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3.1) Smart solutions for energy consumers

(Create technologies and services for smart homes that provide smart solutions to energy consumers)

Purpose of this document

This document¹ is intended to progress the implementation of the actions contained in the SET-Plan Communication², and specifically the actions concerned with Action 3 "Create technologies and services for smart homes that provide smart solutions to energy consumers". It is part of a series of Issues Papers jointly prepared by the European Commission and discussed with the representatives of the EU Member States and countries part of the SET-Plan, working together in the SET-Plan Steering Group.

The Issues Papers are sent to stakeholders for comments/feed-back. They are meant to propose to stakeholders strategic targets/priorities in different areas of the energy sector. They will frame the discussions of the SET-Plan Steering Group with the stakeholders within action 3 and will be used to come to an agreement on targets/priorities.

The issue paper for this action is split in two parts looking first at Smart solutions for energy consumers (3.1), i.e. mostly households, and then at building/district level with the Smart Cities and Communities initiative (3.2). An energy system level perspective is taken under Action 4 dealing with energy systems.

Stakeholders are invited to take position on the proposed targets in accordance with the guidelines set out in the paper "The SET Plan actions: implementation process and expected outcomes" and submit their positions to SET-PLAN-SECRETARIAT@ec.europa.eu by 08/01/2016 at the latest. All relevant documents and material are available on the SETIS website <https://setis.ec.europa.eu/>.

¹ This document is a working document of the European Commission services for consultation and does not prejudice the final form of any future decisions by the Commission.

² "Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation" (C(2015)6317)

Introduction

In the last decade, the European energy policy has made considerable progress towards creating an integrated and liberalised internal market for both electricity and gas. The liberalisation of the market across Europe is expected to lead to a number of benefits for the European consumers including price competition, high standards of consumer protection as well as a better control of their energy consumption and costs.

Our energy system is undergoing important transformations with the deployment of smart meters, smart controls, the emergence of smart appliances, their integration in home networks thanks to smart energy systems with an increasing exchange of data via internet, telecommunication networks, etc. and small scale distributed renewable energy production. In addition, some of the energy consumers are thus becoming 'prosumers', at the same time producing as well as consuming energy and are increasingly expected to be considered by grid operators as 'customers' i.e. not only consuming energy but engaged as actors in a common energy system. The growing share of variable renewable energy production is challenging for the grid but also opens opportunities for consumers to offer services to this grid against the possibility to generate income and lower their energy bill thanks to demand response mechanisms.

New smart technologies and services are emerging which allow consumers to manage energy-consuming devices (i.e. combining different energy sources and increasing energy efficiency), to reduce energy consumption (i.e. decreasing emissions, matching generation, storage and consumption) and thus the energy bill. Automation is a key feature which gives the opportunity to consumers to benefit from these mechanisms, releasing him from detailed monitoring and control tasks.

Although this action focuses on energy aspects, it is important to point out that such devices and services will increasingly be associated and interconnected with other devices and services controlling the comfort (light, humidity, differential temperature levels between rooms, presence of people in the rooms, etc.), the security or even features concerning directly the customer such as e-health, etc. This global environment is referred to as smart homes and requires communications standards, exchange of information, etc. between devices which are targeting different applications and are produced by different providers.

Consumers are also increasingly able to act collectively and to make more autonomous energy choices thanks to the emergence of new actors such as aggregators, cooperatives, etc. which can aggregate the wishes and needs of individual consumers (e.g. energy cooperatives), as well as negotiate with energy incumbents and different levels of government, particularly municipal and regional ones.

Currently, consumers are often insufficiently informed about these emerging opportunities. Moreover, one should not neglect the fact that consumers are citizens and may have other motivations than making savings on their energy bill, such as being actors of the transition towards a low carbon energy system.

In the context of this issues paper, 'consumers' includes not only households but also small entities which can benefit from the same smart solutions and for whom the decisions for energy matters lie with the occupant of the building. Aggregators and cooperative are considered under 'Energy systems' while smart solution for larger buildings where the energy systems are operated by third parties are included in the scope of two other Issue papers on 'Smart Cities and communities' and 'Energy Efficiency'.

Over the last years, the place and role of consumers in the energy system has therefore received a lot of attention and this is acknowledged in the Communication on Energy Union, the SET-Plan Integrated

roadmap and the more recent communications 'Towards an Integrated Strategic Energy Technology (SET) Plan', 'New deal for consumers' (COM(2015)339) and the accompanying 'Guidelines for self-consumption'.

Developing smart solutions to answer the need of consumers in the context of the energy transition is one of the key R&I aspect that needs to be developed in the frame of the integrated SET-Plan Action 3. To achieve this, several aspects have to be tackled:

- Empowering Consumers
- Enabling Demand-Response
- Responding to Consumers' needs

1. Empowering consumers

- The first element is that the regulatory framework should allow demand-response mechanisms and markets thanks to accurate metering and billing that reflect actual energy consumption/ production and provide information on actual time of use.
- The second element is that there should be a framework guarantying the availability of information for consumers and a secure but non-discriminatory handling of data (e.g. work carried out in the frame of the Smart Grid Task Force).

These elements are out of reach of the SET-Plan but it is important to acknowledge that without this framework, consumers will not be able to engage.

2. Enabling smart energy technologies and services and demand-response mechanisms

In this section, we assume that the proper regulatory framework allowing smart solutions and services, demand-response, information to the consumers and protection of their data is in place and we focus on R&I needed to enable smart solutions.

- Technologies (software and hardware) enabling accurate metering and billing (smart meters) that reflect their actual energy consumption and production and provide information on actual time of use.
- Technologies (software and hardware) enabling analyzing, and forecasting of energy consumption and production data, the activation of customer smart appliances (e.g. water boilers, heating system, electric vehicle charging, energy consuming appliances, etc.) relying on common standards, interoperable and open approaches. These should be 'customer-centric' designed and providing consumers with user-friendly interfaces and easy to operate devices; they should be able to pilot customer's assets in an automated way based on self-adaptation to the changing operation conditions including price signals / request for services from the grids and / or customer signals.
- Data handling and communication solutions to allow the exchange of data and information between smart appliances in a Smart Home environment (e.g. relying on Internet of things) and data sharing (e.g. with Big Data platforms) with other actors such as aggregators, distributors, or other service providers, including from other sectors (transport, health, etc.).
- Development and test of innovative, cost-effective services and business models motivating consumers to play an active role (income generation, energy bill reduction, more comfort) and pooling utilities, suppliers and consumers into win-win-situations (from the view point of costs/profits and the reduction of GHG emissions).

3. Responding to consumer's needs

Having a regulatory framework in place and appropriate technological solutions is necessary but not sufficient to ensure the large-scale deployment of these solutions. Consumers need to understand the benefits of the system and be empowered to define their proper place and role within it with a positive and proactive approach. They need to be in a position to engage based on potential benefits related to lower energy costs, enhanced comfort, or participate in the energy transition towards a low carbon world.

This requires new approaches to co-operation, co-design, co-experimentation, co-business involving the traditional utilities, technology providers, social scientists and consumers themselves. The paradigm shift from a centralised regulated energy system towards a decentralised energy system with many consumers fulfilling their new roles and exploiting new opportunities requires studies as regards how new smart solutions for energy consumers will change the roles of existing players, and the appearance of new players facilitating the energy transition based on active consumers.

It is therefore very important to better understand socio-economic aspects of consumers' behaviour. In particular, R&I actions in this field should aim to:

- Understanding what customers value and need using a differentiated approach based on socio-economic, political, cultural, regional and educational dimensions and how they exercise their energy choices,
- Develop comprehensive approaches to engage consumers through information, education, training, marketing, intuitive interfaces with technologies that are fit to their profile,
- Develop feedback / learning mechanisms based on the assessment of the developed approaches (e.g. resulting from demonstration programmes).

Targets

The key objective of this action is to enable the development of smart solutions and services for energy consumers, to give them the possibility to activate their assets to provide services to the grid against economic benefits (e.g. additional income or lower energy bill) and engage at their level in the energy transition. The proposed associated high level performance indicators to be followed over the years are:

- The quantity of energy that is handled through demand response mechanisms (compared to no demand response mechanisms) at EU-level and the associated cost savings with a target of xx % the annual amount of electricity by 2020 / 2030, and xx EUR savings for consumers.
- By 2025, smart homes solutions including e.g. demand response, intelligent energy management and controls, RES integration are implemented in half of European households thanks to relevant progress in smart technologies and services adapted to consumers' needs

Monitoring of targets

In order to measure the progress with respect to the overarching target, (percentage of) energy that is handled through smart energy demand response mechanisms (compared to "business as usual scenarios) at EU-level and the associated savings in the cost of energy, the use of a EU energy / electricity system model is

needed that includes market mechanisms. To determine the boundary conditions and inputs for this system, the following elements will be needed:

1. Empowering consumers

Are the conditions regarding the regulatory framework, information and data handling fulfilled to empower consumers, how many % of consumers can effectively be engaged in smart energy and demand-response mechanisms?

2. Enabling smart energy technologies and services and demand-response mechanisms

It is proposed to monitor in a 'board' the progress in the development of technologies, services and systems enabling smart energy solutions and demand response mechanisms in terms of TRL level over the year. This 'board' should allow to assess at which pace R&I progress is achieved (the pace can vary depending on the technologies), when these elements will be available / ready for deployment and should allow to determine the condition under which a technology, service, system is introduced in the energy system modelling, the level of penetration etc.

3. Responding to consumer's needs

As a part of the R&I work in this field, an estimate of the proportion of people who will engage in demand-response mechanism under given conditions will be determined.

Inputting all these elements in the energy system model should allow determining the percentage of energy handled through these mechanisms and the impact on the cost of energy. This will also give an input to action 4 which will include smart grid technologies, demand response, storage and variable production as elements of flexibility to reach the goal of 45% of variable renewables in the grid by 2030.

Other important elements

There are a number of existing technological solutions. The emphasis of R&I programme should therefore be put on integration and demonstration aspects with a perspective of deployment of these integrated solutions at large scale.

Proposed actions

While Horizon 2020 will continue to support this action via Calls for Proposals, the goal of this round of consultation is to consult stakeholders and Member States to identify a limited number of priority actions which:

- have a strong added value to be carried out at EU level and or through collaboration between Member States,
- have a strong leverage i.e. will need a limited or no support from Horizon 2020 but will pool together a number of resources,
- for which the progress and achievements can be monitored with indicators.

We are therefore looking for your views. The annex below reproduces actions which were identified in the document 'Towards an Integrated Roadmap: Research & Innovation Challenges and Needs of the EU Energy System' and can be used as a basis but proposals for priority actions do not necessarily need to be based on this list.

Annex: Relevant R&I actions based on the Integrated Roadmap document

The following actions included in the Integrated Roadmap are considered as an indication of R&I activities relevant for the purpose of this topic. Feedback on the actions proposed and new indications are welcome.

1. IR Annex 1 – Part 1: Energy Efficiency

1.1. Challenge 1: Improve consumer engagement & changing behaviour

1.1.1. Theories and models of energy consumption behaviour and behaviour change including re-examining the barrier concept, analysing policy applications, strategies to address specific target groups (advanced research programme).

Scope: Traditional models pay little attention to the role of the supplying business towards customers. The EED focuses on the need for energy services and on selling propositions that facilitate customers' choices while guaranteeing a safe and reliable supply.

It is generally assumed that customer/users are price-responsive and able to act in an economically rational way once having received and understood the implications (the economic man model). If the users still do not undertake the actions assumed it is because they have different preferences or because the implicit costs of the transaction are too high and hence the benefit of the energy efficiency action is not sufficient (enough). In this traditional perspective, awareness programmes are necessary to secure that the relevant information is made available. Communicating energy efficiency properties is best done when energy efficiency is the default option; hence "Choice architecture" (Thaler and Sunstein) may have to be applied not only to policies and incentives, but also to equipment and hardware in order to allow correct operation and understanding of functions. Behavioural economics offers different explanations and points out several biases in the decision-making with the user and that market. This allows proposing offers that have been designed to overcome those biases.

Approaches:

- Rethinking and refocusing systems. Rising awareness is often quoted as way to make users ready to accept new technologies and behaviour. It is however quite obvious that individual awareness is not the issue as much as collective and governance awareness of the entire set of opportunities that follows from the change in:
 - ICT.
 - Miniaturisation of (renewable) generation.
 - Smart applications. (KIC) Societal awareness is the first step but social inclusion and active attitudes is the final aim. This means that new business models and collective solutions need to involve citizens as participating partners of the solution.

1.1.2. Support the development and demonstration of users' interfaces for smart meters and energy management systems that trigger behavioural change in energy consumption and the participation to energy markets (industrial and demonstration research programme).

Scope: To promote the development of tools and applications (using for example gaming, serious games and social networking approaches) to motivate citizens towards a more sustainable use of energy and a more efficient attitude. Applications may be fixed or mobile applications and take advantage of the data provided through smart meters, smart plugs, smart appliances or smart grids and rely on ICT in order to trigger behavioural change.

Applications must be low cost, and energy savings generated from these solutions must be greater than the cost for the provision of the services. Applications should aim also at stimulating collaboration between customers and at enabling their aggregated participation in the market.

The applications are designed in order to trigger individual changes and also aggregated actions aiming at enabling the participation of final customers to the market.

Deliverables:

- End users interfaces that provide the customers with information about their consumption profile and empower them to improve their use pattern and to operate in combination with others in order to increase their benefits (e.g. diffused demand response). Interfaces must be deployed and validated in real life conditions.
- Analysis of the socio-economic evidence for ICT investment in the field and include detailed plans for sustainability and large-scale uptake beyond the project's life time.

2. IR Annex 1 - Part II: Competitive, Efficient, Secure, Sustainable & Flexible Energy System

2.1. Challenge 3: Demand Response

2.1.1. Tool development to support new electricity energy market designs that support demand response (advanced research programme).

Scope:

- Development of a new tool for detailed analyses of various balancing market and products designs to identify best practices and to perform large-scale experiments with metered customers that illustrate the costs and benefits of demand Response at local and European level. This will include computer based studies and analysis of new market products that will enable the participation of all relevant actors and clarify their roles.
- To design grid tariff mechanisms for demand response to correlate the load curve and RES integration.

Deliverables:

- New balancing market design(s) and new market products suitable for Demand Response.
- Large scale experiment(s) to test new market and products designs (as above).
- New grid tariff mechanism(s).

2.1.2. Develop mechanisms to enable the participation to the electricity market of all relevant actors and to ensure the full exploitation of demand response (advanced research programme).

Scope:

- Enable the participation of all relevant actors to ensure the full exploitation of demand response across Europe.
- Address solution acceptance by end-users (appliance/smart meters) in all sectors (residential, commercial and industrial) and wider issues such as environment impact, safety, security, health, social acceptance.
- To model aggregated RES/DER generation, flexible conventional generation, demand and storage systems; to use such models for market design, market mechanisms and simulation tools for planning and operation purposes.
- To design market mechanisms for incentivizing both the maximization of the provision of ancillary services by new actors (including aggregated RES, cogeneration and high-efficiency production, demand, storage, etc.) and the minimization of the use at system level of ancillary services. The aim

is to harmonize the requirements of license provider and to help the supervision, control and recording of the services provided.

Deliverables:

- Plans for the full exploitation of DR in Europe.
- Plans for the acceptance by end-users of solutions for the full exploitation of DR.
- Model(s) for the full integration of DR and generation in the electricity system.
- Application of these models to devise market mechanisms for the full integration of DR in the electricity system.
- Market mechanism(s) for the optimization of the provision of ancillary services including with DR.

2.1.3. Demonstrate the capability of smart interfaces, management modes and new services to increase the integration of Demand Response in the energy system (industrial and demonstration research programme).

Scope:

- The potential benefits of demand response for load control (such as peak shaving and energy savings) that involves customers on a large scale must be drawn up before assessing its impact on grid planning and operations.
- Technologies such as smart meters and energy boxes are included in the demonstration and help raising awareness about consumption patterns and fostering active customer participation in the energy market. Demonstration projects will help defining specifications for:
- The data needed by grid operators for the pan-European planning tool.
- Grid operations designed to achieve a reduction in peak demand (10 – 15 %) through active customer participation.
- The requirement to planning tools in case using metering data.
- Models to describe customer behaviour and segmentation.

Deliverables and KPIs:

- Large scale project(s) demonstrating the benefit of smart interfaces for the integration of DR in the energy system.

2.1.4. Demand Response and new users integration: scaling up and replication (Innovation and market uptake programme)

Scope: This action supports scaling up and replication programmes to allow the deployment of demonstrated solutions for:

- Active Demand Response.
- Increased market accessibility for private customers and SME.
- Increased Energy Efficiency through the wider integration with Smart Homes and smart cities.
- Demand side management at Distribution System level that feed into TSO operations in a multi-networks level approach.

Deliverables and KPIs:

- Programme(s) for the scale up of demonstrated solutions for the integration of Demand Response and new users.

2.1.5. Standardisation needs (Innovation and market uptake programme)

Scope:

- To support the development of a set of standards for data exchange at the European level involving all relevant parties (smart meters/aggregators/ICT systems).
- To develop a set of data exchange templates and ICT infrastructures to enable ancillary and balancing services at the EU level.
- Assessment of Open interfaces and protocols allowing integrating control systems from different manufacturers into aggregation.

Deliverables and KPIs:

- Providing recommendations to and/or participation in standardization committee for data exchange in the energy system.

2.1.6. Market framework and business models for demand response (Innovation and market uptake programme)

Scope:

- The specification of a pan-European system for demand response integration based on experimentally validated business models and business cases.
- Definition of Business models in support of virtual power plants at the DSO level.
- Cost-benefit analysis for all market players and for different business cases in the various regulatory contexts.

Deliverables and KPIs:

- Cost-benefit analyses for all market player in various business cases and in different regulatory contexts.
- Business models and frameworks will be delivered for the pan-European grid that improves the real-time market for demand response.

3. Annex I - Part III - Fostering Innovation - Market-Driven Framework

3.1. Challenge 2: Integrated infrastructures-based services

3.1.1. Integrated information service about customer consumptions (electricity, water, heating/cooling, gas) (industrial and demonstration research programme).

Scope: Distribution Energy companies may have servers that collect, store, organize and merge all data from smart meters and provide it to the final user (independently of the retailer) through the platforms already indicated.

Deliverables:

- Integrated networks information services oriented to customers.