Smart appliances and smart homes: recent progresses in the EU

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Among the EU priorities for 2020 the European Commission has proposed the Digital Agenda in 2010 and more recently the Digital Single Market (2015) which aims for to:

- Offer a better access for consumers to digital goods and services across Europe;
- Create the right conditions and a level playing field for digital networks and innovative services to flourish;
- Maximize the growth potential of the digital economy;
The lack of Interoperability and absence of standards are seen by the Commission as a hurdle for the development of the Digital Single Market.

ICT standardization is seen as essential for the interoperability within the Digital Single Market, allowing for the steering of the development of new technologies like 5G wireless communications, data-driven services, cloud services, intelligent transport, energy and building systems and the Internet of Things.
The digitization in basic sectors are seen as crucial in the strategy namely for **e-Energy** as it is seen as an important sector where it is acknowledged a radical change in the energy sector where;

“citizens, industries and commerce will engage in active management of their energy, first as consumers who adjust their consumption, but also as producers of electricity from residential, industrial or community-based renewable sources. Users and companies will be able to optimise their demand or supply of energy through different vectors and local storage, under a new energy market design as addressed in the Energy Union.”
According with the Digital Single Market strategy the three interrelated areas where ICT is expected to have an impact on the efficiency of energy systems are:

1) ICT in buildings - in the form of building management systems and sensor networks;

2) ICT in Energy Grids (Smart Grids) – In order to reduce peak demand and facilitate integration of renewable sources;

3) ICT in households – With the introduction of smart meters and smart appliances, making consumers aware of their energy consumption and trigger potential behavioural changes.

The strategy sets a vision of Europe where availability and take-up of very high capacity networks enable the widespread use of products, services and applications in the Digital Single Market. This vision is based on three main objectives for the year 2025:

- Gigabit connectivity for all main of socio-economic drivers,
- Uninterrupted 5G coverage for all urban areas and major terrestrial transport paths,
- Access to connectivity offering at least 100 Mbps for all European households
Level of internet access in Households, individuals and individuals frequently using the internet (2016) Source: Eurostat
Broadband coverage in Europe (2015) Source: European Commission
The Directives 2009/72/EC and 2009/73/EC concerning the common rules for the internal market in electricity and gas outline the need for Member States to encourage the modernisation of distribution networks through the introduction of **smart grids, smart meters, and developing innovative pricing formulas.**

Member States were required, by 2012, to assess the long-term costs and benefits to the market and the individual consumers of the roll-out of smart metering systems. In the case of this assessment resulting positive, at least 80% of the consumers should be equipped with smart meters by 2020.

The European Commission produced a recommendation for the preparations for the **roll-out of smart metering** strategies (2012/148/EU) In this recommendation, data protection and security considerations are outlined, The recommendation also outlines the common minimum functional requirements that smart meters should present.
For the customer, the meters should provide **readings directly to the costumer since direct consumer feedback** is seen as essential to ensure energy savings on the demand side.

There also the reference for standardized interfaces which should enable energy management solutions in real time like home automation and demand response schemes.

On the metering operator side the meters should allow remote reading, provide two-way communication between the smart meter and external networks and allow frequent readings so that the information can be used for **network planning**.

Other requirements on the functionalities of smart meters are the provision of **secure data communication**, fraud prevention and detection and the provision for import/export and reactive metering to allow renewable and local micro-generation.
Smart Meters roll-out

Smart Electricity Metering Roll-Out (2014). Source: European Commission
Another important development in relation to the energy transition and a competitive energy market with a high degree of renewable energy is **demand response**. Demand Response is seen as a crucial technology on the Strategy for the Energy Union, by allowing the full participation of consumers in the market.

The **Energy Efficiency Directive** allows for the right conditions being created for policy-makers, regulators, network operators and energy businesses to trigger more demand side participation in the energy market.

It is estimates that the volume of controllable load by smart appliances in the EU is of at least 60 GW, of which 40 GW would be economically viable. The shift of this load from peak times to other periods is expected to reduce peak-generation in the EU by 10%.
In terms of accelerating Demand Response in the residential sector, the promotion of **household appliances and equipment that are able to modulate temporarily their energy use**, smart metering systems and energy storage possibilities are seen as solutions for an effective adoption of Demand Response in the European market.
The JRC report on “Demand Response status in EU Member States” gives an overview on the state of Demand Response in the EU-28 and provides a review on the readiness of Member States in terms of the establishment of a legal framework and market readiness for the use of Demand Response in the energy market.

Some key elements for a successful development of Demand Response programmes are:

1. the definition and recognized role of independent aggregators that can ensure the consumer’s right to choose their energy service provider and allow full aggregation of consumer’s loads;

2. market design enabling the participation of Demand Response and some energy markets;

3. clear technical modalities enabling Demand Response participation in energy markets and replication throughout whole Europe.
Member States are in three groups concerning Demand Response enabling and implementation.

Member States that have not yet adjusted their regulatory structures, begun the process of defining the role of an independent aggregator and DR service provider, or adjusted critical technical modalities. Portugal, Spain, Italy, Croatia, the Czech Republic, Bulgaria, Slovakia, Hungary, Cyprus, Greece, Poland or Malta.

Member States more advanced on the enablement of Demand Response are Austria, Finland, Denmark, Germany, the Netherlands and Sweden by enabling Demand Response through the energy retailer with demand side solutions offers as a bundle with their electricity bill.

Member States enables both Demand Response and independent aggregation. This includes Belgium, France, Ireland and the UK. Belgium and France have both defined the roles and responsibilities around independent aggregation.
Definitions of smart appliances

• The preparatory study for Smart Appliances under the Ecodesign directive defines Smart Appliances as “an appliance that supports Demand Side Flexibility that is able to automatically respond to external stimuli e.g. price information, direct control signals, and/or local measurements (mainly voltage and frequency); The response is a change of the appliance’s electricity consumption pattern.”

• Our definition of smart appliances is an **appliance or energy related equipment connected or connectable to other services or products through a network of some kind enabled by ICT services or goods.**

• For the purpose of our paper, smart or connected devices are devices with embedded ICT and that can be connected to other devices or systems via a cable or wirelessly.
Smart Appliances and connected devices within the Smart Home are intrinsically linked with external conditions like the access to broadband internet, smart meters, the possibility to offer Demand Response through aggregators, etc..

This section gives an overview on the status of the European market in terms of the current adoption of smart appliances and connected devices and its potential to further embrace these technologies by:

- universal access to fast internet,
- the roll-out of smart meters
- the readiness of energy regulators to allow final energy consumers to participate in the energy market by offering flexible loads, storage and decentralized energy production.
Volume Sales of Smart Home categories in FR, DE, UK in 2014 and 2015. Source: GFK
Volume sales of product groups from category Smart Major Domestic Appliances in FR, DE, UK (January 2014-March 2015). Source: GFK
World market for smart connected major home appliances in 2014 and 2020. Source: IHS

- **2014**: Total Market 1Mn units
  - APAC: 65%
  - Americas: 30%
  - Europe: 5%
  - MEA: 0.5%

- **2020**: Total Market 230Mn units
  - APAC: 68%
  - Americas: 16%
  - Europe: 12%
  - MEA: 4%
World market for smart connected major home appliances in 2014 and 2020. Source: IHS
Consumer ownership of connected devices. Source Deloitte (2016)
Intent to purchase within 12 months. Source: Deloitte (2016)
Appliances consumers are most likely to replace with a connected device. Source: Deloitte

Base: UK consumers 18+ (n = 2076)
Source: Deloitte research, May 2016
• Deloitte consumer review of 2016 “Switch on to the connected home!” shows some signals of an increase of sales of smart home devices, greatly due to a generational change.
• Younger generations find more value in smart home devices, with UK consumers under 34 years old being more likely than older generations to purchase connected devices with the conviction that these would make their lives easier.
• 48% of the respondents said they think smart home devices are too expensive, while 26% refer to think that the technology needs to evolve further before they buy a smart device.
• Older consumers are more worried about the device’s long replacement cycles than the price.
• While in some categories such as entertainment, consumers are already purchasing connected devices, fewer people own devices in other areas of the smart home ecosystem, with only two or three percent of the consumers having purchased smart security systems, smart thermostats and lighting systems.
• The majority of people within this study (70%) do not plan to buy any connected devices in the near future, and only plan to replace lighting and thermostats with connected devices once they need to.
**CEN**: TC 225 is working on edgeware data capture, namely on bar codes, RFID, and RTLS. Working Group 6 (Internet of Things – Identification, Data Capture and Edge Technologies) focuses on the interface between edge data capture technologies and the IoT. TC 294 is working with “Communication systems for meters and remote reading of meters” and focuses on the exchange of information to non-electricity meters and other supporting equipment.

**CENELEC**: CLC/TC59x Working group is active on the “Performance of household and similar electrical appliances” WG7 “Smart household appliances”. This Working Group is performing standardisation work to enable domestic appliances to improve functionality through the use of network communication like smart grids, smart homes and home networks.

**ETSI**: On the Internet of Things, ETSI is tackling the issues relating to the connection of the smart objects into a communications network by developing standards for data security, data management, data transport and data processing, allowing to make sure that applications like smart metering reach its full potential. Also ETSI has developed the SAREF standard (Smart Appliances Reference ontology which is a shared model of consensus that facilitates the matching of existing assets (standards/protocols/data models/etc.) in the smart appliances domain. The SAREF ontology provides building blocks that allow separation and recombination of different parts of the ontology depending on specific needs.
**IEC:** IEC/CLC/TC 13 “Electrical energy measurement and control” Working Group 14 (Electricity Metering data exchange) by developing the standards to be able to transfer consumption information that is registered in the electricity meter. IEC/TC 57 Working Group “Interfaces and protocol profiles relevant to systems connected to the electrical grid” is focusing on the functionalities and data definitions for Demand Response.

Another working group comprising IEC/TC 57 WG21, CLC/TC 205 and CLC/TC 59X is collecting Use Cases and requirements for the Smart Grid and Smart Home. The use cases collected cover providing energy consumption information, controlling smart appliances, EV charging, power limitation, consumer offering flexibility, battery management, etc.

IEC/TC59 “Performance of household and similar electrical appliances” Working Group 15 “Connection of household appliances to smart grids and appliances interaction” is establishing a set of common terms, concepts and criteria, to assist the TC 59 and its Subcommittees in addressing the technical aspects of interaction between household appliances and the smart grid.

IEC/TS 62950 ‘Household and similar electrical appliances - Specifying and testing smart capabilities of smart appliances - General aspects’ is developing the common architecture which applies to different use cases and appliance types, and the principles of measuring smart performance within the context of the common architecture.
IEEE: The Institute of Electrical and Electronics Engineers Standards Association (IEEE), on its side is in the process of developing a standard for a framework for the IoT (P2413).

IETF: The Internet Engineering Task Force (IETF) is working on developing standards regarding the interoperability between smart object networks and the definition of the necessary security and management protocol for building these networks.

ISO: dedicated Working Group for the Internet of Things (ISO/IEC JTC1 WG10) that is developing ISO/IEC 30141 – the IoT reference architecture. This Working Group has ongoing work in the definition of Terms and Definitions for IoT vocabulary, IoT reference architecture, Support for interoperability of IoT systems in terms of framework, networking, syntactic and semantic operability, use-cases covered by IoT, Monitoring the ongoing regulatory, market, business and technology IoT requirements and IoT standards that build on the foundational standards in relevant Working sub-groups.

ISO/IEC 15067-3:2012 is working on the specification of an energy management model for programmes that manage the consumer demand for electricity using a method known as "DR". Three types of DR are specified in this standard: direct control, local control and distributed control.
**ITU:** The International Telecommunications Union (ITU) is a United Nations institution dedicated to the study and development of standards within the ICT environment and has a dedicated ITU-T Study Group 20 on “IoT and its applications, including smart cities and communities”. The aim of this Study Group is to develop a set of IoT international standards. The work being developed includes “Semantics-based requirements and framework for the IoT, “Requirements of the plug and play capability of the IoT”

On Energy management, ITU has developed within ITU-T Study Group 13 the Recommendation ITU-T Y.2070 “Requirements and architecture of the home energy management system and home network services”.

**3GPP:** The 3rd Generation Partnership Project (3GPP) has a group in charge of 2G, 3G and 4G standardization (GERAN group).

**OIC:** The Open Connectivity Foundation (OIC) is working on the definition of the connectivity of requirements for devices, by the definition of the specification and certification to deliver reliable interoperability.

**W3C:** The Web of Things Interest Group is supporting the overcoming of fragmentation of the IoT by introducing a web-based abstraction layer capable of interconnecting the existing Internet of Things platforms and complementing available standards.
Conclusions

• It is important that a common **definition of smart appliances** is found, in a similar way to smart phone or smart meter, whether it comes from standards body or the market it is still open.

• For the authors the key issue is the ability **to communicate with other devices** and the internet access is the most important feature of smart appliances.

• The definition should also allow to differentiated between smart appliances and other smart devices in the smart home environment, for example smart meters, smart thermostat, and other devices that are connected (e.g. complex set top boxes, home gateways)
Conclusions

• Not only the definition it is important but also the **test methods to measure the energy consumption**, including standby consumption. (Attention to standby consumption!)

• **Communication protocols** shall be based **open** standards.

• There is not yet any information on energy savings potential. There are other benefits such as DR (e.g. enabling RES and less overall electricity costs).

• What are the **benefits** for the users? Will smart appliances **cost more**? Will **consumers buy** smart appliances? For which **reasons**?
Thank you!

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