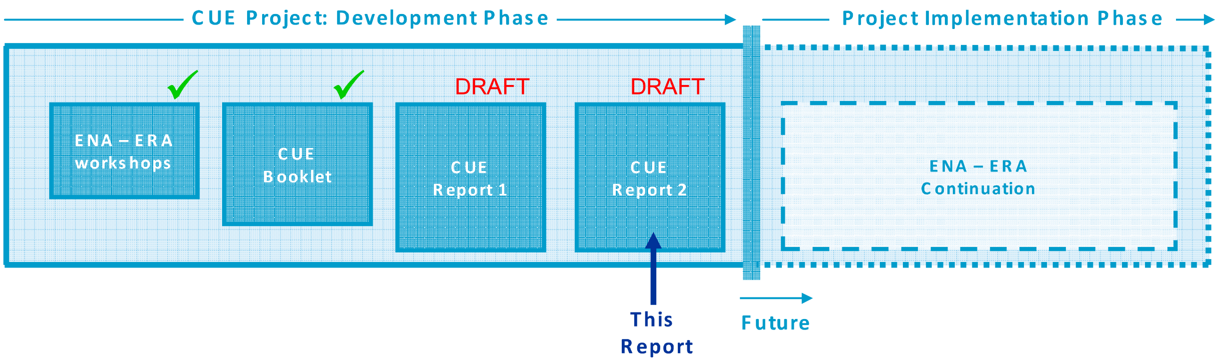
GB Demand Response

Report 2: Strategic Issues and Action Planning

Demand Response: a radical new approach to how and when we use electricity, with real benefits for Cost, Carbon, Convenience and Supply Security.

This is Report 2 that describes in more detail the opportunities, challenges and possible solutions for Demand Response implementation in Great Britain. It builds on Report 1 and makes recommendations for the next steps for implementation.



Commissioned by the Energy Network Association.

Final
Version 1.0
March 10, 2011

CONTENTS

1 INTRODUCTION – DEMAND RESPONSE (DR)

The latest DECC Business Plan confirmed the commitment of the UK Coalition Government to increase the amount of renewable energy in the UK to 15% by 2020. This means that almost 35% of all UK electricity will need to be generated by renewable sources by 2020. The realisation of such a target would put the UK electricity sector to a path of almost entire decarbonisation by 2030, which is consistent with the targets proposed by the Committee on Climate Change, and is on route to achieve an 80% greenhouse gas emissions reduction by 2050, by electrification of space heating and transport. Such targets impose a huge challenge on today's UK electricity sector, and this is potentially aggravated by the renewable generation being of an intermittent nature and by electricity demand profiles that are likely to increase significantly and become of a more peaky nature.

This report builds on the 'Cool Use of Energy: Report 1', that identified demand response as an important tool for supporting the above policies, for opening up new opportunities for better utilisation of renewable and/or distributed energy sources, and for achieving more efficient use of available power network capacity. However, demand response implementation requires a paradigm shift in the way that electricity networks are managed and controlled, (from ***generate what is consumed*** towards ***consume what is generated***) since the traditional approach to network design and operation can no longer meet in a cost-effective way, the dynamic, decentralised, requirements of a decarbonised electricity system of the future.

The implementation of demand response can benefit from the imminent introduction of smart meters in the UK; and indeed several benefits relevant to demand response (as facilitated by smart metering) have already been taken into account in support of the business case for a smart meter roll out in this country.

Therefore, an action plan for demand response is required so that benefits (such as time-of-use tariffs or feedback on energy consumption) can be unlocked as smart meters are rolled out and become established. The smart metering programme provides an opportunity that could help initiate the transition to changing the approach to network design and operation and pave the way for further demand response applications in the future, as part of wider smart grid opportunities.

Although much work has already been undertaken to highlight the qualitative and quantitative benefits of different demand response measures, the actual implementation phase is yet to begin. This report aims at providing a first series of responses to issues such as 'what needs to be done, by when and who by' and 'what challenges need to be overcome', together with an considerations for an implementation plan.

This report is structured as follows:

- Section 2 provides further discussion about the drivers of demand response, why it is needed and what are the perceived benefits for the different stakeholders;
- Section 3 presents some challenges for implementation of demand response measures, with focus more on the commercial, operational and regulatory issues that are likely to arise as demand response technologies will be implemented;
- Section 4 provides some suggestions for resolving the issues presented in the previous section; and
- Section 5 presents a high level approach for implementation, a task-wise view, a risk assessment and an indicative timetable for actions.

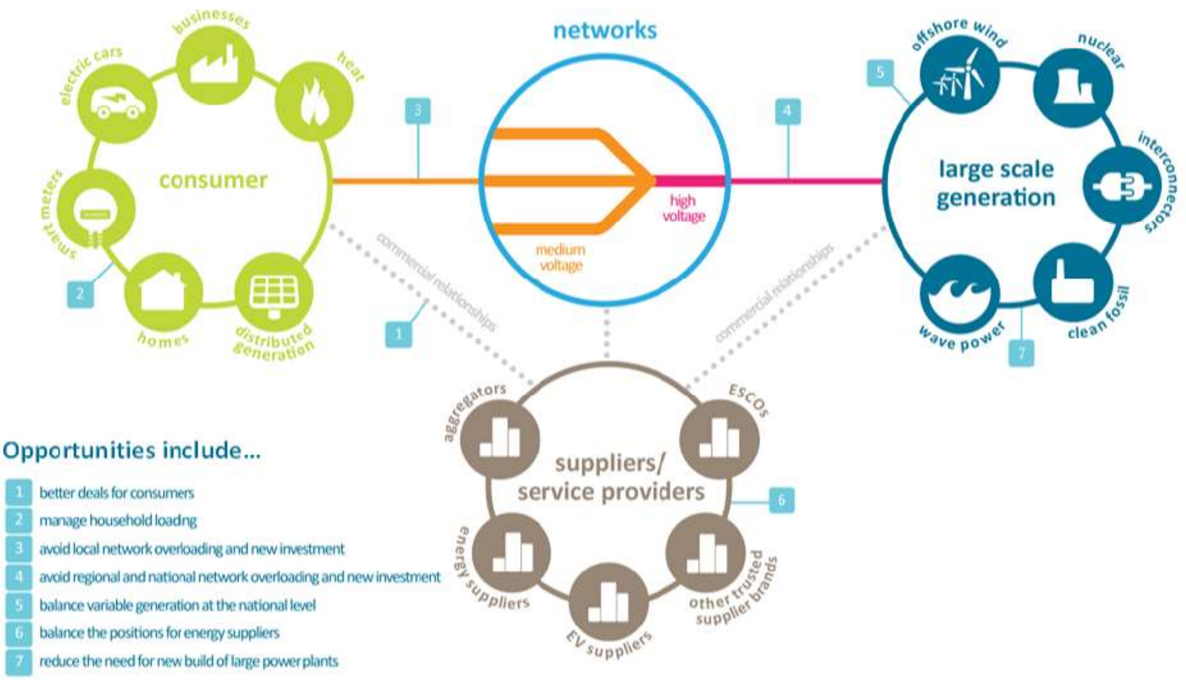
This report is very much a summary of current thinking and is intended to sharpen the agenda and promote resolution of outstanding matters. It is not a self-contained implementation plan. Each section of this report will provide the basis for further refinement, since the issues covered here are complex and will require detailed analysis and planning before demand response applications are ready for implementation. Therefore, the role of this report is to identify the key challenges and inspire action on several fronts through stakeholder engagement and continued cooperation between ENA, ERA, DECC, and OFGEM. A list of immediate next steps is presented in Section 6.3

2 DRIVERS FOR CHANGE

The implementation of demand response is driven by a range of foreseeable benefits that are expected to arise from the paradigm shift away from the traditional one way flow power system that "***generates what is consumed***", towards the future smart grid with the paradigm "***consume what is generated***" meaning that demand and supply are flexible to adapt to system requirements in close to real time.

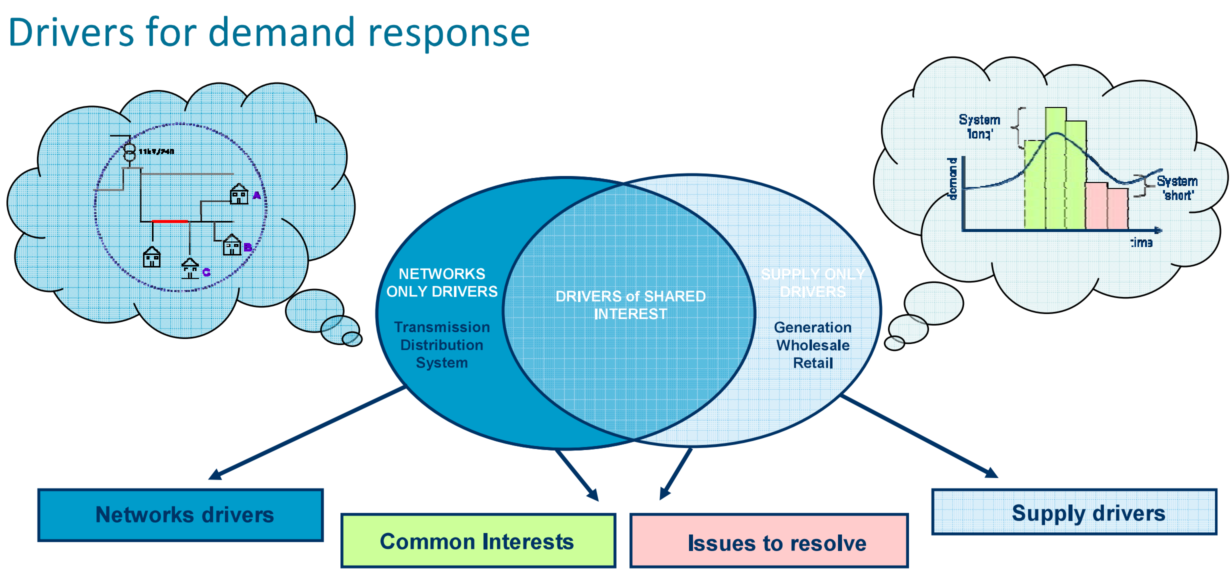
The CUE booklet and CUE Report 1 have introduced the 7 opportunities for Demand Response as a result of his paradigm shift. These opportunities are summarised below.

Figure 1 The seven opportunities for Demand Response



These beneficial changes can be grouped in the four main areas of the power sector: consumers, electricity networks, suppliers/service providers and generation. It is expected that network companies and suppliers are likely lead the transition, as areas of change can be found in the core of their business. Wider benefits can also be identified in regard to export opportunities for the technologies, techniques and know-how represented here. Worldwide interest is strong and Britain would be in pole position if it was able to demonstrate successful commercial deployment of demand response (in contrast to pilots and demonstrations). This applies to all seven applications noted above and the span of designs from commercial systems to networks to communications and beyond. This section will present the individual and the mutual drivers for networks and suppliers, as shown in Figure 2 below. The following chapter will address the common issues / challenges for demand response implementation.

Figure 2 Demand response drivers for distributors and suppliers



2.1 Opportunities for Networks

CUE Report 1 described the 7 opportunities for demand response across the power system. The section below aggregates and describes the opportunities created by the leading agent, in either networks or supply. Each one is discussed in turn below.

2.1.1 Transmission

In transmission networks, demand response applications have the capability of reducing expenditure for transmission capacity reinforcement, through better network utilisation and improved constraint management. Demand response opens up new opportunities for additional operating reserve for system balancing ancillary services, including potential storage applications.

In addition, demand response improves network capability to adapt quickly to unforeseen wind output variations and other system balancing requirements e.g. frequency modulation, voltage control. A direct implication of the above attributes is reduction of losses, energy conservation and fewer emissions.

An additional service for transmission and system operators could be the provision of demand response services to interconnected neighbours, provided that the interconnections are of sufficient capacity.

2.1.2 Distribution

Similar benefits are seen to drive the implementation of demand response applications in the distribution networks (e.g. capacity and voltage constraint management). A primary driver is deferral of investment and this also has associated benefits for avoided disruption from road works and planned customer shutdowns.

A topic for further consideration is the risk reduction due to stranded assets and reduction of uncertainty when investments are delayed. Demand response contributes to improved network reliability and higher utilisation, allowing also for better monitoring and management of power and supply quality.

In addition, demand response could improve management of distribution network constraints and hence facilitate the integration of embedded, distributed and micro generators, as well as the management of new loads such as heat pumps or electric vehicles. Advanced control of demand is a pre-requisite for transition to an era where a greater proportion of power is produced, stored (e.g. embedded through EVs) and consumed locally or regionally, and the system is flexible enough for available energy to be distributed wherever and whenever required. This means, from this perspective, less power network traffic and lower losses, which translate to lower network related emissions. In the counter direction these savings may be off-set by the greater utilisation of networks created by demand shaping (e.g. for EV charging) that shaves the peaks and fills the troughs of demand.

2.1.3 System Services

Demand response applications can bring about benefits relevant to system services. Other than facilitating demand/supply balancing (in both a national and regional level), there are several other ancillary services opportunities such as black start capability with high levels of distributed generation, better reserve response and management of reactive power/losses. Demand response can contribute a zero carbon source of the ancillary services that are critical to operating a secure and resilient national power system.

2.2 Opportunities for Suppliers

On the supply side, opportunities for demand response arise from three areas: power generation, wholesale power trading and retail. These opportunities are outlined below.

2.2.1 Generation

Combined with network flexibility, demand response applications are seen to facilitate more efficient use of inflexible generation, which contributes to the optimal economic use of available generation capacity. This comes with the associated benefit of reduced emissions, with savings coming from both better utilisation of thermal capacity (including nuclear) and better or full use of variable renewables such as wind power.

2.2.2 Wholesale/suppliers

Under current market arrangements, increased penetration of variable renewables can result in periods where prices are negative (excess supply periods when energy is spilled). By mitigating wind intermittency, demand response could assist in price formation and reduce price volatility. This comes with the additional benefit of reducing risk, in both trading and balancing positions. In addition, demand response could enable the creation of a range of new products from suppliers, linked to new brokering deals from the wholesale market. These could interact with other products and services offered for gas and heat. Product differentiation would enhance competition, and suppliers could increase their competitive capability to grow and maintain both profitability and market share.

2.2.3 Consumers / Retail

On the retail side, demand response could enable new product development, which would evolve around supply push (supplier products) and demand pull (customer lifestyle-adapted offerings) products. Although it requires customer engagement, such product development could assist suppliers to retain or grow their customer base. Also, it could allow for greater engagement of new and of small suppliers.

Because of additional flexibility in generation and network use from demand response applications, it is expected that (compared with a Business as Usual, BAU, approach) overall use of network charges would be expected to be reduced, resulting in lower cost energy (lower bills) services with fewer emissions.

However, demand response applications require customer engagement. Customers are likely to be attracted to automation, so as to save time and hassle, but might also require financial incentives to achieve pace and volume of engagement. As will be discussed later, customer engagement is seen to be a topic area that warrants priority attention.

2.3 Common Interests

From the above discussion, it is evident that there are several areas of common interest to both supply and network businesses as follows:

- **System improvements**: Demand response applications have potential to contribute to minimising network constraints, carbon emissions and losses, improve quality of supply, reduce generation/transmission/distribution investment requirements, reduce system operating costs, increase generation capacity utilisation, integrate storage and non-centralised generation, and mitigate uncertainty from intermittent generation.
- **Policy Objectives**: Demand response applications have the capability to reduce emissions (hence serving climate policy objectives), increase security of supply (hence serving energy policy objectives), and minimise delays or queues for

connection of new loads such as heat pumps (HPs) and electric vehicles (EVs). Furthermore, demand response opens up opportunities for electrification of both heat and transport sectors at a national level. Development of expertise in the UK that can be subsequently exported abroad, both as know-how and as proven products, systems and toolsets. There is a strong common interest here to manage political dimensions, media coverage and public opinion.

- **Consumer engagement:** Demand response applications have the potential to minimise cost impacts and maximise added-value to customers. There is common interest to increase customer awareness around the benefits of demand response and starting to earn the trust of consumers for new products and services. Customers require simplicity and transparency, with stable rules and workable arrangements, and would be expected to respond to financial incentives.

The next chapter will address the common issues and challenges for demand response implementation.

3 CHALLENGES OF IMPLEMENTATION

This chapter addresses the challenges of demand response implementation. It will first introduce the technical issues and secondly the non-technical issues. The issues are presented as key questions and issues to be resolved, with indicative solutions being discussed in the next chapter.

3.1 Technical Issues

3.1.1 Specifications, interoperability & standards

- What specifications and standards will apply to demand response services so that an Open Systems approach is established, promoting maximum customer choice?
- How will compliance with standards be enforced?
- How will alignment with (future) international standards be ensured?
- How can future proofing of the chosen technologies be best encouraged?
- What mechanisms will be needed to enable innovation, development and refinement?

3.1.2 Communication and instructions

- What will be the communication specifications and standards?
- Which technology or technologies to choose?
- How can acknowledgement be obtained that a demand response instruction has been executed? (required both for audit trial for settlement and to understand consumer behaviour / adequacy of the operational service provided)
- What is the required frequency and speed of communications?
- Will instructions be carried out immediately or can instruction be stored for implementation later in the day?
- Will the current smart grid prospectus specifications be sufficient to unlock the full potential of demand response (see table below)?

Table 1: Demand response instructions and need for speed of communication

	Benefit	Direct Beneficiary	Recommended Frequency	Recommended Responsiveness (Latency)
1.	Better deals/lower bills	Consumer	In any one or more trading half hours	Moderate Latency. Linked to trading half hours
2.	Domestic load management	Consumer/ Distribution owners	In any one or more [60] minute periods	Moderate Latency
3.	Avoid local network investment	Distribution owners	In any one or more [60] minute periods	Low Latency Close to real time (< 10 minutes)
4.	Avoid regional and national network investment	Transmission/ Distribution owners	In any one or more [60] minute periods	Low Latency Close to real time (< 10 minutes)
5.	Balance variable generation	System Operator	In any one or more trading half hours	Moderate Latency. Linked to trading half hours
6.	Balance trading positions	Suppliers	In any one or more trading half hours	Moderate Latency. Linked to trading half hours
7.	Avoid building new power plants	National	Not Applicable	Not Applicable

The above table is indicative and is presented for further discussion. It raises questions about whether DR instructions have to be sent at the time their action is required, or whether DR instructions could be sent in advance and be time-tagged for later execution locally. Also, definition is required for the communication characteristics of DR available capacity information and DR confirmation information. These are probably less demanding as regards latency.

3.1.3 Network connectivity

- At which voltage levels will knowledge of network connectivity be needed to make demand response services a practical reality? To fully unlock certain demand response opportunities, real time network connectivity will be required as can be seen in the table below. Connectivity refers to network running arrangements (eg position of open points) and the points of connection of each consumer (eg house locations and phase of supply). This connectivity information is not required by the DCC for smart metering purposes.

Table 2: Opportunities from demand response by beneficiary and need for network connectivity information

	Benefit	Direct Beneficiary	Network connectivity knowledge
1.	Better deals/lower bills	Consumer	Network connectivity not needed
2.	Domestic load management	Consumer/ Distribution owner	Household and LV network knowledge needed
3.	Alleviate local network constraints to avoid new primary investment and implement a 'connect & manage' approach	Distribution owner	Knowledge of household location, phase connectivity and LV and HV network running arrangements needed
4.	Avoid regional and national network investment	Transmission/ Distribution owners	Knowledge of higher voltage network connectivity needed
5.	Balance variable generation	System Operator	Network connectivity knowledge not required
6.	Balance trading positions	Suppliers	Network connectivity knowledge not required
7.	Avoid building new power plants	National	Not applicable

- We note here that the emerging impact of electric vehicle charging requires further attention, especially where charging is not through a household supply. For example, street charging, car parks and temporary car parks.

3.2 Non-Technical Issues

Other than technical issues, there are non-technical issues that need to be resolved, relevant to the planning and operation of demand response applications. These are presented as questions below:

3.2.1 Planning

- Who oversees the design of demand response programme(s) to ensure that conflicting calls can be resolved and operational co-ordination will be achieved?
- Are standards needed for implementation/deployment as well as for equipment functionality and interfacing?
- How will different policy drivers be reconciled – e.g. carbon saving or cost saving?
- What is the target timescale for comprehensive national DR capabilities (e.g. 2018, 2025, or 2030)?
- Who are the stakeholders, current and emerging, and how will their requirements be best co-ordinated?
- How will private networks and iDNOs be accommodated?

3.2.2 Programme Implementation

- What market solutions are needed to facilitate implementation and how will their development be co-ordinated with wider demand response implementation?
- The transition period of implementation of demand response programmes is likely to witness running of parallel systems (existing and new). How can new systems be future-proofed to outlive the period of transition?
- Should demand response implementation ‘follow’ smart meter roll-out or are there advantages in alternative methodologies?

- Is geographic implementation of demand response required by some beneficiaries (e.g. for LV network constraint management) and, if so, will that be matched by smart meters geographic roll out?

3.2.3 DR Operations

- Who will control demand response enactment? Is a single party required who will be accountable for co-ordination, or could a self-managing disaggregated design be utilised?
- How will demand response operational implementation conflicts be resolved, recognising that the different industry supply chain parties may have conflicting requirements. How should 'GB optimisation' be achieved. Is there a hierarchy of actions for demand response, might priority be assigned dynamically, or are more sophisticated solutions warranted (e.g. optimisation modelling of trade-offs between risk/carbon/cost)?
- For operational purposes, how will available DR capability be determined and how will DR delivery be verified?
- How is access provided for interested parties to capability and to performance data, in what form and at what cost? How can data be stored securely and offer data privacy protection?

3.2.4 Customer relations

- Who owns the relationship with customer – can there be more than one?
    - For domestic customers
    - For SME customers
    - For large Industrial & Commercial customers
- Would there be benefit in establishing a joint industry programme for raising general awareness and building positive foundations for engagement with consumers and the wider public? Competing parties could then offer their services individually to, hopefully, an aware and receptive audience.
- Does the sector have access to the necessary skills for influencing the public in this way; are new partnerships needed with imaginative marketing. How might distrust in the utilities be overcome?

- How might early wins be achieved, especially for vulnerable customer groups?
- In a context of rising underlying energy prices how can demand response (and smart meters) avoid the risk of being blamed for these increases (as has been experienced in other countries)?
- Whatever scheme of operation is put in place, it will need to be transparent to avoid customer confusion and resistance, and fulfil customer expectations. Also it will need to mitigate the impact on customer bills and help bring forward solutions to assist the fuel poor.
- Who owns and has responsibility for the capability and performance data for demand response?
- How to guarantee social inclusion? Some consumers are not comfortable with technology and might not be able to engage with the innovations that will yield the highest reductions in bills.
- There will be price postcode lottery effects arising from geographic and regional differences in the availability of demand response services, the benefits they offer, and the network costs where BaU solutions have to be adopted. This may be problematic for the general public to appreciate and may lack a sense of fairness.

3.2.5 Regulation

- How will regulatory aspects be identified and enacted for demand response?
- For the regulated companies, how will investment be funded and what would be the treatment of any stranded assets?
- How will costs and savings be spread among stakeholders and how will incentives work in a new value chain; how will consumers be rewarded for providing demand services to networks?
- Will regulatory performance measures be required (do these need to be designed-in to provide performance tracking, for example)?
- Should demand response be included in the new Smart Energy Code?
- How will demand response be governed in to the future?
- How will network companies make decisions for investment deferral given that demand response has a statistical performance characteristic; how will the necessary policies and tools be developed to do this in a consistent manner that respects the interests of customers? This is a potentially complicated issue, since overall capex allowances for new investments in networks need to be approved by OFGEM in advance at the time of Price Control resets, yet investing in demand response

services form a type of ‘capex substitute’, but are not a capital investment in primary plant.

3.2.6 Other issues

- Any consequences for security of supply need to be understood and well managed. Might conflicts arise between suppliers and local network demand response requirements. How might disputes be resolved; is there an arbitration role needed here?
- There is also the issue of managing political expectations and change, as there might be points of debate between Ofgem and DECC. Whatever solution is adopted, it needs to comply with EU standards and requirements, or indeed should action be taken to seek to influence such standards to ensure alignment with our national implementation approach.
- Finally, a lack of people with adequate skills might be expected, especially in the distribution businesses. Although there is a pool of people with significant knowledge of the current status of the system, there is a much smaller group with experience of innovation. Also, it is envisaged a significant roll-out of demand response technologies will require people with new skills sets, such as marketing, behavioural psychology, public campaigning and promotions that can support such an undertaking. Sufficient supply of people with such skills is quite uncertain and will have to be addressed too, among other challenges. New partnerships will be needed but given the critical nature of these areas it might be unwise to simply sub-contract them out. Companies might well advise to add some elements to their core capabilities, if only to ensure they are informed buyers.

3.3 Potential Synergies

3.3.1 UK Smart Metering Programme

The UK Smart Metering Programme is currently pushing ahead and already contains draft plans for opportunities relevant to Demand Side schemes such as time-of-use (TOU) tariffs.

However there is no framework currently in place for implementation. Although the supply industry advocates that TOU can provide a field for innovation, through product/service offering development and competition, a plan needs to be in place so as to achieve the highest benefits at the earliest possible timescale. This might create the additional challenge for suppliers having to run several tariff offerings for customers that have smart meters, along with standard offerings for customers that do not have smart meters. Taking into account that current tariff schemes are already quite complicated for consumers, and that the duration of the smart metering programme will likely last for at least seven years, it's quite clear that the opportunity created by the SM programme will be challenging to materialise. Probably, the simplest solution would be to introduce new tariff schemes once the smart meter roll-out is complete. However, this would prevent any material benefit appearing from TOU for at least another ten years in the future.

The smart meter roll out programme can also present opportunities for other applications, such as home automation or domestic appliance load management. Although it is still quite early to think of these applications, metering and communications technologies that will be installed should be designed such that they permit similar technology applications in the future (e.g. Zigbee in HAN). Although such a proposition might seem to add another level of complexity to the smart metering programme, it is essential for the full potential of the smart metering to be unleashed.

Even so, the opportunity is there and will be up to the industry stakeholders to make the best use of it. Decisions that need to be taken include:

- What level of demand response functionality is realistic for the current smart metering programme
- What is the level of functionality required and what standards need to be created, agreed and implemented
- If demand response schemes were to be introduced prior to the programme completion, which consumers should be addressed first
- What will be the role of the distributors and how can they contribute into potential solutions for demand response schemes
- What market models need to be created for demand response schemes to be accepted by consumers in the most cost efficient manner and with the highest impact

3.3.2 Low Carbon Network Fund Programme

As part of the last electricity distribution price control, Ofgem established the £500m Low Carbon Networks (LCN) Fund. The aim of this fund is to provide Distribution Network Operators (DNOs) with the opportunity to obtain funding to trial innovative solutions to the challenges that they face. Such trials are required to enable DNOs to understand how they can meet the changing requirements of customers and generators as Britain moves towards a low carbon economy. The learning gained from these trials will be disseminated to all DNOs and will be widely available to other interested parties to help them make the changes required in a speedy and cost effective way.

On 29th of November, Ofgem announced the results for the first year of the LCNF. Four out of eleven project proposals were selected, requiring a total funding for the selected projects of £61m against the annual funding limit of £64m per annum.

The selected projects address a broad range of issues that are relevant to the challenges that the network operators will need to address in the move to a low carbon economy. These include:

- trials to assess the impact on the networks of electric vehicles and wind and solar generation;
- how best to provide timely and efficient connection to renewable generation;
- the role that demand response can play in future network operation and
- the extent to which time of use tariffs are successful in changing consumption patterns.

As can be seen from this list, demand response, both from a network and a supply angle, feature strongly in the awarded projects. As part of the LCNF criteria, all selected projects will need to provide significant potential to provide learning that will be beneficial across all networks and the projects include robust plans for disseminating this learning.

3.4 The ADDRESS European project

One of the pioneering European-funded projects on demand response is the *ADDRESS* project, *Active Distribution network with full integration of Demand and distributed energy REsourceS*. This project is on-going and the early experience is reported in Appendix D.

Some of the headline messages are as follows:

- There are few smart appliances commercially available; manufacturers will not invest while there are no standards; creating ‘specials’ is costly and time-consuming
- Interoperability standards are critical to bringing together different components and appliances; these do not yet exist
- Customer engagement has been more problematic than expected; this has required considerable time with individuals and groups
- Customer communication is particularly challenging and is unlikely to be the natural strength of traditional utility staff
- There are unresolved complexities around which party is responsible for ‘unbalances’ between forecast demand, forecast demand response and actual delivery of response.

4 RESPONDING TO THE CHALLENGES

Following the identification of the key technical and non-technical questions and issues, this chapter will discuss some of the solutions available to respond to these challenges. Reference will also be made to the Implementation approach presented in Chapter 5. It is helpful to group the tasks in the following areas of activity:

- Task Area 1: Start-up activities
- Task Area 2: Business case
- Task Area 3: Exploration
- Task Area 4: Solutions
- Task Area 5: Implementation

More details of these tasks will be given in the next chapter. The remainder of this chapter follows the same structure as the inventory of the challenges earlier.

4.1 Technical

4.1.1 Specifications, interoperability & standards

Several technical issues need to be resolved in terms of achieving interoperability between applications and technologies, so that the solutions adopted can work efficiently with each other. This is a crucial issue that has already attracted attention in the current smart metering programme.

Therefore distributors and suppliers and other key stakeholders need to agree on a number of technical standards and functional specifications for the systems to be used. This is a daunting task as whatever standards are adopted they need ideally to be compliant with applications abroad, so as to facilitate a wider supply base and future UK exports; also solutions need to be ‘future proofed’ so as to save costs arising later from upgrading and stranding. In this context, international developments in this area, along with EU initiatives on setting open and common standards for meters, telecoms devices, white goods and other appliances, can prove valuable in terms of experience gained, lessons learned and future potential.

In addition, every effort should be made to enhance as far as possible the ‘customer experience’ (meaning smooth operation of demand response applications with the least hassle to consumers, so as to win their engagement and ongoing support).

These issues will be addressed in ***Start-up activities Task*** of the Implementation Plan when setting up stakeholder engagement (for standards, interoperability and customer experience via engagement e.g. with manufacturers) and in the ***Exploration Task*** of the Implementation Plan to investigate, track and capture international progress and customer behaviour research.

4.1.2 Communication and instructions

Demand response can be achieved via different means and technologies, each with its own pros and cons and different levels of cost and complexity. The fishbone diagram displayed in Appendix B shows four broad options, varying from passive systems to full automated systems; and from systems that require little to full communication.

On a high-level the four options are:

- demand response via **information to the end-user with manual response**
- demand response via **instruction to the end-user with manual response**
- demand response via **instruction to the end-user with automated response**
- demand response via **monitoring of system conditions with automated response**

Appendix B provides more option details as derived by an ENA/ERA workshop session. It is generally believed that the last two options are the most viable, with especially the third option delivering most prospects for (new) commercial services.

The ***Solutions Task*** of the Implementation Plan will address the remaining functional requirements a technical requirements and will link these to the Technical and Commercial Frameworks.

A key issue to be discussed is the communication and aggregation infrastructure and hierarchy. KEMA envisages a role for a ***Demand Response Operator*** (DR Operator) in the power sector (see Figure 3 below). This party would receive all calls for demand response from the beneficiary parties in the power sector, such as suppliers, network companies, and the system operator. Each call would specify how much response is required (kW, MW), when it is required, for what duration, and whether there is any geographic requirement (ranging from none, to regional, to precise street level resolution). The DR Operator would also receive information regarding available demand response capabilities, network connectivity knowledge, and information to assist the forecasting of available capacity. The DR Operator would make decisions on the DR instructions to issue based on calls vs. availability, pre-established prioritisation rules, and be informed by geographical and network connectivity knowledge. The DR Operator would be the party who issues the demand response instructions. As will be explained further, some decisions will require knowledge of network connectivity and this is a key aspect of determining an effective implementation structure and role definitions.

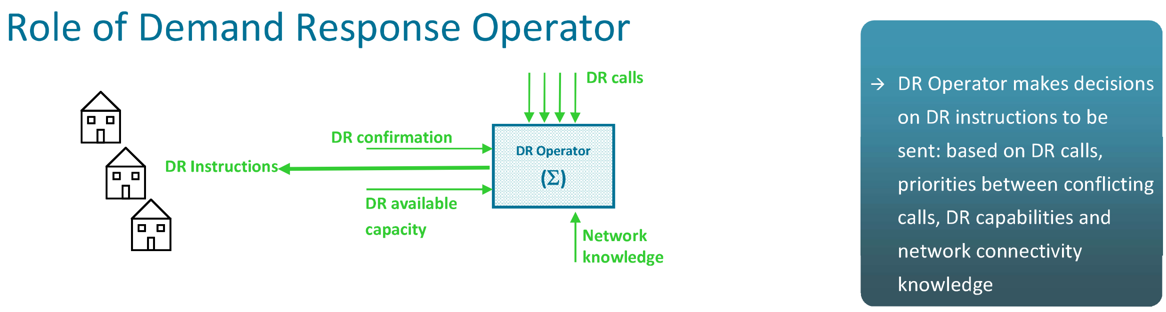


Figure 3 Role of Demand Response Operator

The collection of available demand response capacity and the communication of instructions to and from household devices could be achieved in multiple ways from a system architecture perspective. Two example options are illustrated in Figure 4 on the next page.

Option 1 in this Figure, one-to-one, would have all the devices in one property connect to a local Hub, e.g. the smart meter hub, which will communicate with the DR Operator (or other aggregator).

Option 2 on the other hand, one-to-many, provides for direct access of devices to the DR Operator (or other aggregator) via the WAN.

In both cases the WAN communication is technology independent.

The second option will allow for a simpler home hub, but will result in a significant increase in communication across the WAN and is arguably more exposed to cyber security risks. The first option mitigates these issues but will require a more complex (and expensive) home hub.

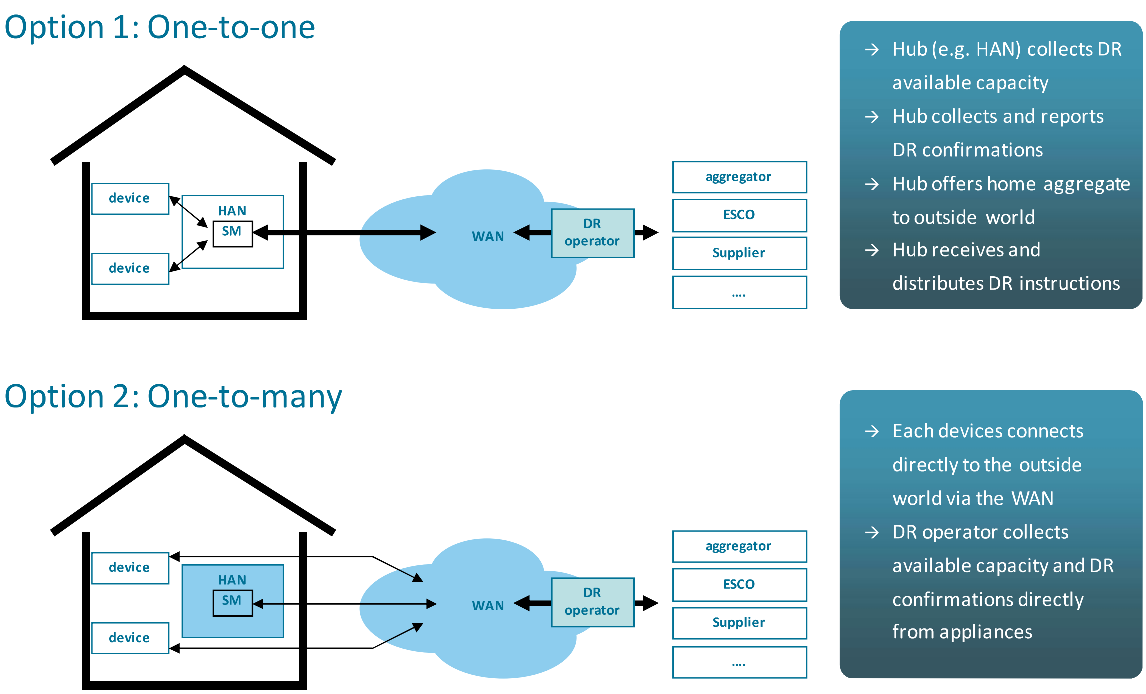


Figure 4: Options for HAN automation

As consumers introduce new intelligent and controllable devices into their homes, and provided they wish them to be available for demand response services, it will be necessary for them to be 'registered' in some way as part of the demand response infrastructure. This needs careful consideration if it is going to be simple and seamless from the customer's perspective. Option 1 may have advantages in this regard. An alternative philosophy might be to consider intelligent systems (perhaps agent software devices) that would detect a new appliance, characterise it, automatically register its presence, and inform the customer and the DR Operator. This concept has some parallels with a mobile phone registering itself to a new network when arriving in another country (and, importantly, not requiring any user intervention).

Although technologies are becoming available to achieve demand response applications, it is still not certain which will set the standard or standards. In most areas, technologies are not mature and commercially available at scale. Because of the amount of investment required to be undertaken, technologies need to go through thorough technical and economic due diligence, so as to establish their suitability for widespread installation. This can be challenging in a liberalised competitive environment and the government is unlikely to wish to be directly involved, as it would be seen to be 'picking winners'. On the other hand, an entirely free market solution could result in extensive deployment of competing (but not fully compatible) technologies, eventually resulting in one or more falling by the wayside and incurring considerable costs for consumers. (Betamax and VHS is an example to consider, noting that many customers were disadvantaged.) This assessment of which technologies to champion will need to be addressed is part of the ***Solutions Task***.

4.1.3 Network connectivity

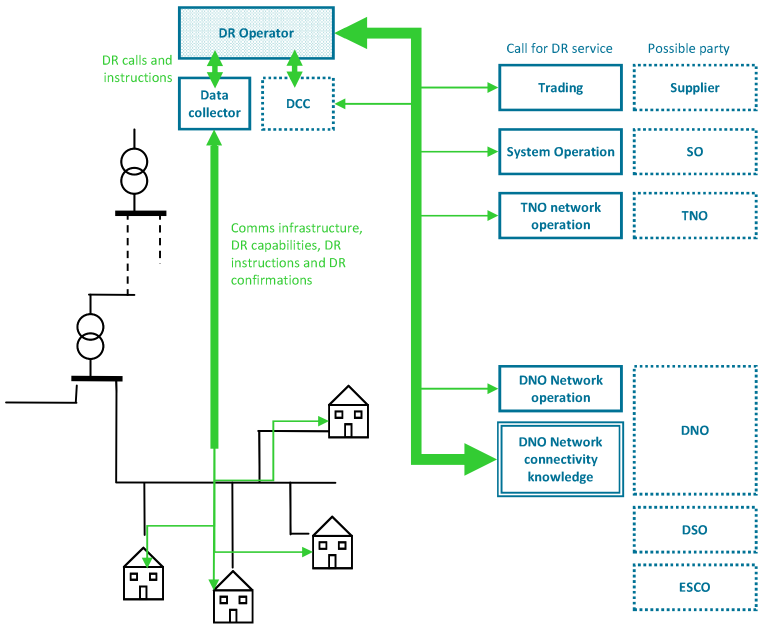
To unlock fully all the benefits of demand response, network connectivity knowledge will be required for certain applications. If part of the low voltage network is congested and is close to overloading, the network owner could wish to call on demand response to ease the loading. For this to happen, the 'DR system', in the widest sense, needs to know which smart meter / hubs are connected to which part of the (low voltage) network and how much demand response capacity they have available.

The knowledge of the network and matching to the smart meter and demand response data has to happen somewhere in the 'DR system'; network connectivity knowledge is a core responsibility of the DNOs and is not static information as network open points may be moved for operational reasons and the alleviation of an LV network overload will require an accurately targeted demand response intervention.

Figure 5 and Figure 6 present two options for demand response communication, aggregation and access to network connectivity knowledge.

Option 1 shows a role for a centralised demand response aggregator (could be the DCC), who collects all the DR capacities and calls from the service users. The aggregated data would then be offered the Centralised DR Operator (could be a separate party), who would prioritise between any conflicting demand response calls from the other parties, and issue the DR instructions to consumers. The role of DR Operator and Data Aggregator could be combined as one.

Option 1: Centralised Aggregator



- → DR data treated similarly to smart meter data
- → All data via central aggregator
- → DR Operator provides central decision making services

Pros and cons:

- → P: Builds on s/meter data structure
- → C: Network connectivity unknown by DCC, needs to be provided by DNOs in real time
- → C: non-trivial task to communicate network connectivity
- → C: likely time lag for processing network DR instructions
- → C: appears to be over-centralised and requires large data movements to the centre, away from where the DR action is required

Figure 5 Communication option 1: Centralised aggregator

The major advantage of this option would be that it aligns to some extent with the smart metering infrastructure. A significant disadvantage would be the overhead (in time and processes) in sending large amounts of non-static local network connectivity data to a centralised processing location and sending the required DR instruction back down to the local network.

Figure 6 presents an alternative option which mitigates these drawbacks by introducing a Regional DR Operator collecting local DR information from a Local Concentrator and allowing for local processing and decisions. This might increase the complexity of the system in some regards, but has the potential for fast local response, a feature necessary to respond to local overloaded networks. It is attractive to consider the benefits of a ‘region’ corresponding to a DNO licensed area, as the network connectivity data is currently held and updated in the respective DNO control systems. The role could be undertaken by the DNO or by an agent.

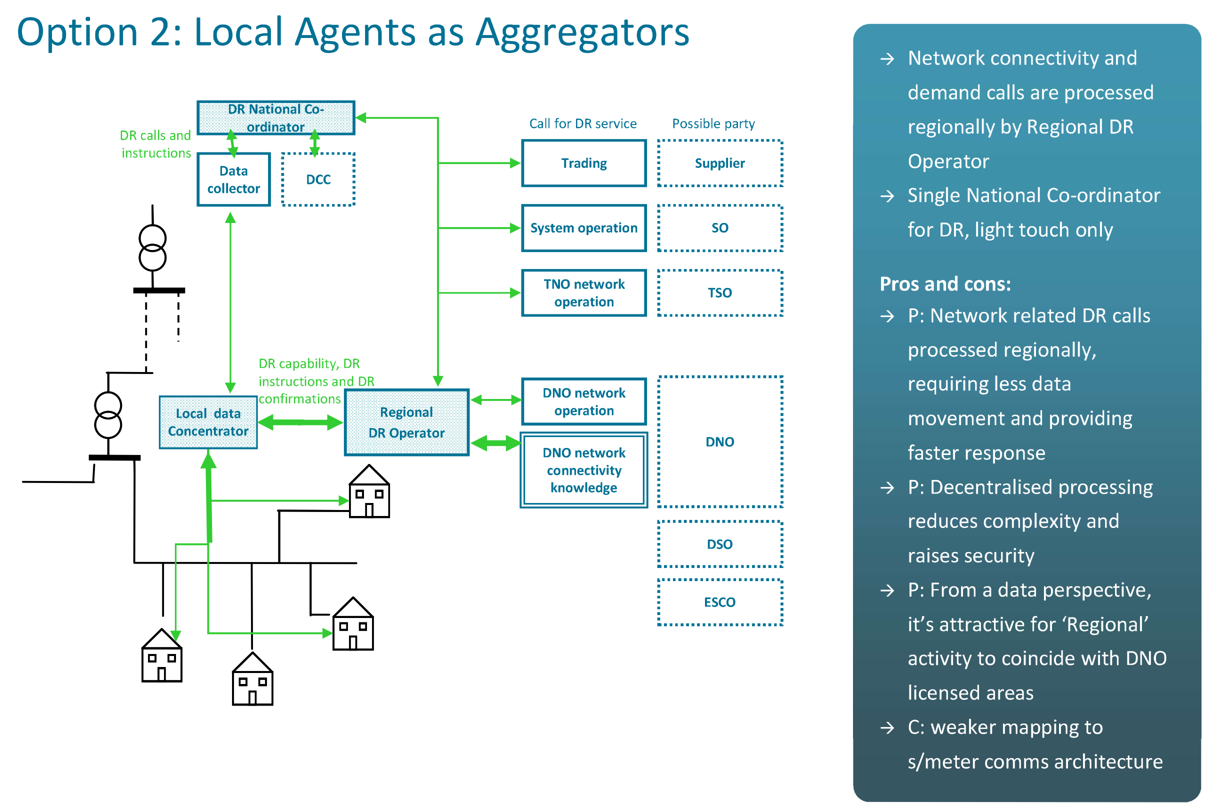


Figure 6 Communication option 2: Local aggregator

The decision on which method to choose will be part of the ***Solutions Task*** of the Implementation Plan, which will address technology choices and the Technical and Commercial Frameworks.

4.2 Non-Technical

4.2.1 Planning

- Project owner / project team & governance: this is addressed in the ***Start-up activities*** of the Implementation Plan. It is likely to require a joined effort between

ENA and ERA, since all demand response schemes will affect, more or less, members of both Associations.

- The main policy driver is likely to be cost efficiency with an additional focus on carbon emissions reduction. This has to have the customer in the centre and look for country wide benefits. It must also align with initiatives and incentives running in parallel.
- Since the current timescale for implementation of the smart metering programme is in the period to 2020, it makes sense to plan demand response measures that are directly dependent to smart metering (like TOU tariffs, Critical Peak Pricing, load management/smart appliances) on a similar basis. In the longer term, the planning process needs to take into account electric vehicles (G2V and later V2G) and small/medium scale energy storage. These applications might be undertaken using enhanced smart metering. For applications in the I&C sectors, demand response measures can probably be developed simultaneously, based on the experience of the current schemes (e.g. Short Term Operating Reserve)

4.2.2 Implementation

- Because of the current grid and industry structure, the management of a transition is likely to be complex and will require a high degree of sophistication, operating over a number of years. This function is likely to be best undertaken by a single party on a project basis, for example a demand response implementation team.
- DR forms an unusual project as it is not a traditional 'Point A to Point B' task; Point B in this case is broadly known (part of the DECC Roadmap and the emerging vision for smart grids in the UK) but there are a number of significant unknowns (for example the penetration rates of EVs and Heat Pumps and emerging technology solutions such as storage) that will affect deployment priorities and the detail of the optimum Point B outcome; a more responsive form of project structure is described later in Chapter 5 to reflect this context.
- Arising from this dynamic development environment and the high content of innovation, the capture and dissemination of knowledge has particular importance. We note that the ENA is considering the role of standards for smart grids and DR might usefully form a subset of the proposed knowledge capture, dissemination, and standardisation processes. ENA will in this context also be responding to Ofgem's requirements under the Low carbon Networks Fund.

- The issue of 'who owns the DR data' is a core issue for resolution. It is likely to need to follow the precedents set by the smart metering programme.
- Because of the different forms of regulatory oversight for suppliers and network companies, it is difficult to see how commercially driven decisions of suppliers can be followed by network companies that are constrained by regulatory decisions set in a 5 year time frame (or perhaps 8 years in the future). This issue is important to resolve in the implementation stage as it could cause serious delays to the demand response programme. Demand Response is an area where innovation can be expected to be an ongoing feature and competitive commercial approaches and their technical solutions will need to be nimble.

4.2.3 Operations

- The communication protocols used should be aligned with smart metering and ensure data security and privacy. Also there will be significant benefits in standardising the core functionality of all communications devices used for demand response applications to provide interoperability and for designs to be future proofed so as to ensure the maximum return for investment. Future proofing might involve modularity, remote upgrade capability, or local optionality settings.
- The DNOs are likely to gain benefit from close to real time access to data; in this regard communication and data architectures are important and experience would suggest that caution should be applied if it is proposed that this is only available via the central DCC smart metering systems. In the majority of cases the DNOs would be interested in aggregated data to a distributor, feeder, transformer or substation level. There may be scope here to offset public concerns over data privacy. The DCC might remain responsible for data collection, management and security. For data storage, the same agency could be used (e.g. Elexon, Xoserve). Data transaction costs should be borne by the interested parties. Also powers need to be given to customers to prohibit the leakage of private data to third parties (such as marketing agencies etc)

4.2.4 Customer relations

- In terms of customer facing, there are advantages in the suppliers taking up the role, since they own the meters. Also it would be preferable for efficient and effective customer relations to have a single point of contact with the customer. Here too the suppliers have the benefit of having call centres in place that can accommodate large numbers of customer enquiries. Also the suppliers are in a good position to market different products to customers and offer integrated products (TOU with LM, remotely accessed by internet or mobile phone, better billing energy services etc.).
- The above notwithstanding, the success of demand response is critically dependent on winning the hearts and minds of the public and customers. As explained earlier, there are more beneficiaries for demand response services than the suppliers alone and it would not appear to be satisfactory to simply hand the customer relations management task to one party alone. There may also be advantage to all parties in a national promotion campaign to lay the foundations for the competitive offerings that follow. There may be merit in forming a joint, multi stakeholder, task force to address a national campaign. Digital Britain may provide some helpful learning points here.
- With such an key role for consumers, it is important to pay attention to wider social inclusion of these new technologies. Research indicates that new technologies can pose a threat for some significant groups of society; IT has become a no-go area for many people especially the older age group. This could threaten the commercial and technical viability of the demand response initiatives as those who are not engaged are likely to be financially disadvantaged.

4.2.5 Regulation

- In terms of regulatory support for introducing demand response schemes, there has to be a broad-ranging policy review so as to examine and define existing regulatory barriers. This may result in significant regulatory changes, including customer protection and interests. Also new regulations should provide the incentive to DNOs to co-operate actively even if the tasks to be undertaken are outside their host areas or bring benefits to other industry parties.
- Cost savings should be shared proportionately among the relevant stakeholders including consumers, broadly following the current regulatory regime and market structure. If the GB power market remains the same then benefits to generation

should be passed on to consumers through the wholesale market. Benefits to DNOs should also be allowed to pass to consumers through regulated revenues. Competition should achieve savings to the consumer in the retail side. Should the structure of the GB market change, special provisions may have to be considered to preserve equitable outcomes.

- It is critical that the single party project team should take action in an effective way, authorised by DECC and overseen and supported by Ofgem. DECC would be well placed to maximise cost efficiency in investment (with best effect for climate policy targets) and Ofgem would be well placed to protect the interest of the consumer, providing a level field for market players and promoting competition.
- A sense of urgency will be required to make timely progress with a project of this complexity. This will require the active engagement of senior industry executives and their equivalents from government and regulators; it will also require a considerable range of specialist engineering skills to be brought to bear. The project will have a multi-year life and it would be wise to consider how continuity and momentum will be maintained. Similarly, investment will be taking place over many years, so confidence in regulatory stability and government determination will be important for raising and committing funding.

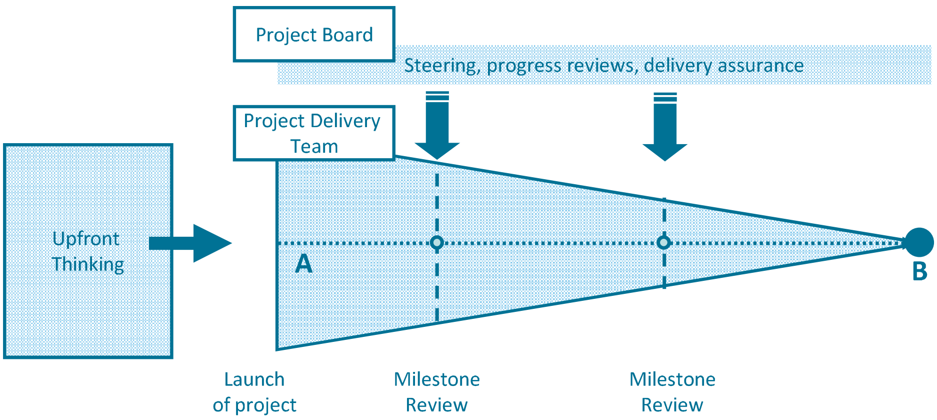
5 PLAN FOR IMPLEMENTATION

This section outlines the proposed steps that will need to be taken to create a national project plan for demand response implementation. Since implementation is still at a very early stage, the following steps mainly demonstrate what needs to be done at a high level. More work will have to be undertaken to complete the steps described below, once the direction of travel has been agreed and the challenges discussed in the previous section have been accepted and are being addressed actively.

As described in the last chapter, the usual requirement for any project is a clear task definition of the delivery objectives; the role of any project team is to move from the present situation (Point A) to the carefully defined future position (Point B). This is the basis of established methodologies such as PRINCE2.

Experience confirms the value of a highly focussed project team who operate in 'delivery mode' with oversight and support provided by a high level Project Board, who typically monitor progress against pre-defined milestones. The diagram below represents the traditional project approach:

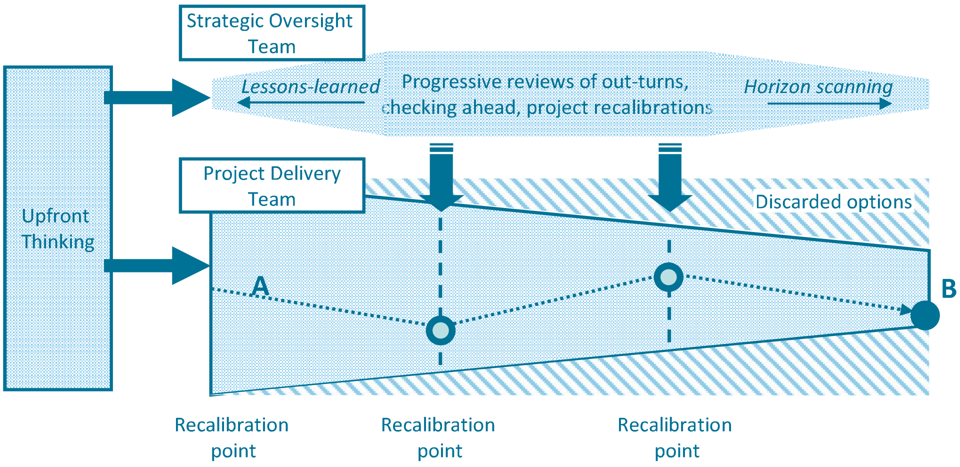
Traditional Project Structure



In the case of Demand Response, the very basis of the traditional methodology is challenged because the outcome (Point B) is not well defined. Indeed, under PRINCE2 the project would not commence. Yet there are unusual circumstances here as many of the project elements have long lead times and it is necessary for work to commence; there are also potential interdependencies with other projects and government initiatives. Waiting until all the uncertainties are resolved is not a practical option.

To resolve this conundrum, it is proposed that the Demand Response project adopts a dynamic scheduling approach. At its heart this utilises two inter-linked organisational groups, one focussed on project delivery and another focussed on strategic oversight that is informed by reviews of emerging experience and by horizon scanning. The project team would operate within a broadly defined envelope (progressing towards Point B as best understood) but subject to periodic recalibration points that provide opportunities for 'mid-course correction' in moving in an informed way to the final goal. This is represented in the diagram that follows.

Progressive Project Structure

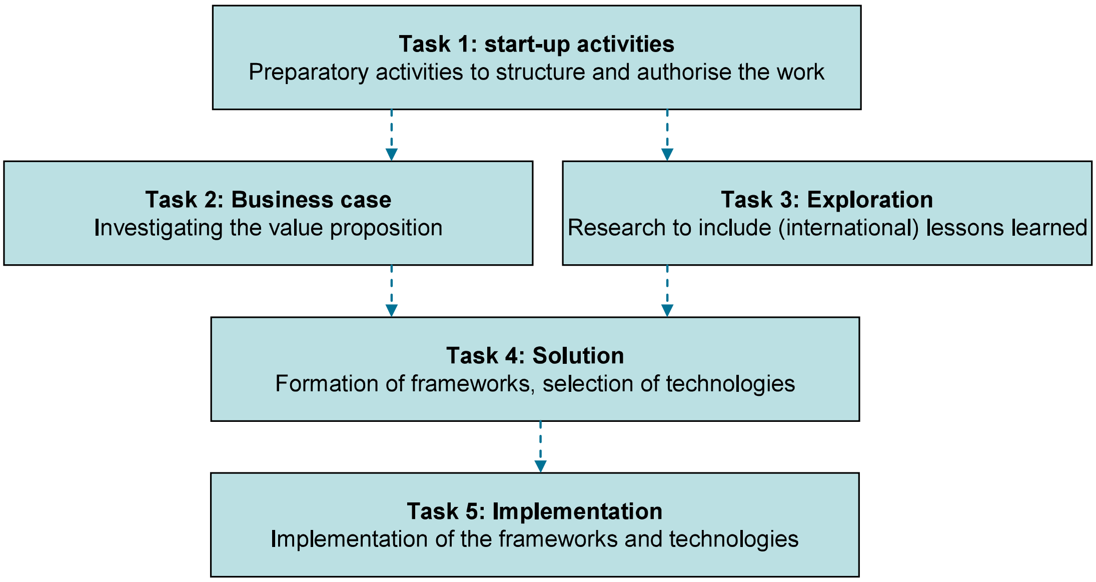


This approach depends on the project being established with full commitment to deliver to Point B; it will fail to deliver if each of the Recalibration points are treated as boundaries between sub projects. Many of tasks must 'flow through' but be designed with sufficient flexibility to accommodate mid-course correction in either timing or content. This will be challenging but not beyond the capabilities of an experienced project delivery team, working in close relationship with its strategic oversight team.

5.1 Implementation Planning

The detailed implementation process will require a clear view of how different schemes are to be rolled-out in the population. Although, at a first stage, there are significant synergies with the smart metering programme, demand response schemes in the networks businesses can be driven by different factors and hence might be developed separately, but with clear lessons learned from the smart metering programme.

KEMA proposes that the Implementation activities are set within five main tasks:



These tasks, their elements and the options will be described in more detail below.

5.1.1 Task 1: start-up activities

This first task will establish the implementation organisations and will comprise the following activities:

- Define project owner / sponsor
- Define the Strategic Oversight Team
- Define the Project Delivery Team
- Determine governance structure and working methodologies
- Set up stakeholder management mechanisms

- Determine the communication policy
- Establish adequate Delivery Team resources
- Set up a Programme Office
- Finalise and sign off the ToR and initial programme for the Strategic Oversight Team
- Finalise and sign-off ToR and output definitions for the Project Delivery Team, scoped to reach the first recalibration point

For the formation of the project delivery team, governance and stakeholder engagement, several alternatives may be considered:

- **Big committee –** buy a large table and invite everyone interested.

- **Nested Structure –** Similar to the big committee but made more manageable by means of multiple sub committees and working groups.

- **Partner Model** – Partner with an independent third party who would bring credibility and provide quality assurance; this would increase third party confidence that the project is not being manipulated to the benefit of the lead stakeholders.

- **Funded Association –** consider a 'Pay to Play' model as used by NIST (USA standards making body for smart grids) and by DESERTEC (power from North Africa into Europe); levels of membership would be established that, for differing participation fees, provide graded levels of engagement to the process; open governance is essential. The payments could be used to off-set the project administration costs. There is a need to minimise the risk of blockers on the work groups. This model would also demonstrate a fresh approach and signal that the project organisation has recognised the complexity and scale of the undertaking.

These options are illustrated below. A variant or hybrid of these options would also be possible.

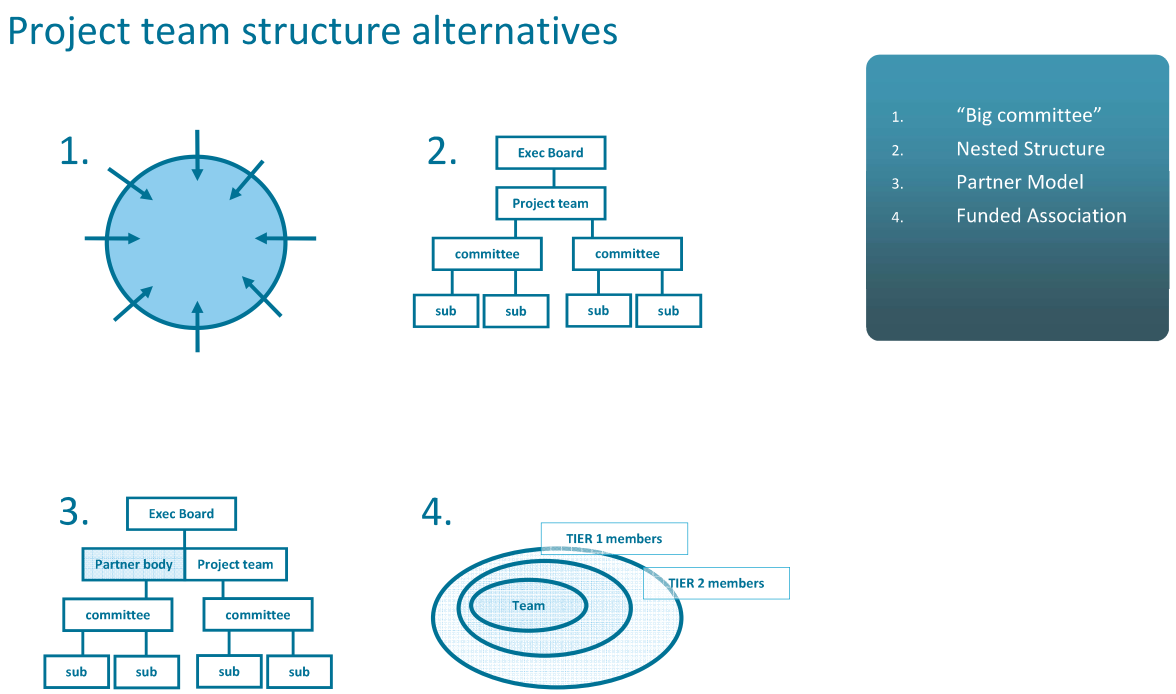


Figure 7 Project delivery team and governance structure alternatives

The team would benefit from working closely with DECC and Ofgem, perhaps provided through the proposed strategic oversight team, with clear expectation management and a no-surprises approach. The project should have a clear link with other smart grid and demand response initiatives and be aligned with the next TPCR/DPCR, with LCNF and similar initiatives (e.g. ETI projects and smart metering roll out).

Key questions when forming the right structure would be:

- How to keep project agile but still stakeholder inclusive?
- Who are the stakeholders? See Appendix C for a first analysis.
- What does inclusive mean e.g. the trade body of white good manufacturers, one representative manufacturer or all manufacturers?
- Should stakeholders be involved differently as primary, secondary or tertiary stakeholders for example (perhaps platinum, silver and bronze membership)?
- Would Government be more comfortable with independent governing of the project (e.g. recruiting and appointing an independent person or organisation to lead the Project Delivery Team)?

Following the structure, the start-up should include the planning of communications and early engagement planning for contact with partners/stakeholders. Communications should lead, not follow, in the project implementation sequence.

5.1.2 Task 2: Business case

This second task comprises developing a resource plan for demand response implementation, covering finances, people (both staff from member companies and consultants if required) and necessary services.

The implementation of demand response could reasonably be funded by public monies since the development is designed to bring national benefit. Alternatively, it could be partly funded by private funds, originating from stakeholders that have significant benefits from demand response implementation. However, this may be a slower implementation route.

Benefits will be identified by means of cost benefit analyses. As a first step, the ENA recently published a study with Imperial College that quantified the benefits from demand response from a low voltage distribution networks perspective. Furthermore DECC has recently commissioned a study to investigate the benefits of demand response for the wholesale market. Results of this study are expected at the beginning of 2011.

From a European perspective, last summer the European Climate Foundation published an extensive study addressing amongst other aspects the cost benefits of demand response to facilitate the integration of large wind farms, carbon neutral large generation and storage on interconnected European transmission networks. KEMA and Imperial College were partners in this work (with McKinsey).

It is envisaged that more studies will be commissioned to explore fully all 7 identified benefits of Demand Response.

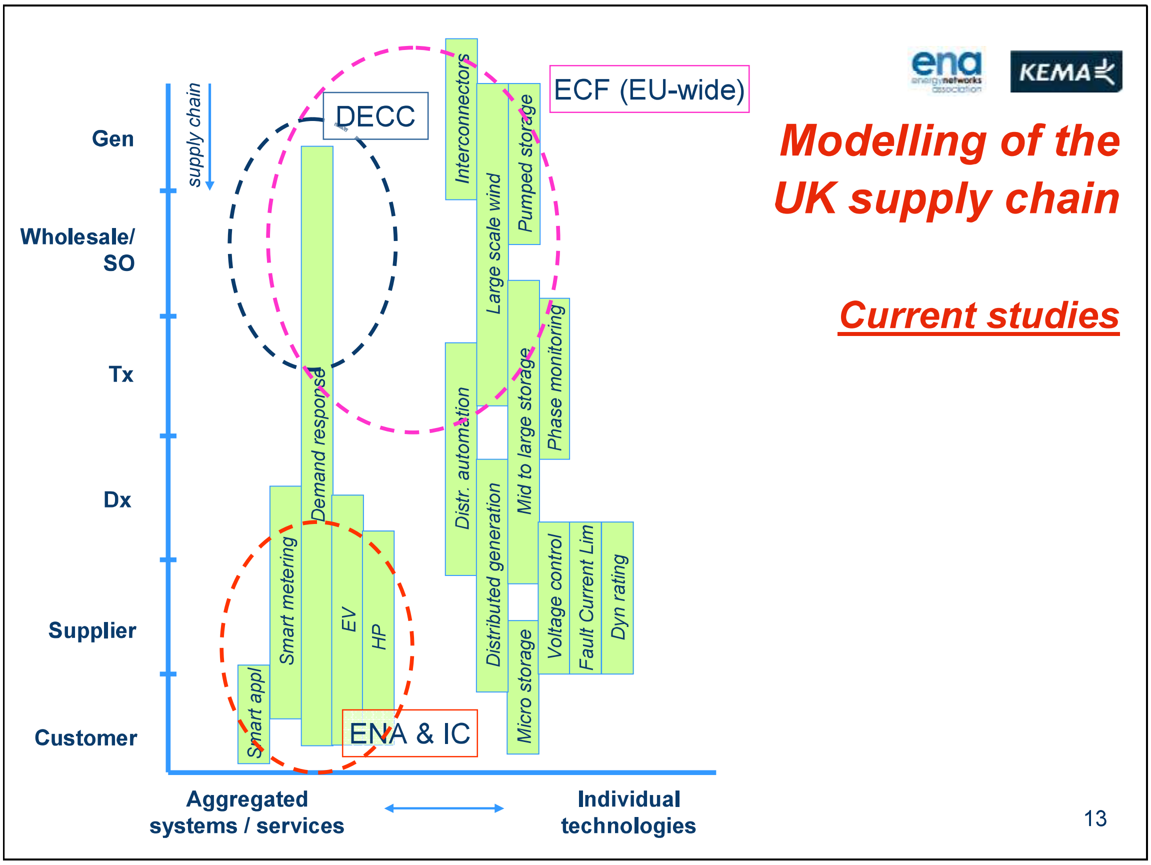


Figure 8 Current studies, covering demand response, delivered or underway in the UK and Europe

Following the resource plan and these cost benefit analyses, a value proposition for the programme can be drawn up.

5.1.3 Task 3: Exploration

The third task comprises three main elements:

- Identification of international experience with demand response
- Research in social acceptance and behaviours
- Early identification of *'..if only we had…'* elements

This important stage will ensure alignment with international demand response activities, European Directives and Standards and lessons-learned from global demonstration projects (see ADDRESS project, paragraph 3.4 and appendix D).

The investigative stage should also focus on the social and societal aspect of demand response in order to avoid later pitfalls of social rejection, bad press and misunderstood behaviour.

These steps will feed in the to early identification of the *'…if only we had…'* elements, a reflective assessment on the implementation plan to avoid problems later. This would form part of the project risk management and mitigation approach.

5.1.4 Task 4: Solution

After all preparatory work, preparing the value proposition and exploration of international experience and options, the fourth task comprises:

- Selection of initial technology option(s)
- Selection of communication option(s)
- Formation of Technical framework (to achieve Functional Requirements)
- Formation of Commercial framework (to achieve Functional Requirements)

An important aspect is a proper analysis of technologies, in terms of economic and technical potential. This analysis might have to be undertaken for several applications separately and jointly, so as to understand where the biggest potential is and what opportunities to pursue first. Technology analysis would gain great benefit from the results of early demonstrations, for example from projects under Ofgem's Low Carbon Networks Fund, from international pilots, and if appropriate by commissioning independent laboratory testing.

Another aim of this task could be the investigation of potential synergies between technologies, so that their roll-out can scheduled and co-ordinated accordingly. For instance, how can demand response schemes utilise communications of the smart metering infrastructure or what other communication devices need to be installed in the LV network, prior to the 'last mile', to increase power system observability for network operators.

Following the selection of technologies, the Technical and Commercial Framework would be drafted and agreed. The Frameworks will need to cover, amongst others, the following topics:

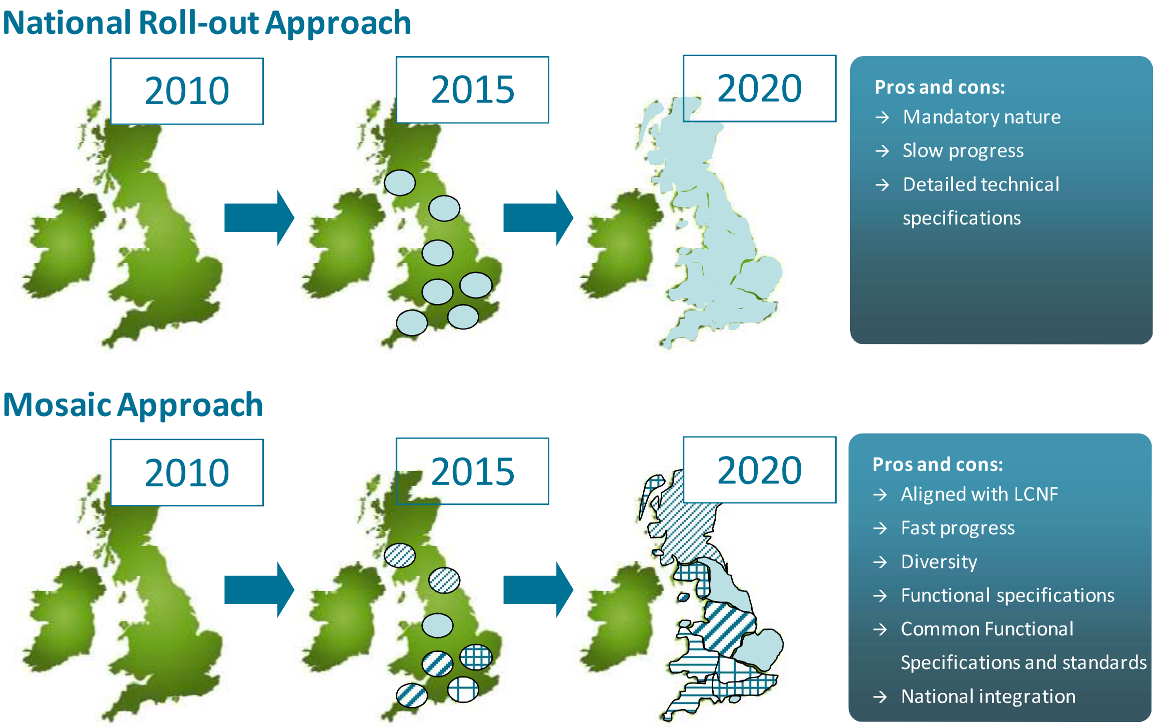
Table 3 Suggested content of Technical and Commercial Frameworks

Topics
Ownership of relationships - with domestic customers - with SME customers - with large I&C customers Demand response decision framework - rules and their on-going management - prioritisation and optimisation choices - ownership of control - market arrangements - commercial arrangements Parties and roles - new requirements - new opportunities Appliances and devices - standardised interfaces - automated recognition - standardised features - customer interface consistency Data - process flows - management - ownership - definitions - access security - access costs Data sources/control points - specs/standards - communications

5.1.5 Task 5: Implementation

For implementation of demand response, alternative roll out options need to be considered. This might be either on a national basis (e.g. in each distribution host area) or as a mosaic approach (where applications are launched where they are most suitable and appealing, but following standards and frameworks that will ensure later integration nationally). An example of the roll-out options is provided in Figure 9.

Figure 9: DR schemes roll-out options



5.2 Time schedule

The following Figure displays an indicative time schedule of the tasks.

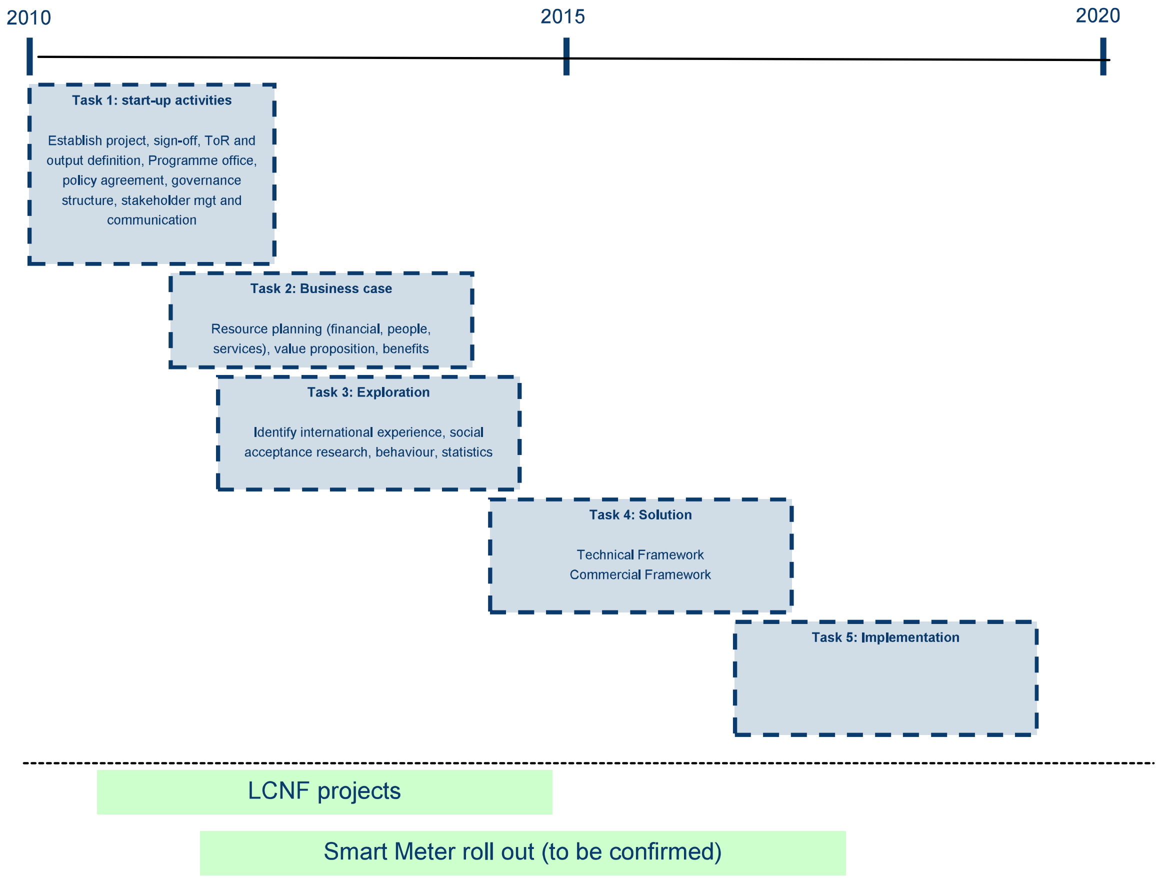


Figure 10 Indicative Project Schedule

5.3 Success indicators

The project plan should include a set of success indicators or milestones to be achieved, linked to the proposed project Recalibration points.

Success indicators need to be set, defined and agreed among stakeholders during the planning process, along with the process that will have to be completed for their achievement. Table 4 below outlines some headline indicators that could be set and what actions need to taken so that they can be achieved.

Table 4: Headline Indicators for project performance monitoring

Task	Indicator / topic	When achieved?
Task 1: start-up activities	Project Delivery team Output definition Governance	Acceptance of solution by: - ENA/ERA group - Ofgem - DECC - Consumer representative body - Wider stakeholder group
Task 2: Business case	Value proposition	CBA of all 7 benefits understood, value proposition supported by sector consultation
Task 3: Exploration	International exploration Research social acceptance	Compilation of good practice guidance and risk identifications, signed-off by project board
Task 4: Solution	Selection of technology and communication options Technical and Commercial Framework	Acceptance of solution by: - ENA/ERA group - Ofgem - DECC - Consumer representative body - Wider stakeholder group
Task 5: Implementation	Implementation strategy	Advice from wider stakeholder group Agreement by project board

5.4 Key dependencies and risks

Common to any project planning process is a risk mitigation strategy that needs to be in place to ensure that foreseeable risks are addressed and mitigated, so as to minimise the impact of uncertainty to project delivery. This is done by constructing a risk mitigation matrix (similar to the one seen in
Table **5**) where all credible risks are identified, assessed and measures for mitigation are put in place. For project budgeting purposes, a quantified risk register can also be created, where risks and associated mitigation measures are monetised so that they can effectively taken into account in project funding.

The Table below outlines some dependencies and risks for demand response implementation and suggested mitigation measures.

Table 5: High-level risk mitigation matrix

Task	Dependency / risk	Assessment	Mitigation
Task 1: start-up activities	Media - (backdrop of more £ or less kWh), big brother, spy on the wall, data security, bad press for smart metering reflected onto DR.	High	Information campaigns, consumer group interactions, advertising campaigns, local community engagement. Actions to support S/M success.
	Lack of involvement/commitment from manufacturers including automotive.	Low	Establish industry commitment by direct interaction in scheme design. Allow sufficient time to build trust in new relationships.
	Indecision / slow processes / governance.	High	Project Planning and monitoring, contingency planning, Executive oversight and intervention.
Task 2: Business case	Cost overruns.	Medium	Budget accordingly to national and international experience, promote competition in tendering. Periodic reviews.
	Funding – resource constraints in businesses.	Medium	Transparency and public interaction (e.g. through public consultations and task groups).
	Roll out is so diffuse that that many DR benefits cannot be demonstrated until very late in the national programme.	Medium	Special care needed if s/meter roll out is supplier led, resulting in limited DR penetrations on a geographic basis. Agreement on focused zones for action might be seen to bring benefit to all parties.
Task 3: Exploration	Alignment with European Directives not achieved.	High	Investigate committees on European Directives; get engaged early in their

			processes.
Task 4: Solution	Market Model - will it be commercially viable? - socially acceptability?	Medium	Draw lessons from international experience and other sectors e.g. telecoms.
	Conflict of DNO & Supplier & generator priorities/drivers	Medium	Clarify and agree issues in planning stage, create a single implementation body.
Task 5: Implementation	Lack of customer engagement / home automation uptake/ outright resistance and media hostility/ poor handling of consumers by DR stakeholders, either in promotions or on site for installation.	High	Design schemes with aligned and proper incentives to benefit consumers. Ensure communications campaign leads the work; get it right first time (recovery is very problematic); use focus groups and similar techniques to litmus test at early stages. Take professional advice.
	All too complex (customers unable to understand DR concepts).	Medium	as above. Design the products to have excellent interfaces and in-built help and automation.
	Inadequate early recognition and resolution of 'mismatch' problems in DR operation (DR forecasting vs DR actual for example).	Low	Ensure timely clarity for mismatch resolution processes and liabilities at the operational level.
	Cowboy installers bring DR into disrepute.	Medium	Consider accreditation schemes, training, quality control and early monitoring.

6 IMPLEMENTATION SOLUTION STRATEGY

The chapter comprises the demand response implementation solution strategy, covering the core strategic principles for effective implementation.

6.1 Core principles

The solution strategy is based on the following core principles:

1. **The need for effective stakeholder engagement**, led by the ENA and ERA, noting new parties such as white good manufacturers and end-user groups.
2. **Provide assurance and visibility** to the Regulator and Government, strengthened by the development of standards and considering the merits of inclusion of demand response in the Smart Energy Code (proposed for smart metering).
3. **Recognition of long lead times and the care required** for customer engagement and new partners. This will require new skills, such as consumer psychology, technology marketing and compelling communications and branding.
4. **The need for a national coordinated communication plan** to lay the shared foundations of DR by targeting media, the public, consumers and industries. Note that competitive product promotion would then follow, having established a willing and enthusiastic national platform of consumers.
5. **To build confidence and credibility** that the project is being designed and implemented in a balanced and objective way e.g. by involving suitable partners and open processes.
6. **To develop the DR programme to maximise the export potential** of products, knowledge and technologies, experience with communications infrastructure and hierarchies, first hand customer interfacing experience. There is strong international interest and this will place the UK in an exceptionally strong position if it can demonstrate the commercial deployment of demand response in a liberalised market. This is very different to demonstration and pilot projects that can be seen around the world.

6.2 Strategy Assessment

Table 6 Assessment of core principles

	Risk & degree of challenge	Time scales	Potential partners
1.	**High:** Non-aligned stakeholders will frustrate the development of Standards and Technical and Commercial Frameworks. Consumer devices might not be ready on time.	Long to plan, agree and implement wider stakeholder engagement.	Mediators and ambassadors for DR ‘walking the talk’.
2.	**Medium:** Government and Regulator not fully backing the project.	Medium to demonstrate clear progress and shared vision.	Consultants, universities, international parties with experience to share.
3.	**High:** Disengagement of consumers; poor social inclusion; projects technically more advanced than consumers are willing to accept.	Long to develop skills required; long to develop relationship with consumers.	Universities, end-user groups, product designers.
4.	**High:** Bad press that delays or stops implementation.	Medium to engage and 'educate' media.	Communication specialists, marketing skills, demonstration facilities.
5.	**Medium:** Project perceived to be rigged by vested interests; or Ofgem/Government uncomfortable that stakeholders are setting new rules eg that pass costs to other parties.	Medium to engage with independent trustworthy party to demonstrate open governance and quality control.	Consider involving a professional Institution or perhaps an academic party.
6.	**Medium:** large potential stream of export revenue could be missed if this aspect is not ’designed in’.	Medium to establish joint up approach.	As above plus international advice and engagement in EU or wider standards development; consult with potential exporters, commission market research.

6.3 Immediate next steps

The table below sets out the ten actions that are seen to address the priority concerns (potential showstoppers) and those issues that have particularly long lead times. The leading and supporting parties are indicated.

Table 7 List of recommended ten priority actions

	Action	Leading Party	Supporting Party
1.	ENA and ERA to progress their joint working, including agreement on task priorities and allocations.	ENA/ERA	
2.	Establish the project, its name and governance structure with clear project methodology and brief (Pay to Play model is commended).	ENA/ERA	DECC/ Ofgem
3.	Implement a partnering approach to give early confidence to wider stakeholders.	ENA/ERA	A professional institution or similar
4.	Review the active LCNF projects to identify activities relevant to DR implementation	ENA	DNOs
5.	Develop and implement a communication plan to address end-user engagement.	DR project	Marketing professionals
6.	Bring forward comprehensive CBA studies to quantify the initial DR business case.	DR project	ENA/ERA
7.	Determine the DR data and communications architectures, and new role requirements such as for DR Operators.	DR project	Smart Meter project
8.	Build engagement with the Government and Regulator (establishing the proposed Strategic Oversight Team is commended).	DR project	ENA/ERA
9.	Engage actively with international developments to learn from elsewhere and, in particular, link with EU standards developments and align with/influence them.	DR project	DECC Parties with EU continental owners
10.	Raise profile, make early senior appointments, set project pace and demonstrate commitment to making concrete progress with strong stakeholder engagement. Consider the proposed Smart Grid Forum for the Strategic Oversight function described on p.35.	DECC/ Ofgem	ENA/ERA

Comments on this report will be welcomed and should be emailed to:

Alan Claxton and Jason Brogden
at the ENA at the ERA

Alan.Claxton@energynetworks.org

Jason.Brogden@engage-consulting.co.uk

APPENDIX A: WHAT IS DEMAND RESPONSE?

'Demand response' (DR) is an overarching term that encompasses all actions which can be taken by electricity consumers, suppliers and distributors to reduce (or increase) electricity demand on the grid. Demand response measures, actions or schemes are usually understood as a subset of a wider set of actions that can be undertaken to mitigate electricity demand, that is sometimes termed 'Demand Side Management' (DSM). This includes actions that aim at overall demand reductions, actions that aim at changing demand profile so as to mitigate or alleviate peaks and actions that increase flexibility so that the system can cope with unforeseen events.

In general terms, demand response can include energy efficiency measures, changes in domestic consumer consumption patterns (up or down) by response to price signals or increased information on energy use, electrical appliance automated operation, changes in industrial and commercial consumer consumption patterns by response to price signals, and system operator actions to optimise the use of renewable, distributed or micro generation.

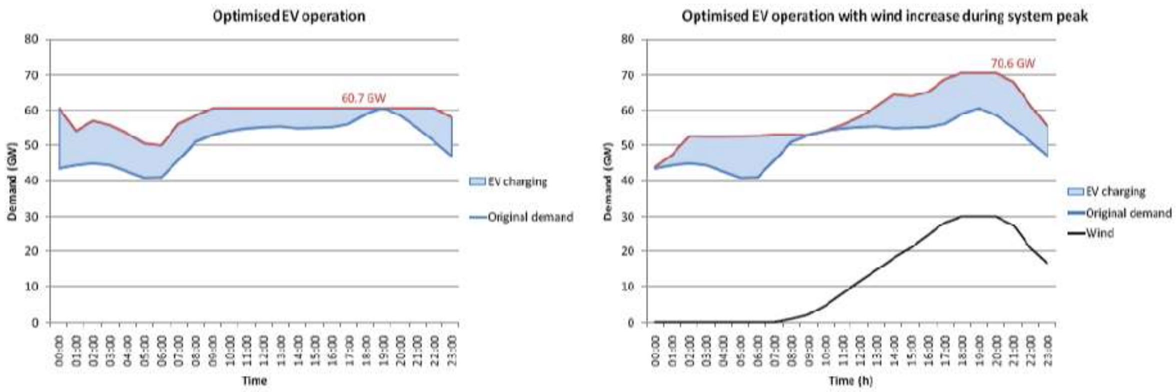


Figure 11 Network-driven vs. price/supply-driven management[1]

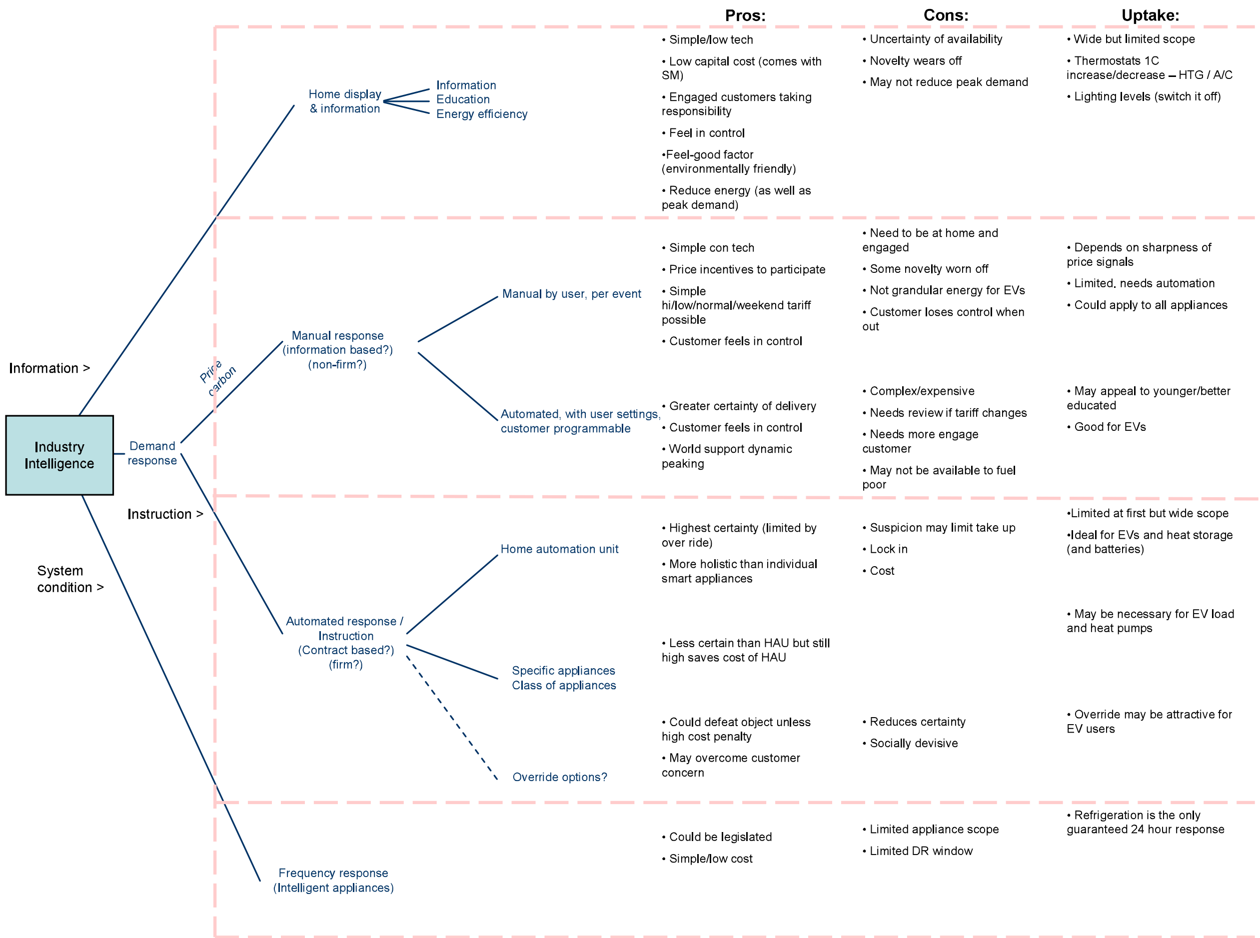
The figure above shows two graphical examples on how demand response can affect load profiles. Demand Response can be any measures that shift consumption away from peak or toward supply, It is not just peak clipping but also load shaping.

In general demand side management actions (including demand response) have the potential to achieve the following six functions:

[1] Benefits of Advanced Smart Metering for Demand Response based Control of Distribution Networks, version 2, ENA, Imperial College

- **Critical Peak Shaving**: this refers to actions that aim at eliminating excessive load peaks that occur at exceptional events
- **Load Shifting**: this refers to actions that aim at shifting daily peak loads to off-peak times
- **Valley Filling**: this refers to assigning specific new loads at daily off peak times
- **Energy Conservation**: actions that aim at reducing the demand profile evenly across time
- **Load Building**: this refers to actions that aim at increasing the demand profile across time (so as to meet available generation)
- **Flexible Load Shaping**: this refers to actions that can reshape entirely the profile shape so as flexible generation can meet flexible demand

APPENDIX B: DR OPTIONS



APPENDIX C: KEY STAKEHOLDER LIST

Table 8 Key stakeholders

Key Stakeholders – for Demand Response design and deployment		
Key parties:	**Supporting parties:**	**Interested observers:**
ENA ERA Suppliers DNOs iDNOs TSO TNOs Government/ DECC Ofgem Energy consumer groups Smart meter programme	EV – automotive sector Built environment sector BEAMA White goods manufacturers DG manufacturers Home automation providers Media popular press Media technical press NGOs SME representatives Wider consumer groups Manufacturers Fuel Poverty organisations AEP/ Generators Communications providers Aggregators Academia and Research organisations	Customers (domestic, SME, I&C) ESCOs Data managers Standards organisations Field operations Other service providers (eg Electralink) Local Governments International observers Investors NAO Energy UK ERGEG/ACER Gas sector Microgen sector Storage manufacturers

APPENDIX D: HIGH-LEVEL OVERVIEW OF EU ADDRESS PROJECT

The *Active Distribution network with full integration of Demand and distributed energy RESourceS* (*ADDRESS*) project is a large-scale Integrated Project co-founded by the European Commission under the 7th Framework Programme, in the Energy area for the "Development of Interactive Distribution Energy Networks". It started in June 2008, with duration of 4 years (2008-2012). The project involves a consortium of 25 partners from 11 countries with a total budget of €16m (€9m financed by the European Commission).

Objectives of the Project

The main objectives of ADDRESS are the development and validation of solutions to enable Demand Response and exploit its benefits. For this reason, the project introduces the concept of "*Active* Demand" (AD, similar to Demand Response), which indicates the active participation of domestic and small commercial consumers in the power system markets and service provision to the power system participants, by means of real time (minutes to half hourly) interaction based on price and volume signals.

AD is the core of the project, which is focused two main area:

- ***Drivers to enable AD***:
  a. Development of technical solutions at the consumers premises and at the power system level; and
  b. Recommendations and solutions to remove possible barriers.

- ***Identification of the benefits of AD***:
  (i). Identification of potential benefits for the stakeholders;
  (ii). Development of the appropriate markets and contractual mechanisms.

ADDRESS follows the following approach to achieve these objectives:

- Detailed analysis of all accompanying measures connected with social, cultural, and behavioural aspects;

- Three different complementary tests sites (in Spain, Italy and France), which consider different demographic and generation characteristics, in order to validate the potential of AD in different situations; and
- Dedicated dissemination of activities to engage in the best possible way every stakeholder.

Project Main Concepts and Architecture

ADDRESS introduces the innovative concept of *demand approach*. Services requested by consumers are based on price and/or volume signal mechanisms and it can be either on voluntary or contractual basis.

To allow this mechanism, a series of actions need to be in place:

- An interaction based on real-time price and volume signals;
- Deployment of appropriate technologies at consumers' premises;
- Deployment of all societal and behavioural measures needed; and
- Local optimisation, to best fit the consumer needs.

The conceptual architecture can be analysed in the figure on the next page. The architecture is constructed around four major stakeholders:

I. **Aggregators**
   - Mediator between consumers and markets.
   - Different levels of optimisation to meet the requirements of topologically dependent services.

II. **Consumers**
   - Households and small businesses directly connected to distribution network.
   - Provide flexibility to Aggregators.
   - Energy box (the orange cube next to the houses in the figure): interface with the aggregator.
   - Optimisation and control of appliances and DER.

III. **Distribution System Operator (DSO)**
   - Enable AD on their network and ensure secure and efficient network operation.

- Interacts with aggregators through markets.
- Direct interaction with TSO for system security.

IV. **Markets and Contracts**

- All types of commercial relationships (organised markets, call for tenders, bilateral negotiations):
  - Energy supply;
  - Relief of overload & network congestion;
  - Balancing services (incl. compensation of RES variability);
  - Ancillary services: steady state V control, tertiary reserve; and
  - Load shaping services (e.g. peak shaving).

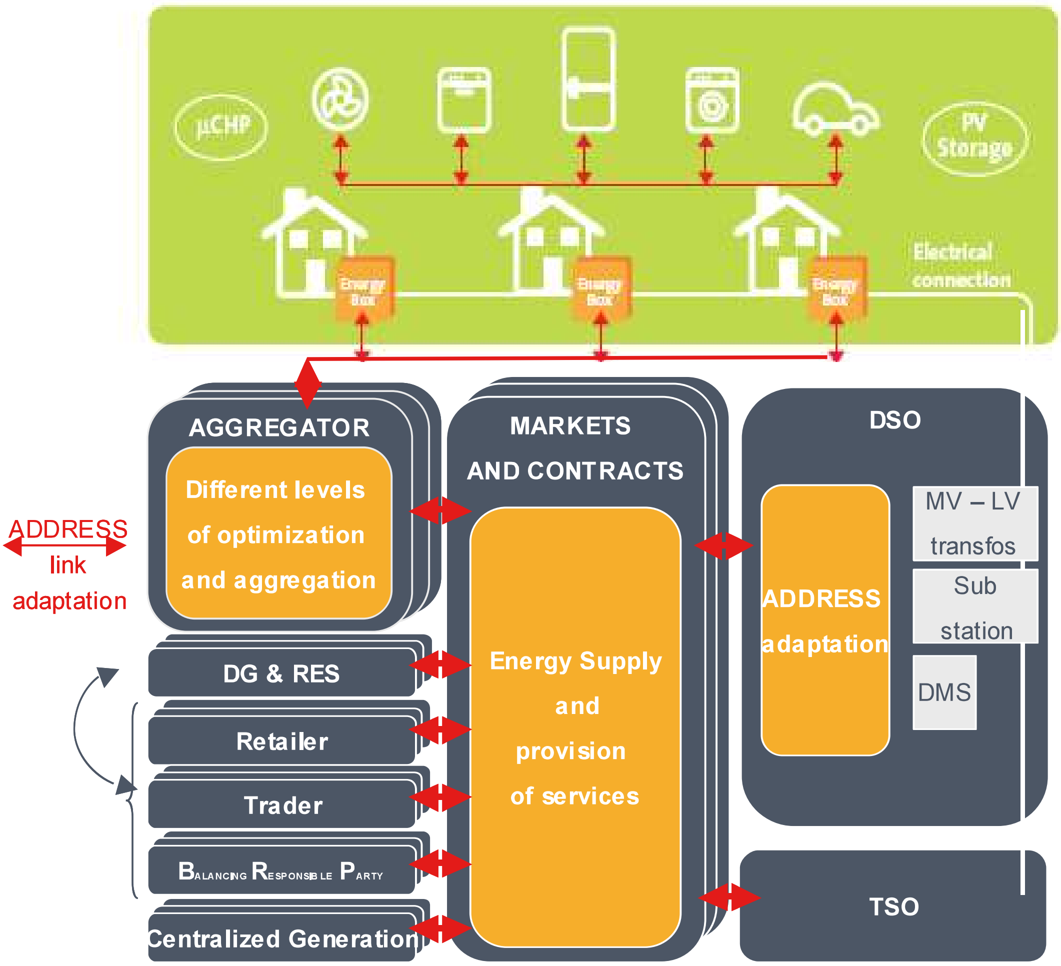


Figure 12 ADDRESS Architecture

The Aggregators have a central role in this conceptual architecture. In this case, the 'ADDRESS Aggregator' is the mediator between the consumers, the markets and the other participants.

In order to perform efficiently, the ADDRESS Aggregator needs to have the following functions:

a. ***Aggregator***: it gathers the capabilities and offered contributions of consumers to “build” AD products;
b. ***AD Market Operator***: it offers/sells the AD products to the power system participants via the markets and in this provide AD services to the electricity system players;
c. ***Risk Manager***: it manages the risks (price and volume risks) associated with uncertainties in the markets and responsiveness of the consumer base;
d. ***Flexibility Coordinator***: it maximises the value of consumers’ flexibility;
e. ***Market "referee"***: it interacts with consumers through price and volume signals and assesses their response and behaviour.

How the aggregator interacts with the customer (i.e. the point e. above) is crucial in the effective implementation of the conceptual architecture.

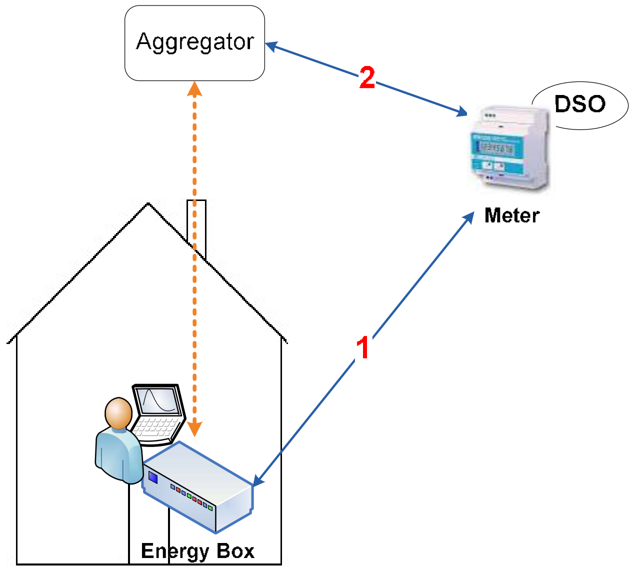


Figure 13 Energy Box in ADDRESS

The *Energy Box* (Ebox) is the key gateway to consumer interaction. Three are the link required:

1. Metering Equipment ←→ Ebox
2. Ebox ←→ Aggregator
3. Aggregator ←→ Metering Responsible (DSO)

Operation takes places according to the following 4 steps:

(i). The Ebox will receive 5 min aggregated measurement information either from the meter itself (where possible) or from a new device.

(ii). The Ebox will then send this information to the Aggregator.

(iii). The Aggregator will send an AD request to the Ebox depending on the needs of the moment. This requests are composed by a combined Price & Volume signals (an incentive (€/kW) based on actual power consumption).

(iv). After the completion of the command sent by Aggregator, Ebox will send back the action performed as a report on AD delivery (not for billing).

The Ebox also registers the consumer profile (every 15 min), which is used for consumer assessment and settlement. Finally, the consumption information is sent by the metering responsible (at least monthly) for billing purposes.

Preliminary findings and early learning points

The ADDRESS project is currently about halfway its project life, but already is has resulted in the following useful findings and learning points:

- The major technical problems in setting up field tests in ADDRESS have been:
  - There are almost no commercially available smart home appliances available. This means that home appliances have to made smart within the project. This requires considerable time and money (safety requirements/small numbers means high costs per unit)
  - There are no standards for interoperability for the different pieces of equipment: Energy Box, smart home appliances, metering equipment. (Manufacturers are reluctant to develop smart home appliances because of the uncertainty concerning the technical requirements.)
- End-user engagement has proven critical for the success of an active demand system:
  - Acceptability of AD-systems: even (or especially) when an AD-system is automated like ADDRESS, end users must receive enough information (feed-back) to have the feeling that they are still in control (system must be transparent)
  - The installation and de-installation of all the equipment at the end user and the motivation and recruitment requires more effort than had been expected. Things that need to be arranged are:
    - Communication channel(s), motivation of the users
    - helpline / hotline
    - appointments with the users (town hall meetings)
    - audit process: conformity of the user's installation, compatibility with tests
    - specification of the installation: contracts, training, certification of the installers
    - implementation of the technical installation
    - coordination between the technical installation and the user relationship management
    - organization of the de-installation
- Another major challenge the project faces is setting up the right commercial incentives and penalties for change in consumer behaviour. One of the strategies under trial is to

benchmark consumers against a normalised usage. The raises the following important issues:

- How to establish the norm? Is this based on the average of a consumer group?
- How to include rural dwellings, as these do not appear to compare well with the average household demand?
- Can this approach be scaled down to individual household averages?
- What happens in periods of out-of-norm usage, such as during extended holidays?

- The architecture delivers valuable insight in the roles and responsibilities of the Aggregator. One of the main issues to be resolved is which party is responsible for a difference in balance position. This erroneous balance position is the result the difference between the forecasted normal demand (done by the suppliers) and the forecasted demand after AD instruction (done by the aggregator). These forecasts are made in advance of real time, e.g. day-ahead or hour-ahead. Both forecasts will contain deviations from reality and these deviations can cause a significant imbalance for the suppliers, which will have to be compensated. A preliminary finding is that this risk is reduced or controlled when the supplier and the aggregator are the same party.
- ADDRESS also describes the role of the network operators facing AD. DSOs and the TSOs may not be the buyers of the AD products/services, they are involved in order to, at least:
  - Define and publish the required location information, e.g. the allocation of each consumer
  - participating in the AD into the relevant Load Area and Macro Load Area.
  - Verify whether AD applications (e.g. increase/decrease of power demand at specific network location and at a specific time) are compatible with secure and reliable network operation.

The project has compiled Sensitivity Matrices, which indicate the potential for Active Demand per postcode and/or per LV network section. These estimations are provided to the Aggregator as input. The project will also address which incentives are needed for the network operator to produce these matrices in a later, commercial, setting.