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COMMISSION STAFF WORKING DOCUMENT

Incorporing demand side flexibility, in particular demand response, in electricity markets

Accompanying the document

COMMUNICATION FROM THE COMMISSION

Delivering the internal electricity market and making the most of public intervention

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Delivering the internal electricity market and making the most of public intervention

1. MORE DEMAND-SIDE PARTICIPATION NEEDED AND POSSIBLE IN EU'S INTERNAL ENERGY MARKET

European households and businesses should be enabled to lower their bills and obtain further benefits if they help relieving pressures in the energy system by simply adapting their demand so as to consume energy in periods when it is relatively cheap or available in abundance. Such consumer action helps optimize the use of generation, transmission and distribution infrastructure, thus preventing black-outs, increasing the efficiency of the energy system, and reducing needs for costly new investments. When energy demand responds in these ways to market or system signals, individual consumers and industries benefit from reduced energy costs and society as a whole covers its energy needs with the least necessary supply and transmission capacity. It is a win-win solution for all.

Greater demand flexibility also enables the internal energy market to increase the amount of zero-carbon wind and solar power it can integrate. The variations in renewable energy generation result in a more complex energy system to plan, control and match supply and demand. Enabling demand response technologies and services, including energy storage[1], allows these variations to be coped with while reducing generation and infrastructure costs and capacity needs.

Demand response programmes have begun to emerge across the EU in recent years. Regulatory developments are creating a momentum which needs to be sustained to deliver a wider choice of demand response options and greater potential benefits for consumers. The gradual rollout of smart metering systems, the development of network codes for the internal electricity market (particularly those on demand connection, system operation and balancing, as well as the related guidelines on tariffs) and full transposition of the Electricity Directive (2009/72/EC) and the Energy

[1] Both local and larger scale solutions including fuel cell and hydrogen technologies are being explored.

Efficiency Directive (2012/27/EU) create the right conditions for policy-makers, regulators, network operators and energy businesses to consider how to trigger more demand side participation in the market in the near term.

This working document further explains the importance of demand side participation, and in particular demand response, and sets out the key elements enabling to make it work more widely in Europe. It outlines what is already being done to put those elements in place and what needs to be done next.

2. DEMAND RESPONSE – WHAT AND WHY?

Building on the provisions on demand side participation in EU legislation[2] and subsequent documents[3], demand response is to be understood as voluntary changes by end-consumers of their usual electricity use patterns - in response to market signals (such as time-variable electricity prices or incentive payments) or following the acceptance of consumers' bids (on their own or through aggregation) to sell in organised energy electricity markets their will to change their demand for electricity at a given point in time. Accordingly, demand response should be neither involuntary nor unremunerated.

The monetary savings achieved by residential and industrial consumers simply through shifting parts of consumption to low-cost periods during demand response pilots have in some cases exceeded 10% of electricity bills[4]. For industrial consumers, the unexploited potential is still important, given that many industrial processes have flexibility to shift large electricity consumption loads[5]. It is estimated that broadly only 10% of the demand response potential is used today.

Equally important is the potential of demand response to reduce the total generation capacity needed in peak hours. In some parts of the US electricity system, up to 8% of peak demand[6] could be reduced in 2010 through demand response; 29 GW of load in the US is already registered for existing demand response programmes[7]. It is estimated that the volume of controllable load in the EU is at least 60 GW[8] – shifting this load from peak times to other periods can reduce peak-generation needs in the EU by about 10%. This is comparable to the total installed generation capacity of two mid-size Member States or about one-third of all EU gas-fired power generation.

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[2] Namely the "Electricity Directive" (2009/72/EC) and the “Energy Efficiency Directive” (2012/27/EU).

[3] Smart Grids COM(2011)202 and the Staff Working Document “Guidance note on Article 15 of Directive 2012/27/EU on energy efficiency”.

[4] Empower Demand I, Vaasa ETT 2011 and Energy Pool (2013).

[5] IFIEC, Industrial Energy Consumers Federation.

[6] US FERC data published in 2011.

[7] SEDC (Smart Energy Demand Coalition).

[8] Energy Pool (2013) estimates total peak clipping capabilities through demand response between 6% - 11% (corresponding to 35 - 60 GW). Only for Germany, VDE (Study "Demand Side Integration") described a theoretical DR-potential of 25 GW in 2010 (to be doubled by 2030), of which 8,5 GW are technical/economical potential, confirmed by the dena-Netzstudie II. Smart appliances have a large potential. The project SMART-A estimated that the demand response potential in the EU by smart appliances only was about 60 GW of controllable load, of which 40-42 GW are economically viable.

Realizing even a part of that potential can bring savings of tens of billions of Euros by 2020. These savings come from avoided investment to match peak demand by adequate generation capacity, lower transmission and distribution capacity needs and reduced electricity bills for customers[9]. A recent study identifies material gains (materially reducing the requirements for additional generation and transmission capacities) from demand side response in the order of €4bn per year[10]. Furthermore, demand response leads to higher efficiency of the energy system and generates energy savings[11] while making it possible for significantly more of variable wind and solar generation to be integrated in the market[12].

3. HOW DOES DEMAND RESPONSE WORK IN PRACTICE

Demand response is an asset for both the retail and the wholesale market. In wholesale markets, equal market-entry opportunities for demand side resources (e.g. industrial loads) alongside generation should be pursued in line with the EU energy policy. The value of demand response for the wholesale and balancing markets, at various time scales (i.e. including the day-ahead, intraday and forward markets) is far from being tapped. EU industries and businesses of all sizes need to have access to these markets and be adequately compensated.

As a consumer-driven and market-based mechanism successfully implemented in many other economic sectors[13], demand response is also an integral part of a consumer-centric retail market vision in the energy sector. Its role is foreseen in the design of the EU internal energy market calling for consumer empowerment. In both wholesale and retail, demand response is centred on fair reward to consumers for demand flexibility and relies on available technical solutions.

[9] Capgemini (2008) explored the development of demand response throughout the EU-15 and expects by 2020 25 Euro billion annual savings in electricity bills for customers.

[10] Final report, 2nd June 2013, "Benefits of an integrated European energy market". The dena-Netzstudie II identified for Germany a cumulated saving potential of 10 Billion €.

[11] In an evaluation made by the Commission Services on the basis of available expert research, including the Impact Assessment accompanying the Commission's proposal for the Energy Efficiency Directive (SEC(2011)779) energy savings from demand response have been estimated to be at a minimum of 15 Mtoe in 2020. Capgemini (2008) estimated that the savings could amount to 100 TWh of annual energy savings in a conservative scenario, achieving 200 TWh of annual energy savings under a more ambitious scenario (increased implementation of demand response programmes, achievement of the EU 20% energy saving objective, full implementation of advanced smart meters or smart energy boxes by 2020). The Commission will launch in 2013 a study on the energy and economic saving potential of demand response and the best means to tap it effectively.

[12] The project SMART-A estimated that the broad use of smart appliances could yield an increased uptake of wind power in the system of up to 70% and a reduction of fossil fuel consumption of up to 6% for 2025. For Germany, VDE estimates for 2030 a controllable amount of electricity of 43 TWh, accommodating electricity generation from 20 GW onshore wind installed capacity in the grid.

[13] Cf. For example peak and off-peak pricing in telecomunications, transport or holiday businesses.

3.1. Demand-side flexibility incentivized through reward schemes

Demand response programmes can be *price-based*, where consumers respond to a retail price structure that differentiates between time periods (e.g. time of use tariffs, real-time pricing or critical peak pricing[14]). Alternatively, demand response schemes can be *incentive-based*[15], giving customers load-reduction incentives that are separate from, or additional to, their retail electricity rate and which may be fixed or time-varying. Such incentive-based demand response programmes (e.g. direct load control, interruptible service or demand bidding programmes[16]) are usually implemented by large industrial and commercial customers, notably the most energy-intensive ones, often through the use of dedicated control systems that allow the curtailing of load in response to a request by the energy supplier or system operator, or in response to changes in market conditions.

Demand response can offer different types of services to relieve the electricity system and the transmission and distribution grid, preventing black-outs and the costs linked to those, as well as avoiding investment in transport capacity. These include *structural and real-time congestion management* (e.g. to accommodate distributed generation and increased variability of demand); *balancing* of the electricity system, which refers to the procurement of reserve by ensuring that demand is equal to supply in real time; and *ancillary services*, which refer to a range of functions which transmission system operators contract so that they can guarantee system security.

3.2. Integrated solutions enabling hassle-free and more demand-side participation

Demand side participation assumes increased involvement of consumers who choose to take part in it for a reward. They have to actively respond to signals or, as may appeal to a larger number of them, make use of automated demand response solutions and conclude contracts with service providers that suit their individual needs and constraints.

With its sharp attention to energy costs and investments in energy management systems, the EU **industry** is the sector that has achieved most energy savings so far, including from demand response, and is keen to tap the significant flexibility that remains. This is crucial to make businesses and industries in the EU less dependent on energy prices, reduce their costs and increase their competitiveness in front of their competitors. While some tailor-made solutions already exist addressing some of the most energy intensive industries, these are not sufficiently open for industry participation, available at different time scales (from real time to forward markets) nor always providing adequate value to flexibility.

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14 Hybrid of the time-of-use and real-time pricing design, where the normal peak price is replaced with a much higher critical-event price under specified trigger conditions (e.g. when system reliability is compromised or supply prices are very high).

15 Benefits of demand response in electricity markets. US DoE 2005, http://energy.gov/oe/downloads/benefits-demand-response-electricity-markets-and-recommendations-achieving-them-report, p.12.

16 Other examples are emergency demand response programmes, ancillary services programmes or capacity market programmes.

Similarly, **commercial** consumers make up 30% of total energy consumption throughout Europe. For these consumers, heating and cooling is the main source of consumption (up to 80%), and therefore commercial buildings could be seen as the immediate storage resource of Europe. These buildings can be pre-heated and pre-cooled efficiently and should be able to offer this flexibility to the market. Furthermore, demand response and energy efficiency work well together in commercial buildings. This is due to the fact that the heating and cooling controls and management systems for energy efficiency can also be used for demand response. Aggregators and Energy Service Companies (ESCOs) are increasingly exploring and using this potential.

To make it more accessible to **residential** and small business consumers, demand response programmes should be able to rely on standardized technological solutions integrating the following components and offered to households and SMEs:

- Household appliances able to modulate temporarily their energy use, without compromising their function, according to user's stated preferences and system, load or (actual as well as forecast) price signals; such signals may come directly from the energy system or through a local energy management tool which can also provide feedback to the consumer if and as desired;

- Smart metering systems, recording energy consumption and able to register consumption in sufficiently differentiated time periods to enable billing which reflects shifts of consumption to low-price periods;

- Storage possibilities that facilitate the shift of consumption in time. These include local storage in buildings as part of their existing heat storage – a potential practically untapped at present, yet with very low costs and short returns on investment.

With solutions integrating these components and offered to households and industries, European wholesale, balancing, reserve and ancillary services markets can benefit from demand-side participation by residential, commercial and industrial consumers, micro-generators, and aggregators.

3.3. Is demand response already happening?

Currently, demand response is progressing slowly in the EU. Programmes to lower energy consumption through feedback making energy consumption visible to consumers are paving the way for demand response and are increasingly associated with more comprehensive demand response programmes. New actors such as aggregators and ESCOs are getting access to the market whilst the retail side is demanding new roles and responsibilities for Distribution System Operators and suppliers.

Demand side products and programmes are being created within the wholesale electricity market, with an increasing number of aggregators active in the markets (e.g. UK). Entry barriers to balancing and reserve markets are gradually being removed and time of use tariffs are available in several Member States for residential

consumers (e.g. UK, FR, IT, ES). More comprehensive residential pricing programmes and industrial load balancing programmes are being developed (e.g. FR).

From the market side, operators or retailers are making available system services for demand response measures, demand side management and micro-generation on electricity markets. The possibilities are numerous and include local storage (e.g. electric hot water boilers and electric heating systems), reduced demand from energy efficiency measures and electro-mobility. But the progress is slow, particularly in the residential and SMEs sectors.

Yet, experience in some Member States[17] where time-variable tariffs were only open to a small percentage of residential consumers points to the fact that not all consumers need to participate in a demand response programme for it to bring important benefits. This shows that demand response can happen now, even in the absence of the optimal and complete technological roll out and market opening. More systematic actions to promote and enable demand response would boost its full development.

4. MAKING DEMAND RESPONSE HAPPEN ON A WIDE SCALE

4.1. A market-based framework - who does what?

To deliver its full potential, demand response needs an internal energy market that treats demand-side participation fairly in comparison with supply and that is equipped with a smart infrastructure system, opening up new possibilities for participation. Depending on the organisation of the market, which varies between Member States, different market actors have a role to play in making it possible:

– *Residential, industrial and commercial consumers*, directly or through an aggregator, profit from dynamic or differentiated retail prices that reward shifting their demand, or bid their demand reduction in the wholesale market or are otherwise incentivised to shift load at strategic times;

– *Aggregators* bringing together residential, commercial and small industrial demand and *larger industries* actively participate in electricity markets or enter demand response programmes offered by the operators of the system;

– *Retailers* can also provide aggregation services to consumers, either as a direct service or in cooperation with an independent aggregator. This includes selling load in the balancing market as well as using it in their trading portfolio for wholesale energy markets;

– *Suppliers* provide consumers with the right incentives including dynamic pricing plans that reward consumers' action. This may result in lower revenues from

[17] The Commission for Energy Regulation (CER) in Ireland ran a feedback and dynamic pricing pilot for 3,858 households over 1 year. They combined a Time of Use tariff (TOU tariff) with in-house displays and informative bills. The combination of an In-Home Display, with a bi-monthly bill and TOU decreased overall consumption by 3.2% and peak consumption by 11.3%. Bill savings were between 3% and 4%. (cf. Smart Energy Demand Coalition' study entitled "Demand Response in the Unified Energy Market").

energy sales so suppliers need to reorient their business models mixing sales with services;

– *Manufacturers* of smart metering equipment and appliances implement technical solutions to making their products able to accommodate demand response in a standardized way, without creating new barriers in the form of proprietary solutions, involving the ICT sector and ensuring interoperability among components, communication and control technologies in use in other sectors of industry;

– *National Regulatory Authorities (NRAs)* play a crucial role *inter alia* by allowing the development of retail tariffs to support dynamic pricing for demand response, ensuring that network tariffs do not include elements that hamper demand response and by ensuring fair and transparent access of demand response to wholesale and retail markets;

– *Transmission and Distribution System Operators (TSOs and DSOs)* responsible for balancing the grid and adjusting demand and supply open the grid to new players such as demand aggregators and promote their access to and participation in balancing, reserve and other system services markets. *Distribution System Operators* also have the role of accommodating demand response by individual or small consumers, and accommodating micro-generators within the distribution network. DSOs can co-operate with aggregators and other service providers to use demand response and ease local network congestion, facilitating the integration of distributed generators.

4.2. Transparent and enabling regulatory framework

The existing provisions in EU legislation (particularly the Third Energy Package Electricity Directive and the recently adopted Energy Efficiency Directive which replaced the Energy Services Directive)[18] make demand response possible. This framework establishes the necessary obligations on Member States, NRAs, TSOs and DSO to enable and promote demand response, allowing the market to develop further and work to consumer satisfaction.

In Member States that have adequately transposed and implemented the Electricity Directive, infrastructure tariffs as well as capacity and infrastructure planning should already take account of demand side participation in line with corresponding national measures. This EU framework requires transmission and distribution tariffs to be fair, transparent and cost-reflective, taking into account the long-term avoided network costs from distributed generation and demand-side management measures. As regards new capacity, the possibility of providing energy efficiency or demand-side management measures through a tendering or equivalent procedure (in terms of transparency and non-discrimination) should be guaranteed. From the infrastructure point of view, when planning the transmission and distribution, demand side measures have to be taken into consideration.

[18] Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services, OJ L114, 27.4.2006.

Furthermore, with the transposition of the Energy Efficiency Directive, the already existing legal framework on demand response will be further enhanced, promoting its access to and participation in the market and the removal of remaining barriers. This Directive mandates NRAs to encourage demand response and requires network operators –both for transmission and distribution- to treat demand response providers in a non-discriminatory way in meeting requirements for balancing and ancillary services. Tariffs that hamper demand response participation should be removed as part of the Directive's transposition and network tariffs and retail prices should support dynamic pricing for demand response. As part of the required market opening, adequate technical or contractual modalities for participation of demand response in balancing, reserve or other system services markets have to be defined and disincentives in transmission and distribution tariffs that might hamper participation of demand response in balancing markets and ancillary services procurement must be removed. This requires removing, where it exists, discriminatory treatment (e.g. where market access for consumers or aggregators is blocked).

Finally, for appliance-based demand response, the Ecodesign Directive 2009/125/EC sets mandatory requirements for the design of energy-related products to improve their environmental impact, while the Energy Labelling Directive 2010/30/EC helps consumers identify products with high environmental performance. Both processes are based on a profound technical assessment and a formalised stakeholder consultation. Ecodesign and Labelling together "push and pull" the market in direction of demand response-ready products and smart appliances.

The transposition record of the Electricity Directive is far from ideal. Without adequate national measures that enable this EU legal framework to apply in Member States, the progress of demand response will continue to be slow. Therefore, full and effective transposition of the Electricity and Energy Efficiency Directives is necessary.

5. ACTIONS NEEDED TO BOOST THE MARKET FOR DEMAND RESPONSE

The existing EU regulatory framework makes demand response possible, but the full potential of demand response will not be realized without further action from national policy-makers, regulators and energy companies. In parallel to renewed impulse and support to EU policy implementation on demand response, additional efforts should aim at:

(i) Creating market-based and transparent incentives for demand response that reward participation through dynamic prices without unnecessary constraints…

The introduction of time-differentiated prices as an option accessible to everybody gives all consumers the possibility to opt into demand response and get rewarded. However, the removal of blanket price regulation, where it exists, is necessary for such dynamic prices to be offered by suppliers. It is equally necessary for market transparency without which time-differentiated prices cannot be effective in reflecting true conditions in the market in real time.

The Commission Communication "Making the internal energy market work"[19] states that "*Member States should seek to cease regulating electricity and gas prices for all consumers, including households and SMEs, taking into account universal service obligation and effective protection of vulnerable customers*". At present, two-thirds of Member States still have some form of direct electricity price regulation in place. Even in Member States where electricity prices are not regulated, administrative procedures (e.g. obligatory notification of price changes in advance to national authorities) can make the availability of effective time-differentiated prices difficult to emerge in the retail segment of the market. Such administrative barriers need to be removed in unjustified cases. Removal of these and other non-technological barriers to price differentiation is also helped by innovation support actions (IEE[20]-type of actions).

Also tariffs or tariff methodologies for infrastructure (transmission and distribution fees), which are set by national regulatory authorities, should adequately support policy goals, such as demand response but also efficient network development, competition, energy efficiency and renewable electricity generation. .

… whilst respecting legal considerations on data security and protection, privacy, intrusion

Demand response involves the processing of personal data and integration of ICT on a significant scale; data protection, privacy and security therefore become major concerns not only for industry and investors, but also for individual consumers as data coming from frequent and remote metering and processed by smart grid operators is classified as personal data[21]. In addition vulnerabilities are emerging for system security. This situation can limit consumers' interest in demand response and can limit the effect of economic incentives provided by dynamic or innovative price offers.

Commission Recommendation 2012/148/EU includes data protection, privacy and security measures. Under the Smart Grids Task Force, the Commission services have also initiated an action on Privacy and Security issues of Smart Grids gathering stakeholders from the energy and ICT sectors, ENISA[22], WP29, EDPS[23], consumer associations and national regulators. For 2013, two concrete outcomes will be delivered: a Data Protection Impact Assessment template as a response to concerns about data protection and privacy[24], and a cyber-security assessment framework as a response to concerns about system security. In addition, ENISA is identifying a set of minimal measures needed for security and resilience with regard to cyber security. These need to be fully integrated in the regulatory frameworks of Member States and

[19] COM(2012) 663
[20] http://ec.europa.eu/energy/intelligent/index_en.htm
[21] Opinion 12/2011 of Article 29 Data Protection Working Party ('WP29') from 4 April 2011. WP29 is the independent EU Advisory Body on Data Protection and Privacy set up under Article 29 of Directive 95/46/EC.
[22] ENISA: European Network and Information Security Agency
[23] EDPS**:** European Data Protection Supervisor
[24] The template constitutes an evaluation and decision-making tool for entities planning or executing investments in the smart grid sector; it promotes a common methodology for data controllers in each Member State.

in business models and operating practices of energy companies with vigour, visibility to the consumer, and under verification by national authorities.

(ii) Opening up the market to exploit the potential of demand response

Treating demand side resources fairly vis-a-vis supply

Even industry stakeholders report remaining barriers to access demand response. For instance, participation is limited to some industrial sectors, neglecting others, or the threshold for participation (shedding limit) is set at too high a level, resulting in a limited number of industrial consumers participating in the balancing market. In other cases industrial participants are looking for access to the day-ahead market[25]. There is a need to identify and promote good practices for demand response across Member States. A stock-taking of national measures to enable and develop demand response, including on the basis of the obligations in Article 15 of the Energy Efficiency Directive, can provide a useful assessment of the situation across the EU.

Unblocking market access also means making it legal for consumers and aggregation of commercial and industrial loads to participate in energy markets. Market access needs to be enabled by clear network and market rules for the participation of demand side resources alongside power generation. The Electricity Directive and the Energy Efficiency Directive open up market access and participation to demand response, placing it on an equal footing with generation and in a transparent and non-discriminatory manner. This requires changes to operational requirements that are designed for traditional incumbents (e.g. 16 hour load reduction requirements or minimal single bid requirements of 25 MW or more) and taking into account the technical capabilities of demand response providers. The provision of technical assistance for industrial and commercial access to demand response can be promoted in the context of the upcoming Horizon 2020 programme for research and innovation.

Elaborating clear and transparent market rules and technical requirements

Ensuring market transparency will tackle the current lack of information in some Member States preventing aggregators and consumers from calculating the value of demand response bids, notably in markets controlled by DSOs and TSOs.

In accordance with the provisions of the Electricity Directive[26] and the Energy Efficiency Directive, consumers must have at their disposal their consumption data and be able to, by explicit agreement and free of charge, make them available to a third party under specific data format and procedures defined by Member States.

The Electricity and Energy Efficiency Directives tackle the current lack of contractual clarity in almost all markets due to the absence of clear technical modalities for

[25] According to information from IFIEC (Industrial energy consumers federation), industry associations in Europe are actively considering a number of initiatives, including setting up an inventory of demand response possibilities for industrial companies and to develop new products designed to stimulate load to participate more directly in the market.

[26] Annex I Point 1h.

demand response access and participation. Furthermore, the network codes, particularly the Demand Connection Code, the Balancing Code and System Operation Code as well as the possible future Tariffs Code will pave the way for demand response achieving its full potential. They will not, however, bring full effect without an active approach from regulators, whose responsibilities should include making sure that the necessary protocols and market rules are in place.

Finally, under *Mandate 490*, European standardization organizations have already developed a first set of standards facilitating the implementation of high-level Smart Grid services and functionalities. A second set of standards, including for demand response, has been requested for the end of 2014 and requires quick action by European standardization organizations.

(iii) Bringing the technology into the market Through the roll-out of smart metering with the appropriate functionalities

Smart metering solutions provide the technical precondition for measuring "real-time" consumption, while the smart grid can offer further, more automatic, demand response measures. These could pave the way to a more optimal balance in the entire supply chain, hence more optimal prices as well for the consumer.

In order to fully support demand response, smart metering systems have to accommodate the common minimum functionalities set out in Commission Recommendation 2012/148/EU.[27] Particularly important to residential consumers are: a readings update rate of at most 15 minutes, and a standardised interface which enables transfer of individual consumption data and their visualization in combination with information about market conditions and service or price options.

The Commission services are analysing the Cost Benefit Analyses and smart metering roll-out plans received from the Member States. The results should be presented in a comprehensive Benchmarking Report.

From results reported and analysed to date, about two-thirds of Member States plans assess positively the prospects of smart metering systems and plan their roll-out. As result, at least 75% of European households should benefits from smart metering before 2020.

Even in Member States with limited or no plans for wide-scale roll-out of smart meters, consumers must have the chance to make use of the options offered by smart metering systems, including the possibility of participation in demand response. Those Member States should ensure that consumers feel encouraged to individually invest in smart metering systems, assured that they will be able to recover their

[27] OJEU L73 of 13.04.2012 p.9, Commission Recommendation 2012/148/EU of 9 March 2012 on "preparations for the roll-out of smart metering systems" specifies key common minimum functionalities for smart metering systems that will assist consumers. In particular its Art.42 sets up the *common minimum functionalities for smart metering systems* which should be able to deliver accurate measures of actual consumption and bidirectional communication enable dynamic pricing and improve management of the grid.

investment in the short term in a clear financial and contractual perspective of participation in demand response.

To this end, DSOs must be ready to install a smart meter at consumer's request and according to his choice if compliant with applicable technical standards while energy businesses (suppliers or third-party service providers) need to develop innovative and meaningful solutions for consumers to help them know and adapt their demand, including as part of comprehensive packages with energy efficiency obligations schemes.

Consumers need to be engaged and to understand the value and conditions of the programmes. Given the relative complexity of the matter, vulnerable consumers need to be protected (but not excluded) and the market has to be transparent. It can be expected that, along with technological development and as experience in the telecoms sector has shown, smart metering systems will become cheaper.

Creating the necessary framework for smart appliances and energy management systems

Smart appliances and home automation are the most obvious instruments to involve any citizen in demand response activities at large scale making it easier for consumers to lower their bills and benefit from demand response advantages. This is why appliance-based demand response must be accessible to everybody, simple and not limited to high-end products.

While appliance-based demand response builds upon tariff structures, business models and smart metering that give credit to consumers for their flexibility, it also requires an adequate framework that will facilitate the market up-take of smart appliances and management solutions at home. Solutions facilitating the portability of energy consumer profiles to other energy service providers[28], at customer request, need to be established to encourage competition on the energy services market.

The Energy Label is the tool that can trigger consumer awareness and engagement. It helps create a high level of transparency of the market and, at the same time, brings about incentives for manufacturers to invest in smart technology and to produce a broad range of smart appliances. It can deliver solid criteria to incentivise the purchase of smart appliances.

Ecodesign, in tandem with the energy label, allows regulatory certainty for some key aspects linked to the market up-take, such as access to relevant data, and helps enforce interoperability.[29] It also allows optimising the energy use of smart technologies for demand response. Furthermore, the impacts on vulnerable consumer groups,

[28] Compliant with relevant data protection legislation and in particular Directive 95/46/EC.

[29] Key elements of that framework could be a definition of smartness and basic smart features for appliances; access of smart appliances and energy management systems to relevant information, such as almost real-time/forecast pricing, load, metering and grid-status information; capability to communicate and interact with energy management and building control systems (and/or smart metering systems where relevant), across technologies/protocols to achieve full interoperability, which might lead to a "plug and play" scheme.

affordability and comfort, questions of product performance and warranty, the interaction with central building control systems and with micro-generation units are aspects to be explored and tackled in this context. To that end, the Commission services have identified smart appliances/ meters as a priority in the *Ecodesign* work plan 2012-2014. The work under the Ecodesign framework will be closely related to the results of on-going standardization efforts[30].

Accompanied by storage technology and services, in particular those from heating systems

Domestic heating and hot water systems represent an excellent storage potential that can be used for increasing power system flexibility. For example, the installed heat storage in UK and Ireland alone amounts today to some 17 GW; managing actively at least a part of this load can reduce generation needs, allow for easier integration of renewable sources and, importantly, bring savings to the electricity bills of customers. Moreover, fast growth in the use of heat pumps for heating domestic hot water and homes can be expected in the near future, gradually replacing today's electric heaters and offering larger flexibility potential.

Bringing these technologies and energy management systems more broadly into the market requires the large replication of successful business models for demand response, including in the context of innovation and market uptake measures under the upcoming Horizon 2020 programme.

6. CONCLUSION AND WAY FORWARD

Demand response is crucial for meeting future energy needs with the least necessary supply and transmission capacity. It has to be open to all kind of consumers, including households facing increasing energy bills, commercial businesses and industrial players that need to compete with companies from countries with lower energy costs. Flexible demand reduces the needs for costly conventional generation capacities necessary for dealing with demand peaks and the integration of variable renewable energy. It thus makes the supply chain more efficient, triggering lower energy costs and eventually better prices for consumers. Just as a diversified supply-side portfolio is considered beneficial, having different demand response options available to the whole range of consumers should be seen as an advantage for the energy system.

Accordingly, Commission's actions aimed at the development of demand response in the EU have to form an integral part of its energy policy and of its forthcoming actions on the retail aspects of the internal energy market[31]. Actions by other policy-makers, regulators and energy companies are equally needed to trigger more demand response participation in the short term. Together, they should ensure that both price-based and incentive-based demand response programmes are available to different

[30] Interoperability in particular will depend heavily on standardisation. The results of *Mandate 441* to the European standardisation organisations CEN, CENELEC and ETSI will establish European standards for the interoperability of smart meters (electricity, gas, water and heat), including communication protocols and additional functionalities.

[31] See also CLWP 2014

types and sizes of consumers while demand side participation in the market should be given a fair treatment and clear, practical set of technical rules. They should also ensure that demand response is able to play the role it deserves in contributing to system efficiency and reliability.