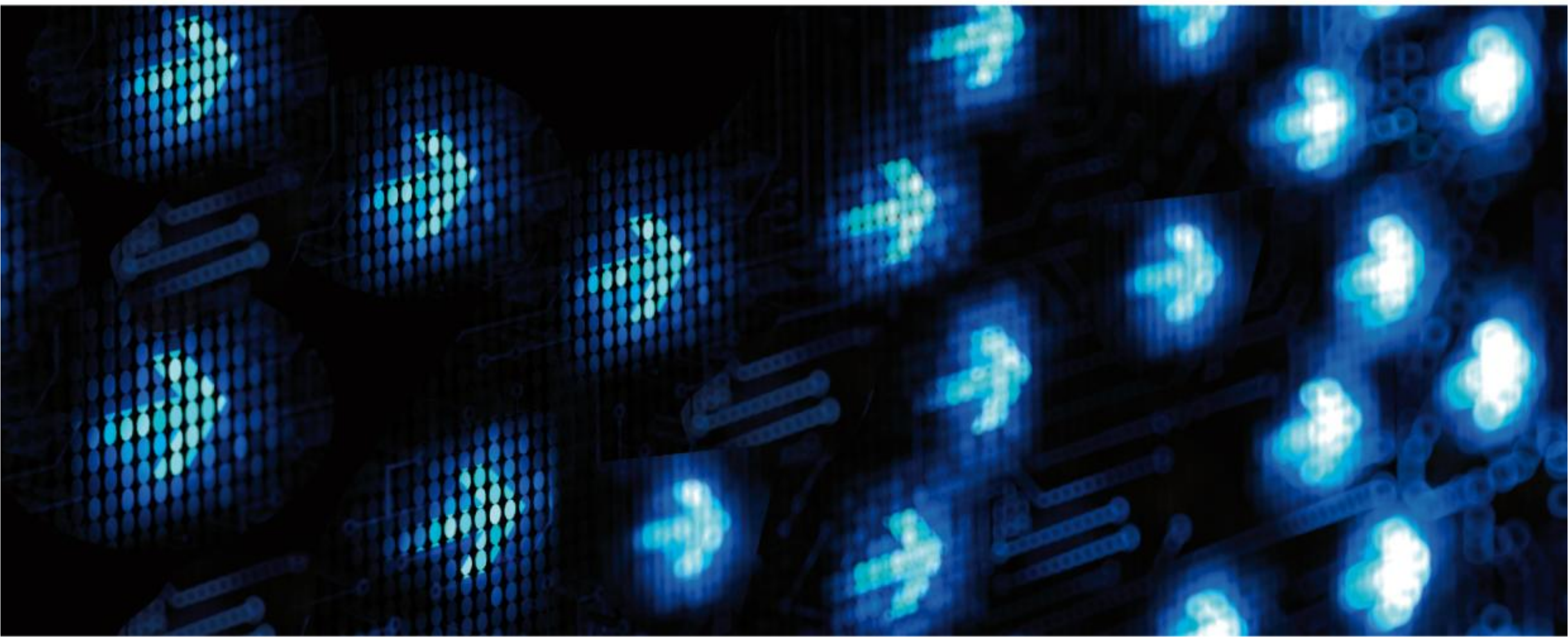
ADVANCED

Active Demand Value ANd
Consumers Experience Discovery



ADVANCED

Active Demand Value ANd
Consumers Experience Discovery

COOPERATION

The research leading to these results has received funding from the European Community´s Seventh Framework Programme (FP7/2007–2013) under grant agreement n° 308923.

Consolidated report on the key ADVANCED conclusions

D6.5

Programme	FP7 – Cooperation / Energy
Grant agreement number	308923
Project acronym	Advanced
Type (distribution level)	[Public]
Date of delivery	30/12/2014
Number of the Deliverable	**[D 6.5]**
Status and Version	Draft, V 1.0
Number of pages	135
WP/Task related	WP6 – T6.5
WP/Task responsible	T6.5 – Silvia De Francisci Enel Distribuzione
Author(s)	Silvia De Francisci, Roelien Attema, Oliver Franz, Maria Sebastian Viana, Pablo Frias, Mercedes Vallés, Philipp Lewis, Thomas Schmid, Thomas Mikkelsen, Gabriela Bodea, Sophie Goudet, Nicholas Becuwe
Companies Contributing	ENEL Distr., TNO, VaasaETT, TNS, Iberdrola, Comillas, RWE, ERDF, Entelios

Executive Summary

Active Demand (AD) has the potential to contribute to solving some of electricity systems current and future challenges while offering significant benefits to consumers

ADVANCED is a research project co-funded by the EU's Seventh Framework Programme (FP7/2007-2013) that aims to shed light on ways to overcome the barriers hindering the mass deployment of AD in Europe.

Within ADVANCED, AD was defined as "*providing electricity consumers with information on their consumption and the ability to respond to time-based prices (either manually or automatically) as well as with other types of incentives, thus motivating them to actively manage their consumption by altering usage in line with the network conditions, such that modifications in consumer demand become a viable option for addressing challenges of electricity systems*".

Accordingly, the research within its scope focused on energy efficiency (EE) and demand response (DR) programmes. EE programmes offer consumers more direct, detailed, comparable and comprehensive information about their household's energy consumption patterns in order to influence their behaviour towards a conserving effect. In DR programs consumers are requested to modify their consumption (either decreasing or increasing it) in response to price/volume signals in order to meet the need of the system.

The project objectives were the following:

- To assess and compare the case studies to understand how scaling up from pilots to real implementation
- To reveal the benefits of AD for the key stakeholders
- To analyse inherent impacts on the electricity system considering its potential contribution to system stability and efficiency

- to develop actionable frameworks (validated recommendations for an efficient design of AD programmes) enabling residential commercial and industrial consumers to participate in AD thus facilitating mass uptake of AD in Europe

The basis for the investigations within ADVANCED is a unique empirical knowledge base including:

- data generated within the ADVANCED sites, four different real life AD demonstration projects: two ADDRESS pilots (Spain and France), E-DeMa pilot (Germany) and Enel Info+ pilot (Italy),
- a database containing a meta-analyses of 138 AD pilots, involving more than 630,000 consumers
- the expertise of a leading provider of Demand Response solutions for commercial and industrial consumers in Europe;
- Results of a qualitative survey with approximately 20 residential or small commercial consumers per ADVANCED site and with some industrial consumers in Germany who are exploiting AD for their business;
- Results of a quantitative online survey among more than 8000 residential consumers in eight European countries.

One of the strength of the ADVANCED project is the access to the aforementioned extensive amounts of pilot data on individual household behaviour in different countries as a response to AD interventions with different characteristics. In order to assess and compare the case studies with the final aim to understand how scaling up from pilots to real implementation a methodology was set up that required a multidisciplinary approach complementing technical data with psycho-social and behavioural knowledge. Achieving this goal was a strong challenge and the use of standardization of data and methods turned out to be of outmost importance.

The first step was the definition of a conceptual model of active consumer participation in AD in which all relevant factors influencing the participation of consumers in AD programmes were included and their relationships described in the form of “hypotheses”. These hypotheses were tested in the project by using the data collected in the ADVANCED sites (at household level) to uncover what profiles of household consumers adjust their consumption the most or the least to certain interventions and to what extent.

For this purpose the ADVANCED knowledge base has been organised in the form of a "target matrix" of variables organised in such a manner that data from a wide range of pilots (differing in terms of recruitment strategies, incentives, communication strategies, functionalities and applied technologies etc.) and consumer segments can be compared in a logical, comparable manner. This extensive list of variables represents one of the main results of the project.

A set of KPIs was defined test the hypotheses in the conceptual model of active consumer participation in AD as well as to evaluate the impact of AD on the system. The following main categories of KPIs were identified within the project taking into account the perspectives of the key AD stakeholders: improving energy sustainability, reducing system costs, maintaining electricity system reliability, improving affordability, and improving customer relationship. Within the aforementioned categories, some KPIs have been identified measuring benefits that take place at the grid level while some other benefits take place at the household level. The "Increased demand flexibility" and "Change in overall electricity consumption" KPIs are extremely common for AD pilots but the success is always measured at an aggregated pilot or group level. ADVANCED is unique in defining, measuring and evaluating these KPIs on a household level. They were chosen for validating the hypotheses included in the conceptual model and a methodology to quantify these KPIs in a univocal manner has been developed. An additional and completely new indicator: "Signal Compliance: difference in consumption pattern" has been defined. This KPI is calculated comparing the consumption trend of each consumer after the DR signal comes into force with its habitual one. It is a unique ADVANCED KPI and can only be calculated using data at a household level.

A qualitative research was designed and carried out based on in-depth interviews with consumers who have participated within AD programmes (residential as well as commercial and industrial). These included both those of the ADVANCED sites, and those who are already exploiting AD for their business as the Entelios' commercial and industrial customers. This research enriched the study with insights into socio-economic drivers of consumers' behavior. The interviews were focused on interactions, beliefs, attitudes and their evolution throughout the experiment and with the AD technologies. It was important to discover what the benefits and barriers were and further to understand if any elements of the project impacted their beliefs and/or made them change their behaviour.

Some additional data were gathered through quantitative online surveys within a representative sample of residential consumers in eight European countries with the aim of providing statistically robust indications of awareness, understanding and attitudes towards AD revealing in particular the degree of knowledge and understanding of AD and consumers' stated flexibility when it comes to their energy consumption.

An ADVANCED knowledge base was compiled through gathering data in a uniform manner, in order to enable comparability. This knowledge base includes the ADVANCED sites databases (with both consumption data as social data coming from questionnaires, recoded to the uniform ADVANCED format), the data within the VaasaETT database, the outcomes of the qualitative and quantitative surveys conducted within the project and some more data coming from the experience of project partners, especially Entelios.

As the conceptual model was built around relatively short-term pilots, the second step was to adapt it in order to extend its applicability to a mass market context. Several principles were considered for defining these adjustments like the complexity of the social and physical environment where consumers act, the evolution of consumers behavior, the capacity to choose among different offers, etc. The conceptual model was validated based on support from the body of evidence collected by ADVANCED through pilot data analysis, the qualitative research and the quanitative interviews. The findings of these reports, when combined provide an additional degree of insight to the conceptual model, specifically clarifying particular aspects of it. In fact the entire model defines the set of drivers that lead to active consumer participation in AD.

From the validated conceptual model has been derived an interpretation of consequential key barriers to active user participation in AD for commercial, industrial and residential consumers. For each barrier, there are suggested associated actions to address those barriers. This was also supported by the practical experience of aggregators, retailers and DSOs, that are active throughout Europe. Hence, the ADVANCED consortium conducted research on the market conditions and regulatory framework for AD in the ADVANCED markets in France, Germany, Italy and Spain. Combining the findings of the interviews with the research in the markets, the ADVANCED consortium elaborated an Actionable Framework for C&I and residential consumers that describes the main barriers and hurdles to Active Demand in general, and Demand Response in particular, and suggests actions and recommendations how to overcome them to support the widespread integration of AD across European electricity markets. The consortium put special emphasis on actionable recommendations with a direct and immediate positive effect which is why focus was put on the most important barriers. The evaluation showed that fixing the three most important barriers are quick wins with a significant impact on creating viable markets for AD services that allow the C&I consumers to participate with their demand-side flexibility. The actions and recommendations are supported by examples of European markets which have successfully removed barriers and hurdles to AD.

One of the final objectives of the project was to create Communication Umbrellas for both C&I as well as residential consumers to be used when designing AD programs. The Communication Umbrella consists of key messages and motivational drivers. The ADVANCED consortium in addition, suggested some communication guidelines how to communicate the concept, mechanisms and benefits of DR. For utilities and DSOs the challenge is to inspire consumers on measures that are economically meaningful but very often complex and abstract.

The flexibilities that AD might offer with demand response and energy efficiency in France, Germany, Italy and Spain have been calculated for a baseline, optimistic and technical potential scenario. The results with regard to energy efficiency indicate that even in the baseline scenario a small potential exists. The results for the commercial & industrial sector are quite better. By taking this into account, the aggregation of the AD potential of the residential sector and the C&I sector indicates that a high AD potential is available in all four countries.

A special DSO perspective was taken in order to find a fit between DSO's (expansion) needs and the possibilities of AD. The outcomes of this analysis are four major categories of (future) system services: frequency control, optimization of distribution network planning and construction, optimization of system operation, management of emergency situations, network or system restoration and islanding.

The benefits in terms of investments for the distribution network reinforcements that a more efficient use of existing and new grid capacity due to AD could defer or avoid have been evaluated. The analysis showed that these benefits are strongly dependent on network expansion drivers, network typology, current level of network constraint, and location of responsive consumers.

A framework was also created for data security and data protection. The analysis was based on a review of relevant EU (policy) documents, technology assessments, of existing guidance and advice and of other selected authoritative sources on topics including smart grids and smart meters. Special attention was paid to available empirical evidence regarding privacy issues in AD systems. The research made use of the unique knowledge and experience available within the project which includes partners involved in deploying AD pilots. The results of some of the ADVANCED pilots as well as the results of the surveys were used. Moreover lessons learnt from relevant international initiatives were taken into account.

The full potential of AD has still not been achieved in most of European countries. From the revision of the main regulatory aspects that should be reviewed in order to unlock the potential of AD, the most concerns are raised by DSO regulation and network tariff design, but also to retail markets, standardization and consumer protection. The main findings in the regulatory analysis have been listed.

Table of contents

Executive Summary 3
Table of contents 9
List of figures 11
List of tables 12
1. Introduction 13
1.1. Scope of the document 13
1.2. Structure of the document 13
1.3. Notations, abbreviations and acronyms 14
1.4. Project overview 16
1.4.1. ADDRESS pilot sites 18
1.4.2. RWE Deutschland E-DeMa pilot site 21
1.4.3. Enel Info+ pilot site 23
1.4.4. VaasaETT database 25
2. A methodology to assess different AD experiences 27
2.1.1. The ADVANCED conceptual model 27
2.1.2. The target matrix 29
2.1.3. The ADVANCED KPIs 30
3. The cross case analysis 32
3.1. The ADVANCED cross-case analysis: theory meets practice in the ADVANCED methodology. 32
3.1.1. Data 32
3.1.2. Key performance indicators calculation (KPIs) 33
3.2. Results 35
3.2.1. Overall electricity consumption KPI 35
3.2.2. Compliance KPI 37
3.2.3. Influencing active end-user participation 41
3.3. Impact and AD pilot cross-case comparisons 50
4. The voice of consumers 54
4.1. Qualitative research 54
4.1.1. The analysis of the residential customers 54
4.1.2. Analysis of the C&I 57
4.2. Quantitative analysis 59
4.2.1. The main results 59
5. The ADVANCED knowledge base 62
6. Making AD happen 64
6.1. The validated conceptual model 64
6.1.1. The validated conceptual model components 65
6.1.2. Identified dynamics of the model 69
6.1.3. Drivers of active consumer participation in AD 70
6.2. The actionable framework for residential consumers 73
6.3. Communication umbrellas for residential consumers 80
6.3.1. Assumptions and methodology 80
6.3.2. Results and findings 81
6.4. The actionable framework for C&I consumers 87
6.5. Communication umbrellas for C&I consumers 90
7. The impact of AD on the electrical system and its actors 93
7.1. Scenario-based results on the flexibilities AD might offer 93
7.1.1. List of basic ADVANCED assumptions: 94

7.1.2. Demand response (residential) ... 97
7.1.3. Energy efficiency (residential) ... 98
7.1.4. Barriers with regards to AD in the residential sector ... 99
7.1.5. Results with regard to the C&I sector (Germany) ... 101
7.2. Active Demand System Services ... 101
7.3. AD Impact assessment on electricity system ... 104
8. Privacy and data protection ... 109
9. Main results ... 113
9.1. Design and management of AD programs ... 113
9.2. Impacts of AD on the electrical system and its actors ... 117
10. Recommendations ... 119
10.1. Collection and standardisation of data ... 119
10.2. Assessment of behavioral changes ... 119
10.3. Communication campaigns to promote and to implement AD ... 120
10.4. How to manage your AD program ... 124
10.5. Privacy and data protection ... 126
10.6. Regulation ... 126
11. Conclusions ... 130
12. References ... 134
12.1. Project documents ... 134
12.2. External documents ... 134
13. Revisions ... 133
13.1. Revision history ... 133

List of figures

Figure 1- The conceptual model (residential consumers).. 28
Figure 2 - KPI's Signal down and –up Compliance.. 35
Figure 3 - Histogram of overall consumption Enel Info+pilot households.................. 36
Figure 4 - Histogram of overall consumption ADDRESS|Iberdrola pilot households 37
Figure 5 - Histogram of overall consumption E-DeMa pilot households...................... 37
Figure 6 - Histograms of compliance (up and down) ADDRESS|Iberdrola pilot households 38
Figure 7 - Histograms of compliance (up and down) E-DeMa pilot households............ 40
Figure 8 - Graph of factors correlated with overall consumption.............................. 42
Figure 9 - Graph of factors correlating with compliance (up or down)....................... 43
Figure 10: Positioning of the ADVANCED knowledge base 62
Figure 11 - The Validated Conceptual Model 65
Figure 12 - The Validated Conceptual Model Including Momentum 69
Figure 13 - The Validated Conceptual Model - Key Validated Variable Inter-relationships 70
Figure 14 - Regulatory Roadmap 77
Figure 15 - Non-regulation AD Roadmap - Infrastructure 78
Figure 16 - Non-regulation AD Roadmap - Relationship 79
Figure 17 - Non-regulation AD Roadmap - Information / Education 79
Figure 18 - Non-regulation AD Roadmap - Offerings & Rewards 80
Figure 19 : *The AD Communications Wheel* 82
Figure 20: The AD Segmentation Model 84
Figure 21: *Factors influencing AD Success. Correlation analysis of the qualitative and quantitative survey* 85
Figure 22: *Development strategy for implementing an ADCommunications platform* . 85
Figure 23: *ADVANCED segments communication approach* 86
Figure 24: The Actionable Framework for Commercial and Industrial consumers. Source: ADVANCED Project. 89
Figure 25 - Stepwise ADVANCED methodology for the quantification of the AD potential 96

List of tables

TABLE 1 – ABBREVIATIONS..15
TABLE 2 - MAJOR QUANTITATIVE RESULTS WITH REGARDS TO DEMAND RESPONSE 97
TABLE 3 - MAJOR QUANTITATIVE RESULTS WITH REGARDS TO ENERGY EFFICIENCY RESPONSE 98
TABLE 4 - REVISION HISTORY 133

1. Introduction

1.1. Scope of the document

The scope of the document is to provide an overview of the ADVANCED project and to summarize the key conclusions and recommendations.

The main results of the ADVANCED project both concern the different aspects behind the design and management of AD programs and the impacts of AD on the electrical system and its actors.

The extensive outcomes and the analyses behind them are available to all stakeholders on the "Results" section of the project website http://www.advancedfp7.eu/

1.2. Structure of the document

The content of this document is organised as follows:

- An overview of the project is reported in the first chapter, that explains its context and details the starting points for its development. The AD real experiences on which the analysis within ADVANCED is based are described.
- The methodological approach (that was designed in the first period) for the assessment of the diverse AD experiences examined within the project is explained in Chapter 2. Following on, the real application of this methodology through the cross case analysis is illustrated, together with the most relevant results of the aforementioned studies in Chapter 3;
- The outcomes of the qualitative and quantitative studies that have enriched the project research with further insights on the consumers' attitude towards AD are reported in Chapter 4.
- Chapter 5 describes the extensive ADVANCED knowledge base;

- The validated conceptual model for consumers participation in AD and consequently the actionable frameworks for the successful deployment of AD in Europe are described in Chapter 6. The communication umbrellas, i.e. a set of tools and a way of working with communication alongside the roll out of Active Demand are also given;
- The quantification of the flexibilities that AD might offer with demand response and energy efficiency, the main AD system services and the benefits in terms of investments for the distribution network reinforcements that a more efficient use of existing and new grid capacity due to AD could defer or avoid are included in Chapter 7.
- Chapter 8 includes the framework for data security and data protection
- A synthesis of the main results and recommendations is outlined in Chapters 9 and 10 respectively.

1.3. Notations, abbreviations and acronyms

AD	Active Demand
AMI	Advanced Metering Infrastructure
BRP	Balance Responsible Partner
CHP	Combined Heat and Power
C&I	Commercial and Industrial
CPP	Critical Peak Pricing
CPR	Critical Peak Rebate
DG	Distributed Generation
DR	Demand Response
DSO	Distribution System Operator
EC	European Commission
EE	Energy Efficiency

EU	European Union
IHD	In-home Display
KPI	Key performance indicator
MV	Medium Voltage
PV	Photo Voltaic
RES	Renewable Energy Sources
SM	Smart Meter
TOU	Time Of Use
TSO	Transmission System Operator
WP	Work package

Table 1 – Abbreviations

1.4. Project overview

Active Demand (AD) has the potential to contribute to solving the challenges of electricity systems. It offers significant benefits to consumers and is considered one of the largest so far untapped energy resources.

A significant barrier to realising this potential is insufficient consumer engagement and awareness regarding their own energy consumption. Another significant barrier are the lack of offerings made to consumers around Europe. Few consumers are offered viable choices which could help them lower their electricity costs or encourage energy savings. An understanding of best practice, consumer engagement mechanisms and required technologies is urgently needed within the industry. There is a lack of insights into the AD related behavioural barriers and unavailability of best practices for AD design.

The ADVANCED (Active Demand Value ANd Consumers Experiences Discovery) project developed actionable frameworks enabling residential, commercial/industrial consumers to participate in AD, thus contributing to AD mass deployment in Europe. The project has also quantified the benefits of AD for key stakeholders and the inherent impacts on the electricity systems considering its potential contribution to system stability and efficiency, according to different scenarios.

The ADVANCED project is promoted by a consortium European energy utilities (Enel Distribuzione, ERDF, Iberdrola Distribución, RWE DEUTSCHLAND Deutschland), universities, research centers and consulting firms in the energy sector (Comillas, Universidad Pontificia, Fondazione Eni Enrico Mattei (FEEM), TNO, VaasaETT), one of the European leading agencies specializing in market research (TNS) and a leading provider of Demand Response solutions for commercial and industrial consumers (Entelios).

The members of the ADVANCED consortium define AD as "providing electricity consumers with information on their consumption and the ability to respond to time-based prices (either manually or automatically) as well as with other types of incentives, thus motivating them to actively manage their consumption by altering usage in line with the network conditions, such that modifications in consumer demand become a viable option for addressing challenges of electricity systems". Accordingly, the research focused on energy efficiency (EE) and demand response (DR) programmes.

EE programmes offer consumers more direct, detailed, comparable and comprehensive information about their household’s energy consumption patterns. This type of information has been shown to influence the behaviour of residential consumers and lead to a conserving behavioural effect. [19]

DR programs are a way to meet the need for flexibility as a product to energy markets. Flexibility is key to building a clean and secure European energy system. Some DR programs can also contribute in mitigating the inefficiencies caused by the fact that although the cost of supplying power to consumers can vary by an order of magnitude within the same day, the price paid by most end-users remains flat all year round in many countries.

In order to reach the project objectives, real data made available by the 4 utilities participating in the consortium and collected through 4 major pilot projects currently running or finished shortly in Europe are analysed: 2 ADDRESS pilots (Spain and France), E-DeMa pilot (Germany) and Enel Info+ pilot (Italy). Furthermore, data collected in VaasaETT’s database (from 110 European Active Demand projects with the participation of around 600,000 residential consumers) have been exploited. In the following paragraphs a brief description of the ADVANCED sites and the content of VaasaETT database is presented.

In-depth qualitative interviews with approximately 20 residential or small commercial consumers per ADVANCED site and with some industrial consumers (recruited in Germany with the support of Entelios) have been carried out and their outputs have enriched the study with insights into socio-economic drivers of consumers’ behaviour.

Some additional data were gathered through quantitative online surveys within a representative sample of residential consumers in eight European countries with the aim of providing statistically robust indications of awareness, understanding and attitudes towards AD revealing in particular the degree of knowledge and understanding of AD and consumers' stated flexibility when it comes to their energy consumption.

1.4.1. **ADDRESS pilot sites**

ADDRESS ("Active Distribution network with full integration of Demand and Distributed energy RESourceS") was a five-year large-scale R&D European project launched in June 2008 and co-funded by the European Community's 7th Framework program (FP7/2007-2013). The consortium, coordinated by Enel Distribuzione, consisted of 25 partners from 11 European countries spanning the entire electricity supply chain: Distribution System Operators (DSOs), Transmission System Operators (TSOs), Energy supply and retail qualified R&D bodies, Communications and ICT providers and home appliances and white goods manufacturers and consultants.

The aim of the project was to study, develop and validate a comprehensive commercial and technical framework to enable active demand and exploit its benefits in the smart grids of the future.

At the consumers' premises electrical appliances, distributed generation and thermal or electrical energy storage systems could be controlled and optimized by an Energy Box, which was the interface with the external world and with the consumer. The Aggregators, through the Aggregator Toolbox, were the mediators between the consumers and the markets, allowing power system participants to explore the flexibilities of the aggregated customers. DSOs could interact with the other power system participants via the markets. Three pilot field test were located in three European countries (Spain, France and Italy) with different network topologies, climate conditions and social acceptance which, taken together, provided a validation of the entire concept.

The **Spanish field test** was located in the city of Castellón (Mediterranean Coast). The network in this region is feeding 100.000 points of supply (200.000 inhabitants) with a meshed MV network typology with radial exploitation. Around 265 consumers were recruited to participate in the field test. The recruitment of the participants has been accomplished through Call Center effort (phone call campaign in the name of Iberdrola) and a well-known contractor in Castellón area that did the work locally (arranging dates with the consumers and signing the contracts).

The pieces of equipment installed in all the consumer premises were:

- Energy Box (EBox) to receive price-volume signals, generate automation commands to control appliances and register consumption;
- five (5) smart plugs connected to different appliances and a measuring device, all of them communicated wirelessly with the Ebox.
- Additionally, 25 participants accepted to install in their houses a smart washing machine and 30 accepted to install air conditioning management equipment.

Previously an AMI system was fully deployed in the area (smart metering + remote management system and Meter Data Management System).

The pilot started the 1st of June 2012 and finished the 31st of July of 2013, a total of 13 months. Not all the participants got the equipment installed at the same time, then they did not start participating at the same time.

The Spanish field test analyses the relationship between the Aggregator Toolbox and the consumers through the Energy Box in order to be able to manage the demand and individual loads. In the pilot consumers behaviour, Home Area Network, Aggregator toolbox and Interoperability & Communications between Aggregator-Energy Box and in the Home Area Network were also tested.

The aim of the **French field tests** carried out in the Brittany Islands of Houat and Hoëdic was to test the whole ADDRESS chain, i.e. from the needs of the electricity system players to the controlled appliances in the consumers' premises, including also consumers' acceptance studies.

Around 30 residential customers and a few small commercial customers were involved in the project. Contracts signed between EDF and the customers included special clauses related to the protection of consumer data. Besides, a declaration of the consumer data collected was made to Commission nationale de l'informatique et des libertés (CNIL) and appropriate measures have been taken to ensure confidentiality of these data.

In the French ADDRESS test site, several scenarios were tested:

- Provision of services by AD based on:
    - actual requests from electricity system functions/players (DSO, BRP, etc.),
    - requests resulting from simulation of possible problems or needs of the players,
    - AD services such as
        - Active power reserve, load/generation balancing services, load shaping,
        - Voltage control, overload/network congestion relief,
- Combination of AD with RES both for load/generation balance and grid aspects;
- Monitoring and forecast of RES production;
- Requests taking into account actual/present RES production and simulated future RES production based on future projects;
- Simulated market interaction of different players with aggregation platform.

These scenarios were tested along with technical performance tests:

- DSO's algorithms and in particular the technical validation of AD actions;
- Aggregation platform and its algorithms;
- Ebox, its algorithms and display;
- Communication and signals exchanged between aggregation platform, Ebox, meter and appliances:
    - Control of appliances at consumers premises:
        - Washing machines ;
        - Smart plugs: classical washing machines, dish washers, deep freezers, etc.;
        - Electric radiators, water heater.

The tests that were carried out also include social validation in order to assess consumers' commitment in field tests and acceptability with respect to AD and project concepts.

1.4.2. **RWE Deutschland E-DeMa pilot site**

The publicly funded E-Energy project E-DeMa targeted an increased mobilization of flexibilities in electricity usage at the household level for the energy system of the future. In order to achieve this goal a regional energy market place, i.e. the "E-DeMa marketplace", connecting the approximately 700 households that have been participating was developed. This market place is an innovative ICT platform that enables current market roles (supply companies) as well as new ones (Aggregators) to offer new and innovative products which in turn help to "harvest" flexibilities from the customers. The project started in 2008 as part of the E-Energy Programme of the Economics and Technology Ministry (BMWi) and Environment Ministry (BMU) and it was completed in May 2013.

Special attention has been paid to consumer recruitment as the project has to be executed in the area of dedicated stations only a limited number of possible participants was available already at the outset. To cope with this situation, E-DeMa was organized as an unbundled project i.e. customers from all supply companies took take part. In addition the recruitment process was designed together with a specialised communications agency and based on dedicated and personal dialogues with potential participants. This approach has led to a high success rate in the recruitment process which is substantial to achieve the desired number of participants.

Two types of interventions were used influence the participants' energy consumption: Energy Awareness/Efficiency and Demand Response. On the one hand, Energy Awareness/Efficiency was enhanced by providing feedback of the energy consumption to the consumer via a display and - in addition - via E-DeMa marketplace, i.e. using a website. On the other hand, home appliances like washing machines, dryers and dish washers as well as decentralized generation devices like micro CHP's were used as flexibilities to manage the energy system, i.e. demand response was realized with time of use tariffs which motivate the consumers to shift energy consumption from times with high prices to low price zones. The actual time of power usage was managed via price signals which are distributed via the E-Energy market place. The control of the home appliances was achieved either manually by the consumer using the energy display or automatically controlled by the home energy gateway. Alternatively the consumer could leave the flexibility of an appliance to an Aggregator. In this case there would be a contract between the consumer and the Aggregator, i.e. the Aggregator would pay the participant a premium for “leaving” the flexibility to him for a minimum of 6 hours but would at the same time be allowed to use the flexibility whenever he wishes to in that time frame, i.e. even at prices higher than would have resulted from a start of the appliance that would be solely optimized against the tariff. Ideally Aggregator aggregates flexibilities of many home appliances to bigger quantity flexibilities which could be used for balancing power or potentially offered to wholesale markets – but for the field test the assumption was that the Aggregator had sold all his flexibilities to the DSO and would use them only in a network-friendly fashion. Measurement of actual 1/4h load profiles was achieved by a smart meter infrastructure in each household. In addition, measurements of grid borne data were used to optimize the operation of the distribution grid.

The pilot participants are divided into two groups:

- Type 1: The consumers receive pricing information via their tablet, however it is basically up to them how to use this information. In this part of the pilot, the consumer decides how to react on this information.
- Type 2: The consumers have a totally automated environment. In order to use the washing machine they choose an end time for the washing machine, and the washing machine will be automatically switched on at the optimal price. This switching can be done based on a received price signal, or directly centrally controlled via de aggregator. In both cases the end user can override the decision, however that will cost them some extra money.

The complete E-DeMa energy system was demonstrated in the framework of a field test comprising households in the Mülheim and Krefeld area in Germany. The field test started in April 2012 and was completed in November 2012.

1.4.3. **Enel Info+ pilot site**

Enel Info+ is a large scale trial of the Enel smart info device that has been designed by Enel Distribuzione to allow end users to have the certified information on electricity data managed by their electronic smart meter at their fingertips. The Trial is part of the “Isernia Project”, a project financed by the AEEG (“Autorità per l’Energia Elettrica e il Gas”) that foresees the installation of a model of smart grid on the grid connected to the Primary substation of Carpinone (a little town in the Isernia district). Enel Info+ involves a representative sample of low voltage households and small commercial consumers served by the Carpinone primary sub-station in some municipalities in the area of Isernia, the potential universe of participants includes about 8000 low voltage households and small commercial activities.

The scope of the project is to demonstrate whether giving to end users a feedback on their energy consumption can address more efficient energy behaviours. The consumers participating to the project thus receive an energy monitoring kit including Enel smart info and dedicated interfaces that they use for one year to view how much electricity is currently being used in their household and to process their historical consumption data. "Prosumers", consumers who are also producers of renewable energy (by photovoltaic or mini-eolic plants), receive an additional Enel smart info in order to manage both production and consumption metering data.

The Enel Info+ kit and the related monitoring solutions are modular and foresee three levels of analysis.

- The first one is based on the use of Smart Info Display, a full colour, touch screen in-house display, that lets the consumers keep an eye on their household energy consumption pattern easily. Smart Info Display provides both close to real time and historical information on energy consumption, which are shown in bar graphs and pie charts to highlight their mean value and how they split in tariff time bands for different periods of time (a single day, one week, one month, a bi-month, one year). Consumption habits are displayed together with the measured consumption data in the graphs, helping consumers identify variations. Historical data is stored for about three years. The instantaneous power is reported together with a scatter plot of its maximum historical values for different periods of time (a single day, one week, one month), thus the consumer can check whether its supply electricity contract is consistent with its actual needs. The instantaneous power values can be refreshed automatically as well as on demand. Tariff time bands are displayed, together with the date and time of tariff time bands switching and colors settings can be modified to be consistent with the user's tariff structure. Alarms can be set by the user to receive an alert when energy usage gets to modifiable thresholds, helping consumers keep it under control and reach their goals of personal improvement. When the contractual power is exceeded an alarm is automatically generated likewise, so that load shedding is prevented. Moreover additional feedback contents are given such as alarms at pre-defined, modifiable thresholds and when the contractual power is exceeded, DSO's announcements and contractual data. Through a dedicated wizard the customer can also measure the power used by a specific appliance.

- The second monitoring solution is based on a software application that allows the consumers to examine their consumption data in depth on their personal computers and the energy prosumers to compare production and consumption data.
- The third monitoring solution is based on a smartphone App that enables the consumers/prosumers remote access to their own energy data.

As the current level of knowledge and awareness regarding electricity of the potential participants to Enel Info+ is quite poor a step by step approach for their involvement in the project has been chosen. At the beginning they only receive Smart Info Display, that is they are equipped with the simplest feedback means. This choice is expected to incline end users towards the subject matter avoiding their rejection of the kit as "too difficult". After a few months their kit is gradually upgraded to provide them with an increased complexity and value. A web portal (www.enelinfopiu.it) has been designed to provide general information about the project and technical support to the experimenters (who can also refer to a dedicated help desk).

The consumption of the LV households and small commercial activities in the municipalities included in the project has been observed by Enel Distribuzione since the end of 2011 (pre-pilot) and compared with the data measured during the pilot to assess the effect of using the Enel Info+ kit having received the consumers' written consent to data management. Additional information are gathered by means of interviews that are carried out among an appropriate representative sample of consumers participating to the trial.

In order to successfully activate consumers Enel Distribuzione conducted an advertising campaign for conveying the objectives of the trial. At the beginning a meeting with the mayors of the municipalities included in the project and a meeting with the local consumers' associations were arranged for presenting Enel Info+ and establishing a collaboration aimed at the achievement of the recruitments goals. Then the company has been present at summer local fairs and other events for a large scale promotion, while a "pre-trial" test involving about 60 clients helped to fine-tune the technological solution and the communication efforts. Since the end of 2012 some dedicated meetings have been arranged with the potential participants for them to know the project in greater detail and to receive their own monitoring kit.

1.4.4. **VaasaETT database**

VaasaETT keeps two up-to-date worldwide pilot databases for both residential and C&I pilots and programmes. VaasaETT's residential database comprises hundreds of feedback, dynamic pricing and other smart pilot programmes from around the world. The database is being updated constantly and even substantially developed during the course of the ADVANCED project. The database was heavily customised for the purpose of the ADVANCED project. The pilots from both residential and C&I databases are chosen with criteria such as larger representative participant population, better research design and in-depth research analysis and result presentation. These pilots are selected from a larger pool which includes pilots whose design or reporting of results were not sufficiently detailed or comparable with the others to be included. Final reports, presentations and academic papers analysing the selected trials are collected from numerous sources. Papers published in academic journals are collected from academic databases. Public pilot reports are collected directly from the organizer (often local regulators or public utilities). On top of that, VaasaETT draws on its extensive network of practitioners around the world to collect pilots whose results were not made public usually from technology providers or investor-owned Utilities. Analysing such a large number of pilots offers the possibility to identify consistent results and allow visualization of the emerging pattern of AD programmes in both residential and C&I sectors. The pilot sites of the ADVANCED project have also been included in VaasaETT's databases.

2. A methodology to assess different AD experiences

2.1.1. The ADVANCED conceptual model

The investigations in ADVANCED rely on the definition of a conceptual model of active consumer participation in which all relevant factors influencing the participation of consumers in AD programmes are included and their relationships described.

AD programs aim at changing the energy use of the consumers either by reducing their total electricity consumption (EE programs) or by shifting load in time (DR programs).

Various factors (determinants) influence user behaviour (relevant determinants, derived from various behavioural theories and/or operational practice by the partners in the pilots sites). There are user characteristics: do they know they need to change their behaviour, do they know how to change it, are they motivated to change, and able, etc. Users always act in a user environment that will strongly influence their behaviour: both a physical environment (e.g. their home and appliances and the climate in their region) and a social environment (e.g. friends that act sustainable or not, government policy). This flow is depicted in Figure 1 below.

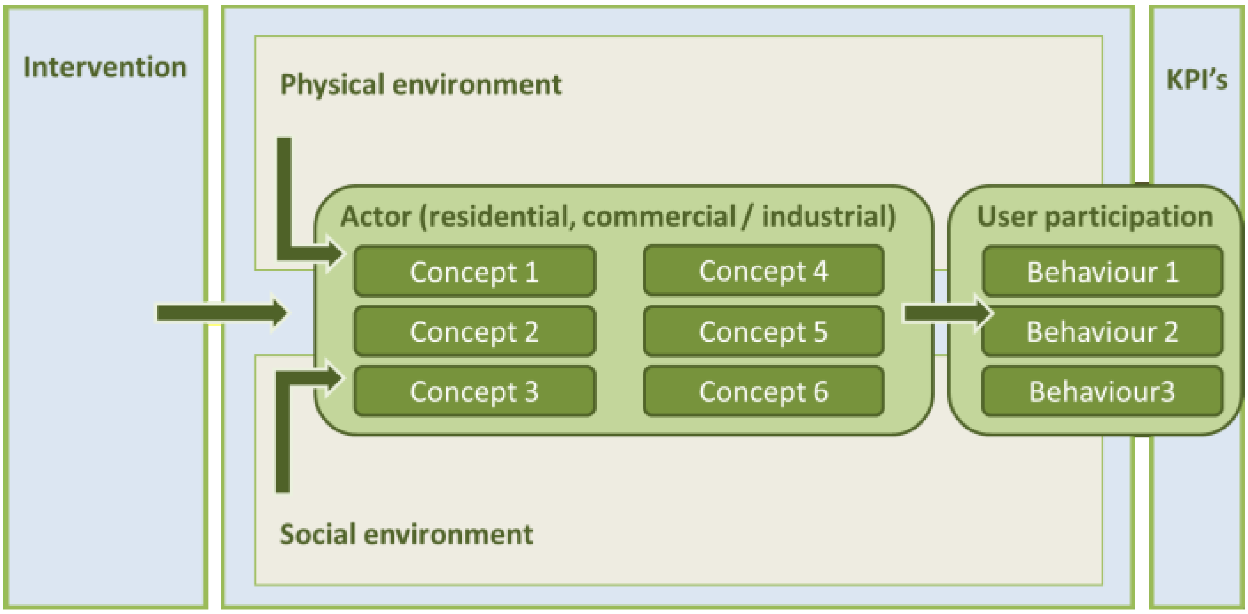


Figure 1- The conceptual model (residential consumers)

In order to stimulate active end-user participation and the desired behaviour, interventions are designed (e.g. providing feedback on energy consumption via an in-home display) and implemented in a pilot with certain characteristics (duration, number of participants, etc.)

Thus the building blocks of the conceptual framework proposed in the ADVANCED project are:

- the desired behavioural change of
- actors who live in,
- physical environments and
- social environments
- upon whom interventions are targeted
- of which the success will be measured by KPIs

By formulating generic concepts within these blocks (derived from both the scientific literature as the practical experience in real-life pilots), numerous context-specific conceptual models can be formulated and tested. Hypotheses are formulated as a causal association (i.e. testable correlations), between at least two concepts (e.g. household size is directly associated with total energy consumption) to provide insight in the mechanisms behind user behaviour and the way interventions for behavioural change can work.

These hypotheses were validated in the project by using the data collected in the ADVANCED sites (at household level) to uncover what profiles of household consumers adjust their consumption the most or the least to certain interventions and to what extent and further explored through the analysis of each ADVANCED site results and lessons learned.

For this purpose, a large pool of comparable data was required within the ADVANCED knowledge base that has been organised in the form of a “target matrix” of variables.

Moreover a set of KPIs was needed to determine the success of the interventions and identify the best practices for active end-user participation under certain conditions.

Designers of new AD-pilots or roll-outs can benefit from this analysis which will identify and make explicit the psycho-social drivers of household behavioural change when it comes to energy consumption (and therefore increasing their chances to successfully change behaviour) and determining which data have to be collected. [4]

2.1.2. **The target matrix**

In order to test the hypotheses in the ADVANCED conceptual model, a large pool of data was required within the ADVANCED knowledge base. This had to be organised in such a manner that data from a wide range of pilots (differing in terms of recruitment strategies, incentives, communication strategies, functionalities and applied technologies etc.) and consumer segments could be compared in a logical, comparable manner.

The ADVANCED knowledge base was built on a “target matrix” that was designed following both a top-down and a bottom-up approach. As a basis an operationalization was made on the concepts identified in the conceptual model, turning them into variables (with corresponding measurement units) that could be collected in the ADVANCED sites and the VaasaETT database or through the surveys of the project aimed at additional data collection (top-down). On top of this operationalized concepts an extended set of variables was identified that could be collected within the ADVANCED sites or gained from the VaasaETT database and that could be used for a bottom-up explorative analysis.

About 250 variables have been identified and included within the target matrix. They have been grouped into four main sections:

- “Generic variables”; that describe the main features of the pilots under analysis.
- “Pilot variables (subject to data privacy)”
- “Personal variables (subject to data privacy)” that are directly related to the

customer's behavior, attitude and performance.

- "Other variables", including all the variables that cannot be collected from any of the ADVANCED information sources (neither from the Advanced sites nor from the VaasaETT database) but should be taken into consideration in designing other AD initiatives

This extensive list of variables represents one of the main results of the project. In fact beyond being a means for carrying out the analyses within the scope of the ADVANCED project, using the target matrix is very important in the design phase of future AD programs as it lists the data that need to be gathered, the units of measurement and the granularities required. [4]

2.1.3. **The ADVANCED KPIs**

AD has a broad range of potential benefits and AD initiatives can help meet EU's energy policy goals (affordable, sustainable and secure energy). The following main categories of KPIs were identified within the project taking into account the perspectives of the key AD stakeholders: improving energy sustainability, reducing system costs, maintaining electricity system reliability, improving affordability, and improving customer relationship.

Within the aforementioned categories, some KPIs have been identified measuring benefits that take place at the grid level, this is the case for:

- Net avoided CAPEX;
- Net reduction in OPEX;
- Maintained quality of voltage;
- Maintained continuity of supply;
- Reduced amount of balancing and reserve power required;
- Net reduction in systemic electricity costs.

Some other benefits take place at the household level, and the related KPIs identified within ADVANCED are:

- Reduction in CO2 emissions;
- Increased customer awareness;
- Increased proportion of consumed electricity produced from intermittent;
- Net reduction in power bills;
- Compensation for flexibility;
- Participant’s satisfaction with AD programs;
- Improved participant’s satisfaction with the energy industry.
- Increased demand flexibility (peak clipping and valley filling);
- Reduction in overall electricity consumption.

The “Increased demand flexibility” and “Change in overall electricity consumption” KPIs are extremely common for AD pilots but the success is always measured at an aggregated pilot or group level. However, this does not make explicit what drives a single household to change its behaviour. ADVANCED is unique in defining, measuring and evaluating these KPIs on a household level. They were chosen for validating the hypotheses included in the conceptual model and a methodology to quantify these KPIs in a univocal manner has been developed.

Nevertheless the “Increased demand flexibility” KPI in fact doesn’t measure behavioural change due to DR signals, therefore an additional indicator: “Signal Compliance: difference in consumption pattern” has been defined. The KPI is calculated comparing the consumption trend of each consumer after the DR signal comes into force with its habitual one. It is a unique ADVANCED KPI and can only be calculated using data at a household level. [5][7]

3. The cross case analysis

3.1. The ADVANCED cross-case analysis: theory meets practice in the ADVANCED methodology.

After setting up the methodology and defining the hhypotheses of active participation of consumers in AD programs, an exploration of these hypotheses was carried out through a **correlation analysis** based on the real data available within the project.

In order to empirically explore and establish associations between household behavioural change (reduction of usage and flexibility) and certain psycho-social concepts it was necessary to operationalize these various concepts into measurable variables. An ADVANCED database was therefore compiled through gathering these relevant variables in a uniform manner, in order to enable comparability between pilot site results. All relevant data (both consumption data and social data coming from questionnaires) were recoded to the uniform ADVANCED format to be transferred and processed.

The following paragraphs report the process the consortium has carried out. [7]

3.1.1. **Data**

As already stated, in order to perform a cross-case analysis an ADVANCED database was created with data from the different pilot sites in an uniform format. This re-coding inevitably leads to lost of information and particularly variance at the household which has consequences for the amount of significant relations.

The analysis was based on two types of data:

1. <u>Consumption data</u> (longitudinal data) - In the pilots (in principle) the smart meters registered the amount of electricity used [Wh] per household per hour of the day for the duration of the pilot. Due to technical reasons, as it is a pilot set-up, some data-points are missing. In the Italian and Spanish case also an equivalent period

preceding the pilot was registered, offering historical data. The German pilot used a different kind of baseline methodology.

2. Survey data (cross-sectional data) – In the pilots one or more surveys were held with the participating households. These surveys included numerous psycho-social questions; tapping various psycho-social concepts like attitude, value orientation, self-efficacy, social norm, trust in the utility, etc. in conjunction with the more usual demographics such as age, gender, household size etc.

As the ADVANCED database was populated with data collected in the context of the local pilot projects, considerable attention was paid to not infringe local privacy rules. This resulted in the exclusion of the French dataset in this analysis.

3.1.2. Key performance indicators calculation (KPIs)

In order to correlate the consumption data (longitudinal) with the psycho-social variables (cross-sectional) the consumption information needs to be expressed in aggregated variables (KPIs) representing energy savings and flexibility within the household, which then could be correlated with the psycho-social variables. In the next section the KPIs will be explained in more detail.

KPI change in overall electricity consumption.

The computation of this KPI is quite straightforward. It represents the overall increase or decrease in electricity consumption of the households when comparing the pilot period consumption of electricity with the equivalent pre-pilot period and is expressed in percentages of increased or decreased usage. This generated one value for *KPI change in electricity consumption* per household whereby the value indicates the rate and the sign indicates an increase or decrease in overall usage. These values were then analysed together with the cross-sectional data (psycho-social variables).

KPIs Flexibility

In the pilots, information is provided to the households to encourage them to offer flexibility. This signal information takes on two forms,

1. either a household is requested directly to use less, or more electricity

2. indirectly through a change in tariff or offering some kind of incentive. A change to a lower tariff/higher incentive can be considered as a signal to use more; conversely, a change to a higher tariff/no incentive, as a signal to use less.

For the pilots involving flexibility of demand (Spain, France, Germany) the onset of the signal at the beginning of the concurrent hour is used as the marker for those hours that households are requested/urged to change their consumption behaviour. They are either urged to use more (signal = +1) or urged to use less (signal = -1), when there is no change, signal =0.

It is known that households show specific patterns of usage. These are reflected in load curves which are usually represented as Wh per hour in a 24 hour cycle. In most evaluations of AD pilots these load curves are aggregated to the pilot level and then compared to other pilot level average load curves (either historical or an analogous control group). In this manner, assessment can be made and conclusions can be drawn with respect to the flexibility of the network/system.

These KPIs however do not measure behavioural change due to a signal, and therefore are not suitable for the purpose of this study. We need to ascertain whether or not households comply to the system requests, whether these are formulated in terms of direct requests to change consumption or indirectly via tariff structures. Furthermore, variance at the household level is needed to be able to correlate with psycho-social concepts, also measured at the household level to ascertain levels of association.

KPIs Compliance

To mitigate the above mentioned problems, a new *KPI Signal compliance* was defined. Given a reference (historical) load curve[1] of a household (habitual behaviour) it can be calculated whether or not a household concurrently complies (for each signal hour = +1 or -1) with a request to use more or less electricity by calculating the difference between the habitual increased% or decreased% in usage in this timeframe (based on the reference load curve) and compare the concurrent increase or decrease in usage with

[1] In this pilot calculated as a mean of thirteen comparable measurements of the same hour of the same day

the habitual increase or decrease in usage. A "**+**" indicates compliance and "**–**" indicates non-compliance, α indicates the difference in percentage points.

Figure 2 - KPI's Signal down and –up Compliance

For each household this down and up compliance is calculated for each signal hour and then averaged over the signal hours within a household. In this manner an aggregated *KPI Signal Down Compliance* value and a *KPI Signal Up Compliance* value is defined, which can then be correlated with the cross-sectional data (psycho-social variables).

3.2. Results

This paragraph will go into the association between psycho-social concepts and behavioural change and with this **test the hypothesis** from the ADVANCED conceptual model. First the **empirical validation of the KPIs** is given, by proofing that the methodology it is applicable for different pilot set-ups, and by describe if and to what extent behavioural change was achieved by the four separate pilots.

It is worth noting that that these values are based on the average increase or reduction in electricity consumption over the households. Furthermore, to gain a more robust result, extreme outliers were excluded i.e. households with an overall consumption value that lies beyond 3 standard deviations from the mean household overall consumption were excluded from the analyses.

3.2.1. **Overall electricity consumption KPI**

The KPI for measuring electricity reduction within a household was measured for all three pilots. This was done with the purpose of validating the KPIs and relating the other variables to the KPIs. It was not the aim to perform an absolute evaluation of the pilots.

Both Enel Info+ and E-DeMA had set energy reduction as a target and they managed to realise that with respectively 3% and 9%. Within the ADDRESS spanish pilot an increase in electricity consumption is shown of 7%, which is can sometimes be seen in pilots focusing on flexibility[2].

3.2.1.1 Enel Info+

The *Enel Info+ pilot* achieved an overall reduction in electricity consumption on average over the households amounting to almost 3%.

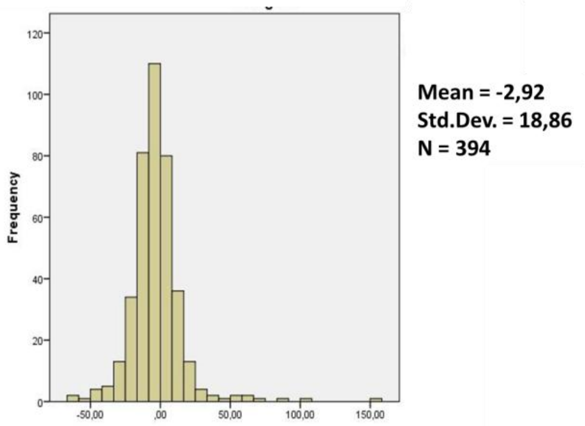


Figure 3 - Histogram of overall consumption Enel Info+pilot households

3.2.1.2 ADDRESS Spain

The *ADDRESS Spain pilot* households did not achieve an overall electricity reduction; on average the households used almost 7% more electricity during the pilot than in the pre-pilot period.

[2] Consumers know that electricity is lower cost than usual for much of the day, they therefore consume more of it. This points to the need for feedback and education to be included with any flexibility program.

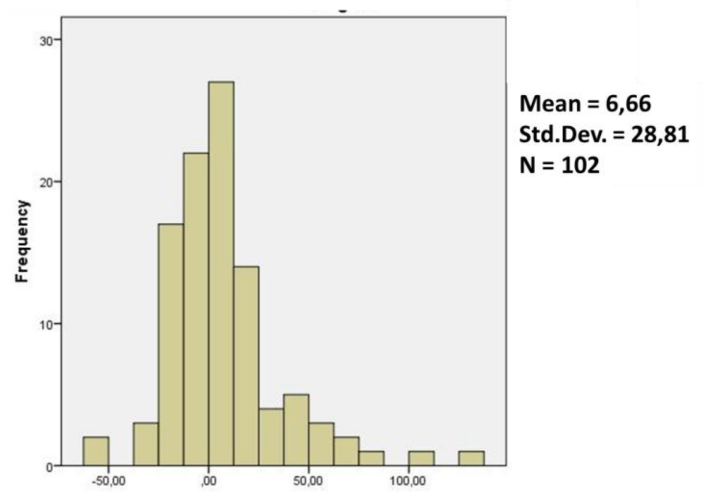


Figure 4 - Histogram of overall consumption ADDRESS|Iberdrola pilot households

3.2.1.3 E-DeMA

The *E-DeMA pilot* households, on average reduced their electricity consumption by almost 9%.

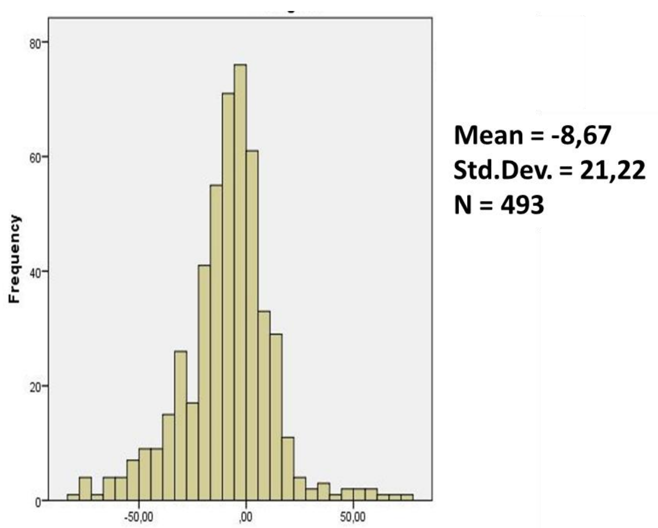


Figure 5 - Histogram of overall consumption E-DeMa pilot households

3.2.2. **Compliance KPI**

Due to the fact that the Enel Info+ pilot was only focused on energy reduction the KPI for compliance to signal requests was calculated for two pilots (Spanish ADDRESS pilot and E-DeMa pilot). Two KPIs are calculated for every pilot: the compliance of a household to a 'down-signal' (a request to use less energy) and the compliance with an 'up-signal' (a request to use more energy).

3.2.2.1 ADDRESS Spain

When we examine the compliance of the *ADDRESS spanish pilot* households we see that the households on average comply to the up signal, they use on average 6% more electricity when requested. However, when asked to use less electricity they actually use 8% more electricity on average. This result may seem confusing. In theory, the automation could have been set for one hour intervals. However, the signal was often set to last only 15-30 minutes. This was done in order to safeguard consumer comfort during the pilot. However the ADVANCED methodology measured the difference in consumption after one hour, in order to create comparable results with the other ADVANCED Pilots. In the case of the Spanish ADDRESS pilot, this meant that often the bounce back effect was measured rather than the down-signal. Consumption was higher toward the end of the hour, because the heating or cooling had been turned off at the start of the hour.

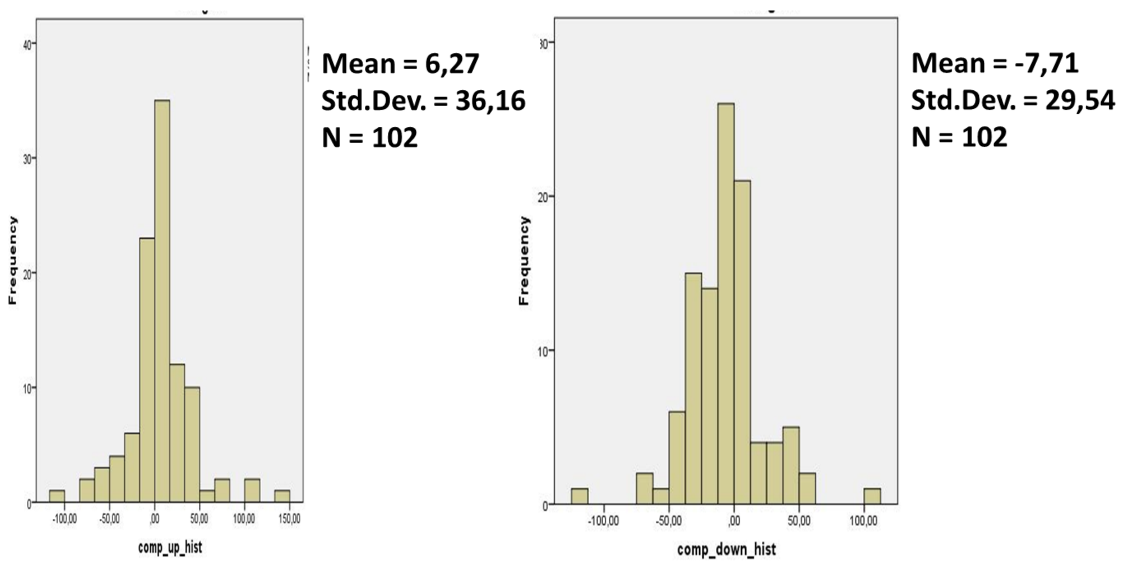


Figure 6 - Histograms of compliance (up and down) ADDRESS|Iberdrola pilot households

These results are obtained by comparing the increase or decrease in usage for the concurrent signal hours per household when compared to historical increases or decreases in usage for the same hours in the past year. The calculation used was “52 weeks x 7 days x 24 hours = 8736” hours in the past, which controls for hour of the day and day of the week, thus controlling for season and habits. The assumption we made was that this was the best approximation for habitual electricity consumption.

3.2.2.2 E-DeMA

Due to the fact that the *E-DeMA pilot* used a different kind of baseline methodology an alternative reference for the calculation of compliance to signal requests had to be used. We explored the possibility of using the mean load curves per household during the pilot period as a reference (habitual behaviour) to compare the increase/decrease in usage with. Because the Spanish *ADDRESS pilot* data had both historical and actual pilot data we tested the applicability of this option. We correlated within the *Spanish ADDRESS pilot* dataset, the compliance up and down KPIs using on the one hand historical reference data with on the other hand mean load curve data. For *compliance up* we found a highly significant correlation between the use of historical reference data and the mean reference data which amounted to an $R^2 = 0.354$. For *compliance down* we also found a highly significant correlation between the use of historical reference data and the mean reference data which amounted to an $R^2 = 0.388$.
This proofs that using the mean load curves during the pilot instead of a historical reference is a valid approximation for calculation of the compliance KPI, extending the applicability of the methodology towards pilots that do use different baseline concepts[3].

The up and down compliance for the *E-DeMA pilot* making use of the mean load curves per household is now calculated. Based on these calculations we found that on average, the households do not comply with the incentive to use more electricity when urged to do so by lowering the tariff, households actually used 12% less electricity on average. We also found that households did comply when urged to use less, on average they used 21% less electricity when urged to do so by increasing the tariff for that concurrent hour.

[3] From a methodological perspective a historical baseline has the preference for future pilots.

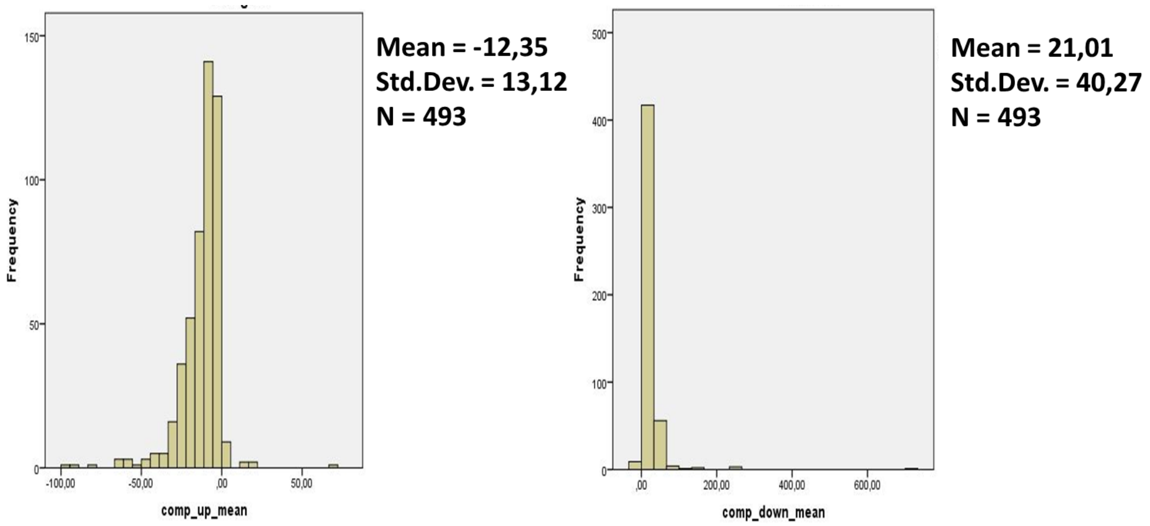


Figure 7 - Histograms of compliance (up and down) E-DeMA pilot households

We also tested the automation factor, we were able to compare the up and down compliance of households within the E-DeMa pilot, and found no significant differences for either up compliance or down compliance. This is a puzzling result, as we would have expected that within the automation condition there would be significantly more compliance (up and down) than in the manual control condition. What this suggests is that even though households have opted for automation E-DeMa Type 2 (running appliances through external control) this does not contribute to more compliance. One explanation could be that some of the Type 2 households did not activate the automation service (there is evidence of this in customer interviews in Del. 3.2), another could be that some of the Type 1 households were actually quite compliant, or a combination of both.

3.2.2.3 Intermediate conclusions

The ADVANCED project attempted to define a set of standardized indicators that reflects behavioural change in electricity consumption based on actual household hourly electricity consumption. Furthermore this has to be done in an uniform manner so that this procedure could be used in future Active Demand pilots and would allow for empirical identification of factors that influence electricity consumption of households. These household level behaviours need to be understood if communication or influence strategies are to be developed to facilitate Active Demand schemes.

Both the KPI on electricity reduction and the new KPI for flexibility, being signal compliance, turn out to be applicable in multiple pilot set-ups. This proves the ADVANCED methodology offering a measurement of behavioural change. Some additional thoughts on the methodology are shared below:

- The first caveat we are confronted with is the resolution level of consumption data. We were forced to use the 60 minutes interval as our lowest level of resolution (common denominator) to make cross cases comparison possible. This same procedure could be used at a smaller interval, for example 15 minute or even less, however our data did not allow for that. It is advised to compute the KPI on the time period matching the exact signal period to properly assess the response of the households. This of course makes it harder to compare different pilots, so for this purpose a standardized period of 60 minutes was used.
- A second caveat is that we used historical load-curve data, or for that matter mean load curve data as an approximation of habitual behaviour. This is due to the lack of matched pairs control groups at the household level. In a truly rigorous experimental design control households should be matched to experimental households on relevant distinguishing factors, such as age, household composition, social economic status, load curves, and other variables. We did not have this data and were forced to make do with prior behaviour or average concurrent behaviour to establish compliance. Another point of attention when using historical data is public holidays and vacancy periods. In short trials with relatively many holidays, this might influence the result.
- A third caveat could be the difference in weather when comparing the historical data with the concurrent data. Years do differ in the hourly temperatures which could confound our findings, however, for the *Spanish ADDRESS pilot dataset* we could not find a significant difference in the average hourly ambient outside temperature between the pre pilot period and the pilot period.

3.2.3. **Influencing active end-user participation**

With these KPIs (overall electricity consumption, compliance up and down) we can now correlate these with the psycho social cross sectional data gathered by means of the various questionnaires of the three pilots to which we had access to parts of the data. In this way the significant factors influencing overall consumption and compliance are explored.

3.2.3.1 KPI Change in overall electricity consumption

Some concepts directly relate to the KPI *Change in overall electricity consumption*. Important factor to notice is that an minus sign corresponds with an inverse relationship.

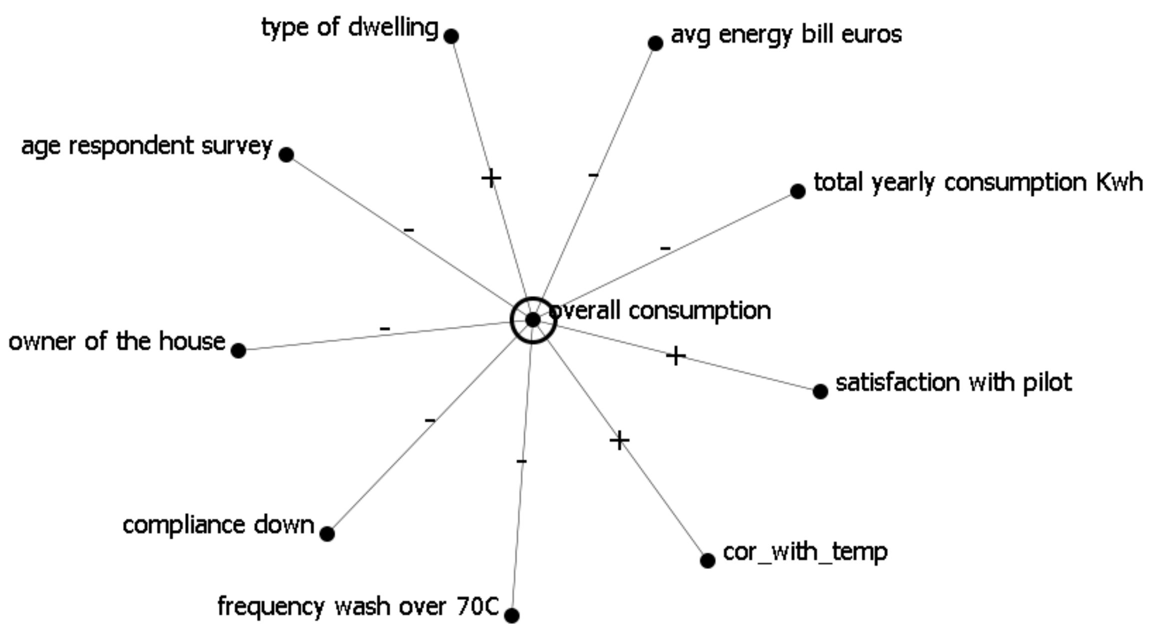


Figure 8 - Graph of factors correlated with overall consumption

The *annual consumption* is inversely correlated with *change in overall electricity consumption*, which suggests that households with a higher overall consumption have a greater likelihood in electricity savings than households with a lower annual consumption. The same is true for the average bill as this is one-to-one related to the consumption level. The potential to save is much bigger for these households than the ones using less electricity either because they already took energy efficiency measurements or because they live in a small house with fewer appliances.

Homeowners are more likely than household renting their place to reduce their energy consumption. They might have more possibilities and money to implement energy efficiency measures. Also families living in houses (as opposed to apartments) are more likely to show a reduction in overall electricity consumption.

This also counts for respondents that are older (*age*) and for households that initially have said to *frequently wash over 70°C.* They show a greater *reduction in overall electricity consumption* when compared to households with a younger respondent or infrequently wash over 70°C. Washing on a lower temperature might be easy to change behaviour when provided with information and insights on the effect of this behaviour during the pilot.

A negative influence on reduction in overall electricity consumption is seen by households that are *satisfied with the AD-pilot*. This is very counterintuitive and not explainable by looking at the data or other insights from the ADVANCED project.

3.2.3.2 KPI Signal compliance

Some concepts directly relate to the KPI Signal compliance.

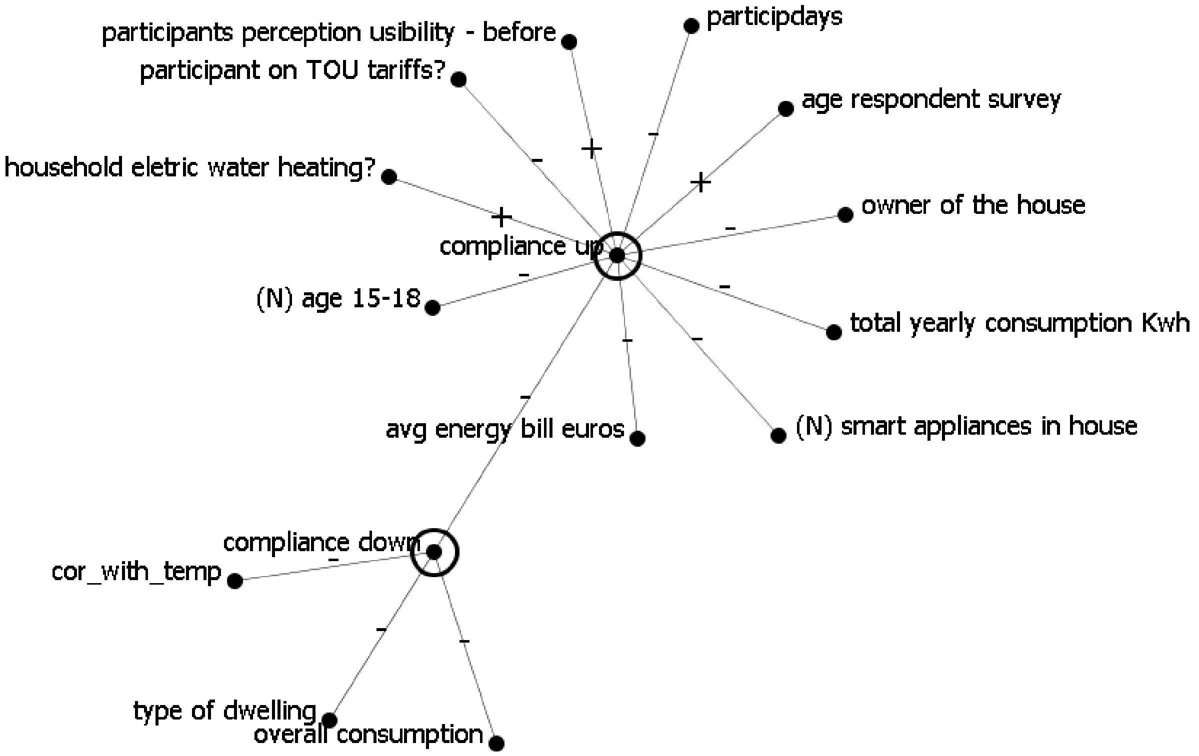


Figure 9 - Graph of factors correlating with compliance (up or down)

Where older respondents turned out to be more likely to save energy the same goes for up signal compliance, they are more likely to comply to a request to use more energy for a while. Household with *children in the age of 14-18* are less likely to comply with an up signal.

The *total yearly consumption* of a household sent an interesting mixed message. In the case of flexible pricing (E-DeMa Germany) the consumption level positively relates to the ability to respond to a request to use more energy for a while (up signal compliance), whereas in the case of a direct request (ADDRESS Spain) the relation is inverse. This might be explained by the fact that the characteristics of these households are quite different in the two contexts, as were the automation signals and programing. Therefore this contradiction may point to the importance of pilot and automation design rather then the characteristics of consumers.

It has been found that *Home ownership* has an inverse relationship with *up signal compliance*. In other words, people who rent are more likely to comply to use more electricity; conversely, people who own are less likely to comply in using more electricity. Looking at the *type of dwelling* it turns out that households living in an house are more likely to comply with a down signal (a request to use less energy), where people living in an apartment are less likely to do so.

The experience of the households also plays a direct role in their behaviour. Households that are positive about the *usability of the technolog*y before the pilot (so might be familiar with technology) are more likely to comply with an up signal. Where people with pre-pilot *experience with ToU-tariffs* are less likely to comply.

Also the number and type of appliances in a home play a role. Households with *electric water heater* turn out to better react on a request to use more energy for a while (up signal compliance). A high *number of smart appliances* in the house has the opposite effect, they are less likely to comply with an up signal. The same is true for household that are *participating more days* in the pilot, which is counterintuitive.

3.2.3.3 Intermediate conclusions

Considering the above results, we can see that based on the available data, certain factors contribute to overall energy reduction and certain factors contribute to compliance. What we can also see is that a lot of these factors are more or less unchangeable, for example: *home ownership, type of dwelling, age of children, etc*. There are a few actionable factors, such as *consumption level*, *frequently wash over 70°C, usability of the technolog*y and perhaps even the *experience with ToU-tariffs*. There are two ways to deal with this phenomenon. For the factors that are not changeable, the acquired insights can be used to have a more precise targeting and dissemination of information of audiences in future AD programs. But the real gained insight is that if AD programs actually want to achieve behavioural change it is going to be crucial to identify when (day of the week, hour of the day) the high consumption devices are being used in the household and configure the automation in such a manner that shifting these distinct behaviours in time fits with the household behaviour patterns. This would mean household specific behavioural analysis with respect to the high consumption appliances. It will not suffice to ask if households have these appliances but will be necessary to understand when these are used and what the shifting in time options are, which then can still be overridden. What we see is that human habits (washing, drying, heating, air conditioning, bathing, cooking) are quite resilient and it will take more than mere overall consumption information or complex pricing schemes or even automation to achieve shifts in these behaviours.

3.2.3.4 Further insights

For the relevant concepts directly related to the ADVANCED KPI's some further insight is provided in this paragraph on related characteristics. The concepts are divided into the categories of the conceptual model

User characteristics

The age of the respondent has a relation with the two ADVANCED KPI's. Older people tend to find it harder to realise an overall energy reduction in this analysis. They however tend to be better in complying to a request to use some more energy temporally.

AGE

In line with the fact that they save less energy a German household where the respondent is older has a more negative attitude towards energy conservation. They have a lower education level and family income and a smaller household (with less chance of smaller children under the age of six walking around). They however tend to be more likely to frequently check the data on their display, to have more appliances in the house, to have a higher knowledge level in regards to their energy consumption and prices, a higher awareness of their own possibilities, and a more positive personal environmental norm.

Italian households with more people older than 65 years old tend to be more present in their family houses in the morning, they have a lower family income, less PC's, smart phones and tablets, and know less well if they save any energy or money. Italian households with more children tend to be more present in the afternoon, evening and night in their apartments and they have more PC's, smart phones and tablets and find the feedback provided during the pilot simple (enough).

Spanish households with more people older than 65 years old tend to live in family houses. Spanish households with more children tend to live in bigger households, they have a more positive perception of the usability of the technology after the pilot.

Habits and experience before the pilot - In the Spanish context households that frequently wash above 70°C are better in energy saving, and households that have previously experienced time-of-use tariffs where less able to comply to a request to use more energy temporarily.

Frequently wash above 70°C

Spanish households with the habit of washing on high temperatures also frequently wash below 50°C. They tend to be smaller households without children that only spent a small share of their income on electricity and have much knowledge around their own energy consumption, their reduction and electricity prices. These houses are more likely to be isolated.

Previously involved in ToU tariffs

Spanish households with former experience with ToU-tariffs are less likely to have electric water heating and more likely to use a reference temperature for their bedrooms in the winter.

Experience during the pilot - In the Spanish context satisfaction with the pilot is an indication for the ability to save energy within a household. In the same context a positive perception of the usability of the technology before the pilot is an indication for the ability to comply with a temporary request to use more energy. Counterintuitively households participating longer in the pilot find it harder to comply to an 'up-signal'.

Satisfaction with pilot

The Spanish household that is satisfied with the pilot is likely to have older children (15-18 years). Household with children are present more in the afternoon, evening and at night and being present is related to a high electricity consumption. This might explain the fact that they are less successful in reducing energy.

The Italian household that is satisfied with the pilot is likely to be positive about the usability of the technology and are comfortable with the technology after the pilot. They are satisfied with the helpdesk and more likely to recommend the pilot and AD to others.

Perception of usability

German households with a positive perception of the usability of the technology during the pilot tend to be an 'early adopter type' and comfortable with technology before the pilot, to have a lot of appliances and their house and to frequently check their data. They are more likely to have a positive attitude towards energy conservation, to be aware of the relevance of their own behaviour and to have knowledge on their own energy consumption and energy prices.

Italian households with a positive perception of the usability of the technology during the pilot tend to bigger households, with more male and more young children (under 8 years old). They tend to have a higher education, higher family income and are present during the evening and the night. They tend to have more PC's, smartphones and tablets, to frequently check their data and to find the feedback provided during the pilot simple (enough). They are more likely to have experienced energy efficiency, or more general energy friendly behaviours before the pilot and they feel they have saved energy/money. They are more likely to be satisfied with the helpdesk and to recommend Active Demand and the pilot to others.

Spanish households that have a positive perception about the usability of the technology <u>before</u> the pilot are the households that are likely to feel comfortable with technology before the pilot. Spanish households that have a positive perception about the usability of the technology <u>after</u> the pilot are likely to feel comfortable with technology both before and after the pilot and are in general satisfied with the pilot. They are more likely to have children (younger than 18 years) and to have air-conditioning with time-programming.

Social environment

Home owners are better capable of saving electricity (KPI) and complying to a request to use more energy. Households with more elderly children find it harder to comply with a request to use more energy .

Home ownership
These Spanish households are big of size and have an air-conditioning system.

Children age 14-18
These Spanish households are big of size and so are the houses (more rooms). They are more likely to have electric water heating.

Physical environment

The consumption level of a household is an important variable relating to the ADVANCED KPIs. In all three pilots it is directly related to the amount of electricity the households are able to save (KPI). This makes the households with an high average consumption an interesting target group (low hanging fruit to see direct effects).

Consumption level
The consumption level of a household is related to the number of rooms in a house, the number of (smart) appliances and the number of PC's, Smartphones and tablets in the house. It is also related to the number of people that are present in the house in the morning/afternoon/evening.

In the case of flexible pricing (E-DeMa Germany) the consumption level positively relates to the ability to respond to a request to use more energy for a while (KPI), whereas in the case of a direct request (ADDRESS Spain) the relation is inverse. This might be explained by the fact that the characteristics of these households are quite different in the two contexts.

Consumption level
Households with high consumption levels, in the German context, have a positive attitude towards energy saving and they don't know if they saved energy or money. This might sound counter intuitive, but households with a positive attitude have a higher education level and probably higher family income making them in general in favor of 'environmentally friendly behaviours' saving the climate, but less aware and motivated by personal savings.

In the Spanish context we see these households living in a family home (as opposed to an apartment) and spending a large share of their income on electricity.

The type of dwelling (being either a family house or an apartment) people live in is another relevant variable in the ability of households to save energy. It shows some country specifics.

Type of dwelling

In the German context the people living in apartment are able to save more electricity (ADVANCED KPI). They also check their display more often.

In the Italian context the people living in an apartment have a high family income, more PC's, smartphones and tablet and they frequently check their display. In these households there are more children and less adults and elderly people

In the Spanish context another picture arises from the data. People living in an apartment (less elderly) have a lower level of energy consumption and have less (smart appliances) and they have a more negative attitude towards energy savings. On the other hand they do remember having seen an efficiency label.

A higher number of smart appliances in the house makes it harder for a household to comply with a request to use more energy (KPI).

Number of smart appliances in the house

This are Spanish households that are living in a family house, with a lot of rooms with a high consumption level. They have knowledge about their own energy consumption and are quite aware of their own possibilities to act.

Households with electric water heating more often show compliance with a request to use more energy (KPI).

Presence of electric (water) heater

This are Spanish households that also have air-conditioning (in all rooms) in their homes. They often have older children (14-18 year), have no experience with Time-of-Use tariffs before the pilot and have a low level of awareness of the (environmental) consequences of their behaviour. Households with air-conditioning in all rooms usually have air-conditioning with a thermostat or time programming. The *household using a heating system with a thermostat are likely to have a positive attitude towards energy conservation. Actually making use of a heating program increases the chances of having a higher grade of house insulation and a higher knowledge level on energy consumption and energy prices.*

Italian households with electric water heating tend to know about the regulated versus the free energy market and are more likely to favour the combination of PC and display (as opposed to display alone) in the AD-pilot.

3.3. Impact and AD pilot cross-case comparisons

It has been argued and demonstrated that household level analysis is a prerequisite for gaining insights in the behavioural drivers behind AD. This requires a multidisciplinary approach; in other words, complementing technological advancements with psycho-social and behavioural knowledge. This results in a methodology that combines smart meter data collection with behavioural change insights, by means of a newly developed KPI, *Signal Compliance*.

It has been seen that standardizing the variables and corresponding unit of measurement enable cross case analyses. However, because the pilots were initially organised for their specific local purposes they were not configured with respect to experimental design and the measurement instruments were not used in a uniform manner. In the exploration and validation the variables needed to be standardised to an ADVANCED format, resulting in an ADVANCED knowledge base. In this transformation process **information is lost,** which would not have occurred if a uniform methodology would have been used in pilot design.

Furthermore, the empirical validation of consumption KPIs has shown that having historical data at the same level of resolution (hourly at most) as during the pilot is of considerable advantage because this allows for calculation on a household level of signal compliance KPIs. It is demonstrated that it is possible to detect behavioural change of households based on their consumption data and signal information. This is important when incentives for ‘environmental conscious behaviour’ are given to households.

Current AD pilot design, does not allow for optimal cross-comparison, in fact the ADVANCED findings suggest that up to 60-70% of the pilot details and findings may be lost when comparisons are carried out, due to a lack of consistency between measurement, baseline and KPI methodologies. As such publicly funded pilots miss a critical opportunity to build the community of knowledge among stakeholders across Europe. The Horizon 2020 pilots, and other publicly funded pilots, could quite easily and at a low cost, establish a set of basic KPIs which would enable cross comparison between AD solutions and programs.

Future pilots should have **comparable pilot design elements:**
Measurement should include at least the hourly interval consumption readings, though 15 minute readings would be significantly preferable as they allow for even more detailed and well defined findings. For pilots aiming for flexibility is very important to take into account the duration of the flexibility request. When this is a 15, 30 or 45 minute request a 15 minute reading is essential to measure the compliance.

It is advised for future active demand pilots to capture historical data to **generate a baseline** (reference load curves) per household before the pilot itself. They should also establish a control group against which to compare consumption patterns. If possible, this groups should have matched pairs control households to control societal changes over time.

AD pilots should all measure a certain basic **set of KPIs** consistently across pilots, using a standardized measurement and calculation methodology. This set should include:

- **Energy savings**
  This KPI should be included even in AD pilots which aim to enable flexibility only (e.g. demand response, dynamic pricing pilots). Certain flexibility programs, particularly if they use home automation without providing consumption feedback to consumers, encourage an increase in total consumption. If this is the case, it is also important to measure this KPI in order to improve future technological and pilot designs.

- **Consumption flexibility** (shifting housholds' consumption in time)
  An energy efficiency pilot should also measure the impact of the intervention on flexibility, if possible. This provides valuable insights on **when** and **how** consumers are lowering consumption, which in turn can support other energy efficiency pilots and rollouts across Europe. Flexibility and when customers lower their consumption, is a critical indicator of consumer behavior.
- **Monetary savings**
  It is important that publicly funded pilots should calculate the monetary savings or earnings each type of AD program brings participants. Consumer benefits are key for AD success and monetary savings are an important part of these benefits. They should be measured.
- **Customer satisfaction:** AD is meant to provide a beneficial service to customers. It is important that each publicly funded AD pilot measures if participating in the program was indeed a positive experience.

One of the main findings of ADVANCED is that current pilot practices do not easily allow for cross comparison between consumer groups concerning the impact of **psycho-social factors** on AD results. Psycho-social insights, are not collected in a consistent manner across pilots. This is a drawback. Consumers participate in AD within the larger framework of who they are as individuals, their age, gender, home ownership, education, attitudes, financial status etc. Psycho-social data should be collected on a consistent basis **and correlated** with pilot results (KPIs).

This will require running **pre and post pilot questionnaires -** to understand the starting point of the consumer, their expectations upon joining the program and how the pilot changed their awareness, attitude etc. We would suggest to future AD pilots to invest in understanding household high consumption appliance usage. The psycho-social variables to be collected should cover certain factors consistently in order to allow for cross-comparison.

Particularly in the more technically oriented pilots – socio-economic factors and customer satisfaction KPIs are neglected. This is a missed opportunity for gathering valuable information and insights into the consumer experience, which could be used to improve AD program design and AD technologies in other contexts. This information should be gathered within the post-pilot questionnaire and cross-referenced with socio-economic factors.

More generally it is noted that the data involved in AD technologies is subject to **privacy issues**, and hence also the analysis discussed here. In ADVANCED the impact of privacy issues and appropriate countermeasures is also part of the project

Summarizing the above – the use of the KPIs allows for the correlation of various (standardised) psycho-social variables with the actual behavior - and thus generate insights with respect to determinants of behavioural changes. This is the first step in understanding which mechanisms are involved in achieving active demand, in other words, realising electricity consumption reduction and shifting households consumption in time. The exploratory analysis of the available standardised data allows to do exactly that. Furthermore, the KPIs allows the comparison between different interventions and pilot set-ups in their effectiveness on changing household behaviour.

4. The voice of consumers

In order to enrich the research within ADVANCED, two surveys have been carried on - one qualitative and one quantitative - that were aimed at providing insights into socio-economic drivers of consumers' behavior and statistically robust indications of awareness, understanding and attitudes towards AD respectively. [8][9]

4.1. Qualitative research

The objective of the qualitative research was to gain deep (qualitative) insights into the actual drivers and barriers for consumers' behaviour engagement regarding AD.

For this purpose it was decided to conduct a qualitative research based on in-depth interviews with consumers who have participated within AD programmes (residential as well as commercial and industrial). These included both those participating in the experimental AD programs of the ADVANCED sites, and those who are already exploiting AD for their business as the Entelios' commercial and industrial customers. Both the analysis on the experience of the residential and small commercial consumers and the one on C&I customers in Germany who started using Demand Response explore the attitudes, behaviors and their evolution before and through the experiment of Active Demand/ Demand Response.

The qualitative phase is crucial for the project, in order to gain empirically based insights into socio-economic drivers of customers' behaviour related to AD. The aim of this qualitative research is to identify behavioural barriers/enablers and discover key requirements to leverage the participation of the consumers in AD programs.

4.1.1. **The analysis of the residential customers**

Energy was seen by people involved in the study from two distinct points of view. Firstly, it was seen as a household solution, supplying comfort and helping consumers run their daily lives, and secondly as a global resource. For many, energy was a rather abstract concept which they felt they knew less about than they should. It was also surrounded by somewhat complex factors and issues that were not readily understood. People instituted a range of strategies and solutions to moderate energy use and lower costs. Strategies tended to be flexible, rather than absolute (for example, using appliances less often and for less time, focusing on off-peak energy periods, replacing appliances with more energy efficient alternatives).

Whilst there was a general feeling amongst people participating in these energy projects that they would be willing to reduce energy consumption (primarily to reduce costs), most agreed it would not be at the expense of household comfort.

There were a number of strong drivers motivating people to participate in the study. Many participants felt that being part of the project would benefit them by making them more aware of their own energy use and teaching them ways to reduce consumption. Furthermore the project appealed because it was an innovative energy initiative and involved some innovative technology. Some participants were also motivated to support the local community by participating in the project.

Some barriers (albeit minor) needed to be addressed in each market. These barriers were predominately around trust with the providers. Local events, word of mouth and the support of Government worked effectively to overcome these barriers at the test locations. Concerns raised about the impact of installation were dependent on the market and the types of devices to be installed. Most markets seem to have addressed this barrier in the information provided about the project, as well as through face to face meetings (showing the equipment) and in France via a home demonstration.

The analysis shows that the installation phase needs to be seen as efficient and causing minimal disruption. Overcoming concerns about the impact of devices on appliances also needs to be addressed through information and demonstrations. Potential participants need to know that whatever is installed will be easy to use.Addressing concerns around the impact of lowering energy consumption on lifestyles and/or comfort was important. It is important to provide reassurances to not undermine the potential benefits of the project.Privacy of data was a minor issue related to mistrust of the project and providers. It was only raised spontaneously in Germany, however, it could be a barrier in other markets unless it is addressed.

Respondents were asked to comment on how well the project worked within their households and living with and using the devices to understand and impact on energy consumption. As part of this, participants reviewed how well the installation process went, how well they understood the devices provided, and how these devices were used during the experiment.

In most test sites people did not understand the way in which devices could/should be used throughout the experiment. Most understood the basic features around consumption data/readouts, but not everyone understood or felt confident enough to interact with devices or make changes using computer based information/programs and websites. There was also a lack of understanding around automated processes (smart plugs and smart machines) and the aims/objectives of how these devices were operating.

The concept of Smart consumption was supported by most people in the study. It was clear that people wanted to reduce household energy costs and “consume less and consume better” fed into this motivation. There was a clear fit between consuming less and reducing household consumption levels (and therefore reducing costs). Beyond this however, behaviour change and what it might achieve was not always clear.

As a result of being involved in the study and the original projects before that, the majority of consumers started to think more consciously about their own usage and energy consumption. Providing people with feedback on consumption data within their own household also increased people’s sense of responsibility toward energy usage and raised awareness of the need to moderate consumption and use energy more efficiently.

However, raising awareness did not necessarily lead to behavioural change.

Motivating people to reduce energy consumption to meet environmental goals or goals around sustainability, requires education as, unlike cost, these issues are not always top of mind (although there are exceptions). In addition, it is not always clear how household energy usage (and therefore reduction) impacts on these collective issues.

The link between household usage levels and collective useage issues needs to be made so people understand that what they achieve in their own household can impact on wider energy goals.

To assist/ensure behaviour changes happen people need to clearly understand what to change as well as and how to change their behaviour. The consumption data provided to consumers should be simple, easy to understand that is not hampered by technically difficult equipment. The technology/devices used to deliver consumption data, and inform people about changes, as well as enable them to interact with appliances needs to be user friendly.

Demand Response is a very new concept for consumers: it does not fit easily into existing consumer thinking or consumer frameworks. This is both in relation to how people understand cost and reducing costs, and the fact that most people focus only on reducing/changing household consumption. By contrast, Demand Response requires people think about energy efficiency in relation to collective consumption peaks and the need to ‘smooth these out’.

4.1.2. **Analysis of the C&I**

In Germany, the industrial sector is the largest energy consumer and therefore has the highest Demand Response potential. The barriers and benefits of Demand Response in the industry sector were examined. Furthermore recommendations that would facilitate the implementation process, as well as increase the participation in Demand Response programs amongst industrial consumers are provided. It is worth noting that while the section related to residential customers dealt with pilots, fake bills and remuneration, the section on C&I customers deals with real implementation of demand response, where customers actually invest in the program, assuming higher risks, and have higher committement.

The data for the report was gathered in 13 interviews amongst industrial customers. Based on the companies’ Demand Response status (whether they were current users, at the implementation phase or non-users), two versions of the discussion guide were drafted - one for companies already using Demand Response and one for companies that do not use Demand Response or are in the implementation phase. Entelios supported the development of the discussion guides based on their experience with commercial and industrial consumers.

The discussion guides covered general questions regarding energy and the “Energiewende” in Germany. They were divided into three parts. Part one covered the initial contact with Demand Response and the experience before it was implemented in the company. Part two explored the experience while implementing Demand Response in the company. The final part focused on experiences during the active use of Demand Response. Finally, the interviewees from different industries were asked about their expectations regarding Demand Response, for example further developments or possible improvements to facilitate the system.

Energy is an important and very current topic/issue in all the companies involved in this study. For most of the companies, energy consumption has become a major competitive factor over recent years.

As a result, several firms in Germany had invested in energy generation processes, such as combined heat and power or photovoltaic, in order to make themselves less dependent on electricity price changes and developments. In addition, companies were motivated to increase energy efficiency to reduce costs, and improve environmental aspects; and move towards goals of “Energiewende”.

Overall the companies that are using Demand Response are positive about it. The main criterion for participation in Demand Response programs is a positive cost-benefit ratio. As long as the companies gain some profit, Demand Response is applied. The use of Demand Response is not the primary business for these the companies; their focus is on their products. Only if the quality and security of the production process can be guaranteed are flexible loads used.

The whole system of Demand Response has to be more flexible and public. In addition to the existing Demand Response markets should be considered in order to better match the type of flexible loads in the industry. The regulations for all participants need to be simplified in order to speed up implementation. Legal regulations, for example, individual use-of-system charges, might need revision, so that incentives for companies involved are high enough.

In order to increase the awareness of Demand Response in Europe, the system needs more publicity. Promotion of Demand Response could help to companies find out about the opportunities for using Demand Response in their companies.

4.2. Quantitative analysis

The objective of the quantitative survey was to gather consumer data for the ADVANCED project, as defined in the ADVANCED target matrix. The quantitative survey design was based on the ADVANCED conceptual model identifying the possible drivers and barriers for active end-user participation in AD. An online survey was conducted with a nationally representative sample of consumers in Italy, France, Spain and Germany being the countries of the ADVANCED sites as well as in the United Kingdom, the Netherlands, Poland and Sweden in order to cover a large share of the European population. The survey provided a statistically robust indication of awareness, understanding and attitudes towards energy consumption and reduction among the general public in Europe.

4.2.1. The main results

On the surface, many of the results of **this survey are positive for the development of Active Demand in Europe**. Consumers are concerned about energy cost and most pay at least occasional attention to energy use. The majority agree it is important for them to reduce their energy consumption, and many are already taking steps to do this. Furthermore, most express a willingness to further adapt their energy use by modifying the time they do key household energy activities such as clothes or dish washing or by modifying heating use. Active Demand seems the logical next step to assist consumers with energy management.

- Almost all respondents saying they pay attention to their energy consumption at home at least occasionally (95%).

  - Italy and Spain have the highest proportion of respondents regularly do this (74% and 71% respectively), particularly compared to Sweden (36%) and the Netherlands (44%).

- There is little variation between countries in agreement that paying attention to energy consumption can lower energy bills (92%-98%), that it is the right thing to do to protect the environment (89%-97%), or that it is easy to pay attention to home energy consumption and act accordingly (81%-89%).
- Almost all respondents say it is important that they reduce their energy consumption (94%), although this view is less widespread in Sweden (77%) and the Netherlands (85%) compared to the other countries (92% - 98%).
- A large majority of respondents agree it is their responsibility to do something to save natural resources and protect the environment (94%) that their individual actions can play a role in overcoming environmental and climate change issues (89%), or that citizens in their country think it is important to reduce their energy consumption (77%)
  - Those in France are the much more likely to say citizens in their country think it is important to reduce energy consumption (95% vs. 66%-82% for other countries)

However, **the results of this survey clearly show the key obstacle to Active Demand** is not consumer's willingness to monitor and modify their household energy use, **but sharing or giving up control over common energy or appliance use behaviours to energy companies**.

- The majority of respondents are willing to adapt their use of electrical appliances in a range of ways to save energy, but only if they are able to manage this for themselves. Those in the Netherlands and Sweden are generally the most likely to say they are not willing to adapt their behaviours.
- A significant proportion (31%) is unwilling to allow their electricity provider to monitor the electricity consumption of some of their appliances. Respondents in the UK, Italy and Poland are the most likely to be willing to allow this kind of

monitoring (74%-75%), particularly in comparison to Sweden (54%).

The image of energy companies is likely to be one component of this barrier. Fewer than one in five has a positive image of energy companies, and having a negative or neutral image of energy companies has been shown in this study to be associated with a reduced willingness to allow energy companies to monitor appliance use, as well as a reduced willingness to make changes to specific energy use behaviours such as moderating heating and cooling.

- Respondents in France are the most likely to have a positive image (30%), and France is the only country – with the Netherlands (20% positive/19% negative) where the proportion with a positive image is higher than those with a negative image. Spain is the only country where an absolute majority have a negative image of energy companies (62%), although the UK is not far behind with 48%.

A lack of information may also be part of this barrier. The results of this study showed that feeling well informed about energy production is associated with attitudes more favourable to Active Demand, including being willing to share control with energy companies in managing appliance use, and more regular electricity monitoring.

- Just over half of all respondents feel they are not well informed about electricity production in their country (51%), with those in Spain (64%) most likely to say this, particularly compared to respondents in Sweden (43%) and Italy (44%).

However information by itself will not be sufficient. The behaviour change index further confirmed the relationship between making it easy and hassle free to monitor home consumption, and more regular active monitoring. **Combining information with easy methods of monitoring and managing electricity consumption will be important components of successful Active Demand projects**. **With almost all consumers concerned about energy costs, an appeal to cost saving is less likely to be effective in promoting energy behaviour change than addressing concerns about the ease of monitoring energy consumption, as well as promoting being energy-wise as a social norm.**

5. The ADVANCED knowledge base

All the data used for the investigations within the project were organised in a unique and extended knowledge base, that addresses various perspectives (behavioural, economical, technical, pilot characteristics), and offers an international context. This has enabled the project to realize a fact-based conceptual model to build upon and to guide analysts, strategists and practitioners in the world of AD. [6]

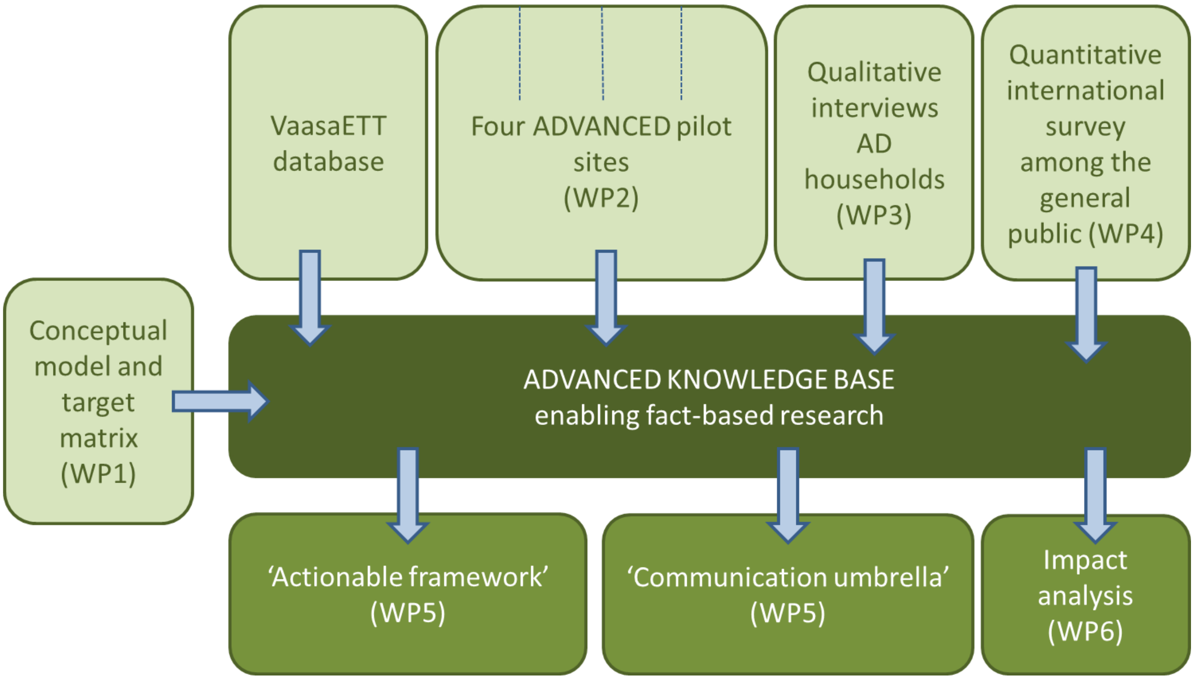


Figure 10: Positioning of the ADVANCED knowledge base

Through using multiple information channels, the ADVANCED pilot sites, the VaasaETT database, interviews and the questionnaire, the project has been able to create a robust knowledge base, which provides at least preliminary insight into the majority of ADVANCED concepts. Based on this knowledge base the Actionable framework and the Communication umbrellas have been built

The ADVANCED knowledge base consists of different building blocks that have been gathered by different methodologies and activities:

1. VaasaETT database

2. Pilot and cross-case dataset: The pilot sites have collected as much variables (as described in the target matrix) as possible from their pilots and transformed these variables to ADVANCED variables in the proper format enabling cross-case comparisons. This includes both household level consumption data as data derived from surveys.
3. KPIs: based on the consumption data (both actual as historical) the ADVANCED KPIs have been calculated for the different pilot sites. These KPIs have been added to the datasets.
4. Cross-case analysis results: the analysis results from the (preliminary) cross-case analysis are important inputs for the ADVANCED knowledge base providing insights in the relations between the different variables and the key factors for influencing the KPIs
5. Pilot analysis results: in addition to the results of the cross-case analysis, the ADVANCED project can make use of the analysis results of the pilot sites themselves to gain additional (pilot specific) insights.
6. Qualitative insights from interviews within the scope of ADVANCED, providing deeper insights in their attitudes towards and experiences with AD.
7. Quantitative insights from the international online survey withn the scope of ADVANCED, to gain insights in their current attitudes and behaviours and their future behavioural intentions.

6. Making AD happen

6.1. The validated conceptual model

As reported in chapter 2 above, based on scientific knowledge and practical lessons learned by the consortium partners a conceptual model was built identifying relevant concepts influencing active user participation in AD in particular and the energy transition in general. The conceptual model was designed to assess the different AD-interventions tested in the ADVANCED pilots and others against the ADVANCED KPI's, and to research and enable the understanding of the different factors influencing households' behavioural change and therefore enable the design of more effective intervention or the personalization of interventions and communication towards specific target groups.

As a step beyond, the conceptual model was validated based on support from the body of evidence collected by ADVANCED through pilot data analysis [7], qualitative interviews [8] and quantitative surveys [9], as described in the reports that investigate those parts of the ADVANCED project. The findings of these reports however, when combined also provide an additional degree of insight to the conceptual model, specifically clarifying particular aspects of it.

The insights gained through the analysis of the pilots and the surveys were integrated to transform the model into a practical model that could be used to support the actionable framework for AD and the communication umbrella. This asked for a translation of the different building blocks of the 'static' conceptual model into a more dynamic real-life, mass-market context where consumers are subjected to information and marketing and a plethora of other interventions and environmental complexities, have the freedom to choose between different commercial offers and have continuously evolving opinions and actions. The outcome of this study is therefore the model described in summary in the following sections. [10]

6.1.1. **The validated conceptual model components**

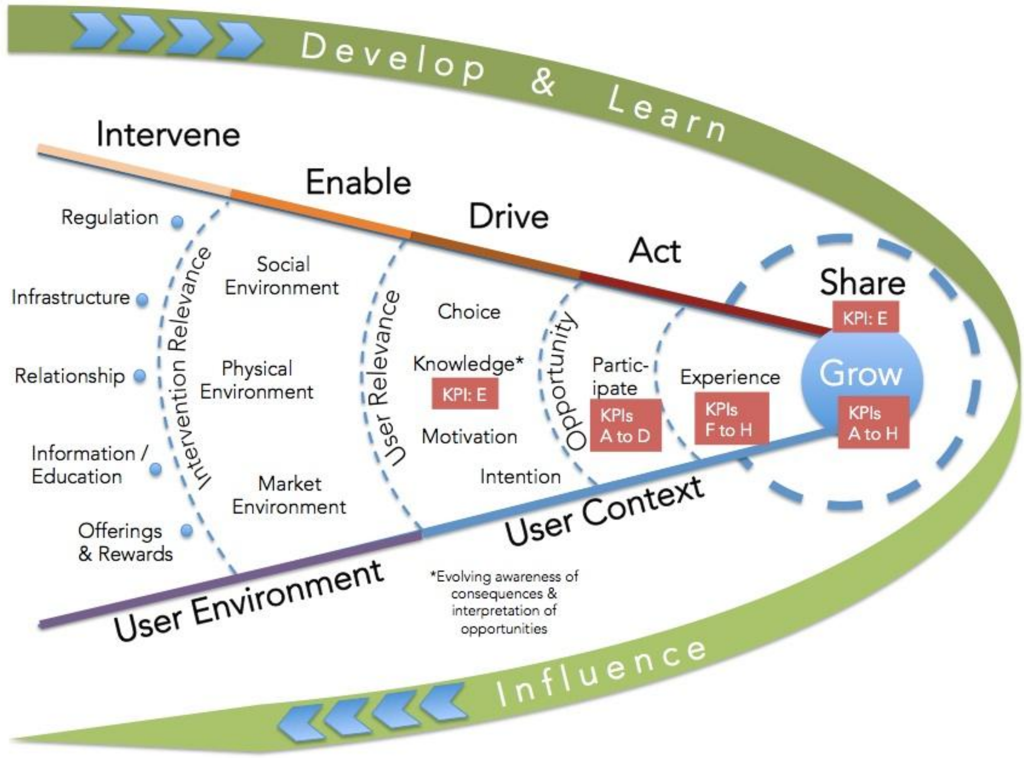


Figure 11 - The Validated Conceptual Model

Incorporating the above principles, an adjusted conceptual model of active consumer participation in AD has been developed. The model comprises the following core components:

6.1.1.1 User Environment

The user environment concerns components that are essentially beyond, or external to the consumer.

6.1.1.1.1 Intervene

Interventions are modifications, or attempted modifications to the nature of variables throughout the model, in order to influence the behavioural outcome (KPIs). They can take many forms, including 'regulation', 'national, regional and local infrastructure', 'relationship' changes between the consumer and service provider, 'information and education' giving, as well as 'offerings and rewards'. Interventions can come from multiple sources and can interact. Any combination of these interventions are at any time, and over time presented to the consumer (in the case of e.g. information) or infused into the user environment (in the case of regulatory changes).

6.1.1.1.2 Enable

The 'social', 'physical' and 'market environment' are influenced by and act as a filter for the significance and relevance of interventions, referred to in the model as **'Intervention relevance filter'** .

6.1.1.2 User Context

The user context concerns components that are essentially internal to the consumer.

6.1.1.2.1 Drive

The consumer is motivated to actively participate ('motivation'[4] leading to a disposition and an 'intention' to act) in AD by various motives that prevail in conjunction with the awareness and understanding ('knowledge') of the consequences perceived to result from actions pertaining to the offerings ('choice') presented to them.

The consumer's knowledge and motivation, together with other characteristics - such as their demographics - act as a **'User Relevance Filter'** for the significance and relevance of enablers and interventions. A realistic chance of a match between relevant interventions and consumer drive facilitates realistic choice and a consideration of action.

Drive is therefore influenced by both interventions and enablers.

6.1.1.2.2 Act

If all the preceding conditions are appropriate, and the consumer intends to participate and if the opportunity prevails ('opportunity') - a condition that should not be under-estimated - the consumer will 'participate' in an act of AD and KPI's will be impacted in accordance with that participation. The participation will in turn lead to an 'experience',

[4] There are numerous theories and processes of motivation as explained in earlier deliverables of ADVANCED.

which will be the consumer's interpretation of the outcome and success of the participation in AD.

Opportunity: Ultimately intended action can only take place if the right conditions conspire. A consumer, for instance, may need to have the money at that moment to purchase the service, they may need to be in the right place to see the offer for the service, they may need to be at home using the washing machine or air conditioning that day to respond to the peak price, or they may not be able to respond to a demand for peak reduction because they are having some people to visit and they want it to be cool in the house and cook all the food they need for the guests. It may even be that their internet or home energy management system is not working when the request for home automation is sent to them. Or they may simply decide to 'do it later', or hesitate due to caution despite having made the decision to do it. The list of possible reasons why an intention to engage in AD, either as a whole or at any moment in time, may not result in 'Participation'.

6.1.1.2.3 Grow

Each experience, and all that comprises it, will add to the next experience and combine with the consumer's overall knowledge of and orientation towards active consumer participation in AD. The consumer's growth is the residual impact on the consumer of everything the consumer receives, thinks and does over time.

6.1.1.2.4 Share

The consumer's behaviour and experience is shared with other consumers, either by the consumer by means of word of mouth (including social media) or by other's anonymously (e.g through services that compare consumers with peer group averages or ranges). Furthermore, the consumer learns from the sharing by or about other consumer's behaviour or experiences. Next to individual changes this leads to evolving social norms.

6.1.1.3 Develop, Learn and Influence

The model of active consumer participation in AD is not serial or uni-directional in nature. As each variable changes it not only impacts on everything in front of it but also on everything behind it. For every forward flow of development and learning, there is a backward and sideways flow of influence. For example, as the consumer experiences through participation, the experience will impact back on (not limited to) their drive (e.g. former experience, attitudes to energy consumption), their physical environment (e.g. if they purchase some more smart devices for their home), their relationship with their supplier (if they trust the supplier more as a result and therefore allow them to automate their home's consumption more in future), and the combination of experiences by many consumers will influence the social environment though word of mouth and social norms.

6.1.1.4 Momentum

The combined rate of progression towards more active consumer participation in AD - measured in terms of a KPI - can be interpreted as the level of momentum in the market. This level of momentum will logically be a reflection of the product of the progression (suitability for participation in AD) of all the elements of the validated conceptual model. This concept is not addressed by the research conducted for ADVANCED since it can only be observed in a real world environment, not through pilots or hypothetically through interviews or questionnaires. As with any innovative market though, there is a sense of momentum of all the forces in the market. The market for tablet computer, for instance gathered powerful momentum very quickly. As such momentum and timing are closely related issues. AD is expected to be more rapidly adopted when the timing in the market is right: when all the pre-requisites for active consumer participation come together and the market gathers momentum.

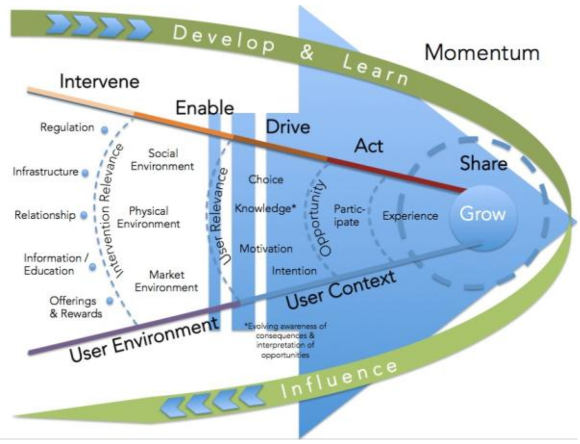


Figure 12 - The Validated Conceptual Model Including Momentum

6.1.2. **Identified dynamics of the model**

The findings of the qualitative interviews, quantitative surveys and pilots specifically validated many key inter-relationships between variables that fit within the model as reported in Figure 13 below. These variables are supported to a greater or lesser extent, quantitatively and qualitatively, and do not represent all the variables and relationships suggested or identified, but provide an overview of those which are considered most supported.

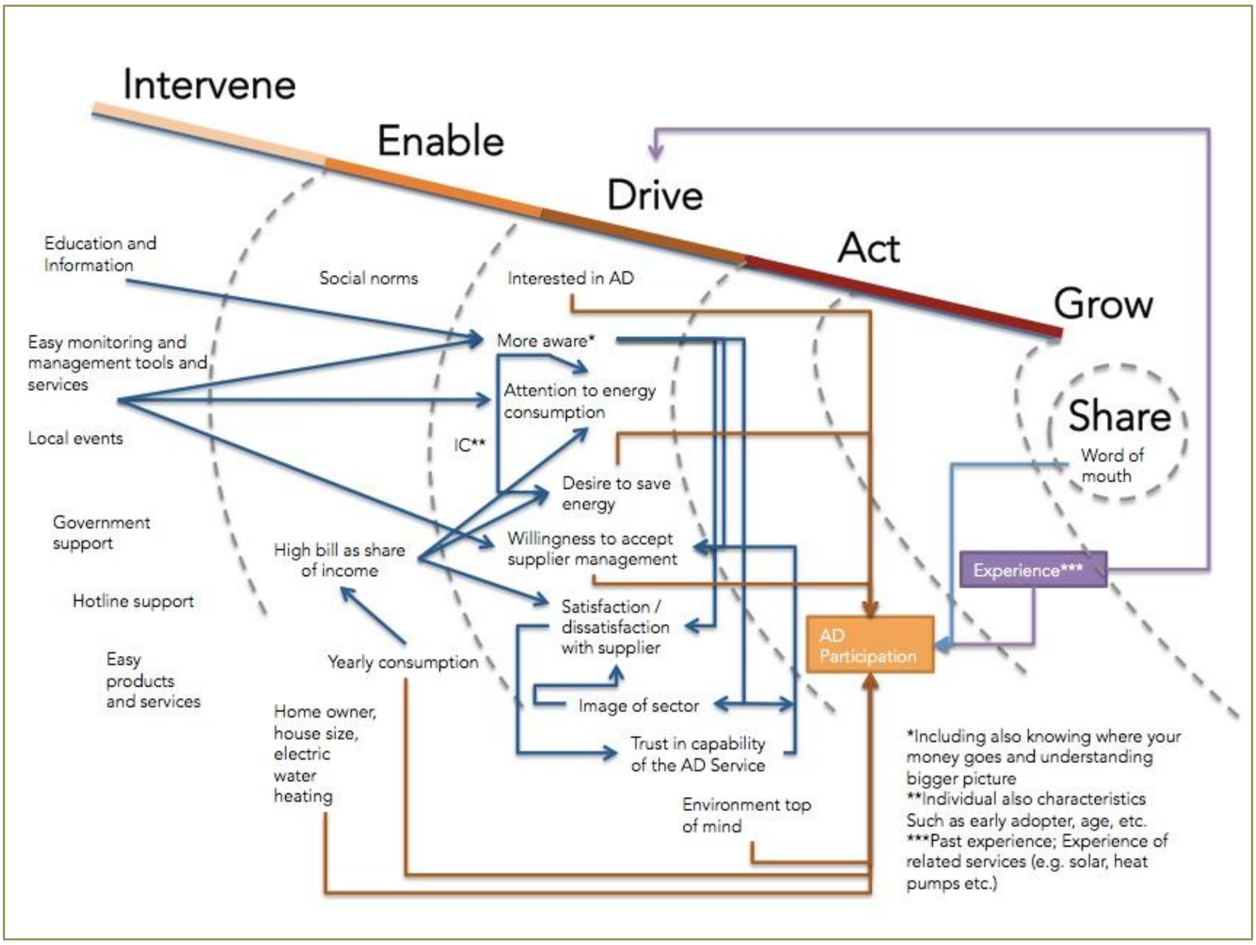


Figure 13 - The Validated Conceptual Model - Key Validated Variable Inter-relationships

6.1.3. **Drivers of active consumer participation in AD**

Many identified drivers of AD are suggested by the validated conceptual model. In fact the entire model defines the set of drivers that lead to active consumer participation in AD. Some key dirvers that stand out, however, include:

- **Knowledge thorough education and feedback**. Many consumers simply do not know enough about their consumption, the impact on the environment or how much they can do themselves to help the environment through their own AD related actions (sense of responsibility and empowerment). They must be educated through well before and during the service. The environment also needs to be more top of mind for more consumers. Events are one good way of achieving this, though traditional communication such as leaflets and welcome packs are also important. It should be noted though that for most customers there is not a need to focus on the idea that there is a benefit from energy efficient behaviour, but we should focus on the degree of that benefit that comes from different types and degrees of action and effort. **Consumption feedback (monitoring)** is therefore an essential part of knowledge. Customers need to relate their behaviour to their consumption. Consumption feedback is an extremely effective channel in this respect.

- **Trust and relationship through experience.** Even small experiences, if positive can lead to a significant improvement in the likelihood of participating in AD and the likelihood of consumers talking to others. Customers therefore need to be touched by positive experiences. Trust is implicated closely with the image of the sector (currently not good enough in most markets). If the image of the sector can be improved, satisfaction with individual service providers will improve, and so in turn will trust in the capability of the AD service, and ultimately so will consumers willingness to accept supplier management (an important pre-cursor to ultimate AD automation). Trust is therefore a reflection of the relationship that the consumer has with the AD supplier and the energy sector. Data privacy is also a pre-requisite of this trust.
- **Consumer Journey, one step at a time.** Consumers will need to be taken on an AD journey if they are to remain engaged in and accept ever more increasing levels of AD. Consumers are cautious and like to move at their own speed, a step at a time. They are easily bored. They must, through their journey increase their trust in the AD supplier and in their energy consumption being increasingly controlled by that supplier. In the meantime, they will also need new reasons to remain active. This will be a big challenge for AD providers, especially if there is an absence of compelling business models. The consumer journey is essentially the growing relationship between the consumer and AD, the AD supplier and the energy sector.

- **Support when it is needed.** It is often forgotten that AD requires support in many forms, in the form of pre-education (mentioned above), technical support, advice and suggestions. Consumers who do not receive sufficient support (e.g. in the form of a hotline) are likely to not become active, give up, or simply not benefit from the full potential of AD afforded to them and thereby be less successful and satisfied.
- **Comfort and Confidence with technology.** Naturally consumers who like or are confident in the use of new technology - early adopter types - are more likely to get involved in technical oriented AD offerings. However, the use of simple technical solutions and good education of people prior to use of those technologies make AD appealing to more consumers.
- **Opportunity, need and desire.** Many consumers still do not have, or feel they have much to gain from AD due to: their social or physical environment (e.g. they may not be home enough, have enough controllable appliances or AD ready appliances, smart meters and other infrastructure etc.); the insufficient cost of energy; the high cost or limited availability of offerings due to regulatory and market limitations. AD will become increasingly appealing as consumers have more to gain through the use of AD in coordination with the synergies afforded by e.g. roof-top solar, storage and electric vehicles. It will become more common when regulations and markets evolve, facilitating the growth of appealing AD offerings. The development of appealing offerings and effective and consistent communication is essential for this sense of need and desire.
- **Spreading the word.** While energy is often not considered an interesting topic by observers in the energy market, consumers often discuss energy issues with their frends, family and neighbours (word of mouth). If they have something to discuss, they often discuss it. AD can become a more prominent topic of social discussion. Consumers need something to shout about.
- **Conforming and competing.** Consumers are driven by the norms around them, the knowledge of how they compare to other consumers and their own track record. As AD becomes more common, it will also become a more

prominent and powerful driver of behavioural energy efficiency. AD therefore, to some extent, drives itself.

- **Right consumers, right message, right time.** There is no doubt that participation in AD depends heavily on the nature and state of the consumer. Some consumers are more suited to AD (such as those who like technology or are home a lot). Some consumers are more likely to be early adopters. Different consumers want and are driven by different motives, want different things and therefore need to offered differentiated offerings and especially need to be communicated to with different messages. Implicit in the validated model is also the significance of timing. The relevance of active consumer participation in AD is very heavily context specific. AD is relevant for instance when the consumer has the opportunity, when the offerings are good enough, energy prices high enough, offering costs low enough, regulation appropriate, and when the consumer knows enough, has experienced enough and trusts enough, The level of participation will increase as all of these factors evolve and as the consumer grows, shares her/his experiences and as AD becomes part of the norms of energy consumer behaviour. The success of active consumer participation in AD is therefore highly dependent on offering the right service to the right consumer at the right time. Segmentation is therefore essential to the successful adoption of AD by consumers.

6.2. The actionable framework for residential consumers

Through the consideration of the drivers and the Validated Conceptual Model, in light of the broad expertise of the ADVANCED project partners, a set of 27 barriers to the participation of consumers (residential only) in AD are identified that are reported in the following table. [11]

Barriers to AD	
No.	Enable
1	Lack of access to data / smart meter & in-home feedback and AD infrastructure and follow through
2	Appliances (including smart appliances) are rarely 'AD ready' ; Insufficient

	controllability of appliances (including also EVs)
3	Tariff and Billing inflexibility (lack of enablement of dynamic prices)
4	National needs for AD not always sufficient to drive policy
5	Market arenas under-developed
6	Energy companies do not know their customers well enough
7	Lack of competition
8	AD not yet social norm
	Drive
9	Technology centricity
10	Lack of choice
11	Not enough consumers have been touched by a positive AD experience
12	Lack of trust and relationship (including readiness to accept supplier management / trust in capability of the AD service)
13	Incorrect use of opt-in/ opt-out
14	Consumer's knowledge shortfall
15	Insufficient appeal (including cost of solutions) and usability of offerings
16	Appropriateness of marketing and communication
17	Contradictory messages
18	Insufficient proof and guarantees
	Act: Opportunity
19	Few realistic offerings / availability of AD offerings
	Experience
20	Consumers need to feel more in control of the developmment of AD
21	Better consumer support will need to be developed
22	Modest savings and savings significance potentials
	Grow
23	Not enough journey (one step at a time)
	Share
24	Insufficient social discussion
25	Not enough to shout about
	Data Privacy
26	Issues of data privacy and customer protection
	Momentum
27	Lack of market momentum for AD

An actionable framework was then developed to translate the drivers and barriers into actions. Put simply, the framework postulates that regulation and the energy industry intervene deliberately or otherwise. The consumer experiences and interacts with the social scene to share and interpret the interventions and experiences. An intention of the energy regulation and the energy industry should be to create the conditions under which the social scene has something positive to share. Media & Reps refers to for instance the news media, magazines, and consumers associations (consumer associations may to be broadly official in nature but generally considered to be on the consumer's side of things). Naturally media and reps (e.g. bloggers) may extensively or in some cases entirely use the social media as a channel, but they are, as the energy industry and consumers themselves, a separate entity within the social scene.

Within the framework the following action categories are applied: Regulation, Infrastructure (including the market), Relationship, Information/education, and Offerings & Rewards. For each barrier, there are suggested associated actions, specified in detail, to address those barriers as well as the drivers. All actions are crossed referrenced with the barriers and driver categories they address. Regulatory barriers were identified by considering the above barriers and what else is known by the experts within the Advanced project.

19 regulatory and 31 non-regulatory actions are identified and specified. It is noted that different actions are not of equal importance, difficulty or duration however and the order by which they are addressed is critical. Different stakeholders also need to be responsible for different actions. . To simplify this complexity and provide clarity of strategic direction, roadmaps were built that illustrate the steps towards achieving mass consumer participation in AD. One roadmap is proposed relating to the regulatory actions necessary for the adoption of AD and four roadmaps concerning non-regulatory actions. The roadmaps are reported in Figure 14, Figure 15, Figure 16, Figure 17 and Figure 18 below.

The roadmaps illustrate the need for the majority of actions early on in the process of AD development - and as soon as possible if Europe is to meet its environmental targets - but also the need to hold off on some actions until they have the support that they need from other actions and conditions in the market. But most of all the roadmaps illustrate the need to push hard all the way until 2030 and beyond. In particular, however, the immense importance of suitable regulation and infrastructure as a pre-requisite for the plethora of consumer engagement actions becomes evident.

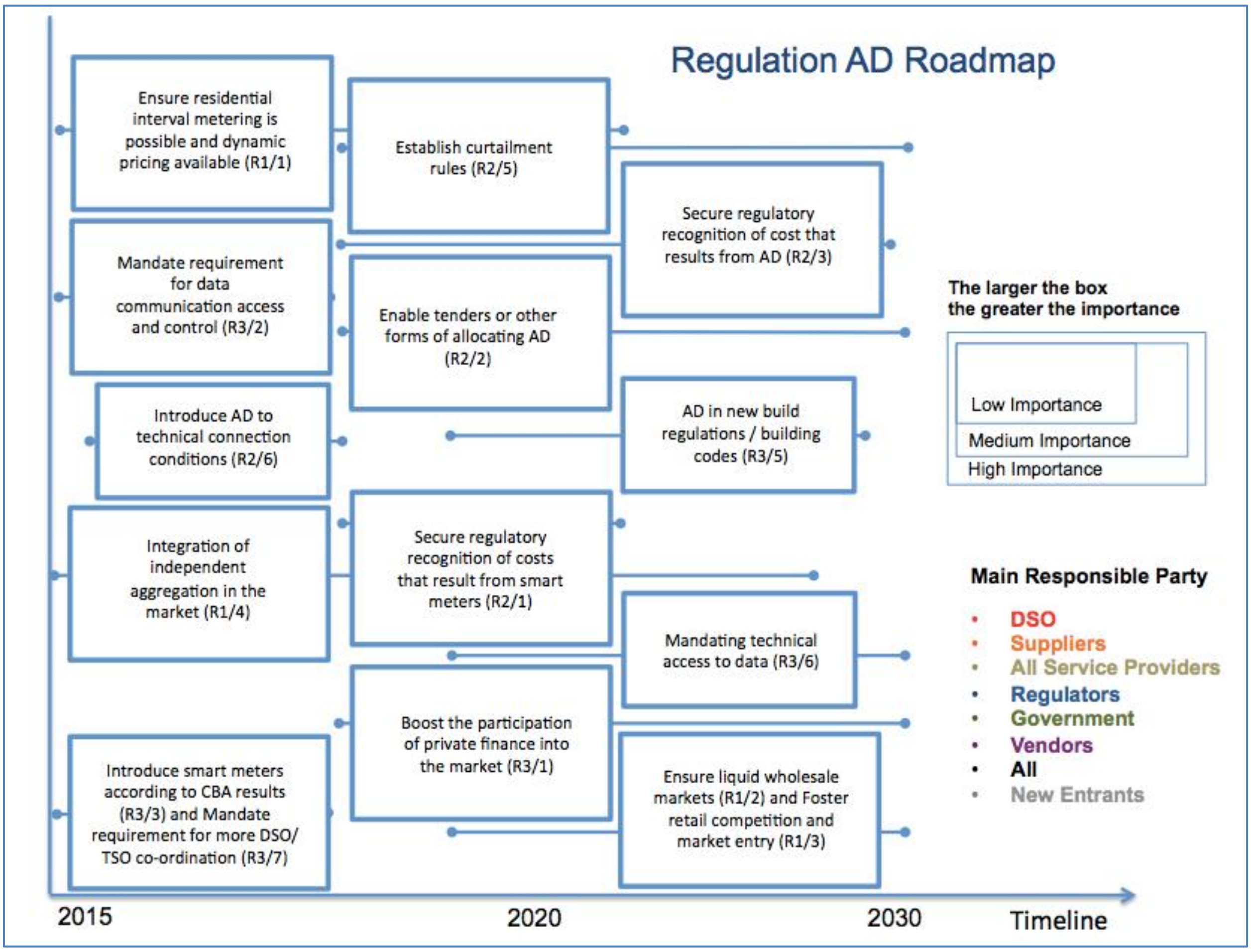


Figure 14 - Regulatory Roadmap

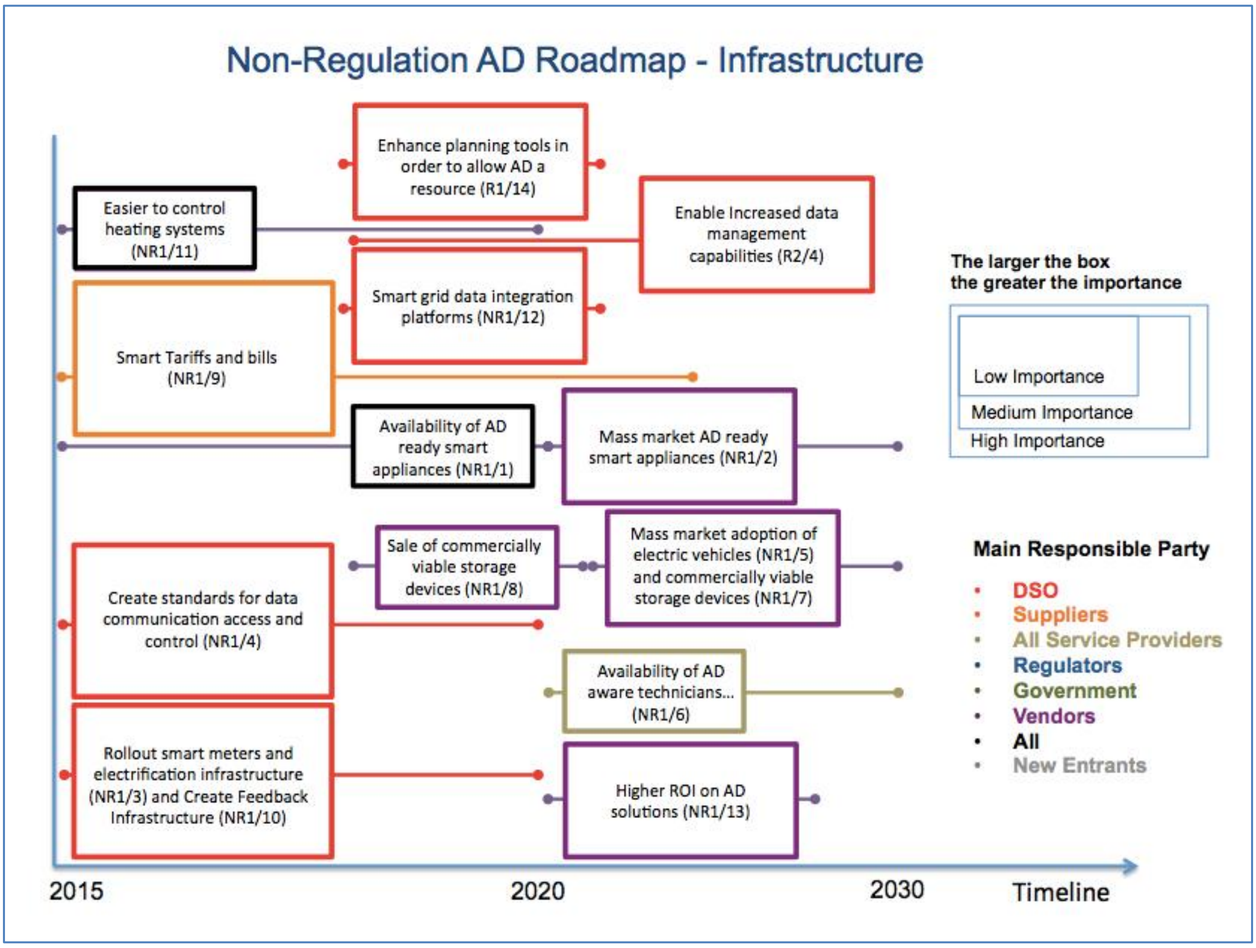


Figure 15 - Non-regulation AD Roadmap - Infrastructure

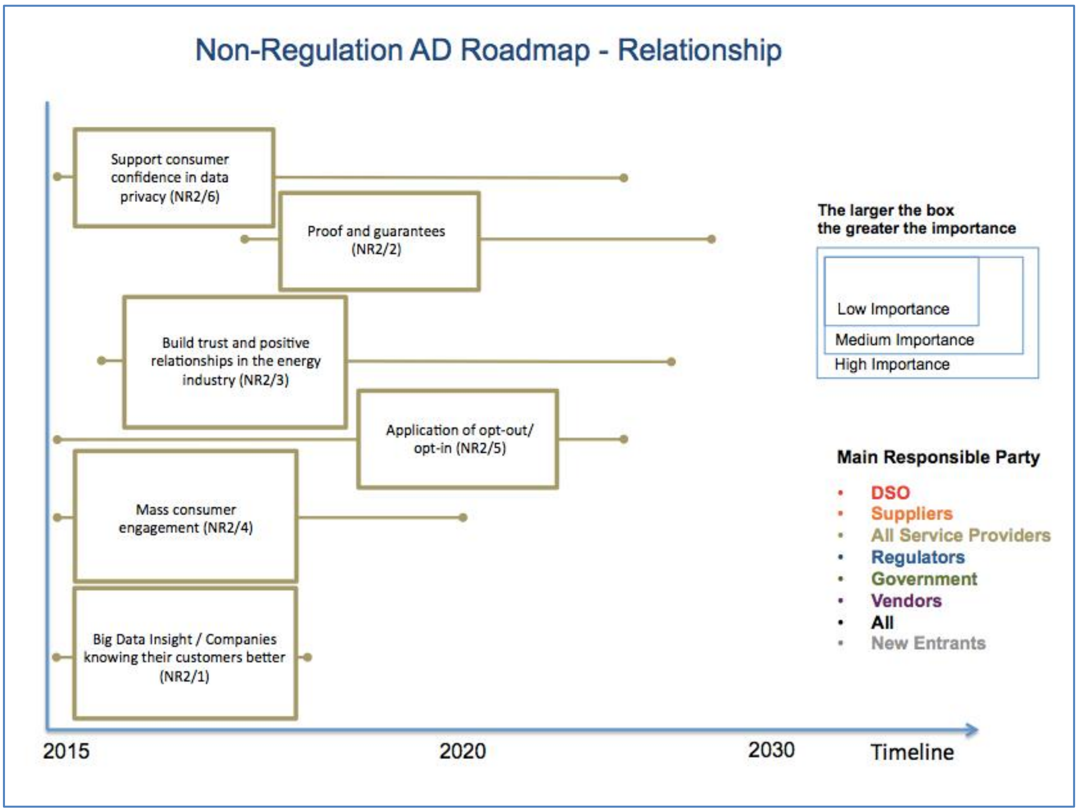


Figure 16 - Non-regulation AD Roadmap - Relationship

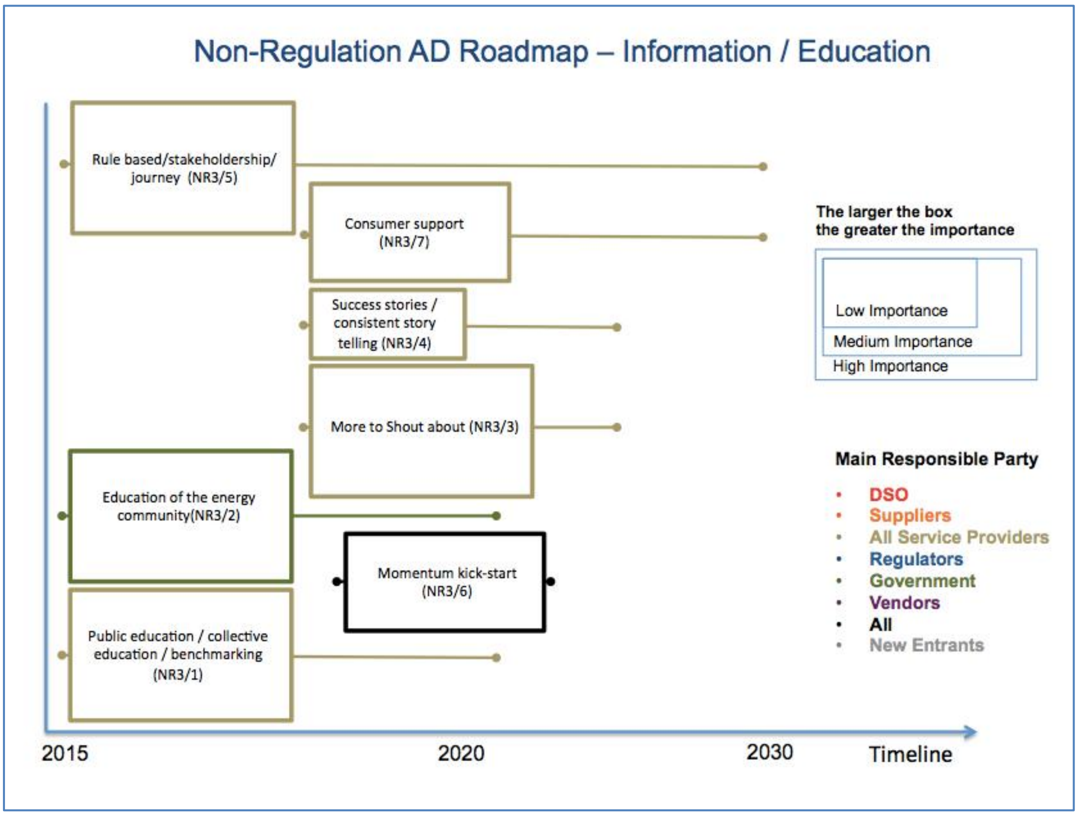


Figure 17 - Non-regulation AD Roadmap - Information / Education

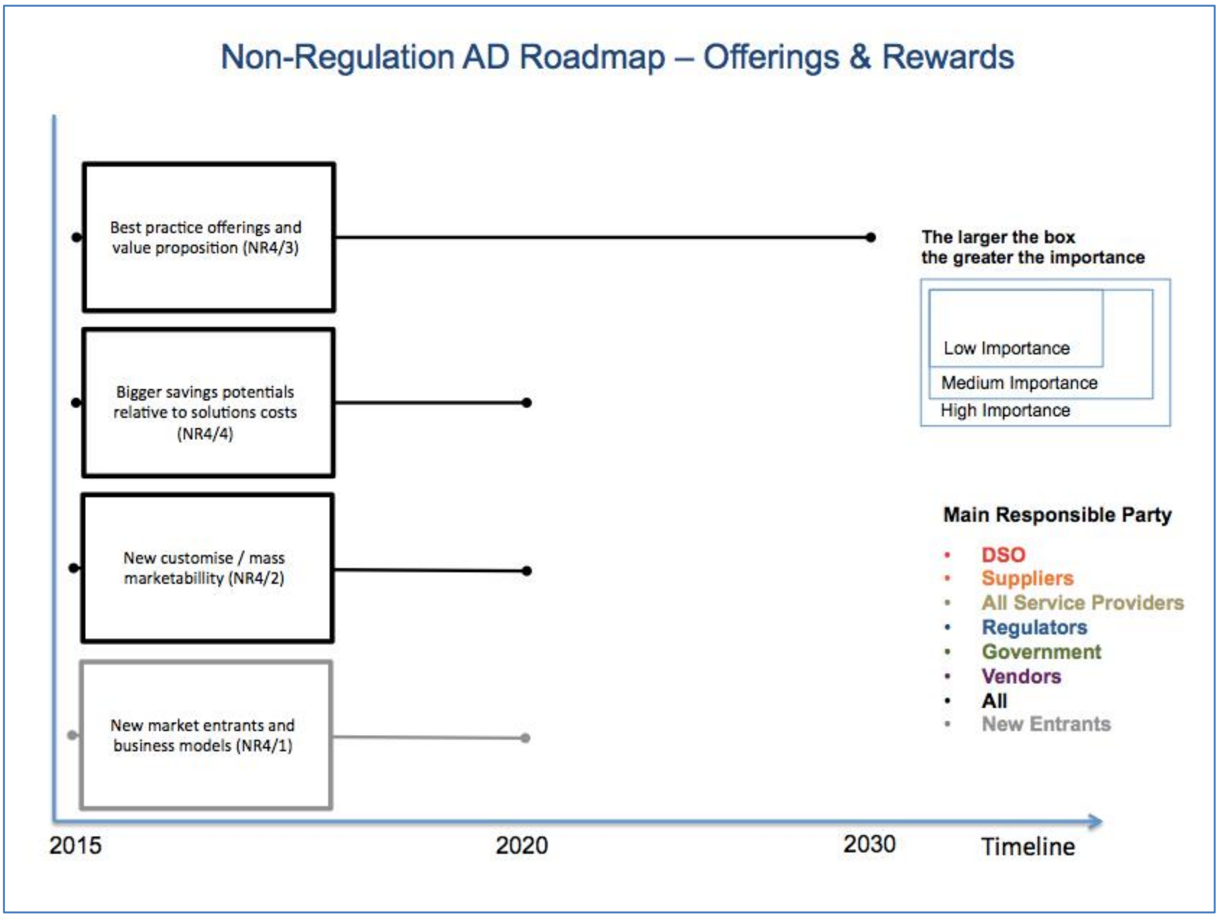


Figure 18 - Non-regulation AD Roadmap - Offerings & Rewards

6.3. Communication umbrellas for residential consumers

The ADVANCED Customer Communications Umbrella for residential customers is one of the most actionable outcomes of the whole ADVANCED project. [13]

6.3.1. Assumptions and methodology

An important starting point in the research was the realization, that Active Demand is not a tangible product but more of a service. One could even argue, that it is not even a service but rather a concept, where a company and a client or customer reach a mutual understanding of the needs of the other - and accepts their different roles and responsibilities in making the concept function to the benefit of both parties.

The goal of the study was to show which kind of communication effort and strategy is needed to introduce such a concept for residential customers.

An analysis of existing communications material from the pilot and the research from the surveys established in the project was carried out, and on this basis is provided a set of tools and a way of working with communication alongside the roll out of Active Demand which seems promising for the future.

6.3.2. **Results and findings**

An important first result is found through analyzing the way communication has been treated and used in the utility industry since the liberalization process began around or just before the year 2000. The conclusion is that there is a close resemblance between the politics influencing the industry and the way communication appears and is being used and that communication trends are similar in between different European countries.

This result is linked to the development in communication in general and in communication channels. They have undergone a dramatic change from being focused at primarily one way and mass communication to a much more complex and digitally oriented communication, which involves the end-customer and focuses on understanding the mechanisms of interaction between the end-customer and the retailer and how to establish an actual relationship. The utility industry has so far not been focusing their communication efforts within these new areas and has very little experience in doing so.

From these analysis it is possible to build a communication model, called the AD Communications Wheel. Its focus is to introduce a concrete way of driving customers through the phases of the Conceptual Model.

Figure 19 : ***The AD Communications Wheel***

It builds on the different stages of the AD customer in the Conceptual Model, but transforms the developments into actionable steps. In doing so the AD Communications Wheel also introduces a learning curve for both the utility and the customer. It builds on the fact, that customers are not alike, do not share the same readiness to participate in programs like AD and therefore needs to be addressed in different manners. Similarly it encompasses the other factual part of the equation; that utilities need to change and adapt to customer behaviour in a similar way as the customer does. In other words: the communication will have to change in accordance with the changes in the engagement between the two parties as it grows larger and they become more and more interdependent.

The blocks of the wheel can be described as follows:

- Targets and Goals: the first step to be addressed is the focus of the communications and should initially consist of answers to questions like: What is the primary focus of the communication – i.e.: Are we focusing on education, information or actual participation?

- Stakeholders: before initiating any communication first step should always be to consider the environment in which the communication is going to take place;
- Identifying customers: the next step is to identify who will be addressed in order to get questions answered and goals achieved;
- Data collection and analysis: identifying what we know about the customers will enable targeted and personalized communication and with this increase the potential effectiveness of the communication;
- Communications: this stage is where the message is defined, the channel is chosen, the timing is decided upon;
- Measuring effects: the measuring of effects should be taken very seriously in the business and instead of asking whether the communication succeeded it is much more fruitful to ask: What did we learn? In this way communication is also accepted as a process instead of a means to a definite end.
- Organizational set-up: The last part of the loop before it can start all over again is to look internally at the deliveries and responsibilities of the organization, as each loop in the communications wheel also changes the relationship between the sending and the receiving party.

Introducing a way a strategic tool for working with communication related to introducing AD, is then supplemented by a specific customer segmentation model, based on the outcomes of the quantitative interviews. The resulting segmentation model is showing the differences in customer perception and preparedness to participate in AD programmes.

To make the segmentation more comprehensible personas [Jenkinson, 1994] – or personifications – of each segment were created. It means creating a character, with whom you will be able to relate and who has a set of distinct characteristics which you will find represented among the customers belonging to a certain segment.

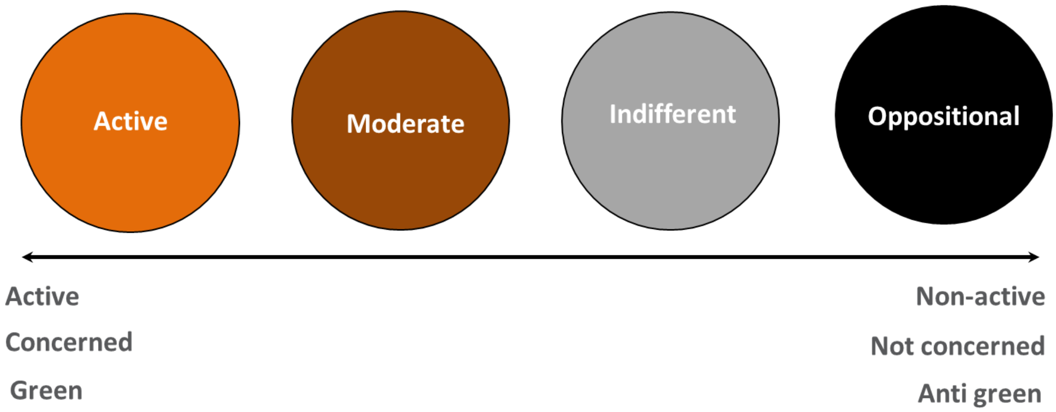
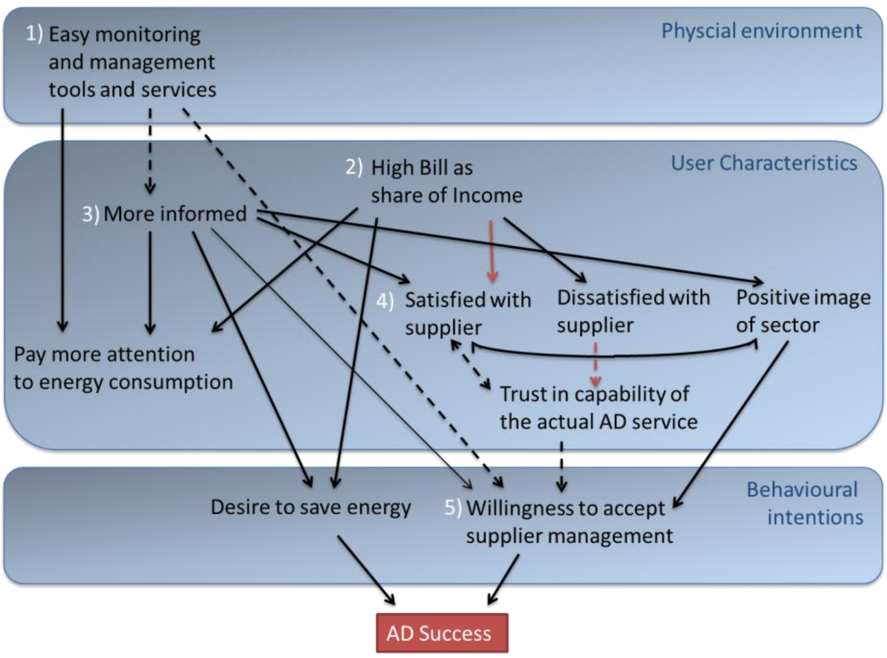


Figure 20: The AD Segmentation Model

The segmentation model and findings from the surveys is also the starting point for bringing forward a concrete communication strategy and methodology for establishing trust, understanding and lasting relationships between the parties of an Active Demand programme.

Figure 21 below represents a summary of the Factors influencing AD Success and their correlations as explored in the outcomes of the surveys carried out within the scope of ADVANCED. Looking at this chart it is in other words clear, that making people feel informed is an important element in making AD a success



<u>Legend:</u> The plain arrows in the chart mean that there is a direct link between the variables studied. For instance, the more respondents have a positive image of energy suppliers the more they are willing to accept supplier management. The thicker the arrows are the stronger the link is. The arrows with only dots mean that there is an indirect link between the variables

Figure 21: ***Factors influencing AD Success. Correlation analysis of the qualitative and quantitative survey***

The concrete implementation methodology consists of five steps and a launch phase and ends up as a development strategy: It is the engine to maintain AD communications and establish an ongoing relationship with the end-customer.

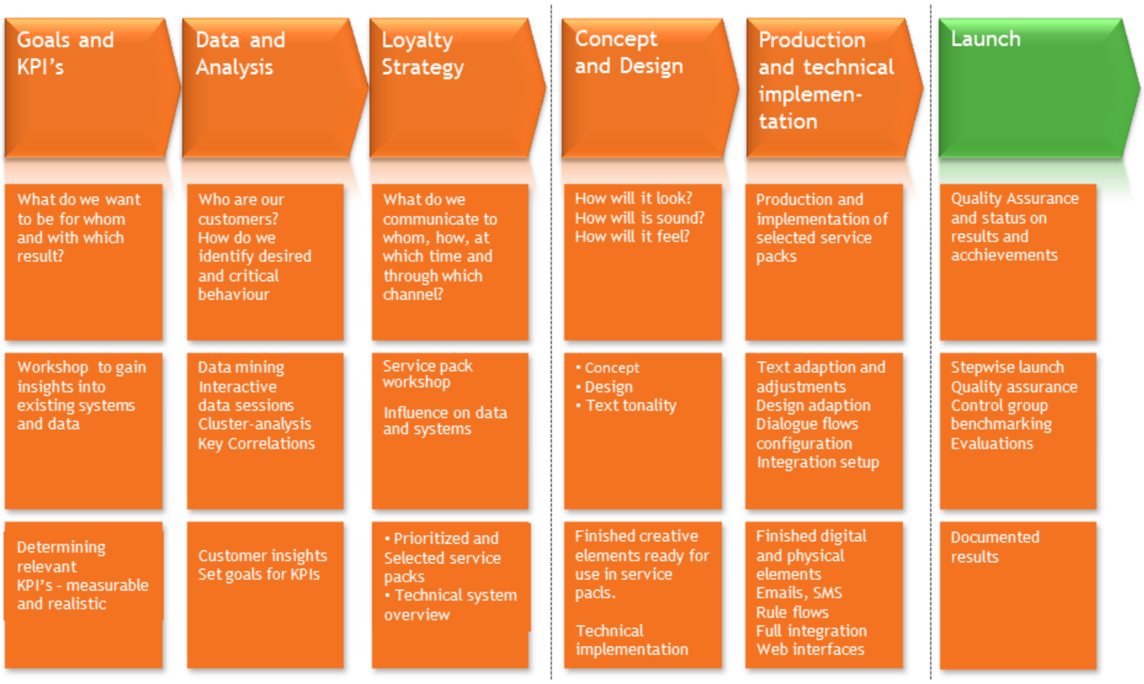


Figure 22: ***Development strategy for implementing an ADCommunications platform***

Next, the learnings and content of the communication from the four pilot projects of the participating utilities were used to derive messages and explain what works and what does not, when it comes to customer communication about AD. As the last step, the implementation tool and conceptualization was used to create customers journeys for each segment. This work was partly based on the four pilot programmes run by the project and partly on the findings from establishing the Conceptual Model and the analysis of communication methodologies in the utility sector and the development of interactionable communication from digital media.

On this basis, concrete examples were developed to show the methodology functioning in reality.

Segment	Utility Role	Nature of propositions
Active (Daniel)	Guide	Energy Saving programs with documented benefits, Benchmarking tools. **AD as a way to economical savings and a green way of consuming energy** Goal: **Saving**
Moderate (Maria)	Coach	CO_2 saving scheme, educational programs, Energy Reports. **AD as a way to a greener way of consuming energy** Goal: **Trust**
Indifferent (Susanna)	Advisor	Retention programs, **AD as a way of assuring price stability** Goal: **Confidence**
Oppositional (Simon)	Mediator	Information and education. Storytelling and case stories. **Not selling AD, instead explaining and educating.** Goal: **Relation and change of attitude**

Figure 23: ***ADVANCED segments communication approach***

An important finding of this study reveals that in order to ensure the building of trust and establishing a relationship a step by step approach is needed in the communication. Furthermore, this *is* possible – especially since utilities in the relatively short period since the liberalization of the energy markets in Europe has been able to relate to changes in their environment very quickly. With new digital ways of communication at hand, the transformation in communication needed in the industry is mostly about making the decision as to when and where.

In this respect it seems most possible, that the potential flexibility and the energy savings of future energy consumers can be dramatically changed. This however demands a change not only in the customers mind, but also in the approach of the utility sector towards their customers and towards communication over all.

The most important findings can be summed up in the following 8 points:

1) A new methodology – the AD Communication wheel – has been created. It emphasizes the fact that communication about AD programmes of the future needs to be a part of the business development and take its starting point in actual business goals.

2) From analysing pre-existing communications in the utility sector – not necessarily related to AD activities, but in a broader sense focusing on the messages sent and perceived from all communication coming from the industry - it has been observed, that communication until now has been focusing on mass market and above the line communication channels and content. When moving into AD, this needs to change to become personalised and relevant for the individual customer.
3) At the same time as the energy market has been liberalized the whole world of communication has seen a dramatic change from traditional mass media campaigns to digital and targeted communication.
4) Findings from surveys in the ADVANCED project have been turned into actionable goals and segments, which enables a much more targeted communication approach.
5) On the basis of segmentation, the project has been able to establish a digital Engagement engine, which provides a methodology to ensure the roll out of AD programs in the future.
6) The pilot projects from the participating utilities has provided unique insights into which communication methods that works, and which does not. This has been a major contribution to developing the methodology and the examples of communications for driving AD participation.
7) Most importantly, the finding from the ADVANCED project does not only require change within the minds of the customers but as important internally in the organizations of the utility industry.
8) The methodology of personal customer communications opens up also new possibilities and business options for the industry

6.4. The actionable framework for C&I consumers

Commercial and industrial (C&I) consumers report a high interest in Demand Response (DR). However, there is a range of barriers for DR in many European markets. Regulatory barriers are the main issue and hinder markets for Active Demand (AD) services to grow. This starts with essential prerequisits such as opening all markets to demand side resources (e.g. loads, storage and distributed generation). Second, as the vast majority of commercial and most industrial consumers do not have the means (e.g. because their loads are below the minimum bid size or because of prohibitive penalty requirements) to participte directly in DR programs, they require DR services providers like 3rd party Aggregators or Retailers, acting as Aggregator. [12]

However, aggregated DR in many European countries is impossible because of regulation or even illegal as is the case in Spain.This is in non-compliance with the Energy Efficiency Directve (EED), Artcile 15.8 that requires national regulators and TSOs to allow consumers access to markets through DR programs, to enable the participation of service providers such as retailers or Aggregators and to enable and encourage program development [20]. So, making aggregation legel and opening the various markets for DR, including for Aggregators, is already European law, but not yet implemented everywhere.

The ADVANCED consortium calls on the European Commission to follow-up on the compliance with Article 15.8 by opening all markets to aggregated DR and by removing the main barriers and hurdles. Therefore, the ADVANCED project developed an actionable framework that outlines the main barriers and hurdles and recommends actions through how to overcome them. In fact, removing the three main hurdles are quick wins in terms of ease of implementation and urgency. In particular, solving the BRP / Retailer issue and providing third parties access to balancing groups is a major step towards viable DR markets.

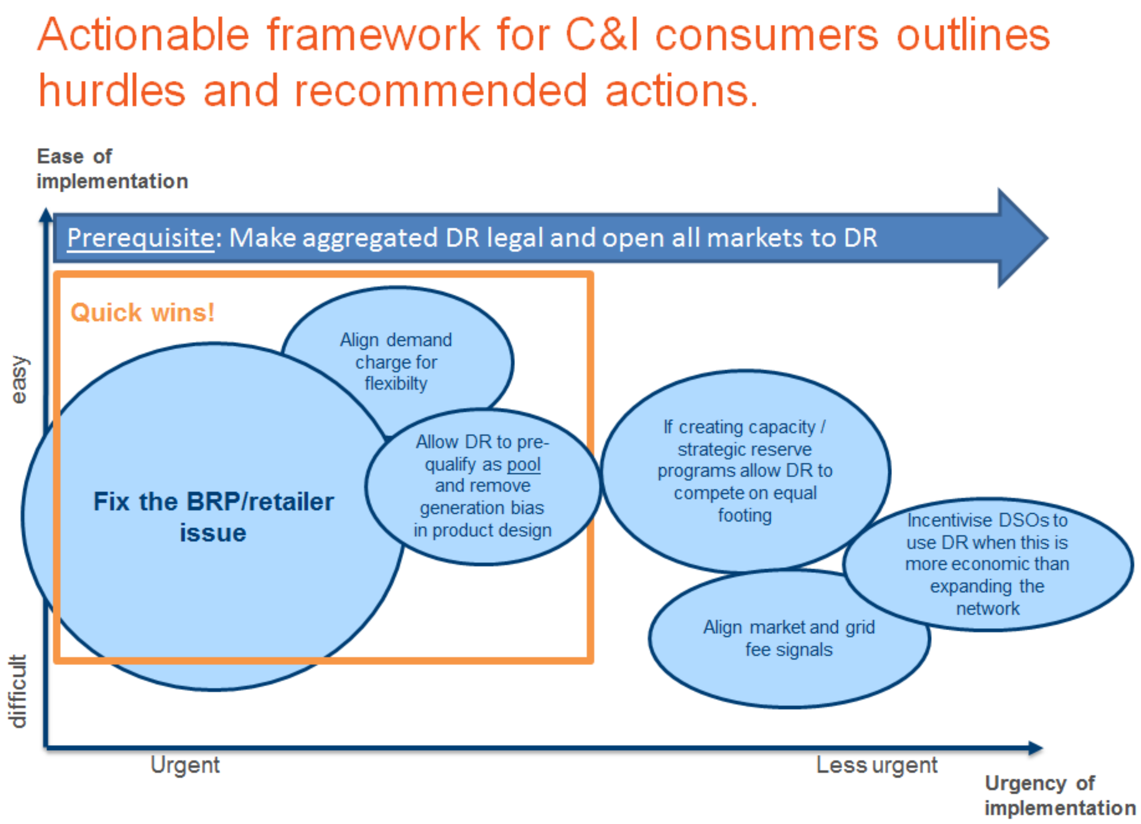


Figure 24: The Actionable Framework for Commercial and Industrial consumers. Source: ADVANCED Project.

A key driver for more DR is competition and entry of independent players (3rd party Aggegators), therefore creating a role for third party Aggregators and standardising the interactions with other parties is crucial for the development of DR services. If this is not solved incumbent market players can continue to block entry of independent DR service providers such as third party Aggregators. Another urgent action is to ensure that other market rules, such as network charges, don't hinder DR development. The increase of load during a DR event could lead to higher network charges that outweigh the participation payments thus in fact penalizing the consumer for helping the grid.

For the creation of a viable market and the development of DR products and services, it is of utmost importance that the particularities of demand side resources are accounted for. So, if designing capacity markets or reserve programs, DR shall be allowed to compete on equal footing. That means, for example, that the requirements for participation are set at aggregated level, as if the aggregated loads are a single power plant. With other words, it should be the pool of aggregated loads that is prequalified. This includes also the requirements for verification and measurement (such as baselining). The objection of an alleged lacking reliability can be rejected as data shows that DR as an aggregated resource is as reliable as generation or even more reliable. Hence, DR should be able to participate alongside traditional generation and receive equal payment - for availability (MW) and energy (MWh). This allows aggregated DR to compete with generation to ensure the depoyment of the resources with the lowest cost. To conclude, the actions recommended in the Actionable Framework for C&I consumers are quick wins as removing the main barriers and hurdles to DR will allow for viable markets with products and services that allow commercial and industrial consumers to participate in Active Demand.

6.5. Communication umbrellas for C&I consumers

To make Active Demand (AD) more widespread across Europe, a main prerequisite is that Utilities develop products and services for Commercial and Industrial (C&I) consumers so that they can participate and contribute with their demand-side resources in different markets. The term Utility in this case is used as a catch all term for Retailers, Energy Service Companies and/or DSOs. Retailers, Energy Service Companies and potentially also DSOs could assume the role of a Demand Response (DR) Service Provider / DR Aggregator. The C&I consumer segment includes many of the Utilities' most important customers, from the largest named accounts to the engaged small-to-medium enterprises. For many Utilities, non-residential demand is more than 50% (often up to 75%) of total demand. [14]

C&I consumers are a very heterogeneous segment. Therefore, personalized and relevant communication on benefits and implications of participation is challenging for a utility but at the same time key to a DR program success.

For utilities that want to offer DR services, the challenge is to inspire C&I consumers about measures that are economically meaningful but very often complex and abstract. Also, businesses and owners differ in contact method preferences. C&I consumers want information that fits them: Correct industry / business type and understanding the opportunity and limits of their business type even by acknowledging rate structures.

Overall, successful communication regarding DR means creating clearer connections between businesses, messaging, and behavioural outcomes.

The first question is *"Who should be contacted?".* For DR to be adopted by a C&I customer, executive level buy-in is required. However, the route that can be followed to get this commitment varies between consumers and often depends on the "energy awareness" of the business. For example, for an industrial customer, energy consumption is critical to the operation of the business and so there are often specific employees and/or departments with responsibility for procurement of energy (and related services). For commercial customers, depending on size, there can be a low level of energy awareness, as there is often no dedicated individual to handle such matters. The methods of approaching C&I consumers depends on the market conditions of the country of focus. In countries where DR markets are new and relatively unknown, most customer acquisition is likely to be initiated by the DR Service Provider. As the market conditions develop, DR becomes more productized, so that the majority of communications are initiated by the consumers themselves, as they see a desirable product which they wish to use.

Next, the focus is on *"What should be communicated?"* C&I customers will have many questions about DR and what it means for their business. The ADVANCED project has compiled key messages that explain the concept and benefits of DR as well as examples for demand-side resources of C&I consumers. Furthermore, frequently asked questions are outlined to provide further guidance on what should be communicated. The communication should also address barriers and hurdles and perceived detrimental effects: the C&I customers have a core business (e.g. manufacturing goods, serving customers, etc.) and need to understand how signing up for DR services might affect their ability to continue to deliver their core business. In this context, it is important to explain that DR is designed to have no knock-on effects on the productivity of a commercial or industrial consumer's core business. DR Service Providers have to work closely with businesses to ensure this. Furthermore, the technology that will be installed should be explained in communications: what is the technology, what are the security aspects, etc. A frequent prerequisite for C&I consumers is that they keep full control of all processes, assets, etc. at any time. Successful DR programmes make sure that consumers maintain sovereignty about their processes.

Along the customer interaction by the DR Service Provider regular, consistent feedback and progress reports can create positive encouragement on ongoing participation.

7. The impact of AD on the electrical system and its actors

7.1. Scenario-based results on the flexibilities AD might offer

Very generally speaking, Active demand (AD) is one of the most untapped energy resources in Europe today and it is believed by many actors inside and outside the energy industry that properly designed AD programs are increasingly needed to cope with the challenges of the ongoing energy transition, i.e. more and more DRES in the markets, electrification and increasing demand at least in some countries..

This general believe and hope towards AD is in stark contrast to what is currently known about the actual potentials in Europe. In order to shed some light onto this issue the ADVANCED consortium used available information from the ADVANCED data base and the ADVANCED pilots, developed an innovative methodology and thus was able to calculate “expectation values” for the AD potential in the four ADVANCED countries (France, Germany, Italy and Spain) for different scenarios. The analysis was undertaken with regards to two dimensions of AD: The potential was calculated as the maximum impact of AD activities on either **total energy consumption** or **peak consumption**. ADVANCED used a **forward looking approach** in this particular step of work, i.e. results focus on the potentials that are expected to exist in 2020.

In order to perform these calculations different input factors (for instance the state of the smart meter roll-out, but also questions of market organization like balancing regimes) that influence AD were identified and assumptions about their realization were made in three different scenarios (baseline, optimistic, technical potential) for each country. More specifically the baseline scenario was designed to mirror the current developments, without any major policy innovation. For the optimistic scenario more ambitious assumptions were made, outlining an almost ideal degree of energy savings and tapping of load shifting potentials but still respecting the human factor, i.e. not all customers will join such programmes. Contrary to the first two scenarios the technical potential scenario was defined as a hypothetical situation where the full potential of demand response, as well as the full potential of energy efficiency is achieved. [15]

7.1.1. **List of basic ADVANCED assumptions:**

- The introduction of Smart Meters (SM) will accelerate AD programs[5].
- In-home Displays (IHD) are considered as 'direct feedback', all other feedback programs as 'indirect'.
- Feedback programs cannot be combined (they are considered to be mutually exclusive).[6]
- Dynamic pricing programs cannot be combined (they are considered to be mutually exclusive).[7]
- Program type effectiveness expresses the impact of any program as a percentage figure, i.e. the reduction in (a) total energy consumption or (b) peak consumption.
- The program type effectiveness is considered to be similar in all scenarios.[8]
- The time horizon for electricity consumption (peak and total) is 2020.
- Only total consumption and peak demand for residential consumers are considered.

Of course there are many different types of AD programmes around and so ADVANCED did not only group them in EE programmes (i.e. focusing on total energy consumption) and DR programmes that focused on shiftable loads (i.e. designed to influence peak consumption) but also provided assumptions on the expectation values for the introduction of different technology within these two groups, e.g. the effect of in-home feedback by a display or by a more informative billing.

[5] Excluding off-peak-heating or cooling systems and water heaters, which are already steered by the DSOs or suppliers to avoid peak consumption. Today this is done without a SM (for example in France or Germany).

[6] The VaasaETT data base does not contain values for combined feedback programs. The separation of the impact of an in-home display or a website in one household is not possible. For this reason it is assumed, that the programs are not combinable, even though they clearly are in reality. The main purpose of that assumption is to make calculations possible.

[7] Some exceptions do exist: for example, in France, the Tempo tariff can be considered as being the addition of a TOU tariff and a CPP tariff. In the present methodology, it will be considered as being a CPP tariff.

[8] Program type effectiveness could have been another key parameter in the calculation.

	AD programs	Program Type Effectiveness
Feedback programs	Informative bill	5,68%
	In-Home Display (IHD)	9,10%
	Website	4,38%
Dynamic Pricing programs	Time of Use (no-automation)	5,16%
	Time of Use (automated)	15,45%
	Critical peak (no-automation)	16,33%
	Critical peak (automated)	32,47%
	Real-time pricing (no-automation)	10,19%
	Real-time pricing (automated)	11,25%

AD programmes and their effectiveness as taken from the ADVANCED data base

By using this innovative methodology, different AD potentials for France, Germany, Italy and Spain could be evaluated and also were presented in a **register** to compare the potentials of each country.

While the work focused on residential customers and their system-wide load for the larger part, data was also collected and analysed for the commercial and industrial sector(s). Here the analysis was focused on Germany as the data available was especially good, but is being considered as exemplary for other EU countries by ADVANCED.

Based on the results that were used to fill the register ADVANCED also calculated two **KPIs** that were already proposed by the project at its outset, namely: **financial savings achieved by energy efficiency** and the **CO_2 reduction by energy efficiency** in the residential sector.

For each scenario, all programmes were investigated separately and also technical, regulatory and political barriers were identified for each programme which gave ADVANCED the opportunity **to also compile** some first **qualitative results** concerning **important barriers to an implementation of AD** in the focus countries. After investigating which programmes could be realized in each country, the AD values for each programme type were calculated on the basis of the AD programme effectiveness, the SM rollout and the AD program uptake rate. If a single barrier was considered to be of major importance for any programme type and it was assumed that it could not be overcome short-term it was considered to be a "showstopper", i.e. the overall programme effectiveness within either the baseline or the optimistic scenario was set at zero.

FEEDBACK PROGRAM	communcation of daily-hourly readings (meter -> DSO)	automation technologies	balancing regime and usage of load profiles	comm capabilities	data privacy issues	placeholder - not in use	SCORE
Time of Use (no-automation)	1	1	1	1	1	1	1
Time of Use (automated)	-	1	1	1	-	1	-
Critical peak (no-automation)	1	1	-	1	-	1	-
Critical peak (automated)	-	1	-	1	-	1	-
Real-time pricing (no-automation)	1	1	-	-	-	1	-
Real-time pricing (automated)	-	1	-	-	-	1	-

Example for the analysis of qualitative or non-quantitative variables using the show-stopper methodology

All these elements were then brought together in more calculable methodology for the quantification of the AD potential in the four ADVANCED countries.

Figure 25 - Stepwise ADVANCED methodology for the quantification of the AD potential

7.1.2. **Demand response (residential)**

The **demand response results**, which were calculated in the manner described above, indicate that the potential in the baseline scenario is rather small in all countries surveyed (cf. the table below). This is due to the technical and even more the regulatory issues that currently remain unsolved with regards to AD. Only Spain does report to have any showstopper in their baseline scenario, but the uptake rate estimated for Spain for demand response (resp. dynamic-pricing) was rather low, so the results are still in line. Setting aside all the technical and regulatory barriers in the optimistic scenario, the demand response potential increases, but it still remains mostly under 5% of the peak load. Only France would reach a higher potential, including their installed base in steerable electric boilers and heating systems thanks to existing ToU and CPP programs, but the remaining potential was also under 5%. The calculations in the technical potential scenario were all based on the same assumptions concerning the effects of single programs. Hence, the absolute value in the technical potential scenario pointed out the maximum influence of the residential sector on the national peak load (and not only the peak load due to controllable appliances), i.e. reported values differ in "steerable" kW. The following table shows the results of the investigations for demand response.

		demand response					
country	sector	baseline scenario		optimistic scenario		technical potential	
		GW	%	GW	%	GW	%
France	residential	0,14	0,32	0,28	0,65	13,80	32,47
Germany	residential	0,12	0,31	0,92	2,30	12,99	32,47
Italy	residential	0,08	0,52	1,32	8,25	5,20	32,47
Spain	residential	0,20	1,24	0,75	4,60	5,27	32,47

Table 2 - Major quantitative results with regards to demand response

7.1.3. Energy efficiency (residential)

The **results with regards to energy efficiency** indicate that even in the baseline scenario a small potential exists. The less technological and regulatory barriers (c.f. optimistic scenario) prevail, the higher the energy efficiency potential. The results for the technical potential scenario indicate that the residential electricity consumption in France and Germany is higher than the consumption in Italy and Spain, and therefore total absolute potentials are higher for Germany and France. For the two latter countries potentials were not only analysed with a forward-looking view, but the potentials already harvested today, e.g. from the steering of certain heating appliances in in the case of Germany were also shown. The following table shows the results of the investigations for energy efficiency.

		energy efficiency					
country	sector	baseline scenario		optimistic scenario		technical potential	
		GWh	%	GWh	%	GWh	%
France	residential	1.199	0,71	2.574	1,53	15.315	9,10
Germany	residential	3.898	3,07	9.220	7,26	11.557	9,10
Italy	residential	216	0,27	2.516	3,19	7.189	9,10
Spain	residential	928	1,12	1.879	2,28	7.510	9,10

Table 3 - Major quantitative results with regards to energy efficiency response

Concerning the overall results for residential and household customers they should be considered as a first indication of the potential that could be harvested in the future. This potential as it was identified by ADVANCED is large enough to justify further research and pilots. The analysis has also shown that restrictions and barriers exist beyond the methodology developed for this work. These will work to make the potential smaller to a vast extent. Especially in the residential and household sector transaction costs (of any kind) should be kept as low as possible. Insofar an increased analysis of possible regulatory innovations that might help enable AD to become available faster is also necessary. In addition ADVANCED tried to mirror the “human factor” in its methodology but the uptake rates that were estimated are to be understood as an educated guess.

Designing a proper communication around an introduction of AD in the household sector will therefore be a prerequisite of success.

7.1.4. **Barriers with regards to AD in the residential sector**

Generally speaking the (national) AD potentials that were reported above are mainly limited by regulatory and technical requirements for realizing sophisticated AD in Europe. The balancing/settlement regime and the data privacy issues could be identified as being key barriers that hinder the realization of AD in Europe. Experience from the field tries conducted also shows a major lack in customers' awareness and knowledge on AD especially and the energy sector in general. Here communication campaigns can bring an added value.

Nowadays the electricity delivery to households is organized via load profiles in all countries surveyed. The implementation of AD-based business models in countries where the electricity mass market is organized via deliveries according to load profiles will lead to a significant deviance between the forecasted load profile and the actual load curve. To counteract this deviance new balancing settlement approaches are mandatory (e.g., possible short adjustments of the profiles; using registered profiles). For example the German energy law provides the introduction of a new balancing/settlement regime in Germany that will basically introduce metering by actual profiles. Additionally data privacy in SM and AD is also an issue in all ADVANCED countries, but apparently national lawmakers are already addressing the issue; this might create possible conflicts with the parallel process of European law making in the field of data privacy in general.

The other non-quantitative variables communication and other technical capabilities of SM, assets which can be automated or controlled and communication capabilities of SM or additional technology to customers do also influence the realization of AD in the countries surveyed, but here the realization of the variables are much more country-specific. For example in Italy the DSO is able and allowed to collect necessary technical data (voltage, cos phi, etc.) from SM in short time frames, in Germany the law already foresees such a possibility; whereas in France the DSO is able and allowed to collect technical data from smart meters daily. Inasmuch it seems that lawmakers have generally understood that the network operators will need more data – that might even originate from private persons and thus might involve data privacy questions – in order to run their networks in the future. As the Italian and German examples show, it can be useful to regulate such sensitive issues outright and in a way that is transparent for societies.

Regarding the assets which can be automated, only France and Germany do already have major AD activities in their countries (mainly heating systems and water heaters for France). These might be undertaken via the SM or by more traditional "steering technologies". In terms of future development the countries surveyed by ADVANCED see similar technical means used to perform AD like white goods, freezers and electric vehicles.

The communication technology points out the diversity for the technology and regulatory standards in the different ADVANCED countries. Today, France, Italy, Spain and Germany only test feedback systems in pilots. In detail, a big barrier seems to be the available data density for the feedback systems. Nowadays e.g. in Italy, only three values per month are available and can be visualized to the customer. In contrast to that other countries offer much higher data density up to 96 values per day. A higher data density requires high-performed communication systems and IT. These requirements should be pointed out clearly and addressed to the customers, meeting operators and other involved market actors. They also constitute a cost factor.

The results indicate that the ADVANCED countries start at different regulatory and technical levels. However similar fields of development like the settlement regime or data privacy can be identified. The national regulatory frameworks in the field must be developed further to match the country-specific surroundings. Such a country-specific approach also guarantees that the difference in regulatory systems and market rules (e.g. settlement/balancing every hour or 1/4h) can be taken into account. A final assessment of the regulatory and technical barriers for AD in the countries surveyed leads to the conclusion that some regulatory issues probably exist Europe-wide, but each member state must be considered as a single due to specific regulatory levels and requirements.

7.1.5. Results with regard to the C&I sector (Germany)

The results for the C&I sector indicate, that demand response is available and reality already today. There is a (theoretical) technical potential of 9 to 10 GW curtailable load in the German industry alone. This does not even include the additional demand response potential that is inherent in distributed generation within the demand side, such as emergency power generation units, CHPs etc. However, the assumptions and indications for different scenarios outline that the realization of the potential is inter alia dependent on the regulatory framework and on further use cases for demand side flexibility such as future demand response programs for DSOs etc.

The results for the C&I consumers sectors in Germany are most probably not transferable to the other countries. However the results give some indication on how large the AD potential of the C&I sector is in general and could probably be developed in the other countries (if not already). By taking this into account, the aggregation of the AD potential of the residential sector and the C&I sector indicates, that a high AD potential is available in all four countries. For a detailed interpretation of the AD potential, the values for demand response and for energy efficiency have to be considered separately.

7.2. Active Demand System Services

The impact of AD on system performance and stability with focus on MV and LV grids[9] was assessed. Relevant, value-adding services based on the quantified AD potential were identified and classified. AD value for providing system services and the main issues to be dealt with to develop the use of AD for DSOs and maximize its value were discussed. [16]

The main issues related to the use of AD by network operators are: the need to

[9] In some countries also HV grids might be operated by DSOs but the analysis focuses on MV and LV here.

integrate AD in a "merit order"[10] of other relevant solutions, to clarify the frontier between technical minimum requirements and market-based products, to take into account the geographical dimension of network operators' expectations, to optimize coordination between TSOs and DSOs and to insert the use of AD in different timeframes and business use cases.

A template for expressing flexibility requirements to AD operators is proposed, based on previous work done within the Smart Energy Demand Coalition (SEDC), adapted to DSOs expectations. The objective is to use these requirements for the development of concrete services for DSOs.

When looking for flexibilities or AD solutions to answer their needs, DSOs will have three main concerns: location of the proposed solution, reliability of the solution (expressed in terms of probability of reliability, including firmness and reactivity), and available capacity (power in MW as opposed to energy in MWh) or reactive power.

The expectations of network operators were then analyzed by major objectives: frequency control, optimization of distribution network planning and construction, optimization of system operation, management of emergency situations, network or system restoration and islanding. For each objective, the type of services which could be provided by AD was analyzed, associated flexibility requirements were described and the views of the ADVANCED DSOs on the proposed concepts were presented.

Potential services include peak load reduction, provision of power flow control and voltage regulation. How AD can support distribution grids in critical situations like grid congestion was investigated. Whether AD can be applied to resolve emergency situations in grids which typically require a quick real time response was also discussed.

The views of the DSOs might differ depending on each national context: main drivers for network investments (renewable energy sources development or peak load increase), regulatory context (for example, existence of aggregators or not, or level of smart meters roll-out).

[10] The usage of the term "merit order" does not imply a connection between the discussion within ADVANCED and the organization of the energy-only/kWh-orientated wholesale markets for electricity. The term is used here to describe a principle of economic order by which cheaper options are used first and more expensive ones only later.

DSOs generally express the fact that AD could help them differ or down-size investments in the future or help them control power flows and optimize operations but question the potential of AD for voltage control and stress the risks of intentional islanding (though micro-grids in degraded mode operation might be studied in pilots).

They are also very consistent on major issues. For example, all DSOs stress out the fact that the impact of AD on system losses can be positive or negative and that the reduction of system losses will only be a side-effect of using AD, and not a main objective.

Then an attempt to describe an ideal set of products needed to meet the DSOs' flexibility requirements was made. The relevant results regarding the definition of system services and product definitions identified in the ADDRESS project were incorporated. Key parameters in the design of successful AD programs were proposed and the necessary trade-off between key elements to match DSO needs with consumers' capabilities and constraints are stressed, taking into account best practices and examples reported by Entelios (and ENERNOC).

The results on the quantification of AD in different segments, countries and scenarios were then incorporated and a qualitative approach on the way these flexibilities might be available on different network types and how they can meet network operators' expectations was developed.

Feasibility and implementation costs of using AD for DSOs (including the integration of AD in new or evolving business use cases) were pointed out to complement the analysis of benefits.

Finally, cooperation between TSOs, DSOs and AD operators (mainly aggregators or suppliers) will be key to assess and prevent undesirable side effects of AD on distribution networks and for the evaluation of AD benefits for DSOs. When the application of AD is solely market driven and does not take into account the state of the grid, AD may affect grid stability and thus increase the need for distribution network investments. On the contrary, effective interactions between all players and cooperative approaches will help maximize the value of AD.

7.3. AD Impact assessment on electricity system

The economic benefits of AD for the key stakeholders at distribution network level under different boundary conditions materialized in a set of scenarios were quantified. Stakeholders considered include DSOs, consumers and intermediary AD providers. The defined scenarios cover a range of combinations of specific technological, regulatory, economic and societal local conditions that could affect the performance of AD and the impact on the system and all involved agents. Furthermore, some of the main regulatory barriers for the implementation of AD in the different contexts of the European scene are identified. As a conclusion, a series of recommendations are provided in this sense in order to facilitate the future development of AD in electric power systems. [17]

A scenario-based analysis of the following specific aspects was carried out:

- The characterization of the expected responsiveness of consumers to different types of AD programs in terms of load changes in the different countries and scenarios. This estimation is based on real consumption data collected from the ADVANCED pilots and the AD flexibilities quantified within the project.
- The quantification of the potential economic benefits coming from AD on the operation and investment costs of distribution networks in each scenario.
- The discussion around the allocation of these benefits among DSOs and other stakeholders, including AD providers acting as intermediaries between end consumers and the system, according to the regulatory arrangements present in each national context.
- The identification of the most relevant regulatory barriers for the practical implementation of AD in the European context and the provision of some recommendations to overcome them.

AD is expected to bring a broad range of potential economic benefits at different scales of electric power systems and for the variety of stakeholders involved. AD is also widely recognized as a key resource to cope with the current and future challenges of power systems, such as the need for additional flexibility that is required to accommodate the increased electrification of energy consumption and the growing penetration of renewable intermittent energy.

The added value of AD for the system, regardless of the parties involved, is a more efficient use of existing generation and network capacity, thus resulting in a reduction of network congestion and generation costs in the short-term. As a consequence, in the long-term, AD can reduce the need for additional generation adequacy and network reinforcements to integrate further renewable energy in the system and satisfy the load growth. Therefore, the value of AD lies in the possibility of reducing or postponing investments in network and generation capacity.

The expected potential benefits of AD can be observed at various scales. The research within ADVANCED was focused on the distribution system level and the agents related to the local impact of AD. As a consequence of many forms of AD, the simultaneity of local peak loads and congestions at critical times could be reduced, thus moderating the need for new investments in distribution networks. Provided that the expected avoided investments outweigh the costs of implementation, AD could replace investments in network reinforcements and provide a net social benefit. This process would be possible as long as DSOs are entitled the tools to reliably incorporate the foreseeable positive impacts of AD on customer load in the worst scenarios into network planning.

The potential economic benefits of AD at distribution level have been quantified for a series of country-specific case studies comprising a combination of national network realities and scenarios. These benefits have been measured as the avoided distribution network reinforcements that a more efficient use of existing and new grid capacity due to AD could defer or avoid.

The results of the economic analysis show that under certain circumstances, AD could effectively help distribution network operators to reduce investment costs without endangering reliability, then allowing for a more efficient network planning strategies. Various local and country-specific circumstances have been observed to greatly condition the desirability and the effectiveness of integrating certain forms of AD into network planning strategies for DSOs and regulators.

In particular, the variety of network configurations, the projection of future demand growth and new DG connections, the degree of congestion of the current networks, the distribution of responsive consumers, the power intensity per squared kilometre and the rate of participation in AD have been identified as pertinent factors of analysis in view of the simulations that have been carried out.

In view of the results obtained from the simulations that have been performed, AD has a great potential to defer network investments whenever they are driven by large load increases and small or hardly any new DG penetration. AD can also moderately alleviate the reinforcements needed to integrate high levels of new Solar PV.

Results have shown that AD could be expected to have a more positive impact on investments in highly constrained networks. According to this, the highest investment savings predictable would be observed in urban networks with high utilization rates, where reinforcements due to a small increase in demand or new connections are deemed more necessary.

Another relevant finding is that the location of consumers has been observed to be relevant only for scenarios with low AD participation rates. In such scenarios, it is generally more beneficial for investment requirements if these consumers are concentrated in a few locations instead of randomly spread throughout the network. However, when the required reinforcements in a scenario without AD are rather diffused in the network, a dispersed response is also more beneficial.

A key conclusion of this work is that the potential of AD to defer distribution network investments is very dependent on the local circumstances, especially in the case of rural networks. Hence to scale up or replicate the results to a region or country it is required additional research is required. This comparative analysis of the impact of AD on the investment needs of different types of distribution networks aiming to reflect some of the current concerns of DSOs about the possibilities of AD in four different countries in Europe is one of the main contributions of this work.

It has been discussed that part of these benefits could be transferred to final consumers and part could be kept by DSOs, according to the design of the remuneration mechanisms and the distribution network tariffs in the specific country reality. Retailers and other intermediaries could share part of these savings with customers. This means that even when the potential economic benefits of AD may be significant from the perspective of society as a whole, and therefore from the regulator standpoint, they may be dispersed across the value chain and among involved stakeholders. This may reduce the incentives for participation but not the need for the efficiency improvement that AD could bring to electricity systems and society.

The full potential of Active Demand is not yet achieved in most of the European scene. Its realization requires that certain mechanisms in the market are in place and that the regulatory conditions allow for its completion at wholesale, network and retail level.

From the revision of the main regulatory aspects that should be reviewed in order to unlock the potential of AD, the most critical concerns that have arisen are related to DSO regulation and network tariff design, but also to retail markets, standardization and consumer protection.

It is advisable that the distribution activity were revised in order to incentivize DSO to make long-term efficient investments and reward innovation more than focus on short-term optimization.

The different tariff components may sometimes conflict among them. Nonetheless, regulation should ensure that end users are charged cost-reflective network tariffs that incentivize the most efficient demand response for the system as a whole, without forgetting tariff and billing simplicity concerns. In line with this recommendation, it is advisable to avoid purely volumetric tariffs. This is particularly relevant due to the advent of prosumers and self-consumption. Otherwise, cost recovery and free-riding problems may arise.

Adjusting regulation to enable the implementation of AD has the difficulty of clearly defining the roles of new emerging actors in this context. For instance, it would be desirable that DSO were entitled the choice to count on certain forms of AD to alleviate congestions, which remain to be defined and regulated. In addition to this, a competitive market without entry barriers should be guaranteed for retailers, aggregators and other commercial agents to provide smart AD services.

Finally, consumer protection should be guaranteed beyond the security of the data to the rights of consumers to be informed and be provided the tools to understand the new smart tariffs and complex contracts to which they can be exposed. This key challenge must be dealt with if consumers are expected to be engaged in AD.

It is hence possible to improve the current regulatory practices for the application of Active Demand in the European context and consequently contribute to the achievement of the EU targets of energy efficiency improvement and consumer engagement and protection.

8. Privacy and data protection

The high-level risks related to privacy and data protection in AD programmes have been mapped in preparation of the generic privacy impact assessment (PIA).

Due to internal problems, this research is in a second review phase and will be uploaded in the participant portal by February 20th. The Consortium is not satisfied with the quality of this deliverable that's why an extra month to review it again was asked.

The studies carried out within the project on the issues of privacy and data protection were focused on residential customers and had the aim to:

- map main potential risks related to AD in the context of smart grids and in relation to privacy, data protection and other relevant fundamental rights and freedoms (e.g. autonomy) as recognised by the EU Charter of Fundamental Rights;
- define a series of high-level requirements (technical, organizational, legal, etc.) for AD systems which should ensure that privacy, data protection and other relevant fundamental rights and freedoms are taken into account when designing and running such systems;
- use both potential risks and corresponding mitigation strategies as an outline for a privacy impact assessment.

The analysis was based on a review of relevant EU (policy) documents, technology assessments; existing guidance and advice (e.g. the recommendations of Article 29 WP on smart metering and those of the Smart Grids Task Force/Expert Group 2 on data safety, data handling and data protection); and of other selected authoritative sources on topics including smart grids, smart meters, also outside the EU. Insofar as possible, the task also took into account the expected changes in the EU privacy and data protection framework, currently underway.

Additional emphasis was placed on using available empirical evidence regarding privacy issues and relevant to AD systems. This included lessons learnt from relevant international initiatives (such as the privacy by design in smart grids experiment from

Ontario, Canada, the failed introduction of compulsory smart energy meters in the Netherlands, etc.). Moreover, the research made use of the unique knowledge and experience available within the ADVANCED project that includes partners involved in deploying AD pilots. The results of some of the ADVANCED pilots as well as the results of the project surveys were used to fine-tune and finalize the AD PIA framework.

The result is a high-level overview of potential risks posed to individual privacy and data protection (including security) and other relevant fundamental rights and freedoms relevant for AD. Corresponding solution and/or mitigation strategies are also included in this report insofar as possible to define them at this stage. Data protection counsels of participating partners helped compile the PIA matrix suggesting solutions to address privacy and data protection issues and giving examples of the ways in which issues are approached in their respective countries (i.e. Italy, Spain, France, Germany, the Netherlands).

From the research emerged that by and large, knowledge of actual consumer concerns (real or perceived) regarding privacy an data protection is minimal and mixed, with few AD and smart meter pilots in Europe and in the US exploring potential privacy issues explicitly. It also revealed an apparent discrepancy between the nature and extent of privacy concerns raised by regulators and consumer groups on the one hand, and those raised by utility providers and generally by the private sector on the other hand. Privacy concerns have also been raised through media outlets and litigation. The most salient privacy concerns raised across the board regard data processing in all its aspects, and in particular the creation of user profiles and gaining intimate knowledge into user behaviour and in the privacy of his home.

A selection of main privacy and data protection issues relevant to AD services which would need to be analysed as part of a PIA includes:

- The amount and granularity of data collected – can exceed the immediate purpose for which they are collected (e.g. billing);
- The types of data collected – can exceed the immediate purpose for which they are collected (e.g. billing);
- The frequency of measurements – can be unjustifiably high;

- The near-real-time data processing – can be construed as monitoring and/or surveillance of customers;
- The possibility to infer (patterns of) customer behaviour (daily routine, number of inhabitants of a household, presence or absence of inhabitants in a household, etc.);
- The retention periods of data in relation to the purpose for which they were collected – can be exceeded, the required retention periods can differ per type of data;
- The security and confidentiality of data – insufficient or inadequate measures available or in place;
- The secondary uses of data/exchanges of data with third parties – without customer's consent or without adequate guarantees for data protection by third parties;
- Access to data - inadequate protection of data shared with third parties;
- Notification in case of security breaches – no (adequate) measures in place;
- Customer consent for the types of data collected and the uses of those data – not specific, not explicit, not clear;
- Interface for the user – absent, difficult to interpret, virtually invisible after a time (through lack of interaction, interest or motivation on the part of the customer);
- Customer scope of choice and control – no opt-out available, limited access to own data;
- Autonomy issues – remote control and decision over delivery or termination of services; issues of data portability;
- Legal issues – interpretation of the applicable law still pending;
- Other rights issues – is access to electricity a human right?

The list is by no means exhaustive. At the same time, it should be stressed that not all issues will apply to all AD systems. The relevance of individual issues will depend on the concrete configuration of specific systems and will have to be determined on a case-by-case basis. Also, the likelihood, and thus the risk, posed by such issues will vary from one system to another depending on its concrete properties.

9. Main results

The main results of the ADVANCED project both concern the different aspects behind the design and management of AD programs and the impacts of AD on the electrical system and its actors. Here below the most relevant of these results are reported.

9.1. Design and management of AD programs

How to assess and tune an AD program?

1) A “target matrix” was defined that is the structure of the ADVANCED knowledge base. It includes about 250 variables organized in such a manner that data from a wide range of pilots and consumer segments can be compared in a logical, comparable manner.

Beyond being a means for carrying out the analyses within the scope of the ADVANCED project, using the target matrix is very important in the design phase of future AD programs as it lists the data that need to be gathered, the units of measurement and the granularities required.

ADVANCED D1.1 – Report describing the conceptual model and the target matrix

2) A set of KPIs was defined to measure the benefits of AD for the key stakeholders and for the whole electrical system. A univocal way to carry out these calculations was described and in fact these indicators where used within various stages of the ADVANCED project. It is worth saying that the KPIs on flexibility and energy conservation have been calculated on a household level being this an important evolution with respect to the traditional calculations carried out within AD programs. An additional indicator: “Signal Compliance: difference in consumption pattern” has been defined. This KPI is calculated comparing the consumption trend of each consumer after the DR signal comes into force with its habitual one. It is a unique ADVANCED KPI and can only be calculated using data at a household level.

ADVANCED D1.2 - Report on the validated KPIs

ADVANCED D2.2 - Cross case analysis

3) A model of active consumer participation in AD was defined where the determinants behind the behavioral change required by the participation in AD programs have been included and their relations described.

ADVANCED D1.1 – Report describing the conceptual model and the target matrix

ADVANCED D2.2 - Cross case analysis

How to recruit and engage consumers in AD programs?

1) The motivations behind joining AD programs were explored. Residential consumers showed to be mainly moved by the ideas of becoming more aware of their energy use (and therefore learning how to reduce their energy consumption), of being part of innovative initiatives based on the use of new technologies and of supporting the local community through their participation. Word of mouth turned out to be of outmost importance. Also for C&I consumers saving money opportunities are major drivers for increasing their energy efficiency (that also leads to environmental benefits) and for participating in DR programs, if the security of their production process can be guaranteed. The reduced need for larger contract sizes and for grid expansion and the opportunity to optimize their business are also important drivers. Building trust is essential for involving all the consumers segments.

ADVANCED D3.2 – Report with conclusions from the qualitative surveys

2) Customers fears and “likes” were identified. The increased awareness of their energy consumption was the main “like” of consumers. Moreover residential consumers were

satisfied of realizing that saving energy is not so difficult. The main concerns of residential consumers are the installation of the devices composing the technical solution, the effect that using these devices could have on appliances and the impact that reducing energy consumption could have on lifestyles and comfort. Minor concerns are about the privacy of data. C&I customers are concerned about the contractual complexity behind the participation in Demand Response initiatives and the perceived risk of incurring penalties in case peaks exceed the limits as defined in the grid fee.

ADVANCED D3.2 – Report with conclusions from the qualitative surveys

3) The strategies to engage consumers with programs in the long term have been detected. The link between household usage levels and collective usage issues needs to be made so people understand that what they achieve in their own household can impact on wider energy goals. Motivating people requires education. The consumption data provided to consumers should be simple and easy to understand. The technology/devices used to deliver consumption data, and inform people about changes, as well as enable them to interact with appliances needs to be user friendly. In fact to assist/ensure behaviour changes happen people need to clearly understand what to change as well as and how to change their behaviour. A step by step approach where consumers are gradually provided with more advanced features and solutions and a continuous support starting from the installation phase and going on during all the program are of outmost importance for granting a long term engagement.

ADVANCED D3.2 – Report with conclusions from the qualitative surveys

4) The readiness of consumers to AD was scouted. This research produced many important outcomes that can help identify how to promote AD and the most promising targets for its implementation. One of the main findings was consumers are concerned about energy cost and most already pay at least occasional attention to energy use. The majority agree it is important for them to reduce their energy consumption, and many are already taking steps to do this.

ADVANCED D4.2 – Report describing AD perception in EU

5) A high-level overview of potential risks posed to individual privacy and data protection (including security) and other relevant fundamental rights and freedoms relevant for AD have been identified. Corresponding solution and/or mitigation strategies were defined.

ADVANCED D6.4 – Report on privacy and data protection impact assessment

Which are the actions and communication strategies to make AD happen?

1) An actionable roadmap for consumers participation in AD with outlined hurdles and recommended actions was designed. The starting point was the design of a model presenting a state-of-knowledge view of the way AD is developed beyond pilots, into the real world identifying numerous Drivers of Active Consumer Participation in AD (e.g. Knowledge through education and feedback, Trust and relationship through experience, etc..). Barriers to Active Consumer Participation in AD were developed and suggested actions proposed to counter those barriers. These barriers were then formulated into a set of practical roadmaps to guide practitioners and policy makers in their efforts to prioritise their activities.

ADVANCED D5.1 – The AD Conceptual Model

ADVANCED D5.2, D5.3 – Actionable framework for residential and C&I customers

2) Communication umbrellas were defined. In particular Strategic Principles were identified (e.g. communication needs to change to become personalised and relevant for the individual customer; need for more digital and targeted communication; need for change not only within the minds of the customers but also internally in the organizations of the utility industry, etc). The "AD Communication wheel" was defined as a new methodology for the communication about AD programmes. An extensive

segmentation analysis was conducted which enables a much more targeted communication approach, giving the segments: “Active”, “Moderate”, “Indifferent”, “Oppositional”. A Digital Engagement Engine which provides a methodology to ensure the roll out of AD programs in the future was established.

ADVANCED D5.4 , D5.5 – Communication umbrellas for residential and C&I customers

9.2. Impacts of AD on the electrical system and its actors

What is the AD potential on the electrical system?

About the impacts of AD on the electrical system and its actors, the main results concern the AD potential and the services and opportunities for the system.

1) The potential flexibilities that AD might offer with demand response and energy efficiency in France, Germany, Italy and Spain have been calculated for a baseline, optimistic and technical potential scenario. The results with regard to energy efficiency indicate that even in the baseline scenario a small potential exists. The results for the commercial & industrial sector are quite better. By taking this into account, the aggregation of the AD potential of the residential sector and the C&I sector indicates that a high AD potential is available in all four countries.

ADVANCED D6.1 – Scenario based report on AD potential

2) Services and opportunities for the system were defined. A special DSO perspective was taken in order to find a fit between DSO’s (expansion) needs and the possibilities of AD. The outcomes of this analysis are four major categories of (future) system services: frequency control, optimization of distribution network planning and construction, optimization of system operation, management of emergency situations, network or system restoration and islanding.

The benefits in terms of investments for the distribution network reinforcements that a more efficient use of existing and new grid capacity due to AD could defer or avoid have been evaluated. The analysis showed that these benefits are strongly dependent on network expansion drivers, network typology, current level of network constraint, and location of responsive consumers.

ADVANCED D6.2 – AD based system services

ADVANCED D6.3 – Economic benefits for stakeholders

10. Recommendations

10.1. Collection and standardisation of data

Use the ADVANCED target matrix since the set up phase of an AD program to identify which are the variables for its assessment, thus which data need to be collected, the unit of measurement and the granularity.

Use standard measurement instruments so that the comparison of different pilots is easier. This would greatly enhance the understanding of what facilitates Active Demand

Measurement of consumption data should include at least the hourly interval readings, though 15 minute readings would be significantly preferable as they allow for even more detailed and well defined findings. For pilots aiming for flexibility is very important to take into account the duration of the flexibility request.

Capture historical data to generate a baseline (reference load curves) per household before the pilot itself. A control group against which to compare consumption patterns should be established. If possible, this groups should have matched pairs control households to control societal changes over time.

Run pre and post pilot questionnaires to understand the starting point of consumers, their expectations upon joining the program and how the program changed their awareness, attitude etc

10.2. Assessment of behavioral changes

All AD pilots should measure a certain basic set of KPIs consistently across pilots, using a standardized measurement and calculation methodology: energy savings, consumption flexibility, monetary savings and customer satisfaction.

Use the new ADVANCED signal compliance KPI based on household hourly electricity consumption associated with psycho-social concepts to assess compliance with the program and to gain actual insights in the drivers behind active participation of households in AD.

10.3. Communication campaigns to promote and to implement AD

Communication about AD programmes of the future needs to be a part of the business development and take its starting point in actual business goals.

Work should be done to improve information about energy production and to improve the image of the energy companies. This should increase consumers' willingness to accept sharing control over their energy consumption.

Be careful not to send contradictory or inconsistent messages. The whole body of communication around AD should be as consistent as possible.

Provide consumers with proof and guarantees of the benefits of involvement in AD, otherwise the consumer is being expected to act in blind faith on the advice of an industry they do not necessarily trust very much. This proof must go hand in hand with greater transparency

Become expert at social media, crowdsourcing and other channels of sharing as well as understanding the psychological and sociological dynamics of them to make sure your marketing and communication strategies are appropriate. Marketing and sales need to be timely, targeted and extremely proactive.

Mass market solutions that can be sold across multiple countries and even continents can be cost efficient. Both AD technologies and supporting services need a mass customisation. vendors should create solutions that are broadly appropriate to many, most if not all relevant markets, and made appropriate to a given market primarily through software and the modularisation of add-ons. Just as mobile phones, apps, computers and computer games are largely the same in all markets, so too should AD solutions.

A mass market of customers needs to be touched by AD in order to realise its value and pass on the word to the whole market.

<u>When you try to reach residential consumers:</u>

Adopt segmentation so that you can reach the Right consumers, with the right message at the right time. Different consumers want and are driven by different motives, want different things and therefore need to offered differentiated offerings and especially need to be communicated to with different messages. Implicit is also the significance of timing. The success of active consumer participation in AD is highly dependent on offering the right service to the right customer at the right time. Refer to these segments: Active, Moderate, Indifferent, Oppositional, that were defined on the basis of the experience in the ADVANCED sites.

Do far more research into their consumer bases. It is not possible to build AD services around customers that you do not know or have any direct contact with, unless you simply build the service for specific segments of customers and have enough marketing for the right customers to come to you. Build or hire competences to secure data collection and data mining to provide the basis for rule based communication in accordance with targets and goals for the company.

It is utmost important, that each communication addresses only a very few elements, since trying to communicate everything at once will make the communication unclear and less understandable – and in the end the effort will most probably have no effect.

The link between household usage levels and collective useage issues needs to be made so people understand that what they achieve in their own household can impact on wider energy goals.

Do not focus on ‘Costs and benefits’ as it would only be effective in changing the behaviour of the very small proportion of reluctant consumers. Most people are already aware and convinced about the monetary benefits they could obtain by paying attention to their energy consumption. Focus on the degree of the benefit that comes from different types and degrees of action and efforts towards energy efficient behaviours. and ensure that the perceived cost (including financial cost, effort and risk) of AD is not greater than the perceived benefits.

Use ‘Social norms’ by enabling people to talk about it with friends and family and hear their opinion: Social norms provide more discrimination between groups, particularly the attitude of family or friends. However, actions focussed on social norms will need to be carefully targeted to be effective - as there is already a consensus amongst most respondents that paying attention to home energy consumption is the ‘right thing to do’ to protect the environment, so campaigns emphasising this aspect may have limited impacts.

Enable, promote and support more social discussion about AD, for people to talk about it more with friends, family and others and to hear their opinions.

Work on people’s ‘Beliefs’ and inform them around the seriousness of the environment and the need for change: Actions on beliefs may encourage a positive change in home energy monitoring and consumption.

Leverage on opportunity, need and desire. AD will become increasingly appealing as consumers have more to gain through the use of AD in coordination with the synergies afforded by e.g. roof-top solar, storage and electric vehicles. It will become more common when regulations and markets evolve, facilitating the growth of appealing AD offerings. The development of appealing offerings and effective and consistent communication is essential for this sense of need and desire.

Spreading the word. AD services will need to be developed in ways that encourage the desire to tell others. While energy is often not considered an interesting topic by observers in the energy market, consumers often discuss energy issues with their friends, family and neighbours (word of mouth). If they have something to discuss, they often discuss it. AD can become a more prominent topic of social discussion. Consumers need something to shout about.

Since Active Demand is not known among potential participating customers it is needed to feed in stories of what it is, how it works and that is it actually a benefit. This task is related to “Word of Mouth” as an actual participant rather should tell a success story than by the company offering the service.

Conforming and competing. Consumers are driven by the norms around them, the knowledge of how they compare to other consumers and their own track record. As AD becomes more common, it will also become a more prominent and powerful driver of behavioural energy efficiency. AD therefore, to some extent, drives itself.

<u>When you try to reach C&I consumers:</u>

Take into account C&I consumers are a very heterogeneous segment. Therefore use personalized and relevant communication on benefits and implications of participation. It is key to a DR program success.

Create clearer connections between businesses, messaging, and behavioural outcomes, as this can lead to a successful communication regarding DR.

The commitment of consumers towards AD often depends on the “energy awareness” of the business. For example, for an industrial customer, energy consumption is is critical to the operation of the business while for commercial customers, depending on size, there can be a low level of energy awareness.

As C&I customers have a core business (e.g. manufacturing goods, serving customers, etc.) they need to understand how signing up for DR services might affect their ability to continue to deliver their core business. It is important to explain that DR is designed to have no knock-on effects on the productivity of a commercial or industrial consumer’s core business.

Give good explanations of the technology that will be installed in communications: what is the technology, what are the security aspects, etc..

Provide customers with regular, consistent feedback and progress reports as it can create positive encouragement on ongoing participation.

10.4. How to manage your AD program

Educate consumers through well before and during the service as many of them simply do not know enough about their consumption, the impact on the environment or how much they can do themselves to help the environment through their own AD related actions (sense of responsibility and empowerment). Events are one good way of achieving this, though traditional communication such as leaflets and welcome packs are also important.

Provide consumers with a proper choice. In order to engage in AD a consumer needs to be able to select a service that suits their needs, preferences and capabilities and to be able to access a realistic and convenient service. Make sure offerings have sufficient appeal and usability.

Make sure the methods promoted are easy and hassle free. Use simple technical solutions and provide people with a good education prior to use of those technologies to make AD appealing to more consumers. Naturally consumers who like or are confident in the use of new technology - early adopter types - are more likely to get involved in technical oriented AD offerings, but solutions should not only be appealing to early adopters so simplicity and usability of technology needs to be enhanced.

Create feedback infrastructure to Provide customers with Consumption feedback (monitoring), it is an essential part of knowledge. Customers need to relate their behaviour to their consumption. Consumption feedback is an extremely effective channel in this respect. Consumers need to feel more in control of the development of AD. Customers will not accept AD unless they feel that what they are doing and the pace of its development is what they have chosen, actively or passively. Consumers often do not want to be pushed too fast into being controlled and automation without behavioural AD taking place first can lead lower consumer knowledge levels.

Build trust and relationship through experience. Positive experiences can lead to a significant improvement in the likelihood of participating in AD and the likelihood of consumers talking to others. If the image of the sector can be improved, satisfaction with individual service providers will improve, and so in turn will trust in the capability of the AD service, and ultimately so will consumers' willingness to accept supplier management (an important pre-cursor to ultimate AD automation). Trust is therefore a reflection of the relationship that the consumer has with the AD supplier and the energy sector. Data privacy is also a pre-requisite of this trust. Few energy companies have what could be called a relationship with their customers and customers often have issue with the way the industry behaves (e.g. price rises, high profits, salaries, sales practices etc.) or at least the way the consumer perceives they behave. Stronger, more trusting relationships are therefore needed to convince consumers that the negative connotations with the energy industry are not associated with AD service offerings.

Take consumers on an AD Journey, one step at a time to keep them engaged in and make them accept ever more increasing levels of AD. Consumers are cautious and like to move at their own speed, a step at a time. They are easily bored. They must, through their journey increase their trust in the AD supplier and in their energy consumption being increasingly controlled by that supplier. In the meantime, they will also need new reasons to remain active. This will be a big challenge for AD providers, especially if there is an absence of compelling business models. The customer journey is essentially the growing relationship between the consumer and AD, the AD supplier and the energy sector.

Give support when it is needed. It is often forgotten that AD requires support in many forms, in the form of pre-education (mentioned above), technical support, advice and suggestions. Consumers who do not receive sufficient support (e.g. in the form of a hotline) are likely to not become active, give up, or simply not benefit from the full potential of AD afforded to them and thereby be less successful and satisfied.

Evaluate case by case whether using an opt-in or opt-out approach. Opt-in is usually considered the best option. This is not always the case though. The fact is that the wrong option is often chosen and or wrongly applied, leading to missed engagement potentials or public relations issues. The key is to get them to opt out of or opt into something very simple and appealing at first and grow it from there

10.5. Privacy and data protection

Choose a proper type, amount, granularity and retention period of the data collected within the scope of the AD program. The customer consent for the types of data collected and the uses of those data has to be explicit also in case of secondary uses of data/exchanges of data with third parties.

Adopt proper measures that grant the security and confidentiality of data (also in case of data shared with third parties) and ensure that customers are provided with notifications in case of security breaches

Ensure that customers can have a full access to their own data

10.6. Regulation

It is possible to improve the current regulatory practices for the application of Active Demand in the European context and consequently contribute to the achievement of the EU targets of energy efficiency improvement and consumer engagement and protection.

DSOs

- DSO regulation could be revised in order to incentivize DSO to make long-term efficient investments and reward innovation more than focus on short-term optimization.
- DSO could be entitled the choice to count on certain forms of AD to alleviate congestions, which remain to be defined and delimited but a direct commercial relationship with customers may not be advisable in order to boost competition and new business models.
- Regulation should make the introduction of AD itself and its support technologies financially viable for DSOs

- Regulation should enable DSOs economically and technically to procure AD from customers connected to their grids in a non-discriminatory fashion
- A clear guidance on how to connect DRES and other intermittent generation and under which circumstances and at which costs these installations might be curtailed is needed
- Regulatory intervention/support is needed in order to instigate a process in which technical connections conditions and technical minimum requirements are overhauled in order to make them AD ready.

Market design

- A competitive market without entry barriers should be ensured for retailers, aggregators and other commercial agents to provide smart AD services. it should be the general aim to allow as much competition for DR-services as possible, in order to unlock as much potential as possible, and to allow consumers to choose among a broad range of DR service providers
- Regulation should improve market liquidity and ensure that market prices reveal the different resources available at the time of the gate closure. Ideally this should be done in 15 minute intervals in order to reflect the full benefits of low cost renewable generation.
- Network fees should be aligned with flexibility requirements, while today network fees tend to incentivize a flat consumption pattern.
- Regulation should ensure that end users receive cost-reflective tariffs to make the most efficient decisions as a whole (considering as well simplicity concerns).
- An absolute prerequisite for DR participation in the market is aggregation as the vast majority of consumers are far too small to offer their flexibility to the electricity market on their own. independent aggregation in the market should be granted through the definition of clear roles, responsibilities of the consumer’s DR service provider, the consumer’s retailer and the BRP, as well as regularisation of the arrangements needed between the parties

- DR should be allowed to be prequalified as pool and generation bias should be removed in product design.

Coordination among stakeholders

- Cooperation between TSOs, DSOs and AD operators (mainly aggregators or suppliers) should be regulated as it is key to assess and prevent undesirable side effects of AD on distribution networks
- The operative process and compensation among BRP/suppliers and aggregators after a DR-dispatch should be standardised and a neutral entity between them should have a role in the central administration of these processes
- The flow of information between players handling Smart Grid data should be regulated. The aim is to develop procedures (e.g. frequency of access and what information to make available) and format that allow the access to the information contained in these data bases to achieve an appropriate equilibrium between integrity of the information, privacy of the information, clarity and transparency of the information facilitated to the end consumers.

Smart metering

- Regulatory intervention is needed in order to make the roll-out of smart meters financially viable.
- Standardization in relation to Smart Metering functionalities and smart appliances is an open issue of discussion but under certain circumstances, it could be advisable not only at MS level but even at EU level.

Smart surrounding infrastructure

- The existing public telecommunication networks and the frequency allocation behind those should be developed in a manner that takes the AD / smart grid demand into account and even develops products that are tailored to those needs.

- Regulatory intervention needed in both the product and the finance side. On the product side, a speed up in the financing process might come from standardized financial packages, valuation metrics and contract templates. On the financial side, a stable regulatory framework, with clear rules, limited bureaucratic procedures and low market entry barriers are critical enablers.
- The existing building codes should be set up in a way that not only fosters energy efficiency (i.e. primary energy usage and primary energy factors per technology) but also includes AD as a source of efficiency.

Data privacy

- Consumer protection should be guaranteed beyond the security of the data to the rights of consumers to be informed and be provided the tools to understand the new smart tariffs and complex contracts to which they can be exposed.

11. Conclusions

Active Demand (AD) has the potential to contribute to solving some of electricity systems current and future challenges while offering significant benefits to consumers

ADVANCED is a research project co-funded by the EU's Seventh Framework Programme (FP7/2007-2013) that aims to shed light on ways to overcome the barriers hindering the mass deployment of AD in Europe.

Within ADVANCED AD was defined as "*providing electricity consumers with information on their consumption and the ability to respond to time-based prices (either manually or automatically) as well as with other types of incentives, thus motivating them to actively manage their consumption by altering usage in line with the network conditions, such that modifications in consumer demand become a viable option for addressing challenges of electricity systems*".

Accordingly, the research within its scope focused on energy efficiency (EE) and demand response (DR) programmes. EE programmes offer consumers more direct, detailed, comparable and comprehensive information about their household's energy consumption patterns in order to influence their behaviour towards a conserving effect. In DR programs consumers are requested to modify their consumption (either decreasing or increasing it) in response to price/volume signals in order to meet the need of the system.

The project objectives were the following:

- To assess and compare the case studies to understand how scaling up from pilots to real implementation
- To reveal the benefits of AD for the key stakeholders
- To analyse inherent impacts on the electricity system considering its potential contribution to system stability and efficiency
- to develop actionable frameworks (validated recommendations for an efficient design of AD programmes) enabling residential commercial and industrial consumers to participate in AD thus facilitating mass uptake of AD in Europe

The basis for the investigations within ADVANCED is a unique empirical knowledge base including:

- data generated within the ADVANCED sites, four different real life AD demonstration projects: two ADDRESS pilots (Spain and France), E-DeMa pilot (Germany) and Enel Info+ pilot (Italy),
- a database containing a meta-analyses of 138 AD pilots, involving more than 630,000 consumers
- the expertise of a leading provider of Demand Response solutions for commercial and industrial consumers in Europe;
- Results of a qualitative survey with approximately 20 residential or small commercial consumers per ADVANCED site and with some industrial consumers in Germany who are exploiting AD for their business;
- Results of a quantitative online survey among more than 8000 residential consumers in eight European countries.

The ADVANCED project has provided answers to the following issues that concern the design and management of AD programs and the impacts of AD on the electrical system and its actors:

How to assess and tune an AD program?

- The target matrix to know what and how should be measured
- Validated and operationalised KPIs both at pilot and household level
- Determinants behind behaviour change

How to recruit and engage consumers in AD programs?

- What motivations behind joining AD programs?
- What are customers fears, what their “likes”?
- How to engage with programs in the long term?
- What about readiness to AD and how to select the most promising targets?

Which are the actions and communication strategies to make AD happen?

- The actionable framework
- Communication umbrellas

What is the AD potential on the electrical system?

- AD potential in the 4 pilots' Countries
- Services and opportunities for the system

Furthermore recommendations to maximize the impact of AD have been provided. These recommendations cover the following topics:

- Collection and standardization of data
- Assessment of behavioural change
- Communication campaigns to promote and to implement AD
- How to manage an AD program
- Provacy and data protection
- Regulation

12. Revisions

12.1. Revision history

Version	Date	Author	Notes
0.1	30/11/2014	Silvia De Francisci	First release
0.2	10/12/2014	TM	Comments
0.3	13/12/2014	Silvia De Francisci	Document revision
0.4	16/12/2014	PC	Comments
0.6	22/12/2014	Silvia De Francisci	Document revision
1.0	30/12/2014	PC\QM	Final approval

Table 4 - Revision history

13.References

13.1.Project documents

List of reference document produced in the project or part of the grant agreement

[1] Description of Work

[2] Grant Agreement

[3] Consortium Agreement

[4] D1.1 – Report describing the conceptual model and the target matrix

[5] D1.2 - Report on the validated KPIs

[6] D2.1 - Consolidated ADVANCED knowledge base

[7] D2.2 - Cross case analysis

[8] D3.2 – Report with conclusions from the qualitative surveys

[9] D4.2 – Report describing AD perception in EU

[10] D5.1 – The AD Conceptual Model

[11] D5.2 - Actionable framework for residential customers

[12] D5.3 – Actionable framework for C&I customers

[13] D5.4 – Communication umbrellas for residential customers

[14] D5.5 – Communication umbrellas for C&I customers

[15] D6.1 – Scenario based report on AD potential

[16] D6.2 – AD based system services

[17] D6.3 – Economic benefits for stakeholders

[18] D6.4 – Report on privacy and data protection impact assessment

13.2.External documents

[19] J. Stromback, C. Dromacque, M. H. Yassin, 2011, “The potential of smart meter enabled programs to increase energy and systems efficiency: a mass pilot comparison”, 15-16.

[20] SEDC Smart Energy Demand Coalition (2014): Mapping Demand Response in Europe Today. Tracking Compliance with Article 15.8 of the Energy Efficiency Directive