Why is demand response not implemented in the EU? Status of demand response and recommendations to allow demand response to be fully integrated in energy markets

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Abstract

The importance and benefits of Demand Response (DR) are well known, especially its contribution to the decarbonisation of the electricity supply.

Despite the barriers remaining today, in 2013 Europe was almost entirely shut to Demand Response while today consumers in some Member States have the opportunity to participate in Demand Response programs. In particular, the Energy Efficiency Directive Article 15.8 establishes consumer access to energy markets by asking Member States to encourage Demand Response.

The paper summarises the status of Member States legislations, market rules and technical regulations to enable Demand Response. In reviewing Member States progress in enabling Demand Response and consumer load aggregation, it emerges that a significant portion of them have yet to begin their regulatory review with any seriousness. However those Member States who have looked to enable Demand Response are succeeding despite continued challenges. In successful cases, TSOs and regulators are using the deregulated and competitive market structures to empower providers and encourage market entry for consumers. Europe's energy market is unique, and there is the opportunity to create unique solutions, combining competitive market structures with the decarbonisation agenda.

Finally the paper identifies and proposes regulatory initiatives that would significantly further facilitate this development. An important consumer enabler is to define and allow full Aggregation of Consumer Load. European market design should enable the participation of Demand Response and other distributed resources, to the same degree they now facilitate centralized generation units. Design elements include frequent auctions, short time durations, small minimal bid sizes, and the acceptance of asymmetrical bids. There is now good knowledge of best practice concerning this market design and this should be implemented by all the Member States.

Introduction

EUROPEAN ENERGY POLICIES

EU energy policy has three main pillars: sustainability and decarbonisation of energy production and consumption, security of energy supply (secure energy supplies to ensure the reliable provision of energy) and competitive energy market resulting in affordable energy supply for end-users.

The EU electricity market was progressively liberalised starting in the late 90's [1]. This major initiative was to give more power and options to customers and to make the market more competitive through un-bundling and cross border trade. Old national and regional utilities monopolies were gradually (the process is in reality not yet fully completed) transformed in unbundled companies (generators, distributors and retailers) operating in different markets and with different revenue sources.

The third "liberalisation" package further opened up the gas and electricity markets in the EU. The package was proposed by the European Commission in September 2007, and adopted by the European Parliament and the Council of the European Union in July 2009. It entered into force on 3rd of September 2009 [2].

The third package covers five main areas:

- unbundling energy suppliers from network operators
- strengthening the independence of regulators
- establishment of the Agency for the Cooperation of Energy Regulators (ACER)
- cross-border cooperation between transmission system operators and the creation of European Networks for Transmission System Operators
- increased transparency in retail markets to benefit consumers.

In parallel to the opening up to the electricity market the 2020 energy and climate targets have been adopted in 2007 (Conclusions of the European Council of 8 and 9 March 2007):

- A 20 % reduction in EU greenhouse gas emissions from 1990 levels;
- Raising the share of EU energy consumption produced from renewable resources to 20 %;
- An improvement in the EU's energy efficiency to achieve a 20 % savings on the EU primary energy consumption.

Recently more ambitious targets have been adopted by the EU leaders in *2014* for 2030:

- a 40 % cut in greenhouse gas emissions compared to 1990 levels
- at least a 27 % share of renewable in final energy consumption
- at least 27 % energy savings compared with the business-as-usual scenario (same scenario used for the 2020 target)[1].

In particular the 2020 targets for renewable energy have also contributed to a large change in the electricity sector in Europe. Under the Renewable Energy Directive [3], Member States (MSs) were allocated binding national targets for raising the share of renewable energy in their energy consumption by 2020. These targets, which reflect MSs' different starting points and potential for increasing renewables production, range from 10 % in Malta to 49 % in Sweden. The national targets will enable the EU as a whole to reach its 20 % renewable energy target for 2020 – more than double the 2010 level of 9.8 %. In 2014 the share of renewable energies in energy consumption was 16.1 %, and in particular the share of renewable energy generation was 27.4 %. Renewable energies, especially PV and wind generation, tend to fluctuate over time due to weather conditions and other factors. The penetration of renewable energies has created the need for additional balancing and other ancillary services for keeping the network operating. In the some EU Member States in some days renewable energies have fully covered the electricity demand, sending wholesale prices at very low levels. With renewable being available more than current demand, additional consumption could be triggered to store energy or to shift load. While traditional ancillary services were provided by integrated utilities mainly with generation options or with some demand side options controlled by generators, in the last year it has emerged clear the concept that electricity demand can be flexible and offer cheaper and "cleaner" solutions to balancing the grid than traditional options. Demand participation in balancing activity is defined as Demand Response (DR).

MARKET STRUCTURES

The wholesale markets are by far the largest and (theoretically) most liquid markets in any given Member State. Here retailers look to buy sufficient energy either from their own generators or from the market, to supply their customers. In order to maintain balance they should buy the same amount of energy for any given time period, as their customer's will consume.

This is part of their balance responsibility and each retailer will therefore have such a Balance Responsible Party (BRP)[2]. Wholesale markets include futures markets but also intra-day and spot markets, where energy is bought and sold 15–60 minutes prior to the time of consumption. After this point there is 'gate closure'. The wholesale market activity is at an end and the TSO is responsible to maintain balance from the time of gate closure to the micro second prior to consumption. This is done through balancing markets and ancillary services.

Retailers may be required to pay the TSO for these services according to the amount that they were off in their balancing calculations. However the company's generators may also earn from providing balancing and ancillary services to the TSO. This mechanism differs from Member State to Member State, but the principle remains the same.

ENTSO-E writes: 'Balancing refers to the situation after markets have closed (gate closure) in which a TSO acts to ensure that demand is equal to supply, in and near real time.

Efficient balancing markets ensure the security of supply at the least cost. An important aspect of balancing is the approach to procuring ancillary services. Ancillary services markets provide a range of capabilities which TSOs contract so that they can guarantee system security. These include black start capability (the ability to restart a grid following a blackout); frequency response (to maintain system frequency with automatic and very fast responses); fast reserve (which can provide additional energy when needed); the provision of reactive power and various other services.' [4]

DR is first established within the balancing and ancillary services markets [5]. These provide the best investment security and prices. The types of services required by the TSO also fit a consumer's capabilities well. Therefore this paper pays close attention to these markets.

Methodology

The present paper is based on a two years project carried out by the European Commission Joint Research Centre for the European Commission DG ENER. The project was to evaluate the status of Demand Response in each EU Member States based on the definitions and requirements of the Energy Efficiency Directive Article 15. In particular barriers to DR were

1. Recently the European Commission in its Winter Energy Packages adopted on 30 November has proposed the revision of the Energy Efficiency Directive, which includes a binding target of 30 %.

2. An independent aggregator must also contract with a BRP in order to maintain their own balance.

identified and common solution proposed. During the project a very detailed on line questionnaire was sent to national regulatory agencies, TSOs, large utilities (retailers), DR aggregators and independent experts. More than 50 replies were submitted. These were complemented by phone interviews, literature search. An expert workshop[3] with the same stakeholder listed above was also organized in October 2015. The final report prepared by the JRC and published in 2016 contains the most updated pictures of the DR status in EU MSs. In addition, it is worth noting that there are not many journal articles on the barriers and enablers of demand response in Europe.

Demand Response definitions and key characteristics

Demand response (DR) is a tariff or programme established to incentivise changes in electric consumption patterns by end-use consumers in response to changes in the price of electricity over time, or to incentivise payments designed to induce lower electricity use at times of high market prices or when grid reliability is jeopardised.

Demand Response programmes can be categorised into two groups:

a. **Explicit Demand Response** is the type of DR discussed in this article. In this programme, demand competes directly with supply in the wholesale, balancing and ancillary services markets through the services of aggregators or single large consumers. This is achieved through the control of aggregated changes in load traded in electricity markets, providing a comparable resource to generation, and receiving comparable prices. Consumers receive direct payments to change their consumption upon request (i.e., consuming more or less). Consumers can earn from their flexibility in electricity consumption individually or by contracting with an aggregator. The latter can either be a third-party aggregator or the customer's retailer.

b. **Implicit Demand Response** (sometimes called "price-based") refers to consumers choosing to be exposed to *time-varying electricity prices* or *time-varying network tariffs* (or both) that partly reflect the value or cost of electricity and/or transportation in different time periods and react to those price differences depending on their own possibilities (no commitment). These prices are always part of their supply contract. Implicit DR does not therefore allow a consumer to participate alongside generation in a market.

It is important to note that neither form of DR is a replacement for the other. Many customers participate in Explicit DR through an aggregator, and at the same time, they also participate in an Implicit DR programme, through more or less dynamic tariffs, such as a day/night tariff. The requirements and benefits of each are different and build on each other. The two are activated at different times and serve different purposes within the markets. They are also valued differently. While consumers will typically receive a lower bill by participating in a dynamic pricing programme, they will receive a direct payment for participating in an Explicit DR programme.

Explicit DR provides a valuable and reliable operational tool for system operators to adjust load to resolve operational issues. Implicit DR, (dynamic pricing) does not allow a customer to participate in the balancing or ancillary services markets, or in most existing capacity markets. It will also not allow for regional demand-side services for TSOs and DSOs, and it does not provide the system as a whole with a dispatchable resource. For this reason it is critical that DR activation and market participation is separated from the supply contract. This means that the offering is separated from the customer's electricity price. On the other hand, explicit DR does not have the same market reach as a retailer-enabled dynamic pricing programme. Both forms are therefore required to allow all consumers to fully participate and benefit from their flexibility.

THE ROLE OF THE AGGREGATOR

The separation of the supply contract requires a new role: the role of the aggregator. An aggregator is a service provider who operates – directly or indirectly – a set of demand facilities in order to sell pools of electric loads as single units in electricity markets. The service is provided separately from any supply contract[4]. The aggregator – a service provider who may or may not also be a retailer of electricity – represents a new role within European electricity markets, but is well established in the USA, Australia, South Korea and Japan. Most consumers do not have the means to trade directly into the energy markets because, for example, they are too small to manage the complexity. They require the services of an aggregator to help them participate. Aggregators pool many different loads of varying characteristics and provide backup for individual loads as part of the pooling activity, increasing the overall reliability and reducing risk for individual participants. They create one "pool" of aggregated controllable load, made up of many smaller consumer loads, and sell this as a single resource. These loads can include electric heating and cooling, fans, water boilers, grinders, smelters, water pumps, freezers, etc.

Aggregation services provided by an independent player or a retailer are a necessity for creating explicit DR programs. However, there are certain business model factors which can make it difficult for many retailers to provide these services. These can be broken into two categories, the retailer's potential conflict of interests concerning DR and the required changes in business model.

DR is outside the expertise area of a retailer. It is a highly specialised service offering centred largely on knowledge of heating and cooling systems, industrial process, and marketing. To be successful, retailers must either outsource this expensive expertise or hire and train new staff – they will not have these resources in-house. Added to this, DR could disturb their existing revenue streams from generation and balancing. For example, retailers who own generation assets, may earn an important part of their annual returns when prices are high. They also charge the large (and small) consumers for taking on their balancing risk – if they provide demand response they

3. The workshop presentations are available at http://iet.jrc.ec.europa.eu/energy-efficiency/node/9100.

4. An exception: A retailer may aggregate and automate their consumer's load in order to manage their own balancing risk, along with generation assets. The consumer may therefore not receive a direct payment but only a lower electricity cost. That said their load will be used in the same way by the retailer as a generation asset.

lower their income from generation, as well as the income from providing protection against balancing costs[5].

Some retailers do rollout DR programs, (and do this well, EDF, E.ON, Dong Energy and Helsinki Energy being three examples). As in other competitive markets, such as Victoria, Australia and New York, there are also small independent retailers – who do not own generation assets – now emerging in Europe. A portion of these have made DR a core part of their business model[6]. However, truly independent retailers, which are not owned by municipalities and do not own their own generation assets, serve a tiny proportion of European load (estimated at less than 2 %).

To date, the activity of these retailers alone has not created market momentum for DR or a positive cycle of investment in any competitive market globally. Without aggregators, the programmes stay small and subordinate to generation assets. This is why the role of the independent aggregator is important.

The upfront costs, the risk of failure and the decrease in known and trusted revenue streams means that a retailer will not engage in DR easily. Established retailers who do engage seriously in DR do so because they face at least one of three challenges:

1. A total collapse of wholesale market price, removing the value of their generation portfolio. However, this involves destroying the market signal.
2. Ownership of an inflexible generation fleet, such as nuclear or wind, which drives up balancing costs and does not provide the retailer with a means of earning from exceptionally high prices.
3. Threats from outside independent aggregators, who create market momentum, a sense of competition over services and who raise consumer awareness.

When a retailer states that, dynamic tariffs, feedback programs or DR programs provide no positive business model – this is probably accurate. There may be no viable business model for the retailer. What may not be accurate is that the same programs would create no benefit for industrial, commercial or residential consumers.

Clarifying the role of the independent aggregator is therefore an important enabler of consumer engagement and the healthy growth of market competition around DR services in a Member State. An aggregator can only succeed when their customers succeed and benefit from DR. Competition between participants, aggregators and retailers, therefore spurs healthy competition in DR services for customers and creates substantial volumes of flexibility. For example, the PJM Market Activity Report on DR (from August 2015) shows that 82 % of Demand Response capacity in PJM comes from independent aggregators [6]. This trend has been increasing over the last few years. The shares are similarly high in other jurisdictions that have mature DR markets, such as Western Australia, New Zealand or other US interconnections (e.g., New England and New York).

Demand Response in the Energy Efficiency Directive

In order to accelerate the pace towards the full deployment of the Demand Response's potential, the recent Energy Efficiency Directive (EED) 2012/27/EU, include specific provisions and significant actions in support to Demand Response.

Art. 15.1 requires that technical or contractual modalities, in particular network tariffs and regulations are adapted or changed if necessary in order to allow energy efficiency measures and services to be implemented: this implicitly allows the development of Demand Response participation in the energy market (without affecting the security of the system).

Network tariffs and dynamic pricing can be considered to give clear market signals.

Art. 15.4 requires that network tariffs and regulation do not prevent TSOs, DSOs or energy retailers, from offering measures to shift demand from peak to off-peak or measures inducing customers to reduce demand. Moreover, network tariffs must reflect the reductions in network costs brought by Demand Response.

Art. 15.8 contains dedicated provisions for effective relationships between different stakeholders, allowing for the engagement of the various actors including DR alongside supply in wholesale and retail markets. In meeting requirements for balancing and ancillary services, TSOs and DSOs must treat Demand Response providers, including aggregators, in a non-discriminatory way: Member States engage in the definition of technical modalities to promote access and participation of DR in balancing, reserve and other system services markets. By promoting dialogue and coordination between the parties, National Regulatory Authorities should also guarantee that clear technical rules and operational requirements (tendering, contractual arrangements, etc.) are disclosed, based on which DR can take part in the balancing market and in other system services.

Below is an overview of the elements used to analyse the current status of MSs' regulation concerning the implementation of Article 15.8.

THE TECHNICAL MODALITIES REQUIRED FOR DEMAND RESPONSE

Article 15.8 requires that regulators, TSOs and DSOs, adjust the technical modalities and requirements for market participation in line with participants' capabilities and the needs of the market. These modalities fall into 3 general categories. Though they usually are developed in cycles, they are all required for healthy market growth.

Technical modalities which:

1. Authorise DR, allowing consumer load to compete alongside generation assets in all markets;
2. Legalise and enable aggregation in all markets;

5. When a customer receives a flat electricity price, they do so because the retailer has taken on the balancing risk (the risk that wholesale prices may go higher than planned). This is a form of insurance for the customer. Just as an insurance company will not want their clients and competitors to know what they earn off of the insurance premiums, the retailer may not want consumers to know what they earn from taking on the balancing risk.

6. The wholesale market structures (except in the Nordics), insurance requirements, balancing requirements, data requirements, registration requirements plus most of the technical barriers that face aggregators, also face small retailers providing DR. A retailer business is also more expensive to establish, an aggregation business requires €5–7 million, a retailer at least €15–€20 million and they will continue to have issues of scale. Today, they do not have a single group representing their interests in Brussels, likely due to their small size and the difficult business model. This is unfortunate as their needs would require support.

3. Adjust technical modalities in all markets, in line with consumer capabilities and market requirements.

1. Authorization of demand-side resources to compete alongside supply

Authorisation is provided through a specific set of rules for each market, delineating how load participates. This condition is far from being fulfilled in the majority of EU Member States. In fact, in the majority of national electricity markets, demand-side resources are not allowed to participate, or they are allowed to participate in only one programme. Generators providing resources are pre-qualified, measured and paid. They also pay penalties if they do not supply according to contract. These same structures are required for DR resources as well, if they are to participate alongside supply. Prequalification, measurement and verification protocols must ensure reliable delivery of demand-side services in a manner that will still enable strong resource development. Several MSs claimed that they had legalised DR but they had not developed any methods for pre-qualifying[7], measuring, communicating with or paying providers.

Fair and transparent baseline methodologies should be publicly available. The volume of demand variation being sold into the market is assessed against a baseline[8]. Volumes of demand-side flexibility are calculated as the difference between what the consumers normally consume (the baseline) and their actual measured consumption during the dispatch, measured using appropriate metering. If no baseline methodology is developed, consumers cannot be paid for what they provide.

Pre-qualification, measurement and verification processes should be defined and take place at the aggregated level. It is important that the pre-qualification and communication protocols imposed are between the system operator and the aggregator. This saves the individual consumer from having to sustain the same administrative and measurement burden of a centralised generator and is a key element of adjusting technical modalities in accordance with the capabilities of participants.

Payment criteria, volumes and values should be transparent and based on open and fair competition. For similar services delivered to the system, meeting the requirements of the market, compensation for Demand Response payments should be commensurate with those services delivered by generation[9].

The market structures should reward and maximise flexibility and capacity in a manner that provides investment stability.. This may entail availability payments, a guaranteed number of activations during the year or some other form of reliable payment. These should create investment stability to allow for the building of new resources designed to be available at short notice and for short periods of time. Ideally, market participants should be paid according to the Pay as Cleared (PAC) principle, to allow for the most competitive outcomes, as stated today within the European Network Codes.

Penalties for non-compliance should be defined, fair and should not favour one resource over the other. Penalties needed to ensure reliability, so both supply-side and demand-side resources should be penalised for non-compliance. That said, penalty calculations for each may need to be differentiated depending on the market and the risk posed.

2. Enable Aggregators

In order to allow aggregators to participate, a Member State must define roles and responsibilities around aggregation providers. Several Member States[10] have allowed aggregated load to be sold in the market but have not defined the roles and responsibilities of those selling them. This by default means that only retailers are able to provide these services to consumers. To enable independent aggregators to enter the market in a safe and scalable manner, it is critical that the role and responsibilities of these new entrants are clarified. In particular, it is important that the relationships between retailers, Balance Responsible Parties (BRPs), and independent aggregators are clear, fair, and allow for fair competition. To promote demand-side flexibility, a market design should guard consumer interests and create a level playing field for all competitors. Consumers that wish to generate revenue from their flexibility should be able to choose freely between all market options and available service providers. They should not be restricted to using a service provider that is tied to or approved of by their retailer.

For this to happen, the aggregation service provider must be able to operate independently from the consumer's BRP/retailer, which is potentially its competitor who may block their market entry[11]. Therefore, standardised frameworks and processes should be put in place to enable the smooth functioning of the market and at the same time protect the customer-aggregator relationship.

There are four elements to be defined through a standardised framework to allow the market to function reliably while allowing consumers to choose their aggregation service provider.

Volumes: Standardised processes for assessment of the traded energy between the BRP and the aggregator[12].

Compensation: The retailers' BRP is required to buy, or source, electricity in advance in order to maintain balance. When Demand Response activation takes place, they may lose this purchased energy, as the consumer will not consume as planned. This may not be significant in a balancing market

7. Pre-qualification is to assure ex-ante that the DR provider or aggregators has all the technical and economic means to deliver in a reliable manner DR services.

8. As for the evaluation of energy savings derived from energy efficiency action, the baseline is a hypothetical line representing what would have happen in the absence of DR. There are several methods to establish the baseline as presented in [8], in the context of the paper it is highlight the issue that a baseline must be established and agreed.

9. An added issue: In many European Member States today, generation resources have access to the markets at an embedded guaranteed cost through a longstanding bilateral agreement with the TSO or retailer. This can result in suppressing the price for new entrants both retailers and aggregators.

10. Belgium, France, Ireland and UK allows independent aggregators, some Member States only allow retailers as aggregators (The Netherlands, the Nordic countries, Germany) .

11. The French competition authority, in its opinion 13-A-19, declares that the prior agreement to be given by a BRP for the participation on a market by an aggregator was not compliant with article 14.6 of the directive "Services" 2006.123/EC (12 December 2006). This article prohibits "the direct or indirect involvement of competing operators, including within consultative bodies, in the granting of authorisations or in the adoption of other decisions of the competent authorities, with the exception of professional bodies and associations or other organisations acting as the competent authority; this prohibition shall not concern the consultation of organisations, such as chambers of commerce or social partners, on matters other than individual applications for authorisation, or a consultation of the public at large". It is also important to note that if the consumer's retailer owns generation assets, the consumer's demand side flexibility is also a competitor to the retailer's supply side generation.

12. Transfer of energy between the BRP's and the aggregator's balancing groups following a Demand Response dispatch.

but it will be in the wholesale markets. Some Member States such as France have decided that the aggregator should pay the BRP for this energy. Others are still looking for other solutions. However, a solution is absolutely critical to allow independent aggregation and it should be fair to both the retailer, who is fulfilling its required role, and the consumer or aggregator looking to enter a market. Any price formula should reflect as closely as possible the average sourcing costs of the energy transferred.

Data exchange: A clear definition of what data needs to be exchanged between BRP, aggregator and TSO to ensure all can fulfil their obligations whilst not having to share commercially sensitive information.

Governance structure: An appeal process and an appeal body, in case any issues need to be resolved.

Different adjustment mechanisms to address the above situation have been trialled in a few MSs (e.g. France, Austria, the Netherlands) and implemented in international markets. It is important that settlement procedures are fair, standardised and well defined by the regulator and TSO in order to protect the financial interests of all parties.

3. Adjust technical modalities in-line with participants' capabilities

The third set of criteria assesses whether the participation requirements (technical modalities) in the electricity markets enable access by a range of resources, including demand-side resources.

While genuine system constraints and security concerns must be respected, many different product/programme participation requirements were historically designed around the specifics of generators by necessity. Today these narrow criteria are no longer justifiable because they block low-cost demand-side resources, and hence artificially inflate procurement costs. For example, a system's physical need for reserves typically requires the resource to be available for between ½–2 hours. However, the market participation requirements may state that load must be available for 12 to up to 16 hours. This fits the requirements of coal-fired generation, which operates most efficiently for extended periods of time at minimal incremental cost once the start-up costs have been incurred, but it does not reflect the actual system need. Markets should be designed in a granular manner, in order to enable the full range of resources to enter.

As results of the survey and the workshop the following technical modalities were identified, reflecting the elements, which would enable DR. They also capture the main barriers facing DR in the EU MSs markets today

Competitive framework: the market becomes significantly more competitive when auctions are held often encouraging participation in a transparent manner. This also supports demand side resources as a consumer may be available one month or one week but not be able to guarantee availability for an entire year.

The required size of a bid: bidding size requirement should be small in order to open markets to new entrants. A consumer or aggregator may need to provide up to 50 MW to participate in a market (a big barrier) – rather than the more realistic 3–5 MW or less.

Duration of the call: Extended duration or availability requirements are a barrier for consumers and do not represent the technical requirements of markets. Therefore the length of time a participant should be required to adjust consumption should be as short as possible.

Frequency of activations/short recovery periods: depending on the type of market, consumers require time to rest between activations.

Provide the option of asymmetric bidding: few consumers can increase and decrease consumption equally. A requirement for symmetrical bids acts as a significant market barrier to consumer participation. In Member States where the TSO is willing to enable Demand Response, asymmetrical bids are allowed.

The technical modalities describing participation rules of the different products/programmes should allow a range of technologies to participate, taking into account their different characteristics, while ensuring that the system's needs are met. In a competitive market, the TSO and regulator have the responsibility to enable a range of resources to compete on an equal footing – not only selected forms of generation. Each MS has individual market structures and therefore there is not a one-size-fits-all set of perfect market products.

As can be seen from the list above, enabling DR is a significant development in any MS's regulatory framework. It requires that the regulator and TSO[13] decide to make consumer participation and market liquidity a priority. It also requires respect for providers and the willingness to engage with their representatives. It will take time to bring political theory in line with regulatory reality.

Status of DR in EU MSs

In reviewing the continued progress of MSs toward opening markets for DR, a uniquely European model begins to emerge. In these successful cases, TSOs and regulators have used the deregulated and competitive market structure to empower providers and encourage market entry for consumers. These positive examples as described in this articles, could be replicated across Europe by national regulators and TSO to enable DR.

While a significant portion of MSs have yet to begin their regulatory review with any seriousness, those who have looked to enable DR are succeeding, despite continued barriers and remaining issues. This bodes well for the future of the market, particularly when we consider the overcapacity of generation now available in some MSs. The fact that consumer load is still able to compete successfully and reliably under these conditions is positive.

However, further clarity is required. A main finding of the JRC research is that many national regulators find the process complex and confusing. For example, two repeated questions were:

- *Is it enough that Demand Response is not specifically forbidden?*
- *Is it enough that retailers can aggregate consumer load?*

They may also be unsure as to what is needed in order to either fulfil the requirements of the EED or what a positive market structure would include. As one regulator from an inactive

13. At this stage some of the EU MSs TSOs are not all full independent from generation companies, thus creating a possible conflict of interest.

Member State remarked 'But Demand Response is not illegal here, and no one wants it anyway – why bother with all these little technical changes? They are a lot of work.'

MSs can be divided into roughly three groups regarding the regulation and technical rules to enable DR. More details are summaries in the table in the annex.

GROUP ONE

In this group are those MSs who have yet to seriously engage with DR reforms. Obligatory provisions of the relevant EU Directives may have been transposed in name but not in fact.

Therefore while DR may be 'legal' the MS have not adjusted their regulatory structures to enable demand side resources to participate in the markets, nor begun the process of defining the role of the independent aggregator and DR service provider, nor adjusted critical technical modalities. The result is therefore that though DR is 'legal', there is no defined party to offer the service, no way to measure or pay for the service and no markets in which consumers or aggregators can sell demand side flexibility. Therefore, despite significant progress in certain EU MSs consumers and DR providers therefore remain barred from the majority of electricity markets in Europe.

These national regulators often state they find the development of the needed regulatory changes complex and confusing. It may also not always be understood how (or why) the regulatory environment would need to be changed at all. Regulators in Portugal, Spain, Italy, Greece, Croatia, the Czech Republic, Bulgaria, Romania,. Poland, the Baltic countries, Slovenia, Slovakia, Cyprus and Malta have not as yet enabled DR or aggregation. However, Italy is aware of the issue and is undergoing a regulatory review, the status may change within 2017–18. Greece has created one auction-based program for large consumers and intends to open the market further. Poland has created two programmes, however these are not successful today due to the low and controlled prices offered by the TSO.

Traditional supply approach in most of the CEE countries makes DR to be considered as a hassle or an alien solution. Mostly, regulation text allows the participation of DR (all or almost all), and EU Directives are transposed, but this does not translate into real practice. In Hungary, the regulator always keeps an overcapacity from traditional power stations that equal the expected load profiles from RES each day. In these regimes, the Regulator legally allows DR to join the network, however when the licensing procedure takes place, in the end licenses are not approved on minor or questionable basis. There is no market pressure, and out of the very few applicants only 1 or 2 succeed to finally participate. For example, in Hungary, the only participant is a very flexible chemical factory, which has an additional on-site power generator (CHP), which was the way the Regulator was convinced about the low risk of participation in DR.

The wide-scale use of ripple control[14], an out-dated, but structurally built-in load-management system is seen as a key barrier to DR in several CEE countries, such as Czech Republic, Slovakia and Hungary. Currently, the control is in the hands of DSOs, in e.g. the Czech Republic, and the function as DR is partial. In effect, the problem is that in case of ripple control, all the decision is in the hands of the supplier/retailer/DSO, while DR would allow the consumers to make decisions themselves. Ripple control works with dual-tariffs (or other time-of-use tariffs), which have developed in recent years, but responsiveness is far below from DR. In addition, this technology is not compatible with smart meters, increasing the cost-benefit ratio of this introduction significantly in the affected countries.

Finally, in many of the CEE countries (e.g. Bulgaria, Croatia, Hungary), and all of the Baltic countries, the implementation of the Third Energy Package in practice and a full liberalisation of the electricity markets are lagging behind. Only, after full unbundling and increasing competition, would it be possible to start developing the regulating market, which could make it more attractive for a wider range of customers to provide regulating and/or emergency reserves. In all of these countries, at least some of the prices are regulated, especially those of households and small consumers.

GROUP TWO

The second group of MSs (Austria, Germany, the Netherlands, and the Scandinavian countries) are in the process of enabling DR through the retailer only. This is an important choice – due to the fact that the customer will not be offered a clear value for their flexibility – rather they will receive this bundled with their electricity bill. They either need to reject the entire package or accept. However it is difficult or impossible for them to know what they are in fact rejecting/accepting as they will very rarely (if ever) have a fully transparent offer[15]. It also limits market offerings to those that are positive for the retailers in a given country – which is often not be the same as those which would benefit the consumer.

These Member States limit aggregators to the role of service providers to retailers rather than independent parties providing independent offerings to consumers. The Nordics, the Netherlands and to a certain degree Austria, are in this group. Germany is considering enabling independent aggregation but a formal decision and key regulatory adjustments are yet to be made.

The Nordics have put in place Smart Metering and a liquid wholesale market. They have also performed regulatory reviews, which map market entry barriers for new entrant retailers and made dynamic pricing available to residential consumers. They have also enabled full aggregation of consumer load. Prequalification for participating in a market is therefore measured at the aggregated pool level, rather than for each consumer individually – an important enabler of DR. This is positive, however only retailers can provide aggregation services freely, and unfortunately the business model issues for retailers concerning DR remain the same in the Nordics as anywhere else and therefore growth will continue to be slowed. Also while the Finnish TSO and regulator have made progress in adjusting other technical modalities to allow DR, Sweden and Denmark

14. Ripple control involves superimposing a higher-frequency signal onto the standard main power signal, in order to regulate the load from outside through a receiver that is attached to non-essential (heating and water-heating) devices.

15. This is not because the retailer will be looking to 'hide' value – rather the fact that the customer engages in DR will impact several aspects of the retailer's business model, their balancing costs, their company earnings from generation, network tariffs. The DR offering is therefore joined to the cost of the customer's electricity. It is not transparent and separated.

have not as yet opened the market sufficiently to allow market entry even for retailer driven DR.

Germany does not yet enable independent aggregation and has made little progress in adjusting technical modalities to allow market entry for demand side resources. Added to this, the structure of their network fees still penalise (fines) large consumers who participate in the programs, while smaller consumers are never provided the opportunity as the metering infrastructure is not in place and/or the cost of entry is too high. The government is aware of the issue and is performing a regulatory review.

The Netherlands does not enable independent aggregation. However, it has succeeded in opening the balancing market to consumer participation through the BRP. Beyond the balancing market there is little activity today and little aggregated DR in any Dutch market.

The Austrian TSO and regulator have established innovative market structures, which encourage competitive consumer participation, and allows DR to participate alongside supply in the ancillary services market. They also have looked to open the market to new entrants by lowering the cost and risk of becoming a BRP. This is not fully successful, but is an interesting solution and has enabled 4–5 new entrants to provide services. The technical modalities in place still cause entry barriers, particularly in the area of punitive communication requirements (such as a requirement for a €10,000–€20,000 dedicated telephone line to each consumer) and onerous pre-qualification procedures.

GROUP THREE

The third group of MSS that enables both DR and independent aggregation includes Belgium, France, Ireland and the UK. Belgium and France have both defined the roles and responsibilities around independent aggregation.

In France this work is completed and aggregators participate in every open market. France creates standardised processes which allow the aggregator/consumer direct access to market without requiring the permission or involvement of their potential competitor, the retailer. The process defines: volume measurement criteria, data exchange procedures, and payment formulas to allow for smooth payment of sourcing costs to the retailer/BRP. Though issues remain, the system has created one of the most dynamic DR markets in Europe.

The technical modalities remaining in the balancing and ancillary services markets still cause entry issues and are under continued review by RTE, who has already made significant adjustments. More complex issues remain within the FCR (*Primary Control*) and FRRa (*Secondary Control*) and capacity market design. In all three of these markets (for different reasons), EDF is or will be both the main buyer and provider of resources. This causes obvious conflicts of interest issues and entry barriers for new entrant providers, though aggregators have contracted successfully with EDF to provide FCR and FRR resources. Within the FCR and FRRa it would be possible for RTE to purchase the resources, as they are the party in charge of this market and the final user of the resource. This would solve the structural issue. The capacity market design has several important elements encouraging and enabling DR and aggregation, though the issue of a single main purchaser and provider is likely to remain.

The Belgium ancillary services markets are open to independent aggregators and DR. The technical modalities have been adjusted to enable and encourage DR within the ancillary services markets. Access to the balancing and wholesale markets remains problematic. Discussions are underway to create a standardised process between aggregators and BRP/Retailers. When these are completed the path to market should significantly improve for consumers and aggregation service provides.

In Great Britain the ancillary services market is open, and the regulator has allowed aggregators free access, despite the fact that the role is yet to be defined. Therefore, both retailers and aggregators now actively provide services to residential, commercial and industrial consumers when this is possible within the given market structures. GB is also rolling out smart meters and encouraging both DSOs and retailers to create innovative services. The market is dynamic with many small technological start-ups also benefiting for GB's healthy financial market to establish companies and create innovative solutions[16]. That said, the introduction of a capacity market structure which heavily favours generators, has been a significant set-back for DR in GB. Fair and open capacity markets can provider a critical source of investment stability for DR, however due to the fact that the market structure in GB presents entry barriers, within every level of the market structure (from the structure of the auctions to the measurement of load) DR providers now have to compete with a generation fleet benefiting from subsidies that they do not receive.

DR providers and small independent retailers also voiced frustration at a lack of full representation during key meetings on market design. Similarly the Short Term Operating Reserve (*STOR*) market structure was changed in a manner which lowered the earnings of consumers and encouraged the entrance of older generators. A large portion of demand side flexibility and approximately 9–10 aggregators left the STOR market in 2014–15 as a result, lowering the creation of new demand side capacity. Aggregators voiced the hope that with the new government, a more constructive dialogue between providers and policy makers might be possible. Several aggregators are already successfully engaged with National Grid and providing Ancillary Services using everything from residential to industrial loads.

The Irish market is centrally dispatched and therefore relatively simple to access for aggregators, as the TSO is in full control of the market they are able to ensure the retailer and BRP are not thrown out of balance by the DR activation. There are two ancillary service markets open, however the frequency market and the balancing and wholesale market are not yet accessible. Today technical modalities have yet to be fully adjusted in order to enable aggregation or DR. This includes for example insisting that each consumer undergo an expensive pre-qualification process rather than measuring and qualifying the aggregated pool.

Recommendations for further developing DR in the EU

Following the analysis of the DR markets in the EU Member States and the discussion with the stakeholders a list of positive developments in Member States was identified, these developments are essential to establish a real DR participations in energy markets in any Member State. It is also important

16. Access to capital is an important enabler of British start-ups, a critical resource that can be almost entirely missing in other EU Member States.

to notice that at the time of the analysis (early 2016) no one Member State yet contains all of these elements, however they are complementary and could well be combined as a repeatable template for success.

KEY ELEMENTS FOR ENABLING AGGREGATED DEMAND RESPONSE

As already stated in this article aggregation services provided by an independent player or a retailer are a necessity for creating explicit DR programs, even for large industrial loads in order to offer the needed flexibility and the required size of curtailment.

A rough template of a dynamic market structures, encouraging flexibility resources and Demand Response:

Market Structure Elements and Aggregation

Open to DR Wholesale, Balancing, Ancillary Services and eventually, the capacity markets. (France is the first and only Member State to open its wholesale market to aggregated Demand Response.)

Both Energy and Availability Payments Made in at least one ancillary services market: the customer is paid for providing capacity to the system. This allows for investment security and encourages participation. Multiple Member States (e.g. Belgium, France, etc.) provide this)

Frequent auctions are needed for all the markets, and in particular the capacity one (Austria). Weekly auctions for capacity payments: the weekly bidding for the customer's availability payment allows the customer to calculate their availability on a weekly basis taking into account factors such as vacations, orders, weather, etc. For example, in an annual bidding process customers and aggregators have to bid according to their lowest availability level for the entire year. The weekly bidding is therefore an important enabler. Daily energy auctions – mean that the consumer can set the price for that day's availability.

Appropriate Network Fees should be in place in order to avoid penalising DR: market efficiency is encouraged by not penalising consumers for participating in DR, and changing their consumption profile. For example, the Austrian DSOs separate balancing energy from normal consumption when calculating network charges, and charge for the balancing energy at a much lower rate.

DSOs are encouraged to enable energy efficiency and DR: in the GB the regulation surrounding the payment of DNOs has been fundamentally adjusted and they are now able to benefit from improving the efficiency of their systems, including through demand side program development. This mechanism is unique to GB today but could be replicated in other Member States.

There is the need for *Matching Markets to Capabilities of Consumers:* example of this is the Belgian Frequency Market. The market is divided into three parts, part one is a symmetrical program – suitable for generators. Part two and three are asymmetrical programs, one for increasing and the other for decreasing consumption, a critical enabler of consumer participation as consumers will rarely be able to increase and decrease consumption symmetrically. Part two and three are activated between ±100–200 mHz allowing consumers to balance the larger changes in frequency. This solves two issues: i) consumer load is well suited for following large changes in frequency, often at a lower cost than generation: and ii) the larger shift means that the consumer is activated less often. This is an example of a market design which is moving away from a generation centric model and endeavouring to capture the strengths of both resources.

*Reward Aggregation and establish relations with BRPs***:** the standardised process between BRPs and aggregators is a significant enabler as it creates the framework by which aggregators can have a clear path to market (France, Belgium). This framework includes: volumes, i.e. standardised processes for assessment of the traded energy[17]. Compensation, e.g. for markets where there is a significant energy component (balancing and wholesale) a price formula to calculate the price for the transferred energy is needed. This is energy the retailer bought which the consumer does not consume because they are participating in DR. There is widespread acknowledgement that the retailer does indeed lose income through the balance responsibilities during a DR activation by an independent aggregator.[18] In the case of demand reduction, the aggregator pays the BRP/retailer; in the case of demand enhancement, the BRP pays the aggregator. This price formula should reflect as closely as possible the average sourcing costs of the energy transferred.

Data Exchange: a clear definition of what data needs to be provided to the BRP through the TSO, to ensure both the aggregator and the BRP can fulfil their obligations whilst not having to share commercially sensitive information.

And finally Governance structure: an appeals process and an appeals body, in case any issues need to be resolved.

Technical Modalities, which take into account the capabilities of participants

Enable Full Aggregation of Consumer Load (Finland, Denmark, Sweden, BG, France …): qualification for participating in a market is prequalified and measured at the aggregated pool level, rather than for each consumer individually. This is an important enabler as it allows the aggregated pool of consumer load to be treated as a single resource, maximising the group's joint potential. It also allows the aggregator to act as mediator for the consumer, protecting them from onerous and complex technical pre-qualification measures. It is questionable that some TSOs in Europe are capable of accepting pre-qualification of the pooled load and others are not. They should all accept it. If four or five MSs can do it the others MSs can as well, and this critical barrier could be removed from all MSs.

The *baseline methodology* is appropriate and realistic – based on consumer capabilities and metering data (Greece, GB, France among others).

17. I.e. the transfer of energy between the BRP's and the aggregator's balancing groups following a Demand Response dispatch.

18. According to the market modelling of the SEDC, using the hourly market price (winter 2013–14), in France alone, 1 GW of Demand Response activated 500 hours a year would lose the French generators €469 million a year in reduced wholesale market revenues (due to the lowered clearing prices), while sourcing costs would come to only €27 million (according to EDFs own calculation methodology). At the same time the payment of this €27 million by French aggregators to the retailer would remove 85 % of their margin for participating in the wholesale markets – effectively killing their business. Therefore there is reason to believe that the argument of large retailers insisting on the payment of sourcing costs is not over the €27 million a year but to protect against the €465 million of potential losses a year to the generation assets. (In Germany the generation losses through the reduced clearing price would be €959 million a year against €27 million for sourcing costs). The sourcing cost issue therefore justifies careful analysis.

The *payment criteria* is clear and transparent and pays a full price for services rendered (Greece, Austria, Belgium, France, GB, Nordics …).

Pay as Cleared (this element is already included in the Network Codes today): this means that all market participants are paid the clearing price for the market, even those that would have provided resources for less. This has a benefit as the low cost resources multiply, gradually lowering the clearing price.

Granular Availability Requirements: for example, the Austrian Secondary control market is split into three time periods meaning that a consumer available during the day can be paid for this availability and does not need to be available at night as well, for example.

Short Call Duration in the reserves markets: should be 1–2 hours in alignment with actual market requirements.

No minimum required size for consumer participation (Finland, Denmark, Sweden).

Real-time prices in the balancing market is communicated to consumers. This allows them to react to these prices and earn off of their ability to help balance the system (the Netherlands).

The *capacity payments* within the capacity market support investment security and consumer engagement (Ireland).

Conclusions

Despite the barriers remaining today, in 2013 Europe was almost entirely shut to Demand Response. Significant progress has therefore been made between 2013 and 2016, in particular as results of the introduction of the EED and the progresses in the electricity market liberalisation. Europe's energy market is unique, and there is the opportunity to create unique solutions combining competitive market structures with the decarbonisation agenda (e.g. high penetration of renewables). This review has provided new insights on key success criteria for Demand Response which are in line with and benefit from, Europe's competitive market design.

No single MS has yet succeeded in incorporating all the enabling elements described above in their markets. However these elements complement each other and bring about a constructive unity. They are in fact a repeatable template for realistic and positive enablers of DR and Aggregation in Europe[19]. Today this template is not communicated to regulators fully. While some TSOs and regulators clearly understand DR and aggregation well, and have even succeeded in encouraging growth, others require further information and support.

TSOs and regulators in for example, Belgium, France, Austria, Great Britain and elsewhere, have been making a concerted effort to enable DR to enter the markets within the competitive and de-regulated framework. Some of these solutions are innovative and capture the capabilities of demand side resources in a uniquely European manner. What is now needed is for these solutions to be unified, communicated and replicated across MSs. A regular reporting on the status of the DR in the EU MSs should be produced and discussed with all the stakeholders

19. The work of EG 3 within the Smart Grid Taskforce has also made important progress in creating a template. That said, there would be a place for highlighting and repeating existing best practice, which are demonstrated and proven.

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