ADDRESS – MAIN LESSONS LEARNT AND RECOMMENDATIONS FOR THE DEPLOYMENT OF ACTIVE DEMAND

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ABSTRACT

ADDRESS ("Active Distribution networks with full integration of Demand and distributed energy RESourceS") was a five-year large-scale R&D European project launched in June 2008, which received funding from the European Community's Seventh Framework Program (FP7/2007-2013) under grant agreement n° 207643. The aim of the project was to develop a comprehensive commercial and technical framework for the deployment of "Active Demand" and the market-based exploitation of its benefits [1]. In ADDRESS, "Active Demand" meant the active participation of domestic and small commercial consumers in the electricity markets and in the provision of services to the other electricity system participants. ADDRESS developed a complete chain of innovative solutions for the implementation of Active Demand from the formulation of the needs of the electricity system players to the control of electric appliances at consumers' premises. This chain includes in particular the simulation of market interactions between the electricity system players, a platform and software tools for the Distribution System Operator (DSO), a platform and software tools for the aggregation of the consumer demand flexibility, as well as an Energy Box (EB) and smart devices installed at the consumers' premises to control different electric appliances [2], [3].

After the definition of the concepts and of the detailed specifications, technological prototypes were developed and tested first in laboratory. In the last year of the project they were tested on the field in three complementary test sites in Italy, Spain and France. In addition to technical aspects, studies were also carried out to assess the potential benefits of Active Demand for the different electricity system participants, to investigate appropriate contractual structures, market mechanisms and regulatory evolutions needed for the exploitation of these benefits, and to appraise the consumers' acceptance, as well as their motivations and potential commitment to Active Demand programs.

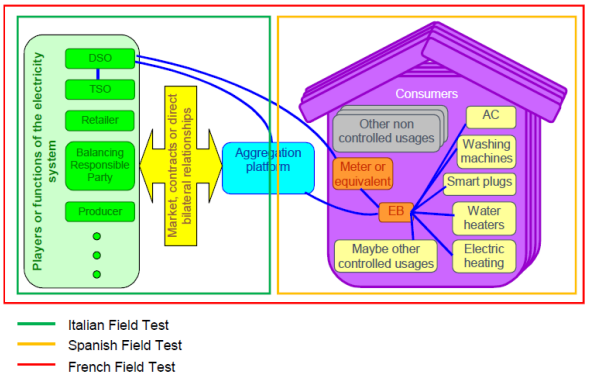

Figure 1 – The whole ADDRESS chain and the field test domains [4]

The results of the project have already been reported in several publications [4], [5]. The objective of the present paper is to go one step further and to present the main lessons learnt and recommendations from the ADDRESS project for the deployment of Active Demand, regarding for instance the involvement of the consumers, the roles of the Systems Operators (DSO, TSO), the aggregation function and the deregulated players, the manufacturers and the issues related to communication and standardization, as well as future R&D needs.

INTRODUCTION

Reaching the objectives and exploiting the results of the ADDRESS project can help the European Smart Grids Technology Platform vision to become a reality: a network that is flexible, reliable, accessible and economic. In particular the ADDRESS project developed a comprehensive technical and commercial architecture to enable Active Demand at small commercial and domestic consumers, exploit the benefits of Active Demand with supporting activities and validated the architecture through 3 complementary test sites in three European countries with different network topologies and social and cultural backgrounds. This paper will report the main recommendations for the key stakeholders that

have been derived from the work carried out for the deployment of the active demand.

Consumers needs

In the ADDRESS project, the gateway to Active Demand (AD) was the Energy Box (Ebox), a home energy management interface that controlled shiftable loads (washing machines, dish washers and electric clothes dryers), interruptible loads (electric heaters, fridges and freezers) and thermal loads (air conditioners) according to parameters set to reflect the relative priorities of financial savings, comfort and convenience. Overall, control of interruptible loads was successful and in many ways 'invisible' to consumers, but the shifting of consumption was found to be more disruptive to existing ways of doing.

Building on these findings, to aid uptake of AD, it is essential that consumers are able to schedule their consumption easily to fit in with their daily routines; to this end, user interfaces must be simple to understand and to input settings. Consumers will need support with the installation of AD technology in their homes to minimise problems both from a technology perspective, but also to facilitate setting the load control parameters to ensure that consumers are not inconvenienced and discomfort is minimised.

Automation of load control is convenient for consumers so they can choose how frequently they manage or control their responses but the ability to over-ride the system when needed is very important.

Contracts need to be clear to understand, transparent and clearly set out the potential financial benefits and implications of different actions. Some consumers may have concerns over privacy which must be addressed, by ensuring data protection and clear understanding between consumers and providers on how data will be used. In this respect, trust in those offering an AD product is important, to build consumer confidence over protection of their data, their privacy, the fairness of contracts and appropriate distribution of financial benefits.

Whilst financial benefits are important to consumers, other factors may influence their decision to adopt AD technology such as interest in new technology or to help address issues specific to their region such as allowing greater use of renewable electricity or managing scarce supply. The full range of benefits must be clearly communicated to consumers to ensure as wide a take-up as possible.

Aggregation function

In the ADDRESS architecture, the Aggregator provides AD products to other players willing to buy them upon contractual agreements. Thus, the Aggregator is also called the AD provider. The Aggregator has to interact with different power system actors in regulated and deregulated environments with the objective of enabling AD services. The main actors that interact with the Aggregator are deregulated power system participants, DSO/TSO, EB (consumers), metering responsible parties. Recommendations to allow the aggregator participation in the energy market can be summarized as follow:

- Identifying and modelling the potentially attractive Active Demand conditions

The Active Demand potential in a specific setting should be modelled with scenarios defining geographical characteristics of the area, customer characteristics and load density, power sector environment and technological context.

- Responsibilities for the Aggregator

The Aggregator should have balancing responsibilities associated to the activation of the Active Demand services and their payback (the change in consumption that appears after or before the Active Demand service in the opposite direction). For the latter, a new type of bid, namely payback bid, could be introduced to the market.

The Aggregator should formulate and maintain a diversified portfolio of active customers to account for the ever changing requirements of Active Demand buyers and uncertainties associated to customer flexibility and availability.

- Market and policy changes

Instead of introducing new markets, minor changes should be made to existing market mechanisms to enable Active Demand services; in particular, reducing minimum requirements (e.g. MW) for products to be traded in the markets.

The data and interfaces used by the Active Demand enabling technology must be standardized with the aim objective of allowing customers to switch Aggregators, thus fomenting competition and the participation of small Aggregators.

- Active Demand enabling technologies/data

The Active Demand data and physical interfaces should be standardised to facilitate competition.

Active Demand data ownership should belong to customers, whereas different parts of the aggregated data could be sold to different actors through separated data channels.

- Business models

Energy based Active Demand business models could be implemented successfully in scenarios where the costs of Active Demand enabling technologies and the burden for Active Demand consumers become negligible.

The economic attractiveness of capacity based Active Demand business models can be case-specific. Thus, it should be targeted to the most beneficial applications, such as for distribution networks operating near their limits and subject to significant load growth uncertainty.

System Operators

With AD the electricity consumption flexibilities of domestic and small commercial consumers, including the flexibilities of micro-generation and storage that may be present at their premises, are available on the electricity market.

The behaviour of consumers, who can be at the same time producers, can be different from expected and the providers of AD products could be concentrated in such a way to determine network violations.
In this framework SOs have to ensure, anyway, a reliable operation of their networks without prejudice of the quality of energy supply. The AD product exchanges have thus to be monitored in order to meet this objective.
AD can be used by SOs to solve network operation problems as well.
The algorithms and prototypes developed within the ADDRESS project let DSOs both to enable and exploit AD products visible at LV, MV and HV levels.
The services provided by SOs to AD market in terms of generation of location information, technical validation, provision of metering information (depending on the regulation), guarantee transparency and non discriminatory access to all involved actors.
Although limited (by the necessary budget and resource limitations in the project), the field test results have shown that some DSO and TSO needs can indeed be satisfied and some network constraints can be solved by the AD products buying.
The distribution of intelligence and the positioning of measuring devices along MV and LV networks as well their amount has to be optimized taking care of algorithm (like DSE) performances and huge number of devices involved.
The availability of cheap communication media as well as standardized protocols and interfaces is really key for the integration of the ADDRESS technology in the future Smart Grids.
SOs must be totally confident in the tools they use: energy services / products delivered by AD must offer a sufficient level of reliability could be subject of additional contractual clauses to guarantee specific reliability expectations.
Coordination is necessary among TSOs and DSOs taking into account their own responsibilities and different needs and constraints of regional and local networks.
SOs control systems have to be upgraded introducing new functions to enable and exploit AD.
SOs, as well as Aggregators, also have to ensure the consumers' privacy dealing with their data/information.
SO's regulation (way of remuneration) has to include the fixed costs associated to the services provided to enable AD and has to allow DSO/TSO to purchase AD products (country specific) in order to maximize the existing network usage factor integrating RES in a sustainable way.
The System Operator should have a role in the verification and measurement of AD products.

Deregulated players

Apart from the flexible consumers, deregulated participants can be categorized as follows:

- Producers (centralized and decentralized producers, with or without regulated tariffs)
- Intermediaries (retailers, production Aggregators, electricity traders and brokers, Balancing Responsible Parties - BRPs)
- Large consumers

In essence, the aforementioned deregulated players might all be to a more or less extent interested in the emerging opportunities offered by the AD services identified by the ADDRESS project to be potentially provided by Aggregators.
The contracts between Aggregators and consumers should keep a balance between transparency to protect consumers, and flexibility to allow for different business models. Wholesale markets are rather well-prepared to incorporate Active Demand products without large changes. But Active Demand products should be standardized to facilitate trading in these markets.
The creation of local markets for Active Demand is probably too complex for the moment being.
The System Operator should have a role in the verification and measurement of Active Demand products. The ownership of Active Demand data and infrastructure needs to be allocated appropriately, and data privacy ensured absolutely.
Regulators may need to intervene to correctly allocate correctly costs and benefits among agents.
Finally regulation must also prevent an unfair competition with the regulated default tariff, if it exists.

Communication Infrastructure

Communications shall enable necessary interactions among the market participants for the exchange of technical and commercial information. The overall process for the definition of the telecommunication requirements must take into account the ADDRESS model description with all the actors, their interactions and business services defined, and the list of non-functional and telecommunication functional requirements.
The communications between the players shall satisfy the following technical requirements: performance - bandwidth (data rate) constraints and robustness (availability), supported protocols and interfaces, plug & play capabilities, QoS (quality of service), network management, firmware upgrade and security.
Smart Grid Active Demand communication architecture needs to connect a large number of very different players each having very different communication needs, interfaces, communication channels and specific problems and requirements.
Large parts of the required communication infrastructure have to be accepted as being "given" and cannot be changed.
Any communication solution for Active Demand has to be realised given this constraint.
ADDRESS advocates the consequent usage of available, open and proven standards for any Active Demand related communication.

No restriction to specific communication channels in order to avoid to rule out certain Active Demand participants and heterogeneous communication infrastructure needs to be acknowledged. Successful communication requires a comprehensive underlying modelling.
Model (CIM) has been proven to be very suitable for this purpose. The main recommendation for a realisation of Active Demand communication infrastructure is the use of a Service-Oriented Architecture (SOA) and the exchange of standardized XML-messages by the means of services.
A strong requirement for the success of Active Demand is the simple, robust and efficient implementation of standardized and well-proven communication in end-customers' homes.

Manufacturers

The successful implementation of the AD strategies requires an active participation of all involved stakeholders. Approaching the residential segment it is fundamental to guarantee the acceptance and participation, among the others, of the final consumers in the proposed solutions.
The management of the electricity consumption at the consumers' premises is normally a compromise between residents' comfort and energy use. The availability of electrical devices able to interact from one side with the Energy Box and from the other side with the final consumer in order to properly manage the energy usage is a fundamental element to guarantee the acceptance of the AD solution by those consumers.
To facilitate a large diffusion of Smart Devices able to concur in a successful diffusion of Active Demand policies offered by Aggregators, it is important to create the conditions for:
1. Active customer involvement;
2. Attractive Commercial Offer;
3 Interoperable and Flexible Technical Infrastructure.
The availability of interoperable standards is a crucial element to make possible the successful commercialization of Smart Devices. These interoperable Application Profiles are mainly related to support the communication between the Smart Devices and the Energy Box. The interoperable standards for the integration of the Smart Devices should be open, flexible, secure and global, covering the information to the customer, the control signals and the user needs.
The manufacturers are interested in a global solution able to manage the regional differences in a flexible way to avoid to multiply the effort with dedicated versions for the Smart Devices.

Future R&D needs

The achievements and results of ADDRESS project have set the room for additional R&D. The suggestions for future R&D arguments are necessarily transversal to each category of stakeholders, as each R&D activity will involve more than just one of them. Here, the issues to be addressed are very shortly recalled; more details can be found in [6].
• Trading mechanisms of AD services, even if local markets seem too complex to implement nowadays;
• Reduction of the costs of infrastructures that enables AD services, and availability of smart appliances;
• Evaluation of customer flexibility towards efficient and economical implementation of AD products;
• Usability experiments during development to get interfaces easy to understand and to use;
• Continued field trialling of AD technology to gain a better understanding of consumers' acceptance of AD services;
• Priority of validations of AD products by DSO, and commitment for validated conditional AD products;
• Possible alternatives to curtailment of AD program by DSO;
• Measurement and verification of delivery of AD products, with the appropriate definition of the baseline for the assessment of demand modification;
• Management of the impacts of AD on the retailer, to estimate the diagram (energy) modifications performed by the Aggregator for a fair share of costs between the retailer and Aggregator;
• Advantageous communications implementation and how to get there;
• Deeper understanding of the potential of the exploitation of the whole flexibility of devices;
• Integration of AD functionalities with other added value services available thanks to the communications infrastructure.

Conclusions

This paper has presented the recommendations on the most critical aspects for a broad acceptance of Active Demand.
The recommendations have been proposed as seen from the different parties involved in the ADDRESS architecture: Aggregators, Consumers, System Operators, Deregulated players, Communications, Manufacturers and Future R&D.
In addition some lessons learned derive from the ADDRESS experience, which can be useful for future projects and experiences, summarised as follow:

- Involvement of consumers, pre-industrialization, certification and pre-commercial deployment require plenty of resources, specific skills, focus and organisation
- Unbundling causes difficulties when tests involve different domains
- Privacy and data protection must be taken into account in the project schedule
- Commercial/communication profiles are needed for recruitment
- Standards application is worthwhile, even

though it creates a lot of constraints

- Consumers recruitment leverages also on accountability of the promoters and on the technology and green enthusiastic.

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