizations.
- **Marketplace**: A marketplace is incorporated within the platform. This can include energy related products or not.
- **Demand response**: The platform allows consumers to participate in demand response programs to save energy during peak demand events.
- **Disaggregation**: The solution uses algorithms to identify the pattern consumption of some appliances.

**Electricity**: The solution includes monitoring of electricity consumption.

**Gas**: The solution includes monitoring of gas consumption.

**Water**: The solution includes monitoring of water consumption.

**Hardware based**: The solution uses some type of hardware product to deliver energy management tools.

**Type of data**

- **Smart meter**: Consumption data is obtained from smart meters
- **Submetering:** Consumption data is obtained thanks to the installation of a gate connected to the home electric box.
- **Billing:** The only consumption data available is the one presented in the bill.

“ANNEX 2: Companies offering energy management products/services

The companies the have an *, are offering also sub metering devices (hardware), mentioned in 3.3. Choosing a sub-metering device.

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Opower

Opower is the leading company of the residential energy efficiency sector mainly due to its high amount of final customers. It is a Software as a Service (SaaS) company providing customer engagement software to more than 95 utilities in 9 countries, which represents an scope of more than 50M final customers. Some fact that demonstrates its high influence in the sector is for instance, its dominating position in US market (37% of US households).

Opower define his product as a “customer engagement platform tailor-made for utilities”. It uses smart meters data to inform customers about their energy consumption (including Electricity and Gas). This interaction with the customer is done through several channels: a mobile app, a web portal and the Home Energy Report (HER) which provides a comparison of energy use with neighbours in order to challenge the customer to a more energy efficient behaviour. As many studies defend, social norms have demonstrated to be the most effective way to have an impact on customer energetic behaviour, whereas economic, environmental and community incentives have lower or no impact. Other significant features from Opower’s software are: reward programs, online billing, utility notifications (for instance, high bill alerts) and targeted recommendations. Furthermore, the platform is completely white-labelled in order to brand the web portal and mobile app with each utility branding.

The product is presented in two different sides. On the one hand, it is a demand side management tool for utilities as it offers energy efficiency advice and demand response peak events. On the other hand, utilities also benefit from its customer care side based on digital engagement and bill advisor that increases the customer satisfaction and its loyalty.

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Explore our products

DEMAND SIDE MANAGEMENT

Energy Efficiency
Save energy and promote programs with perfectly tailored energy advice.

Demand Response
Achieve cost-effective peak energy savings with real-time communications.

Digital Engagement
Boost self-service and satisfaction with insight-rich web experiences.

Bill Advisor
Give customers control over their bills with alerts and CSR tools.

CUSTOMER CARE

PARENT T1.3: State of the art of smart meters, sub-metering devices and EMS in the EU
C3 Energy defines themselves as a company transforming the energy value chain by delivering “The internet of energy”. In fact, the variety of their products is very wide within the energy value chain. For instance, they give advice in the oil and gas industry, help organizations to achieve their sustainable goals and provide complex software to analyse and process data.

The Smart Grid applications segment is divided in two sections: one dedicated to the building and running processes regarding the advanced metering system and another tool named C3 Customer Engagement Application. This last instrument aims to offer a new customer engagement tool for utilities to interact with their customers.

Focusing on C3 Customer Engagement platform, it differentiates three types of customers: residential, commercial business and industrial enterprise.

The channels used to interact with the customer are through web portal, mobile app, mails and reports. Moreover, the features offered are for instance, a comparison of energy consumption with an average efficient home or business and the possibility to earn rewards. Finally, the platform is also available to be branded by the utility itself and it gives advice both on electricity and gas consumption.
Silver Spring Network

Silver Spring Network is a provider of smart grid products. Similar to C3 Energy, its product range is very wide and they offer many types of services. For instance, they differentiate between five types of business focus: smart cities, smart utilities, technology, intelligent devices and services.

In the smart cities section, Silver Spring Network provides guidance to cities in their challenges to modernize the infrastructure in the way to become a smart city. This is done for instance by adding new applications such as lighting/parking/traffic monitoring or including advanced meters for electricity, gas and water.

Regarding smart utilities, Silver Spring Network offers a customer engagement platform together with other services. However, this software does not compete in the broad open market, because it is only available for those utilities using their smart meters. It is important to highlight that Silver Spring Network is also a hardware based company selling intelligent devices such as smart meters, thermostats, In Home Displays (IHD) or Electrical Vehicle (EV) chargers.

Its customer engagement platform for utilities is called CustomerIQ and it is a tool for residential, commercial and industrial customers to manage better their energy consumption by providing recommendations and bill projections through a web portal, a mobile app or weekly email reports. The platform is highly configurable and the dashboard is also highly configurable allowing utilities to introduce their own branding. Moreover, as the result of several partners’ agreements, it includes load disaggregation applications. Besides this, Silver Spring Network also provides Demand Response (DR) technology for utilities.

Finally, SilverLink is an app store of industry-leading applications built by Silver Spring and other partners from different sectors (advanced metering, demand-side management, distribution automation, smart cities and software). For instance, Bidgely is one of their software partners. Within this app store, they also offer CustomerIQ Solar which is a tool that utilities can offer to their customers with a prosumer profile in order to maintain their customer relationship.

PARENT T1.3: State of the art of smart meters, sub-metering devices and EMS in the EU
Comverge

Comverge is a company that provides hardware, software and services to utilities related with demand management programs. In addition, it is considered the leading company in the Demand Response (DR) industry and they serve over 500 utilities.

The hardware provided by Comverge goes from smart thermostats to remote control systems. IntelliSOURCE is the software platform offered which integrates demand response, energy efficiency and customer engagement tools. The platform is accessible from laptops, tablets and smartphones, but it was designed to be used from a mobile device. It provides normative comparisons with other users participating in the same utility program and gives personalized tips. Furthermore, it can be also connected to smart thermostats from Comverge or third-party suppliers, in order to control and configure the home temperature remotely. Finally, the platform is also integrated with demand response programs allowing utilities to manage peak load events.
**Bidgely**

Bidgely is presented as “your personal energy advisor”. It provides individually energy efficiency advice, neighbourhood comparison tools, appliance itemization and solar disaggregation. All these features are presented in a web portal or a mobile app, and the user is also able to share its successes through Facebook, Twitter and other communities. Despite they offer this service to end users passing through utilities, the platform can be found either from Bidgely directly or the utility branding. Therefore, in this case the utility may offer an energy efficient service as an outsource service under Bidgely’s branding.

Bidgely’s technology is based on disaggregation appliances, which enables to provide information on how individual appliances impact the bill. However, to have a more precise real-time energy tracking of individual appliances, they also developed a hardware named *HomeBeat Energy Monitor* that works as a bridge between the smart meter and the home router internet. The cost of such device is 35$ which is much more economically accessible than others smart thermostats.
Grid4C

Grid4C is a smart grid predictive analytics company focused on all the actors within the energy value chain. They provide software to analyse data collected from smart meters and consequently, provide forecasts, energy efficiency and customer engagements solutions.

The variety of their products is wide as they are offered specifically for each participant within the value chain: utilities, distributors, retailers and energy consumers.

From the previous products, *Grid4C Customer Engagement* is a software platform focused on final energy consumers. The input information comes from pricing, customer data and smart meters data. As a result, it offers energy efficiency solutions that are translated into economic profit for energy consumers and customer engagement for utilities.

The software is available both in web portal and app. Some of its significant features are: non-intrusive detection of app’s, demand response optimizations and customer segmentation. This allows providing personalized messages to inform about irregularities or give recommendations.
Powerley

Powerley is a new venture created from the collaboration of two companies: Vectorform which is a software developer and the utility DTE Energy.

They define themselves as the only utility-designed home energy management solution in the market. Therefore, its solution is centred on the utility and is completely branded with the utility brand ("delivering a unique experience to each utility").

Moreover, apart from the software, the complete package solution also includes two branded hardware: first, an energy ‘bridge’ that works as a gateway device connected with the smart meter in order to receive more frequent information from it and that can be also connected to other external devices. This device can be connected with the majority of home solutions and therefore, it allows to remotely control thermostats, lights, etc. from the smartphone. Second, a smart thermostat that controls the home temperature remotely and is connected to the previously called energy ‘bridge’ is also included on the package. The cost of such devices depends on how much each utility wants to charge. In the case of DTE Energy, it is offered to their customers for free.

The platform provides real time consumption information, appliance level disaggregation and energy efficiency recommendations from self-learning and personalization method. Moreover, it also offers a collaborative system for peak demand response events. This system encourages customers to participate in community events and enables utilities to better manage their targeted savings.

Finally, a very innovative feature of the app is the so-called PowerScan tool which reads the magnetic field created by a power cable and provides the power consumed and the cost associated with it of any device only by using an iPhone.
**MeterGenius**

MeterGenius offers to utilities a self-branded customer platform for energy management. The platform is available on web portal and mobile or tablet app. It gives general suggestions and recommendations on how to save energy and become more energy efficiency. Moreover, it can be connected to outsource devices such as thermostats from external providers.

Special focus is made on gamification. In order to motivate customers, they offer reward points to stimulate good energy behaviours, engage customers into the platform and create loyalty with the utility brand.

They differentiate themselves from other products (like OPower) by delivering a persistent-engagement platform because their customers continue to see the results due to their gamification programs. However, they claim that in other platforms the customer only sees the results at the beginning and afterwards he or she declines.
**Greenely**

Greenely is a start-up from Sweden focused to help customer in decreasing their energy consumption by offering a platform that stimulates their energy behaviour. The software is available through utilities and therefore, it is also a customer engagement solution and a way to decrease peak costs for them.

The software is presented in an app and a web portal. To stimulate good energy performance, gamification is one of their key features together with comparison tools and community building. To visualize the energy consumption, the platform includes the design of a tree which is directly influenced by the level of consumption.
Plugwise

Plugwise is a Dutch company offering different hardware based products related with wireless energy management and control systems in order to increase energy efficiency in private households and business organizations.

One of their popular devices is *Smile P1* which connects the smart meter with the smartphone or tablet via wireless. The connection is done through a P1 port and therefore, it is required that the smart meter has this output source.

It works as a gateway of consumption data both for electricity and gas. The app is mainly informative presenting hourly, daily, monthly and yearly data. The app is also available for prosumers allowing them to measure both production and consumption.

The product including the hardware and software is available at a price of 99€.

Other products from *Plugwise* are *Anna* and *Cooling*. The first one is a smart thermostat that allows the user to control and schedule home temperature from his smartphone and it costs 249€. The second one is an infrared device to remotely control the HVAC from the smartphone or tablet which costs 149€.
Eneco

Eneco is a Dutch utility company offering Toon, an energy efficiency product that consists of a smart thermostat connected to smart meters. The package is composed by several elements as is connected via wireless to the boiler, the electricity and gas smart meters.

It provides information on how much electricity and gas is being consumed at any time and by day, week, month or year. Besides this, if desired it also offers some tips on how to save energy and is able to control remotely the boiler.

The product is also available for non-utility customers. However, the cost of it varies: for Eneco’s customers, the installation is for free and they charge 3.5€ per month in the bill. For non-customers, they have to pay the installation cost (75€) and a monthly fee of 4.95€.
Green choice

Green choice is a renewable Dutch utility that provides electricity and gas. They have their own platform to provide an energy efficiency service to their customers. The software offered to their customers is a very simple app that provides daily, monthly and yearly consumption information.

The app does not offer real time consumption and the smallest time lapse is daily consumption. However, it offers a comparison with other similar households and provides some tips on how to save energy.

Download the new app Greenchoice

The app will get you as a customer of Green Choice insight into your consumption and you can arrange a lot of energy business itself. Simple, anytime, anywhere:

✓ Submit meter readings in your cupboard
✓ Check your energy consumption and grid per year, month, week and day
✓ View or change your monthly installment amount
✓ Compare your consumption with the rest of the Netherlands or similar households
✓ Use our saving tips to save energy
Bee Group

Bee Group is the energy efficiency department of the International Centre for Numerical Methods in Engineering (CIMNE). The company offers solutions to households, utilities, community buildings and cities, all related to provide tips and recommendations for a more efficient use of energy.

For the consumer side, they offer ControlaEnergia which is an app that provides graphs on your historic consumption, gives recommendations and compares with other users. Also, it includes some gamification tips to enhance the user engagement on the app. For instance, it awards the user with points for different reasons such as daily access or input information. It is important to highlight that the user has to enter his consumption data and is able to enter as much data as desired.

Besides this, the same software together with extra services related to data analytics is offered to utilities as a customer engagement tool. In this case, the software uses the data provided by the utility smart meters.
Green Pocket

Green Pocket is a software specialist based on Germany that provides energy and water management solutions to large and small utilities for residential and business customers.

The channels used within the residential product are: web portal, smartphone app and newsletter. Consumption data is obtained from smart meters, but the software is also able to connect with other hardware that allows offering extra smart home tools. Besides this, social metering is a key feature of the software: it allows posting the user’s achievements on Facebook, challenging your friends and winning badges for personal successes. Furthermore, it is also possible to visualize the energy produced if the customer works as a prosumer.

The software for business customers is similar, but more focused on the management side of time and resources.

In addition, Green Pocket is spreading its product by offering also smart home software. This tool includes remote control of appliances and lighting, and can be connected to many types of hardware (control devices, sensors, etc).

Finally, the company also offers consulting services for those interested in entering the smart home market. They provide different types of help such as market research or hardware acknowledgement as a result of their experience.
Rocket Home

Rocket Home is a German company offering multiple products in a centralized way. All the applications and features are connected in a unique device in order to provide “a complete solution for connected homes”. The fields covered are: home control, home monitoring and home energy.

Their solution is provided with an open software platform called *HomeRUN intelligence cloud*. The platform is white-label in order to allow branding on it and highly customizable. Their customers are mainly utilities and telecommunication companies.
Mirubee

Mirubee is a start-up from Wayra (Telefonica accelerator) that offers an energy efficiency solution in a BtoC (Business to Customer) business model. It is important to highlight that this solution does not use the data from smart meters and requires installing a device into the home’s electrical panel. This device, Mirubox, sends continuously the consumption data via Wi-Fi and its price is 119.50€.

The channels used are smartphone app and web portal. It provides tips on the best electric tariff for the customer based on his/her past consumption. The most important feature is its ability to disaggregate consumption data through Inspectee technology.
Wattio

Wattio is a company providing home control solutions for comfort, energy efficiency and security services. They offer different types of devices such as smart thermostats, smart plugs, security cameras, etc.

For each demand, they offer several packages composed by different devices. For instance, to save electricity, they offer a package composed by a smart plug and an electricity monitor. Both devices are connected to the software provided by Wattio.

The software gives insights on your electricity consumption and provides information on your consumption habits. Moreover, it also provides a comparison with other homes and sends alarm when something unusual happens in the consumption.

The price of a package composed by a smart thermostat, a smart plug, an energy monitor and a home automation centre is 299.90€.
Circutor

Circutor is a company with more than 40 years of experience on designing and manufacturing hardware devices for energy efficiency services such as monitoring, measurement, control, protection, etc.

One of their innovative devices is Wibeee which is a consumption analyser. The device is inserted into the electrical panel and connected to a Wi-Fi connection in order to collect electrical data. The market price of the device is 173€.

The interaction with the user is done with an app also developed by Circutor. The software allows the user to access to his/her consumption data in real time by using a smartphone, a tablet or a computer. The platform provides instantaneous power consumption and allows exporting the data generated to an Excel sheet. Moreover, it also provides instantaneous values for other variables such as active power, reactive power, intensity, voltage, and frequency, etc. The data is collected into the platform in order to observe and compare the evolution of electricity consumption.
Intelen

Intelen is a USA start-up company that provides a customer engagement platform for utility customers both businesses and residential. The company puts all the efforts on providing the most completely personalized service. Understanding each customer’s behavioural pattern is the key success to offer services that “Engage people to rethink”.

The solution proposed, presented under the name of DiG Energy, is white-labelled in order to include utility brands and has many different features that can vary depending on the willingness of each energy provider.

Features are comprised in 4 main sections: DiG Energy, DiG Engagement, DiG Marketplace and DiG Consulting/Analytics. DiG Energy provides tools to monitor daily energy consumption and its associated cost through different functionalities such as peer comparison, peak demand monitoring, energy disaggregation, personalized notifications and bills prediction. DiG Engagement provides educational tools to empower behavioural changes in the users in order to retain them as long as possible and attract new customers. They provide personalized services in order to satisfy customer’s needs through gamification tools. At the same time, users are challenged in order to understand the benefits of their achievements. DiG Marketplace is also related with the gamification tools. It is a place that can be used for the utility as a way to increase the revenues, and with the introduction of virtual coins, it offers the user an extra gamified experience to recompense his/her energy savings efforts. Finally, DiG Consulting/Analytics is a service resulting from the acknowledgement on understanding every user’s routine. This tool is offered to utilities in order to be able to segment more accurately the market and prepare more customized marketing campaigns.
Watty

Watty is a start-up from Sweden focused on disaggregation technologies. Using just one measurement source and applying it to their machine learning algorithms, they are able to diagnose the appliances energy usage. To do so, their solution requires of a low-cost hardware that obtains the data from the smart meter. Moreover, it also compares the appliances with alternatives in the market.

The solution is mainly designed for utility companies to increase their customer engagement. However, they also offer his software to solar providers and connected homes companies. In these cases, they allow to use and integrate with their software.
Alert Me

AlertMe is a UK company offering hardware and software in order to enable household users to monitor and control their energy consumption. Through disaggregation algorithms, they provide energy savings recommendations.

Hardware devices are based on a home hub that can be connected via wireless to other AlertMe devices and third party devices.

The software platform is based on three main products: *SmartEnergy* for electricity monitoring, *SmartHeating* for remote heating control and *SmartMonitoring* for home monitoring.

It has been acquired by British Gas and the original website is no longer available. (65m$)
British Gas

British Gas is the largest UK energy company. They supply gas, electricity, boilers and home services. In 2015, they acquired the company AlertMe in order to offer an energy saving service directly to their customers.

The company offers for free to their customers the installation of a smart meter that monitors at real time the electricity and gas consumption. The smart meter together with the platform My Energy enables the user to visualize his/her daily, weekly, monthly and yearly energy consumption, and compares it with past values and other customers. Moreover, the platform also provides some general energy saving tips.

Besides this, they also offer Hive, a smart thermostat to control and monitor heating. The thermostat is provided in a package with two more devices that enable to connect to the boiler and the wireless router. It is important to highlight that there is no need to be British Gas customer to be able to purchase this product. The price of the complete kit is 249$.
Factor Energia

Factor Energia is an electricity retailer offering a new energy efficiency service to his customers. The service is accessible from an app named *Factor SmartHome* and it is focused on the economic savings through a responsible energy use.

The main characteristic of the platform is the ability to present the hourly price of electricity and give recommendations on the best time for using common appliances such as washing machines. Besides this, the platform also offers the possibility to compare with other consumers. If the user includes information about his/her home, the platform is also able to provide personalized energy saving tips depending on geographic situation, number of people, heating/cooling system, etc.
**Fifthplay**

Fifthplay is a Belgium company delivering smart home solutions for increasing comfort and save energy. They work together with utilities, telecommunication companies and others.

The product range is wide and they offer mainly many different hardware smart devices and software connected to them. The products are assembled in several packages for specific purposes. For example, they offer packages for schools and universities, for software developers and for utilities.

Using the software from a web portal or through the app, the user can control smart plugs, set the temperature of the thermostat and compare the consumption of each device.

Smart cities are also one of their customers. In this case, they offer a specialized solution for them called *Nuvonet* that offers a smart community platform built by blocks that are chose specifically for each type of community.
Onzo

Onzo is a company focused on analysing big data in order to provide customized solutions to utilities for customer engagement services. They emphasize on their ability to develop complete customized tools for specific uses depending on each utility need. Moreover, the platform offered is completely white-labelled in order to personalize the communication between the customer and the utility.

In other words, they analyse big data from the utility to transform and deliver valuable information that benefits both user and utilities. The data received from the utility comes from electricity and gas meters.

They are already working with the utility Green Choice and with Silver Spring Networks.
Wattabit

Wattabit is a Software as a Service (SaaS) company providing a platform to monitor and remotely control energy consumption such as electricity, gas and water.

The company does not take part on the Hardware development, but it enables the connection and communication with any hardware. The software is focused to small business and companies. Moreover, it is also provided to Energy Service companies as a tool to offer their services.

The basic features included on the platform are presented in the image below. Personalized reports, remote control, billing information and detection of extra payment, real time monitoring, etc.
Ijenko

Ijenko is a French company that provides a platform to enhance consumers experience across different IoT environments. The platform offers what they called the Internet of Energy (IoE) which consists on developing services and linking smart energy devices in order to provide a collaborative tool between Ijenko’s customers and residential consumers.

Ijenko’s customers are divided in four figures: utilities, telcos, consumer electronic (CE) groups and smart cities. They enable utilities to engage their customers by providing tools to save energy and demand response programs. Telcos can use the platform to offer added-value services such as security, home automation and smart heating services in order to differentiate. CE companies collaborate with Ijenko to design and develop smart home devices. At the same time, they can use the platform as a bridge to enter new markets from the IoT. Finally, smart cities can take advantage of its platform to deploy integrated energy management systems.

The Ijenko Home Energy Management Solution have different features: Energy efficiency tips such as total consumption, appliances consumption, savings and comparisons. Other features are: Smart heating, Demand response, Electric Vehicles charging, PV production.

The platform is accessible through many APIs which allow customer to create their own end-user experiences.
Efergy

Efergy was founded in 2005 with the central mission to help people save energy, money and the environment by providing online energy monitors and In-home displays. Their systems give an insight on how much energy is being consumed in real time and the cost associated with it. It also shows historical information.

Their monitoring solutions are available both for end users (homes and small businesses) and utilities. Moreover, they participated in public projects for specific cities (for example Queensland, Sabadell and Donostia).

Besides this, Efergy also collaborates with some utilities to develop smart meters by providing PLC gateways and Zigbee enabled monitors.

They are constantly developing new smart home products to keep on the road of the connected home.

They offer different package products with kits specialized for each application and customer.
Smappee offers a solution to monitor the home electricity consumption. They present the product as “the world’s smartest home energy monitor”.

The solution is based on an Energy Monitor that has to be connected to the home’s fuse box. This monitor is connected through the Wi-Fi to their own software accessible from a smartphone and web portal. They provide appliance level consumption due to their knowledge on disaggregation algorithms.

Besides this, they also offer smart home products. Specifically, Smart Plugs are provided to control remotely selected appliances or lighting.

Moreover, the software presents an Awards section that rewards good user’s behaviours such as completing your profile, reduce consumption, label appliances, etc.

The product can be found directly for the end-user and is presented in packages. For instance, the most common product including the Energy Monitor and a Smart Plug, costs 199,00€.

They also offer a version named Pro which is focused on bringing energy monitoring and control to SME’s.

Finally, as their newest product, Smappee has also developed hardware to monitor gas and water consumption. All the hardware offered is connected and is presented together in the same software.
Navetas

Navetas is a UK company delivering services for the smart home. The services are cloud-based energy monitoring and smart data analytics.

They have a product called Loop that works as a personal energy assistant. It consists on a platform that monitors electricity and gas, gives real-time advice and is accessible from your phone, table or computer. Moreover, starting on 2016, it also monitors Micro-generation.

The platform offers real-time monitoring of consumption in terms of energy and cost. It also presents spends on the last day, week, month and year. Gas and electricity are presented together in order to observe the importance of each one.

Moreover, it offers tools such as comparison with similar users and budget challenges proposed by the user: the platform only explains what the current state of accomplishment is and summarizes the previous budgets.

Finally, an important and distinctive tool within the platform is the access to the best deals based on your consumption and the possibility to switch easily from your energy provider. This service is similar to a marketplace of energy providers and is offered through a partnership with uSwitch.com which is the #1 energy switching service in the UK.
Ecoisme

Ecoisme is a Polish company that developed a solution to “save energy in an easy way”. The solution is hardware based and includes a sensor connected to the home electric box that tracks the energy consumption. This measurement is synchronised with a platform that provides recommendations and alerts in order to save energy.

The two principal characteristics of this solution is the ability to detect appliances through disaggregation algorithms and the personalized tips. It is important to highlight that they used power analysis and spectrum analysis to detect devices. This is a very precise tool that requires high frequency measurement hardware.

Moreover, the platform can be also integrated to out-source smart devices. Besides this, it is also connected to social network such as Facebook in order to compare with your friends.

The solution automatically detects the most common appliances. However, the user can also provide some detailed information about them in order to get more precise feedback.

The personalized tips are based on detection of high energy consumption. For instance, with this system, the software can detect if the user forgot to close the fridge or if the iron is turned on for too long. Furthermore, other recommendations regarding the best time to charge the car or to run the washing machine are available.

Finally, the platform also monitors micro-generation in case the user has solar panels or some other micro generation at home.

The project was financed via crowdfunding and the campaign end by June 2015 raising the amount of 67.000$. The product is intended to be available in the market in April 2016, but the price is not presented yet.
Neurio is a company from Canada offering a solution for residential users to save energy and thus, save money.

Their solution is hardware based and consists on installing a measurement device into the electric box. This device is connected through the Wi-Fi to a software platform that monitors the home electricity consumption. Therefore, the platform presents the real-time power consumption of the house and other features such as historic data, ranking comparison with neighbours, bill forecasting and energy saving tips. Moreover, the platform is also able to monitor solar generation in the case it exists.

The product is presented in two versions named *Home Energy Monitor* and *Intelligent Energy Monitor*. The difference between them are the features included, being the second one the premium version. Consequently, Intelligent Energy Monitor offers appliance level consumption and it is able to detect several appliances. Moreover, to have more precise insights, the user can input information regarding his appliances. To do this, the platform includes the “training” mode which is designed specifically to detect appliances.

Finally, the solution also sends personalized notifications to alert of forecasted excess consumption in order to prevent the user.
Simple Energy

Simple Energy is a customer engagement company for utilities with the aim to change people’s mind on energy. Their goal is to “inspire customers to take action”. Their solution offers a range of experiences to engage people and is designed taking into account that different people respond to different things. Consequently, they put a lot of emphasis to send personalized messages to every customer. To receive more precise and personalized tips, the user is able to introduce characteristics of its home using an intuitive survey.

Moreover, the platform also provides comparison with similar houses. It shows the consumption of those houses similar to yours. Furthermore, several tools are used to motivate users. For instance, good behaviours are rewarded, goals are proposed and testimonial stories from other users are shown in order to inspire people to act.

It is important to highlight one of the innovative tools included: community energy saving competitions. This type of competitions is organized during peak energy times and is rewarded with badges or virtual points. Moreover, this tool is their way to build a community because every user participates to achieve a common goal and it compares between users by showing the contribution of each participant. Therefore, the platform also offers a demand side management for utilities in order to allow their users to participate in demand response programs.

Besides this, the platform is also connected to a marketplace branded by the utility that allows customers to take wise decisions when purchasing new energy related products. Some products can be purchased using virtual points or badges.

Finally, the platform is white-labelled and each utility is able to brand the platform and integrate with the utility’s current website.
eGreen

eGreen is a French start-up that helps to reduce water consumption and energy consumption both in electricity and gas. To achieve this goal, it monitors water, electricity, gas and indoor temperature. However, it is important to highlight that users without access to monitoring can join the platform as well. In this case, the user introduces manually the consumption of his electric, gas or water meter regularly.

The monitor these consumptions, an online shop is available to purchase monitoring devices. These devices are installed into the electric box or the gas/water meters and connected via wireless to eGreen’s platform. At the moment, eGreen offers devices to measure electricity consumption, but other external companies can also offer other devices that can be synchronized to eGreen platform.

eGreen’s platform shows the consumption of water, gas and electricity in an hourly time base. Consumptions is presented in kWh consumed, € costed or CO2 emitted. Moreover, it also offers a comparison with anonymous neighbours. It is important to say that within this comparison the user can observe the number of habitants or the house surface in each household in order to have a more effective comparison. Besides this, the platform also provides energy efficiency recommendations and it can be used as a tool to organized friendly competitions. The messages presented or general with the common link to be sustainable, ecological or energy efficiency related.

The product is generally offered to end users. However, it is also available for enterprises and community buildings. Moreover, eGreen has been selected as one of the five start-ups included in a project called DataCity. In this case, the services from eGreen will be offered to the citizens of Paris.
Enernoc

Enernoc define himself as “the world leader in energy intelligence software”. They identify two main customers: business and utilities. For business they offer analytics solutions to control their energy costs and for utilities, they provide solutions to enhance the relationship with their customers.

Their solution compares electricity consumption between neighbours for residential and SME’s. It also sends energy efficiency recommendation messages.

It enables also to organize demand response events in order to increase customer engagement and improve demand-side management.

Enernoc’s solution is specialized on utilities business customers rather than residential.
My Energy

My Energy is an online service company that had been acquired by Nest in 2013. The company itself provides a platform that gathers all your utility bills in one common place. Therefore, it is a way for residential users to collect electricity, gas and water bills in a same place. Moreover, the platform is connected to Facebook or Google social network in order to create a community and compare with your friends. At the same time, by introducing his address, the user is also compared to their neighbours.

The platform is offered directly to residential users in US. However, utilities can also participate on it and use the platform as a customer engagement solution and meet their energy efficiency goals.

Energy savings challenges are organized through the platform allowing its users to participate on them and earn rewards for good energy behaviours. These reward points can be used later in a marketplace offered as a result of the collaboration with other businesses. Energy savings can be achieved thanks to the “tips to save on your energy bill” presented in the platform.
**Current Cost**

Current Cost is a UK company that produces devices to monitor electricity (recently, gas also) consumption. Their solution is hardware based and they offer different devices to track energy. Besides this, they also offer some software to show the data collected from their software online. Moreover, they allow other parties or individuals to develop software to be used with their devices and these options are included in their website.

Their main product is an IHD device that works as an Energy Monitor that track the energy consumption in real-time. There are several models: the simplest one only presents real-time consumption and associated cost, and the new generation models also offer appliance monitoring. This is not based on disaggregation models, but it shows how your consumption is expended during the day in order to identify if you are leaving some appliance on.

In addition, to connect IHD’s to software, it is needed to purchase another device (NetSmart) that works as a bridge between them. This hardware product has been also developed by Current Cost. Finally, there is another energy bridge that is connected directly to the smart meters and obtains energy consumption data from it. However, this product is also compatible with some types of smart meters that are presented in their website.

Finally, they recently developed a product that is connected to gas smart meters and therefore, it also monitors gas consumption. The information is gathered also into their online dashboard. They have two models depending on the smart meter type.

Current Cost’s products can be found directly in their online shop and through some utilities that include their products in their personalized online marketplace.
Dwelo

Dwelo is a start-up company created in 2014 with the aim to transform apartments into smart homes. Their solution is offered to two types of customers: residential and apartment managers.

The product can be divided in three main areas, all gathered in a common mobile app. The first service is focused on Convenience and it consists on enabling the user to control the lighting from the smartphone. Second, it is also a Security service allowing the user to lock and unlock door from the phone. Finally, the third area is focused on Efficiency and it consists on controlling the home’s temperature through a smart thermostat.

The product is offered directly to residential users or home apartment managers. In this case, managers can control all their properties with a central platform accessible from the smartphone or in the website.
BEN Energy

BEN Energy is a SaaS (Software as a Service) company with the aim to change how people interact with their energy. The software is based on data analytics and behavioural science algorithms in order to offer the end-user an energy experience that engages utility companies with residential users.

There is not much information regarding the characteristics and features included in their platform. Nevertheless, it is intended to be highly customizable for the utility and the communication with the user is done in a personalized manner through mobile, web, email or sms. In addition, it can be integrated with the utility service portal and the service can be delivered to users with and without smart meters.

They are already offering different types of end-customer relationship solutions through their services to 28 utilities.
SolarCity

SolarCity is the leader company in photovoltaic solar systems for residential homes, businesses and governments. They provide full services: design, financing, installation and monitoring.

They have recently developed a mobile app called MySolarCity which allows users to monitor their energy consumption and solar production. Consumption and generation data is presented in real-time mode, but also historic daily, monthly and yearly data is presented. Apart from it, the platform also includes extra features such as information regarding where the user can save more energy in his home, a map that shows the location of other users within the community and the possibility to earn reward points and money when recommending to new customers. Furthermore, it also enables users to share their experience through a social media tool called SolarCity story.

This service is only delivered to those customers that installed a special device in their electric panels during the installation phase. This process requires having access into the wires coming from the grid that can be physically limited in some cases.

MySolarCity

Download the MySolarCity app and experience all the features first-hand. See how you can track your solar system's production as well as your home's consumption, tap into the SolarCity community and get a smarter, more connected home.

All MySolarCity's features are available using a demo account if you are a registered Ambassador. As an Ambassador, the new app gives you everything you need to educate your community on how solar works.
Elenia

Elenia is a Finish electricity and heating utility that already had developed a smart electricity grid by integrating power distribution and data systems. Consequently, their customers can access online to their real-time electricity consumption on a month, daily and hourly basis.

This information is provided through a mobile app and a web portal.

Free Elenia Mukana application into your smart phone or tablet

- Monitor your electricity consumption hourly
- Check if electricity is on at your home or leisure house
- Submit a fault notification
- Take a picture of faults threatening the electricity network
- Monitor invoices and keep your details up-to-date
Enel & Ilevia

Enel is the biggest Italian company within the energy market and Ilevia is a company dedicated to develop software and hardware to automate homes and buildings. As a result of their collaboration, they have developed a product called Enel Smart Info which consists on a smart device connected to a socket that connects with Enel’s smart meters and thus, monitors electricity usage.

The information is presented through an app and web portal and it also shows historical data. Moreover, it also monitors generation from solar panels if existing.

It is important to highlight the easy way of installing such device and that it is only compatible with Enel’s smart meters.
Tendril

Tendril is a US company offering a cloud-based platform for utilities to deliver customer engagement solutions.

The solution is based on what they called Tendril’s Energy Intelligence which consists on understanding and simulating how people worldwide consume energy. They also use data analytics to analyse how structural data of the house (size, insulation, thermal capacity, and a long etc) and how weather conditions affect energy consumption. Besides their knowledge on the home, they also analyse behaviours on the home and how people engage with energy services. They emphasize on the unique way of user’s relationship with energy habits and consequently, the importance of personalizing communication with them. Furthermore, no smart data is required to offer his solution.

Features included in the platform are: real-time energy consumption, neighbourhood comparisons and energy efficient personalized tips. The app can also be synchronised and control remotely connected home devices. Moreover, it allows also to participate in Demand Response programs organized by the utility and the user can share his achievements through social media such as Facebook, Twitter and email.

Finally, they identified three types of customers: Utilities & Retailers, Solar providers and Real Estate professionals.
EcoFactor

EcoFactor applies advanced analytics to connected home devices. Their application automatically manages thermostats and air conditioners allowing end users to reduce their energy bill.

The platform is based on three main fields: Proactive Energy Efficiency recommendations, optimized Demand Response events and HVAC Performance Monitoring.

Their solution is offered through different channels: Utilities, Home Service Providers and Energy Retailers. All designed to reach end consumers.

They emphasize on providing solutions that avoid the user to be constantly monitoring and adjusting their thermostat. Their algorithms learn by themselves and adjust automatically. It also prevents from DR events by cooling the home before a DR event starts. Finally, it detects problems on the HVAC system that may affect the energy efficiency of the equipment.

The platform can be integrated to existing interfaces through an API allowing customers to brand their unique consumer experience.
ANNEX 3: Product analysis of the Energy Management Business” presents a whole picture of the analysis carried out. In this annex those companies matching the specifications defined previously, have the box fulfilled in green. Otherwise, the box is painted in red. However, some of the contain text in order to clarify and give more information when is needed.

5.1. B2B companies
The companies analysed can be seen in Figure 14.

![Figure 14. Analysed companies in the B2B model](image)

To analyse the characteristics of B2B companies offering Energy Management services for residential consumers, it has been identified the markets each company is focusing.
As presented in Figure 15 there are some companies completely focused on utilities. These companies are specialized on offering energy management platforms to increase customer engagement of utilities. This are the cases, for instance, of Opower or Onzo.

The utility approach is the most shared and until now, it is the most successful one. Nevertheless, there are some companies that are innovating on the conventional business model. For example, some B2B companies are providing Energy Management solutions to residential consumers through smart cities and community buildings apart from utilities.

Focusing on the “Utilities only”, most of these companies do not require any additional hardware to provide their services. This evidence is reasonable taking into account that until now, the incorporation of hardware has been seen as a drawback for this type of solutions. Residential consumers are reticent to invest in hardware to monitor their house and therefore, companies opt to forget about hardware based solutions.

So, we are able to exhibit in Table 6 the features/functionalities listed above, that these B2B companies are offering to the end consumer.
### Table 6. Features of “Free of Hardware” and “100% Utility faced” companies

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#### 5.2. B2C companies

In this case, 14 companies have been compared, listed in Figure 16, some of them are already mentioned in the “3.3. Choosing a sub-metering device”, more focused on the hardware side of the product.
Further segmentation of this group can be done due to the characterization about the degree of hardware penetration of each company. The following list defines the characteristics of each corner in Figure 17.

- **Free of Hardware**: companies offering an energy management platform to save energy without the need of any hardware installation.
- **Submetering**: a device is needed to collect the electricity consumption data. In most of the cases, it is connected to the home electric box, but devices connected to the smart meter are also considered.
- **Submetering + Other devices**: apart from the submetering device, other devices are offered to complement the solution such as IHD’s, Smart thermostats or Smart Plugs.
- **Smart home**: when the service offered is a compact solution including security measures, light controlling, heating, etc.
The first conclusion that can be extracted from Figure 17 is that in this case, the majority of the companies are located within the third sections including hardware (12 out of 14 companies). In other words, one can affirm that B2C companies incorporate hardware to collect consumption data into their energy management solutions. This evidence is explained by the strong difficulties to access electricity consumption data from smart meters without the mediation of utilities.

The difference between up-right corner (Submetering) and down-left (Submetering + Other devices) corner is the availability to install extra hardware devices into the solution offered such as IHD’s, smart thermostats or smart plugs. The companies within the Submetering corner only incorporate monitoring of electricity consumption into their solution. However, companies located in Submetering + Other devices, offer other features apart from the basic electricity monitoring consumption.

It is also important to distinguish the cases of Neurio, Ecoisme and Smappee because their submetering device is able to collect consumption data at high frequency. The aim of such device is to obtain data accurate enough to be used in disaggregation algorithms. It is important to highlight that the frequency of the data is critical in order to apply effectively for disaggregation purposes.

Regarding the Smart Home corner, Wattio and Dwelo are distinguished because the solution they offer is not only focused on energy efficiency services and it gathers three main areas: security, heating and comfort. Moreover, Dwelo is not including any monitoring of electricity into their solution, but the author considered adequate to include it in the analysis because it is covering a very similar demand from the residential sector.

Finally, it is important to highlight that only two companies are located in the section Free of Hardware. As stated before, this fact is caused by the difficulty to access smart meter data without the mediation of utilities. In addition, being located in this corner could be seen as privileged competitive position in the sector. In other words, Free of Hardware corner does not represent how
nowadays, the majority of B2C companies are making business out of EEM services, but it can be seen as a good strategy to differentiate from competitors.

To understand in more detail what are the features included in B2C solutions and identify the most important characteristics and the main deficiencies, a detailed comparison table between B2C companies is presented in Table 7.

Table 7. Main features included in B2C EEM solutions

<table>
<thead>
<tr>
<th>Feature</th>
<th>Plugwise</th>
<th>energy</th>
<th>wattaio</th>
<th>smappee</th>
<th>NAVETAS</th>
<th>COST</th>
<th>neurio</th>
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<th>SolarCity</th>
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<tr>
<td>Comparison</td>
<td>✗ ✗ ✗ ✓</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✗</td>
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<tr>
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<td>✗</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✗</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>✗ ✗ ✗ ✗</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>✗</td>
</tr>
<tr>
<td>Prosumer</td>
<td>✓ ✓ ✓ ✓ ✓</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>✗</td>
</tr>
<tr>
<td>Gas/Heating</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✗</td>
</tr>
<tr>
<td>Disaggregation</td>
<td>✗ ✓ ✓ ✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✗</td>
</tr>
<tr>
<td>Marketplace</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✗</td>
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</table>

5.3. Utilities

We would like to end the analysis, by 6 utilities, Figure 18, that offer they own EEM solution to their own residential customers or even in some cases, to the general audience. These examples represent cases where utilities decided to offer EEM services without including third parties specialists. In general, EEM solutions designed by a utility have resulted in a successful experience until the moment.
There are some parameters that illustrate very clear the main weaknesses of such solutions and explain the main causes of failings, their functionalities can be seen in Table 8. In general, the positive points are the prosumers, and heating/gas possibility.

Table 8. Features included in EEM utilities own made solutions

<table>
<thead>
<tr>
<th>Feature</th>
<th>Eneco</th>
<th>GREEN CHOICE</th>
<th>British Gas</th>
<th>Enel</th>
<th>factorenergia</th>
<th>ELENEIA</th>
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<td>Comparison</td>
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<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
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<td>✗</td>
<td>✗</td>
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</tr>
<tr>
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<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Gas/Heating</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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</tr>
<tr>
<td>Disaggregation</td>
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<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
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<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
</tbody>
</table>
7. Conclusions

There is a clear commitment from the European Union to promote the smart meter deployment to adapt to the new and modern energy grid. It exists an advanced level of deployment of the smart meters across the member states, mainly to those that adopted the wide-scale rollout. However, there are still difficulties of implementation to fully benefit from the smart meter functionalities, basically those that empower the end consumer. These difficulties differ depending on the EU member state’s legislations, while some of them could accomplish with the recommended functionalities that smart meter should have, other countries are far to achieved them. This non-fully activation and well-functioning of the smart meters generates a market for sub-metering devices, historically this was reserved to large energy consumers, such as industries or large corporate buildings, however these recent years also there is a niche of market for the residential consumers.

Focusing on the residential consumer, the cost of purchasing a sub-metering device is not pay-off for the energy savings that an average residential consumer could obtain, so it could be seen as a nice-to-have device. Therefore, few domestic users are willing to face this extra cost, however the functionalities, features and information that this software offers (real-time data, comparisons, temperature control, alerts, disaggregation...) improve what is expected from the smart meters. Also on the bad side with the cost, is that this implies the installation of another hardware and the data communication, most of this domestic sub-metering communicate via Wi-Fi and it is one of the main problems together with the data quality.

Thus, the market is moving towards the facilitating the access and the exploitation of the smart meter data, which is the logical move. The use of sub-metering devices is seen as intermediate step meanwhile the smart meters are not fully operative, and also the sub-metering seems to be reserved to more technical users.

So, many (software) companies are just offering energy management services through the owners of the smart meter data or third parties (generally utilities) with the main goal to improve the engagement of the end-user by providing the tailored information and they could overcome the barrier of the data access. One of the major issues is the importance of the users’ data protection and security.

To conclude and looking it from a higher perspective, smart meters are not new, similar functionalities as day-night have been around for years regarding electrical heating. Smart meters and the enveloping energy management systems however will need to integrate all energy vectors inherent to household consumption, and comply with one general standard of communication in order to get the most out of the resulting big data stream.

Smart meters and energy management systems will enable ESSO’s to offer their clients a variety of new services. The development of these services will depend strongly on local situations in Member
States (i.e. Demand Side Management, decentralized (renewable) energy production, peak shaving, voltage/frequency support, storage). DSO’s will need to actively change their role in the energy landscape and evolve from monitoring system information (in order to have ‘availability of power’ analyses) to a two direction communication with the end-user.

**Figure 9: DSO future infrastructure and role**

The largest challenge in the further development and roll-out of smart meters is the integration of a vast variety of different hardware systems through a unified communication protocol and energy management systems that are able to communicate with said variety.

There are many small and medium-sized DSOs in Europe increasing their market share and market sector territory. Currently, no correlations between company size and efficiency, nor between the number of DSO’s operating in a market and the quality of supply exist. Germany for example, has several hundred DSO’s and, counterintuitively, the most reliable grids in Europe (according to figures of the System Average Interruption Duration Index (SAIDI)). Hence DSO’s will encounter large challenges in all Member States which can only be tackled through cooperation.
8. References


9. Definitions

Member States are invited to take note of the following definitions:

(a) ‘smart grid’ means an upgraded energy network to which two-way digital communication between the supplier and consumer, smart metering and monitoring and control systems have been added;

(b) ‘smart metering system’ means an electronic system that can measure energy consumption and production, adding more information than a conventional meter, and can transmit and receive data using a form of electronic communication;

(c) ‘data protection impact assessment’ means a systematic process for evaluating the potential impact of risks where processing operations are likely to present specific risks to the rights and freedoms of data subjects by virtue of their nature, their scope or their purposes to be carried out by the controller or processor or the processor acting on the controller’s behalf;

(d) ‘data protection by design’ requires to implement, having regard to the state of the art and the cost of implementation, both at the time of the determination of the means for processing and at the time of the processing itself, appropriate technical and organizational measures and procedures in such a way that the processing will meet the requirements of Directive 95/46/EC and ensure the protection of the rights of the data subject;

(e) ‘data protection by default’ requires to implement mechanisms for ensuring that, by default, only those personal data are processed which are necessary for each specific purpose of the
processing and are especially not collected or retained beyond the minimum necessary for those purposes, both in terms of the amount of the data and the time of their storage;

(f) ‘best available techniques’ means the most effective and advanced stage in the development of activities and their methods of operation, which indicate the practical suitability of particular techniques for providing in principle the basis for complying with the EU data protection framework. They are designed to prevent or mitigate risks on privacy, personal data and security.

(g) The Article 29 Data Protection Working Party was set up under the Directive 95/46/EC

EIB : European installation Bus

ESMIG : represents European companies which provide products, information technology and services for multi-commodity metering, display and management of energy consumption and production at consumer premises. [www.esmig.eu](http://www.esmig.eu)

G3-PLC: Power Line Communication or also power line carrier is already widely in use for switching streetlights and works by putting a high frequency wave on the power cables (smallband to broadband ca. 30 MHz with most known application as Homeplug that works with speeds of 14Mbps to 500Mbps) For large groups of meters and houses, speeds of up to 1 Mbps are realistic

IPv6: Internet Protocol version 6, meaning it has been designed to meet present and future advanced networking and application layer needs. Version 6 however is not widely used in EU so far.

IDIS: interoperable device interface specifications is an association that manages, administers and protects the IDIS quality label and supports rigorous interoperability testing to ensure high quality standards. [www.idis-association.com](http://www.idis-association.com) it is based on existing open standards and formed by Its current members include Elster, Iskraemeco, Itron and Landis+Gyr.

M/441 mandate: EU commission executed a mandate to develop

DSMR: Dutch Smart Meter Requirements

MDMS: Meter Data Management System includes the tools that enable communication among different modules, as well as being in charge of validating, processing, and editing the metering data for a suitable information interchange among the different parts of the Smart Metering system
**UMTS**: Universal Mobile Telecommunications System is seen as the next generation to GSM making G3. This technology allows data traffic of up to 2MBps. G4 is under development and would be capable of transferring to 3 GBps.

**GPRS**: General Packet Radio Service is an extension to the existing GSM that allows working to 20 kbps

**GPRS/LTE**: Long Term Evolution is the first step to the evolution to the G4, can offer 8 to 50 MBps. Disadvantage is that LTE requires brand new network technology and masts and radios

**GSM**: Global system for mobile communications – Groupe Spécial Mobile is the second generation of mobile phoning (G2) developed in 1990 working for about 10 kbps
ANNEX 1: Smart meter standards applicable in the EU

**Standards for Electricity meters** (under the responsibility of CLC TC 13)
- EN 50470-1: Electricity metering equipment (a.c.) – Part 1: General requirements, tests and test conditions – Metering equipment (class indexes A, B and C)
- EN 50470-3: Electricity metering equipment (a.c.) – Part 3: Particular requirements – Static meters for active energy (class indexes A, B and C)
  The above two standards are harmonized under the MID.
- EN 62056-24 (draft) Electricity metering equipment (a.c.) – Particular requirements – Part 24: Static meters for reactive energy (classes 0,5 S, 1 S and 1)

**Standards for tariff and load control**

**Standards for payment metering:**

**Standards for Gas meters** (under the responsibility of CEN/TC 237)
- EN 1359: Gas Meters – diaphragm gas meters
- EN 12480: Gas Meters – rotary displacement meters
- EN 12261: Gas Meters – turbine gas meters
- EN 12405-1: Gas meters – conversion devices – Part 1 Volume conversion
- EN 14236: Ultrasonic domestic gas meters
- TR 16061: Gas meters – Smart gas meters

**Standards for Water meters** (under the responsibility of CEN TC 92)
- EN 14154 series: Water meters

**Standards for Heat meters** (under the responsibility of CEN TC 176)
- EN 1434 series: Heat meters

PARENT T1.3: State of the art of smart meters, sub-metering devices and EMS in the EU
**ANNEX 2: Companies offering energy management products/services**

The companies the have an *, are offering also sub metering devices (hardware), mentioned in 3.3. Choosing a sub-metering device.

<table>
<thead>
<tr>
<th>Company</th>
<th>Website</th>
</tr>
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</table>
Opower

Opower is the leading company of the residential energy efficiency sector mainly due to its high amount of final customers. It is a Software as a Service (SaaS) company providing customer engagement software to more than 95 utilities in 9 countries, which represents an scope of more than 50M final customers. Some fact that demonstrates its high influence in the sector is for instance, its dominating position in US market (37% of US households).

Opower define his product as a “customer engagement platform tailor-made for utilities”. It uses smart meters data to inform customers about their energy consumption (including Electricity and Gas). This interaction with the customer is done through several channels: a mobile app, a web portal and the Home Energy Report (HER) which provides a comparison of energy use with neighbours in order to challenge the customer to a more energy efficient behaviour. As many studies defend, social norms have demonstrated to be the most effective way to have an impact on customer energetic behaviour, whereas economic, environmental and community incentives have lower or no impact.

Other significant features from Opower’s software are: reward programs, online billing, utility notifications (for instance, high bill alerts) and targeted recommendations. Furthermore, the platform is completely white-labelled in order to brand the web portal and mobile app with each utility branding.

The product is presented in two different sides. On the one hand, it is a demand side management tool for utilities as it offers energy efficiency advice and demand response peak events. On the other hand, utilities also benefit from its customer care side based on digital engagement and bill advisor that increases the customer satisfaction and its loyalty.

Explore our products

DEMAND SIDE MANAGEMENT

Energy Efficiency
Save energy and promote programs with perfectly-tailored energy advice.

Demand Response
Achieve cost-effective peak energy savings with real-time communications.

Digital Engagement
Boost self-service and satisfaction with insight-rich web experiences.

CUSTOMER CARE

Bill Advisor
Give customers control over their bills with alerts and CCB tools.
C3 Energy

C3 Energy defines themselves as a company transforming the energy value chain by delivering “The internet of energy”. In fact, the variety of their products is very wide within the energy value chain. For instance, they give advice in the oil and gas industry, help organizations to achieve their sustainable goals and provide complex software to analyse and process data.

The Smart Grid applications segment is divided in two sections: one dedicated to the building and running processes regarding the advanced metering system and another tool named C3 Customer Engagement Application. This last instrument aims to offer a new customer engagement tool for utilities to interact with their customers.

Focusing on C3 Customer Engagement platform, it differentiates three types of customers: residential, commercial business and industrial enterprise.

The channels used to interact with the customer are through web portal, mobile app, mails and reports. Moreover, the features offered are for instance, a comparison of energy consumption with an average efficient home or business and the possibility to earn rewards. Finally, the platform is also available to be branded by the utility itself and it gives advice both on electricity and gas consumption.
Silver Spring Network

Silver Spring Network is a provider of smart grid products. Similar to C3 Energy, its product range is very wide and they offer many types of services. For instance, they differentiate between five types of business focus: smart cities, smart utilities, technology, intelligent devices and services.

In the smart cities section, Silver Spring Network provides guidance to cities in their challenges to modernize the infrastructure in the way to become a smart city. This is done for instance by adding new applications such as lighting/parking/traffic monitoring or including advanced meters for electricity, gas and water.

Regarding smart utilities, Silver Spring Network offers a customer engagement platform together with other services. However, this software does not compete in the broad open market, because it is only available for those utilities using their smart meters. It is important to highlight that Silver Spring Network is also a hardware based company selling intelligent devices such as smart meters, thermostats, In Home Displays (IHD) or Electrical Vehicle (EV) chargers.

Its customer engagement platform for utilities is called CustomerIQ and it is a tool for residential, commercial and industrial customers to manage better their energy consumption by providing recommendations and bill projections through a web portal, a mobile app or weekly email reports. The platform is highly configurable and the dashboard is also highly configurable allowing utilities to introduce their own branding. Moreover, as the result of several partners’ agreements, it includes load disaggregation applications. Besides this, Silver Spring Network also provides Demand Response (DR) technology for utilities.

Finally, SilverLink is an app store of industry-leading applications built by Silver Spring and other partners from different sectors (advanced metering, demand-side management, distribution automation, smart cities and software). For instance, Bidgely is one of their software partners. Within this app store, they also offer CustomerIQ Solar which is a tool that utilities can offer to their customers with a prosumer profile in order to maintain their customer relationship.
**Comverge**

Comverge is a company that provides hardware, software and services to utilities related with demand management programs. In addition, it is considered the leading company in the Demand Response (DR) industry and they serve over 500 utilities.

The hardware provided by Comverge goes from smart thermostats to remote control systems. *IntelliSOURCE* is the software platform offered which integrates demand response, energy efficiency and customer engagement tools. The platform is accessible from laptops, tablets and smartphones, but it was designed to be used from a mobile device. It provides normative comparisons with other users participating in the same utility program and gives personalized tips. Furthermore, it can be also connected to smart thermostats from Comverge or third-party suppliers, in order to control and configure the home temperature remotely. Finally, the platform is also integrated with demand response programs allowing utilities to manage peak load events.
Bidgely

Bidgely is presented as “your personal energy advisor”. It provides individually energy efficiency advice, neighbourhood comparison tools, appliance itemization and solar disaggregation. All these features are presented in a web portal or a mobile app, and the user is also able to share its successes through Facebook, Twitter and other communities. Despite they offer this service to end users passing through utilities, the platform can be found either from Bidgely directly or the utility branding. Therefore, in this case the utility may offer an energy efficient service as an outsource service under Bidgely’s branding.

Bidgely’s technology is based on disaggregation appliances, which enables to provide information on how individual appliances impact the bill. However, to have a more precise real-time energy tracking of individual appliances, they also developed a hardware named *HomeBeat Energy Monitor* that works as a bridge between the smart meter and the home router internet. The cost of such device is 35$ which is much more economically accessible than others smart thermostats.
Grid4C

Grid4C is a smart grid predictive analytics company focused on all the actors within the energy value chain. They provide software to analyse data collected from smart meters and consequently, provide forecasts, energy efficiency and customer engagements solutions.

The variety of their products is wide as they are offered specifically for each participant within the value chain: utilities, distributors, retailers and energy consumers.

From the previous products, Grid4C Customer Engagement is a software platform focused on final energy consumers. The input information comes from pricing, customer data and smart meters data. As a result, it offers energy efficiency solutions that are translated into economic profit for energy consumers and customer engagement for utilities.

The software is available both in web portal and app. Some of its significant features are: non-intrusive detection of app’s, demand response optimizations and customer segmentation. This allows providing personalized messages to inform about irregularities or give recommendations.
Powerley

Powerley is a new venture created from the collaboration of two companies: Vectorform which is a software developer and the utility DTE Energy.

They define themselves as the only utility-designed home energy management solution in the market. Therefore, its solution is centred on the utility and is completely branded with the utility brand (“delivering a unique experience to each utility”).

Moreover, apart from the software, the complete package solution also includes two branded hardware: first, an energy ‘bridge’ that works as a gateway device connected with the smart meter in order to receive more frequent information from it and that can be also connected to other external devices. This device can be connected with the majority of home solutions and therefore, it allows to remotely control thermostats, lights, etc. from the smartphone. Second, a smart thermostat that controls the home temperature remotely and is connected to the previously called energy ‘bridge’ is also included on the package. The cost of such devices depends on how much each utility wants to charge. In the case of DTE Energy, it is offered to their customers for free.

The platform provides real time consumption information, appliance level disaggregation and energy efficiency recommendations from self-learning and personalization method. Moreover, it also offers a collaborative system for peak demand response events. This system encourages customers to participate in community events and enables utilities to better manage their targeted savings.

Finally, a very innovative feature of the app is the so-called *PowerScan* tool which reads the magnetic field created by a power cable and provides the power consumed and the cost associated with it of any device only by using an iPhone.
**MeterGenius**

MeterGenius offers to utilities a self-branded customer platform for energy management. The platform is available on web portal and mobile or tablet app. It gives general suggestions and recommendations on how to save energy and become more energy efficiency. Moreover, it can be connected to outsource devices such as thermostats from external providers.

Special focus is made on gamification. In order to motivate customers, they offer reward points to stimulate good energy behaviours, engage customers into the platform and create loyalty with the utility brand.

They differentiate themselves from other products (like OPower) by delivering a persistent-engagement platform because their customers continue to see the results due to their gamification programs. However, they claim that in other platforms the customer only sees the results at the beginning and afterwards he or she declines.
Greenely

Greenely is a start-up from Sweden focused to help customer in decreasing their energy consumption by offering a platform that stimulates their energy behaviour. The software is available through utilities and therefore, it is also a customer engagement solution and a way to decrease peak costs for them.

The software is presented in an app and a web portal. To stimulate good energy performance, gamification is one of their key features together with comparison tools and community building. To visualize the energy consumption, the platform includes the design of a tree which is directly influenced by the level of consumption.
Plugwise

Plugwise is a Dutch company offering different hardware based products related with wireless energy management and control systems in order to increase energy efficiency in private households and business organizations.

One of their popular devices is Smile P1 which connects the smart meter with the smartphone or tablet via wireless. The connection is done through a P1 port and therefore, it is required that the smart meter has this output source.

It works as a gateway of consumption data both for electricity and gas. The app is mainly informative presenting hourly, daily, monthly and yearly data. The app is also available for prosumers allowing them to measure both production and consumption.

The product including the hardware and software is available at a price of 99€.

Other products from Plugwise are Anna and Cooling. The first one is a smart thermostat that allows the user to control and schedule home temperature from his smartphone and it costs 249€. The second one is an infrared device to remotely control the HVAC from the smartphone or tablet which costs 149€.
Eneco

Eneco is a Dutch utility company offering *Toon*, an energy efficiency product that consists of a smart thermostat connected to smart meters. The package is composed by several elements as is connected via wireless to the boiler, the electricity and gas smart meters.

It provides information on how much electricity and gas is being consumed at any time and by day, week, month or year. Besides this, if desired it also offers some tips on how to save energy and is able to control remotely the boiler.

The product is also available for non-utility customers. However, the cost of it varies: for Eneco’s customers, the installation is for free and they charge 3.5€ per month in the bill. For non-customers, they have to pay the installation cost (75€) and a monthly fee of 4.95€.
Green choice

Green choice is a renewable Dutch utility that provides electricity and gas. They have their own platform to provide an energy efficiency service to their customers. The software offered to their customers is a very simple app that provides daily, monthly and yearly consumption information.

The app does not offer real time consumption and the smallest time lapse is daily consumption. However, it offers a comparison with other similar households and provides some tips on how to save energy.

Download the new app Greenchoice

The app will get you as a customer of Green Choice insight into your consumption and you can arrange a lot of energy business itself. Simple, anytime, anywhere:

- Submit meter readings in your cupboard
- Check your energy consumption and grid per year, month, week and day
- View or change your monthly installment amount
- Compare your consumption with the rest of the Netherlands or similar households
- Use our saving tips to save energy
**Bee Group**

Bee Group is the energy efficiency department of the International Centre for Numerical Methods in Engineering (CIMNE). The company offers solutions to households, utilities, community buildings and cities, all related to provide tips and recommendations for a more efficient use of energy.

For the consumer side, they offer *ControlaEnergia* which is an app that provides graphs on your historic consumption, gives recommendations and compares with other users. Also, it includes some gamification tips to enhance the user engagement on the app. For instance, it awards the user with points for different reasons such as daily access or input information. It is important to highlight that the user has to enter his consumption data and is able to enter as much data as desired.

Besides this, the same software together with extra services related to data analytics is offered to utilities as a customer engagement tool. In this case, the software uses the data provided by the utility smart meters.
Green Pocket

Green Pocket is a software specialist based on Germany that provides energy and water management solutions to large and small utilities for residential and business customers.

The channels used within the residential product are: web portal, smartphone app and newsletter. Consumption data is obtained from smart meters, but the software is also able to connect with other hardware that allows offering extra smart home tools. Besides this, social metering is a key feature of the software: it allows posting the user’s achievements on Facebook, challenging your friends and winning badges for personal successes. Furthermore, it is also possible to visualize the energy produced if the customer works as a prosumer.

The software for business customers is similar, but more focused on the management side of time and resources.

In addition, Green Pocket is spreading its product by offering also smart home software. This tool includes remote control of appliances and lighting, and can be connected to many types of hardware (control devices, sensors, etc).

Finally, the company also offers consulting services for those interested in entering the smart home market. They provide different types of help such as market research or hardware acknowledgement as a result of their experience.
Rocket Home

Rocket Home is a German company offering multiple products in a centralized way. All the applications and features are connected in a unique device in order to provide “a complete solution for connected homes”. The fields covered are: home control, home monitoring and home energy.

Their solution is provided with an open software platform called *HomeRUN intelligence cloud*. The platform is white-label in order to allow branding on it and highly customizable. Their customers are mainly utilities and telecommunication companies.
Mirubee

Mirubee is a start-up from Wayra (Telefonica accelerator) that offers an energy efficiency solution in a BtoC (Business to Customer) business model. It is important to highlight that this solution does not use the data from smart meters and requires installing a device into the home’s electrical panel. This device, Mirubox, sends continuously the consumption data via Wi-Fi and its price is 119.50€.

The channels used are smartphone app and web portal. It provides tips on the best electric tariff for the customer based on his/her past consumption. The most important feature is its ability to disaggregate consumption data through Inspectee technology.
Wattio

Wattio is a company providing home control solutions for comfort, energy efficiency and security services. They offer different types of devices such as smart thermostats, smart plugs, security cameras, etc.

For each demand, they offer several packages composed by different devices. For instance, to save electricity, they offer a package composed by a smart plug and an electricity monitor. Both devices are connected to the software provided by Wattio.

The software gives insights on your electricity consumption and provides information on your consumption habits. Moreover, it also provides a comparison with other homes and sends alarm when something unusual happens in the consumption.

The price of a package composed by a smart thermostat, a smart plug, an energy monitor and a home automation centre is 299.90€.
Circutor

Circutor is a company with more than 40 years of experience on designing and manufacturing hardware devices for energy efficiency services such as monitoring, measurement, control, protection, etc.

One of their innovative devices is **Wibee** which is a consumption analyser. The device is inserted into the electrical panel and connected to a Wi-Fi connection in order to collect electrical data. The market price of the device is 173€.

The interaction with the user is done with an app also developed by Circutor. The software allows the user to access to his/her consumption data in real time by using a smartphone, a tablet or a computer. The platform provides instantaneous power consumption and allows exporting the data generated to an Excel sheet. Moreover, it also provides instantaneous values for other variables such as active power, reactive power, intensity, voltage, and frequency, etc. The data is collected into the platform in order to observe and compare the evolution of electricity consumption.
Intelen is a USA start-up company that provides a customer engagement platform for utility customers both businesses and residential. The company puts all the efforts on providing the most completely personalized service. Understanding each customer’s behavioural pattern is the key success to offer services that “Engage people to rethink”.

The solution proposed, presented under the name of DiG Energy, is white-labelled in order to include utility brands and has many different features that can vary depending on the willingness of each energy provider.

Features are comprised in 4 main sections: DiG Energy, DiG Engagement, DiG Marketplace and DiG Consulting/Analytics. DiG Energy provides tools to monitor daily energy consumption and its associated cost through different functionalities such as peer comparison, peak demand monitoring, energy disaggregation, personalized notifications and bills prediction. DiG Engagement provides educational tools to empower behavioural changes in the users in order to retain them as long as possible and attract new customers. They provide personalized services in order to satisfy customer’s needs through gamification tools. At the same time, users are challenged in order to understand the benefits of their achievements. DiG Marketplace is also related with the gamification tools. It is a place that can be used for the utility as a way to increase the revenues, and with the introduction of virtual coins, it offers the user an extra gamified experience to recompense his/her energy savings efforts. Finally, DiG Consulting/Analytics is a service resulting from the acknowledgement on understanding every user’s routine. This tool is offered to utilities in order to be able to segment more accurately the market and prepare more customized marketing campaigns.
**Watty**

Watty is a start-up from Sweden focused on disaggregation technologies. Using just one measurement source and applying it to their machine learning algorithms, they are able to diagnose the appliances energy usage. To do so, their solution requires of a low-cost hardware that obtains the data from the smart meter. Moreover, it also compares the appliances with alternatives in the market.

The solution is mainly designed for utility companies to increase their customer engagement. However, they also offer his software to solar providers and connected homes companies. In these cases, they allow to use and integrate with their software.
Alert Me

AlertMe is a UK company offering hardware and software in order to enable household users to monitor and control their energy consumption. Through disaggregation algorithms, they provide energy savings recommendations.

Hardware devices are based on a home hub that can be connected via wireless to other AlertMe devices and third party devices.

The software platform is based on three main products: SmartEnergy for electricity monitoring, SmartHeating for remote heating control and SmartMonitoring for home monitoring.

It has been acquired by British Gas and the original website is no longer available. (65m$)
British Gas

British Gas is the largest UK energy company. They supply gas, electricity, boilers and home services. In 2015, they acquired the company AlertMe in order to offer an energy saving service directly to their customers.

The company offers for free to their customers the installation of a smart meter that monitors at real time the electricity and gas consumption. The smart meter together with the platform My Energy enables the user to visualize his/her daily, weekly, monthly and yearly energy consumption, and compares it with past values and other customers. Moreover, the platform also provides some general energy saving tips.

Besides this, they also offer Hive, a smart thermostat to control and monitor heating. The thermostat is provided in a package with two more devices that enable to connect to the boiler and the wireless router. It is important to highlight that there is no need to be British Gas customer to be able to purchase this product. The price of the complete kit is 249$. 

A wireless thermostat

Beautiful design. Clever control. The new Hive thermostat lets you easily control your heating at home.

A hub

Plugs into your broadband router so your thermostat connects to the internet. (We’ll set it up for you in the installation.)

A receiver

Let’s your thermostat and boiler talk to each other. It’s usually fitted near your boiler, so you’ll barely notice it.
**Factor Energia**

Factor Energia is an electricity retailer offering a new energy efficiency service to his customers. The service is accessible from an app named *Factor SmartHome* and it is focused on the economic savings through a responsible energy use.

The main characteristic of the platform is the ability to present the hourly price of electricity and give recommendations on the best time for using common appliances such as washing machines. Besides this, the platform also offers the possibility to compare with other consumers. If the user includes information about his/her home, the platform is also able to provide personalized energy saving tips depending on geographic situation, number of people, heating/cooling system, etc.
Fifthplay

Fifthplay is a Belgium company delivering smart home solutions for increasing comfort and save energy. They work together with utilities, telecommunication companies and others.

The product range is wide and they offer mainly many different hardware smart devices and software connected to them. The products are assembled in several packages for specific purposes. For example, they offer packages for schools and universities, for software developers and for utilities.

Using the software from a web portal or through the app, the user can control smart plugs, set the temperature of the thermostat and compare the consumption of each device.

Smart cities are also one of their customers. In this case, they offer a specialized solution for them called Nuvonet that offers a smart community platform built by blocks that are chose specifically for each type of community.
Onzo is a company focused on analysing big data in order to provide customized solutions to utilities for customer engagement services. They emphasize on their ability to develop complete customized tools for specific uses depending on each utility need. Moreover, the platform offered is completely white-labelled in order to personalize the communication between the customer and the utility.

In other words, they analyse big data from the utility to transform and deliver valuable information that benefits both user and utilities. The data received from the utility comes from electricity and gas meters.

They are already working with the utility Green Choice and with Silver Spring Networks.
Wattabit

Wattabit is a Software as a Service (SaaS) company providing a platform to monitor and remotely control energy consumption such as electricity, gas and water.

The company does not take part on the Hardware development, but it enables the connection and communication with any hardware. The software is focused to small business and companies. Moreover, it is also provided to Energy Service companies as a tool to offer their services.

The basic features included on the platform are presented in the image below. Personalized reports, remote control, billing information and detection of extra payment, real-time monitoring, etc.
Ijenko

Ijenko is a French company that provides a platform to enhance consumers experience across different IoT environments. The platform offers what they called the Internet of Energy (IoE) which consists on developing services and linking smart energy devices in order to provide a collaborative tool between Ijenko’s customers and residential consumers.

Ijenko’s customers are divided in four figures: utilities, telcos, consumer electronic (CE) groups and smart cities. They enable utilities to engage their customers by providing tools to save energy and demand response programs. Telcos can use the platform to offer added-value services such as security, home automation and smart heating services in order to differentiate. CE companies collaborate with Ijenko to design and develop smart home devices. At the same time, they can use the platform as a bridge to enter new markets from the IoT. Finally, smart cities can take advantage of its platform to deploy integrated energy management systems.

The Ijenko Home Energy Management Solution have different features: Energy efficiency tips such as total consumption, appliances consumption, savings and comparisons. Other features are: Smart heating, Demand response, Electric Vehicles charging, PV production.

The platform is accessible through many APIs which allow customer to create their own end-user experiences.
Efergy

Efergy was founded in 2005 with the central mission to help people save energy, money and the environment by providing online energy monitors and In-home displays. Their systems give an insight on how much energy is being consumed in real time and the cost associated with it. It also shows historical information.

Their monitoring solutions are available both for end users (homes and small businesses) and utilities. Moreover, they participated in public projects for specific cities (for example Queensland, Sabadell and Donostia).

Besides this, Efergy also collaborates with some utilities to develop smart meters by providing PLC gateways and Zigbee enabled monitors.

They are constantly developing new smart home products to keep on the road of the connected home.

They offer different package products with kits specialized for each application and customer.
Smappee

Smappee offers a solution to monitor the home electricity consumption. They present the product as “the world’s smartest home energy monitor”.

The solution is based on an Energy Monitor that has to be connected to the home’s fuse box. This monitor is connected through the Wi-Fi to their own software accessible from a smartphone and web portal. They provide appliance level consumption due to their knowledge on disaggregation algorithms.

Besides this, they also offer smart home products. Specifically, Smart Plugs are provided to control remotely selected appliances or lighting.

Moreover, the software presents an Awards section that rewards good user’s behaviours such as completing your profile, reduce consumption, label appliances, etc.

The product can be found directly for the end-user and is presented in packages. For instance, the most common product including the Energy Monitor and a Smart Plug, costs 199,00€.

They also offer a version named Pro which is focused on bringing energy monitoring and control to SME’s.

Finally, as their newest product, Smappee has also developed hardware to monitor gas and water consumption. All the hardware offered is connected and is presented together in the same software.
Navetas

Navetas is a UK company delivering services for the smart home. The services are cloud-based energy monitoring and smart data analytics.

They have a product called Loop that works as a personal energy assistant. It consists on a platform that monitors electricity and gas, gives real-time advice and is accessible from your phone, table or computer. Moreover, starting on 2016, it also monitors Micro-generation.

The platform offers real-time monitoring of consumption in terms of energy and cost. It also presents spends on the last day, week, month and year. Gas and electricity are presented together in order to observe the importance of each one.

Moreover, it offers tools such as comparison with similar users and budget challenges proposed by the user: the platform only explains what the current state of accomplishment is and summarizes the previous budgets.

Finally, an important and distinctive tool within the platform is the access to the best deals based on your consumption and the possibility to switch easily from your energy provider. This service is similar to a marketplace of energy providers and is offered through a partnership with uSwitch.com which is the #1 energy switching service in the UK.
Ecoisme

Ecoisme is a Polish company that developed a solution to “save energy in an easy way”. The solution is hardware based and includes a sensor connected to the home electric box that tracks the energy consumption. This measurement is synchronised with a platform that provides recommendations and alerts in order to save energy.

The two principal characteristics of this solution is the ability to detect appliances through disaggregation algorithms and the personalized tips. It is important to highlight that they used power analysis and spectrum analysis to detect devices. This is a very precise tool that requires high frequency measurement hardware.

Moreover, the platform can be also integrated to out-source smart devices. Besides this, it is also connected to social network such as Facebook in order to compare with your friends.

The solution automatically detects the most common appliances. However, the user can also provide some detailed information about them in order to get more precise feedback.

The personalized tips are based on detection of high energy consumption. For instance, with this system, the software can detect if the user forgot to close the fridge or if the iron is turned on for too long. Furthermore, other recommendations regarding the best time to charge the car or to run the washing machine are available.

Finally, the platform also monitors micro-generation in case the user has solar panels or some other micro generation at home.

The project was financed via crowdfunding and the campaign end by June 2015 raising the amount of 67.000$. The product is intended to be available in the market in April 2016, but the price is not presented yet.
Neurio

Neurio is a company from Canada offering a solution for residential users to save energy and thus, save money.

Their solution is hardware based and consists on installing a measurement device into the electric box. This device is connected through the Wi-Fi to a software platform that monitors the home electricity consumption. Therefore, the platform presents the real-time power consumption of the house and other features such as historic data, ranking comparison with neighbours, bill forecasting and energy saving tips. Moreover, the platform is also able to monitor solar generation in the case it exists.

The product is presented in two versions named Home Energy Monitor and Intelligent Energy Monitor. The difference between them are the features included, being the second one the premium version. Consequently, Intelligent Energy Monitor offers appliance level consumption and it is able to detect several appliances. Moreover, to have more precise insights, the user can input information regarding his appliances. To do this, the platform includes the “training” mode which is designed specifically to detect appliances.

Finally, the solution also sends personalized notifications to alert of forecasted excess consumption in order to prevent the user.

![Neurio product image]

**Home Energy Monitor**
- A smarter way to manage your home energy cost.
- Real-time energy usage and generation.
- Bill forecasting.
- Historic usage and generation stats.
- Energy saving tips.
- Neighbor comparisons.
- Top appliance usage.
- Training mode.

**Intelligent Home Monitor**
- Makes your home smarter, safer, and more efficient.
- Top appliance usage.
- Real-time appliance tracking.
- Smart notifications.

**Home Energy Monitor**: $179.99
**Intelligent Home Monitor**: $249.99
**Simple Energy**

Simple Energy is a customer engagement company for utilities with the aim to change people’s mind on energy. Their goal is to “inspire customers to take action”. Their solution offers a range of experiences to engage people and is designed taking into account that different people respond to different things. Consequently, they put a lot of emphasis to send personalized messages to every customer. To receive more precise and personalized tips, the user is able to introduce characteristics of its home using an intuitive survey.

Moreover, the platform also provides comparison with similar houses. It shows the consumption of those houses similar to yours. Furthermore, several tools are used to motivate users. For instance, good behaviours are rewarded, goals are proposed and testimonial stories from other users are shown in order to inspire people to act.

It is important to highlight one of the innovative tools included: community energy saving competitions. This type of competitions is organized during peak energy times and is rewarded with badges or virtual points. Moreover, this tool is their way to build a community because every user participates to achieve a common goal and it compares between users by showing the contribution of each participant. Therefore, the platform also offers a demand side management for utilities in order to allow their users to participate in demand response programs.

Besides this, the platform is also connected to a marketplace branded by the utility that allows customers to take wise decisions when purchasing new energy related products. Some products can be purchased using virtual points or badges.

Finally, the platform is white-labelled and each utility is able to brand the platform and integrate with the utility’s current website.
eGreen

eGreen is a French start-up that helps to reduce water consumption and energy consumption both in electricity and gas. To achieve this goal, it monitors water, electricity, gas and indoor temperature. However, it is important to highlight that users without access to monitoring can join the platform as well. In this case, the user introduces manually the consumption of his electric, gas or water meter regularly.

The monitor these consumptions, an online shop is available to purchase monitoring devices. These devices are installed into the electric box or the gas/water meters and connected via wireless to eGreen’s platform. At the moment, eGreen offers devices to measure electricity consumption, but other external companies can also offer other devices that can be synchronized to eGreen platform.

eGreen’s platform shows the consumption of water, gas and electricity in an hourly time base. Consumptions is presented in kWh consumed, € costed or CO2 emitted. Moreover, it also offers a comparison with anonymous neighbours. It is important to say that within this comparison the user can observe the number of habitants or the house surface in each household in order to have a more effective comparison. Besides this, the platform also provides energy efficiency recommendations and it can be used as a tool to organized friendly competitions. The messages presented or general with the common link to be sustainable, ecological or energy efficiency related.

The product is generally offered to end users. However, it is also available for enterprises and community buildings. Moreover, eGreen has been selected as one of the five start-ups included in a project called DataCity. In this case, the services from eGreen will be offered to the citizens of Paris.
Enernoc define himself as “the world leader in energy intelligence software”. They identify two main customers: business and utilities. For business they offer analytics solutions to control their energy costs and for utilities, they provide solutions to enhance the relationship with their customers.

Their solution compares electricity consumption between neighbours for residential and SME’s. It also sends energy efficiency recommendation messages.

It enables also to organize demand response events in order to increase customer engagement and improve demand-side management.

Enernoc’s solution is specialized on utilities business customers rather than residential.
My Energy

My Energy is an online service company that had been acquired by Nest in 2013. The company itself provides a platform that gathers all your utility bills in one common place. Therefore, it is a way for residential users to collect electricity, gas and water bills in a same place. Moreover, the platform is connected to Facebook or Google social network in order to create a community and compare with your friends. At the same time, by introducing his address, the user is also compared to their neighbours.

The platform is offered directly to residential users in US. However, utilities can also participate on it and use the platform as a customer engagement solution and meet their energy efficiency goals.

Energy savings challenges are organized through the platform allowing its users to participate on them and earn rewards for good energy behaviours. These reward points can be used later in a marketplace offered as a result of the collaboration with other businesses. Energy savings can be achieved thanks to the “tips to save on your energy bill” presented in the platform.

Use MyEnergy to save on your utility bills in 3 easy steps:

1. Create your account.
   Signup is easy! Just connect with your Facebook or Google account.

2. Tell us where you live.
   Track your energy, whether you live in an apartment, condo, or house.

3. Connect your utilities.
   Enable MyEnergy to connect to your utility company’s website.

Create a free account now.
Current Cost

Current Cost is a UK company that produces devices to monitor electricity (recently, gas also) consumption. Their solution is hardware based and they offer different devices to track energy. Besides this, they also offer some software to show the data collected from their software online. Moreover, they allow other parties or individuals to develop software to be used with their devices and these options are included in their website.

Their main product is an IHD device that works as an Energy Monitor that track the energy consumption in real-time. There are several models: the simplest one only presents real-time consumption and associated cost, and the new generation models also offer appliance monitoring. This is not based on disaggregation models, but it shows how your consumption is expended during the day in order to identify if you are leaving some appliance on.

In addition, to connect IHD’s to software, it is needed to purchase another device (NetSmart) that works as a bridge between them. This hardware product has been also developed by Current Cost. Finally, there is another energy bridge that is connected directly to the smart meters and obtains energy consumption data from it. However, this product is also compatible with some types of smart meters that are presented in their website.

Finally, they recently developed a product that is connected to gas smart meters and therefore, it also monitors gas consumption. The information is gathered also into their online dashboard. They have two models depending on the smart meter type.

Current Cost’s products can be found directly in their online shop and through some utilities that include their products in their personalized online marketplace.
Dwelo

Dwelo is a start-up company created in 2014 with the aim to transform apartments into smart homes. Their solution is offered to two types of customers: residential and apartment managers.

The product can be divided in three main areas, all gathered in a common mobile app. The first service is focused on Convenience and it consists on enabling the user to control the lighting from the smartphone. Second, it is also a Security service allowing the user to lock and unlock door from the phone. Finally, the third area is focused on Efficiency and it consists on controlling the home’s temperature through a smart thermostat.

The product is offered directly to residential users or home apartment managers. In this case, managers can control all their properties with a central platform accessible from the smartphone or in the website.
**BEN Energy**

BEN Energy is a SaaS (Software as a Service) company with the aim to change how people interact with their energy. The software is based on data analytics and behavioural science algorithms in order to offer the end-user an energy experience that engages utility companies with residential users.

There is not much information regarding the characteristics and features included in their platform. Nevertheless, it is intended to be highly customizable for the utility and the communication with the user is done in a personalized manner through mobile, web, email or sms. In addition, it can be integrated with the utility service portal and the service can be delivered to users with and without smart meters.

They are already offering different types of end-customer relationship solutions through their services to 28 utilities.
SolarCity

SolarCity is the leader company in photovoltaic solar systems for residential homes, businesses and governments. They provide full services: design, financing, installation and monitoring.

They have recently developed a mobile app called MySolarCity which allows users to monitor their energy consumption and solar production. Consumption and generation data is presented in real-time mode, but also historic daily, monthly and yearly data is presented. Apart from it, the platform also includes extra features such as information regarding where the user can save more energy in his home, a map that shows the location of other users within the community and the possibility to earn reward points and money when recommending to new customers. Furthermore, it also enables users to share their experience through a social media tool called SolarCity story.

This service is only delivered to those customers that installed a special device in their electric panels during the installation phase. This process requires having access into the wires coming from the grid that can be physically limited in some cases.

MySolarCity

Download the MySolarCity app and experience all the features first-hand. See how you can track your solar system’s production as well as your home’s consumption, tap into the SolarCity community and get a smarter, more connected home.

All MySolarCity’s features are available using a demo account. If you are a registered Ambassador, as an Ambassador the new app gives you everything you need to educate your community on how solar works.
Elenia

Elenia is a Finish electricity and heating utility that already had developed a smart electricity grid by integrating power distribution and data systems. Consequently, their customers can access online to their real-time electricity consumption on a month, daily and hourly basis.

This information is provided through a mobile app and a web portal.
**Enel & Ilevia**

Enel is the biggest Italian company within the energy market and Ilevia is a company dedicated to develop software and hardware to automate homes and buildings. As a result of their collaboration, they have developed a product called *Enel Smart Info* which consists on a smart device connected to a socket that connects with Enel’s smart meters and thus, monitors electricity usage.

The information is presented through an app and web portal and it also shows historical data. Moreover, it also monitors generation from solar panels if existing.

It is important to highlight the easy way of installing such device and that it is only compatible with Enel’s smart meters.
**Tendril**

Tendril is a US company offering a cloud-based platform for utilities to deliver customer engagement solutions.

The solution is based on what they called *Tendril’s Energy Intelligence* which consists on understanding and simulating how people worldwide consume energy. They also use data analytics to analyse how structural data of the house (size, insulation, thermal capacity, and a long etc) and how weather conditions affect energy consumption. Besides their knowledge on the home, they also analyse behaviours on the home and how people engage with energy services. They emphasize on the unique way of user’s relationship with energy habits and consequently, the importance of personalizing communication with them. Furthermore, no smart data is required to offer this solution.

Features included in the platform are: real-time energy consumption, neighbourhood comparisons and energy efficient personalized tips. The app can also be synchronised and control remotely connected home devices. Moreover, it allows also to participate in Demand Response programs organized by the utility and the user can share his achievements through social media such as Facebook, Twitter and email.

Finally, they identified three types of customers: Utilities & Retailers, Solar providers and Real Estate professionals.
EcoFactor

EcoFactor applies advanced analytics to connected home devices. Their application automatically manages thermostats and air conditioners allowing end users to reduce their energy bill.

The platform is based on three main fields: Proactive Energy Efficiency recommendations, optimized Demand Response events and HVAC Performance Monitoring.

Their solution is offered through different channels: Utilities, Home Service Providers and Energy Retailers. All designed to reach end consumers.

They emphasize on providing solutions that avoid the user to be constantly monitoring and adjusting their thermostat. Their algorithms learn by themselves and adjust automatically. It also prevents from DR events by cooling the home before a DR event starts. Finally, it detects problems on the HVAC system that may affect the energy efficiency of the equipment.

The platform can be integrated to existing interfaces through an API allowing customers to brand their unique consumer experience.
## ANNEX 3: Product analysis of the Energy Management Business

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**PARENT T1.3: State of the art of smart meters, sub-metering devices and EMS in the EU**
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**PARENT T1.3: State of the art of smart meters, sub-metering devices and EMS in the EU**