Demand Response participation in Ancillary Services: a set of regulatory proposals for policymakers in Spain

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***Abstract*—Demand response is a key tool to integrate renewable energy sources and ensure the security of supply. In several countries, demand response programmes are widely developed and used in Ancillary Services, but the Spanish Power System presents a scarce utilisation of these resources. The main barriers to integrate demand response in Ancillary Services markets in Spain are associated with regulatory issues. Based on the good practices and demand programs of other countries, this paper presents a set of regulatory proposals to enhance the participation of demand response in the Spanish Power System.**

***Index Terms*—demand response, ancillary services, energy policy, regulation.**

I. INTRODUCTION

The operation of power systems relies on the principle that generation and demand must match at any time to ensure the security and quality of the electricity supply. On the other side, according to the Intergovernmental Panel on Climate Change Report, to stay under a 1.5ºC scenario, renewable energy sources (RES) will generate 70-85% of electricity by 2050. RES integration requires managing their intermittency to ensure the security of supply and the stability of the grid, which makes the system operation more complex The new Grid Code on the electricity balance, approved by the European Commission (EC) on November 23, 2017 [1] includes among its objectives in article 3, section f, "to facilitate the participation of the demand response (DR), including aggregation and energy storage, while ensuring that they compete with other balancing services on a level playing field". Similarly, the EC [2] promotes a consumer centred and flexible system, intending that electricity consumers behave as rational and active market agents by changing their usual patterns of consumption and participating in the market individually or in an aggregated form in order to help integrating RES. According to this novel approach, the paper will be focused on the exposition of regulatory changes to enable final consumers to participate as active agents in ancillary services (AS) in the framework of the Iberian Electricity Markets.

Internationally, the importance of renewable energy in the energy mix has been increasingly appreciated. The advantages of the renewable energy usage for the world's energy security and the environment are indisputable and much discussed in the literature [3], [4]. Most renewable energy investments are spent on materials and personnel to build and maintain the facilities, rather than on costly energy imports. With technological advancements in mass communication, people have now become aware of the demerits of burning fossil fuels. Renewable energy is the need of the hour. RES integration requires managing their variability with flexibility resources such as storage and consumers' demand response potential [5]. An active demand improves the efficiency of the electricity system by providing flexible resources where they are more valuable to the system, deferring investments and increasing competition to provide AS. Nevertheless, the participation of demand is still marginal in markets like the Spanish.

In the last 3 years [6] significant advances have taken place in the training of DR initiatives in many European countries, such as France, Belgium, Finland or Ireland, with regulatory changes in this regard. However, initiatives in such countries as Spain and Portugal have been almost inexistent. DR has proven to be a useful mechanism that produces significant benefits for both the customer and the electrical system. However, a significant barrier is not only the reluctance of grid operators or other market agents (such as generators) to use demand resources massively, but also that consumers themselves are not aware of their potential to contribute to the operation of the system through the proper management of their facilities [7]. This management can be achieved by reprogramming production or by reducing (or increasing) manageable loads.

The use of DR was mainly set to avoid extreme and rare events as system blackouts and severe grid conditions to reduce the grid decay. Nowadays, the advances in Information and Communication Technologies (ICT) show that DR has greater reliability to provide flexibility services to the system than conventional generators. First, DR can have lower costs than other flexible resources and can provide economic profits to the

system as a whole and the consumers that provide it[8]. Second, DR presents an onsite solution to enable an efficient integration of Distributed Energy Resources (DERs) that activate new market agents and open new business opportunities [9]. Third, DR can provide cheap and reliable Ancillary Services (AS) that were exclusively provided by generators [10]. Therefore, power systems are developing around the World new and more dynamic programmes to increase the participation of demand and put them in direct competition with other flexibility resources in the AS markets.

Despite the potential of the DR, it exists a lack of participation in the flexibility markets. This problem has a direct impact in the efficiency of this mechanism [11]. Through the proper legislation, the participation would be incentivized and new consumers would want to be part of the DR market. Moreover, other barriers exist in the DR field (e.g. power systems are evolving from centralised models to flexible and decentralised generation, creating regulatory difficulties which provoke barriers of different nature [12]).

This paper contributes with a review of the main barriers that demand side faces to participate in the Spanish AS market and a list of regulatory changes to overcome and increase the participation of DR resources in these services.

The rest of the paper is organised as follows. Section 2 presents a brief review of the literature about DR advancement. Section 3 summarizes the DR barriers. Section 4 suggests some regulatory changes and Section 5 concludes the review gathering the most important points.

II. A Brief Literature Review

Referring to DR, different programs are being tested by the agents in order to provide demand flexibility and to generate both technical and economic benefits. The policy changes to enhance the creation of DR products is based on other countries experiences, adapting it to the system at issue [13].

The search for new DR products has revealed a global pending issue: the lack of standardisation. TSOs from diverse parts of the world use different terms for similar concepts, and design ancillary services in a different way. Therefore, it often becomes hard to understand a particular description of a service from another part of the world. Besides, this fact can make impossible to apply the same strategy to manage loads in two different countries, because technical requirements may not meet in both places.

TSOs in North America have been using DR products for more than 40 years for both economic and reliability purposes. In Europe, since early 2000, many countries have opened their wholesale and AS markets to DR and have achieved a relevant demand participation. Others are currently surpassing the main regulatory barriers and testing DR performance on pilot projects, which are also used to introduce further adjustments. Some Asian countries are working with DR programmes to face problems related to rapidly increasing demand and renewable capacity. Regarding Oceania, some countries have recently begun to open their markets and design DR products following the European path.

III. Barriers to Demand Response in Spain

Besides the lack of a defined and extended legal framework, DR has further difficulties in Spain. The low participation rates coupled with the unused and recently cancelled Interrumpibility Service are weighing on the market efficiency. In consequence, agents must change their structure in order to provide demand flexibility and obtain economic benefits.

Spanish AS' demanding requisites represent a technical barrier to DR. Currently, only generators with a capacity larger than 10 MW can provide such services [14]. The recently corrected absence of independent aggregators in the regulatory framework made the barrier even more relevant. Notwithstanding the efforts to include independent aggregators in the systems, a revision and enlargement of the legislation is still needed.

In order to include more consumers in the market, the Regulator and the TSO need precise in-real-time information through monitoring technologies that are not installed at the moment and that represent an economic barrier [15].The different kinds of barriers derive from the legislation mistakes, imprecisions or the information gaps.

As previously stated, the most relevant system problems are regulatory barriers. As it is shown in Fig. 1, market handicaps can be classified according to their criticality and how easy are to overcome [16]

As seen in the Fig. 1 [17] regulatory barriers are the most critical and challenging to overcome, making them difficult to deal with. In most cases, barriers affect to more than one agent, negatively impacting them in different ways. Nevertheless, in order to create a legislative reform, if one barrier prevents the proper operation of an agent, all the system is being affected, causing losses and diminishing benefits.

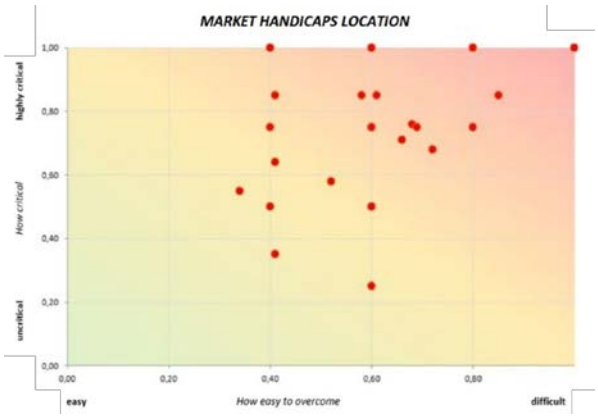

Fig. 1: Market handicaps location

Regulatory barriers in the Spanish Power System include lack of standardization, markets structures designed for generators, absence of a common definition of aggregators and their roles, inexistence of specific DR programs, lack of communication protocols, absence of electric vehicle management with the grid or large minimum bids as described in the report [18]. These barriers present a critical impact on the development of DR as they do not permit any business evolution and creation while are difficult to overcome as they require policy mechanisms and consensus in the sector.

Other countries and systems have overcome these barriers and boosted the participation of DR in their markets by improving elements like the minimum size, specific seasonal products, time of response and other characteristics that programs had and limited the integration of new agents [3].

IV. REGULATORY CHANGES PROPOSAL

The Spanish Power System has a low participation of DR and it has been able to integrate RES due to a system with a large gap between maximum demand needs and installed capacity. However, energy planning has set an ambitious plan to close coal plants and nuclear, that generates 20% of the total demand. At the same time, non-dispatchable RES is expected to increase rapidly in the following years to achieve 74% of the electricity generation by 2030, and so do electric vehicle sales, which will mean a significant raise of demand [19]. This will imply an increase from the actual 38.9% in 2019 [20].

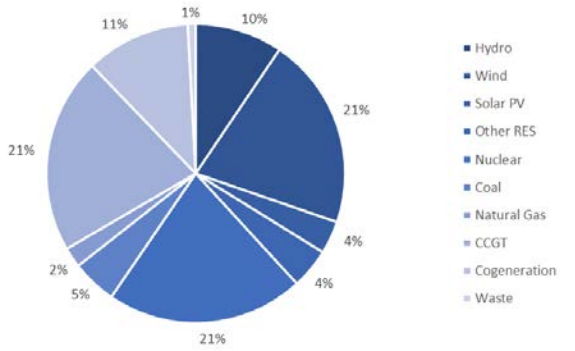

Figure 2 Energy production by technology in the Spanish Power System (2019) [20].

Such quick changes may put in risk the reliability and quality of electricity in Spain. To avoid such issues and integrate RES in a safe and efficient way, the Spanish TSO should use DR as a tool to manage coming fluctuations and imbalances. Nevertheless, the regulatory barriers previously mentioned block the development of DR and its multiple benefits.

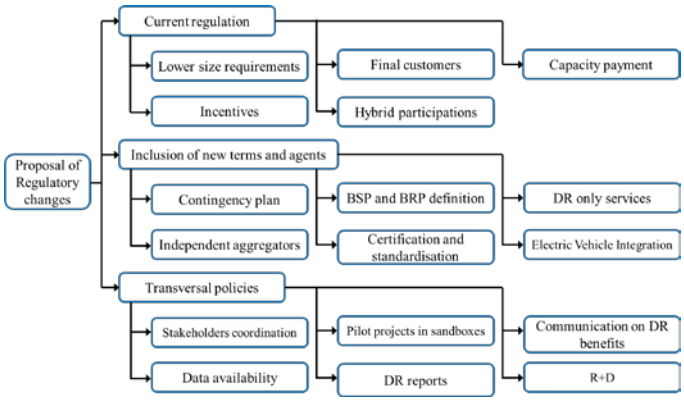

Fig. 3: List of proposals of regulatory changes

Before this situation, this research proposes a series of regulatory changes that will enable demand side participation on the electricity system and, in particular, on the Spanish AS. These proposals, explained in the following sections, are summarized in Fig. 2.

A. *Current regulation*

Proposals in this section are modifications to the current regulation on AS, to overcome the barriers that such regulation has on DR.

1) Lower bids' minimum size requisites. Currently, most AS in Spain require a capacity of 10 MW or larger to participate [21]. Such size prevents medium and small consumers from providing their flexibility in AS, even if they were grouped in a single aggregator. A more reasonable requisite, such as 1 MW, would enable the participation of many consumers who cannot access AS markets today [6].

2) Incentives. RES growth in Spain was motivated by stimulating incentives from 2004. Following a bonus basis, this policy strongly influenced the development of wind power and PV technology, among others [21]. The Government should also encourage DR development with incentives. For instance, it could fund totally or partly the investment needed for communication and control, and/or promote energy audits to identify customers' flexibility potential.

3) Final consumers. Spanish AS remain closed to DR, as large generators are the only agents allowed to provide these services [21]. The operating procedures on AS must be reviewed and changed, so that final consumers could participate either by themselves or as part of an aggregator's portfolio.

4) Hybrid participations. DR's full potential is achieved when demand is combined with distributed generation and storage. Thus, they all should be allowed to participate together on both qualification tests and normal operation of AS Aggregators can act as cluster for all those resources to meet all technical requirements and provide reliable flexibility [22].

5) Capacity payment. Electricity consumers' organisations argue that a capacity payment is needed to assure a certain profitability in the provision of AS [23]. Such concept exists in many DR programmes working on Europe and North America, and it is also applied on the Spanish automatic frequency restoration reserve (aFRR) or secondary reserve. Its application to new DR programmes in Spain must be studied in depth, to determine whether it is a necessary payment and, if so, what is the best procedure to obtain this price.

B. *Inclusion of new terms and agents*

Proposals in this section provide new terms and norms to be added to the regulatory framework.

1) Contingency plan for extreme situations. TSOs from many countries use specific DR programmes to face concrete emergencies. A very common strategy is to curtail load in days

of high demand due to weather conditions [24]. The Spanish TSO should have a DR programme to face contingencies when the scenario mentioned at the beginning of this paper is achieved (closure of conventional power plants), so that security of supply and good quality could be guaranteed even during demand peaks.

2) Independent aggregator. There is a general agreement about the relevance of aggregators on the involvement of demand resources as active agents in electricity markets. Particularly, the European Commission states that aggregators must be independent of retailers [21] The Spanish Royal Decree – Law 23/2020 includes the definition of independent aggregator [8], but its roles and responsibilities are still missing. Policy makers should include such concepts in the law, so that independent aggregators can run a business on a solid basis.

3) Role definition of BSP and BRP. The inclusion of consumers as new active agents will change the energy paradigm. A decentralised model will redefine every stakeholder role and responsibilities. For that, the figures of balance service provider (BSP) and balance responsible party (BRP) should be clearly defined in the law, as well as what particular roles and responsibilities are associated to each agent.

4) Certification and standardisation of DR products. Certification of activities and products provides confidence between stakeholders and ensures that all procedures involved in a business are optimised [6]. In the case of DR, this would also contribute to the standardisation of the products, which currently are parametrised in a different way depending on each country. DR products still lack certification and standardisation, so an international organisation as ISO[1] should develop rules to address this concern. An extension of ISO 50001 could be a suitable starting point for this.

5) Standardisation of a methodology for baseline determination: the baseline defines the load curve that a consumer would have had if a particular DR action had not been performed. This concept is crucial to determine the actual flexibility that the consumer has provided, and to calculate the utilisation payment that they will receive for that. In consequence, operating procedures should include a standard methodology to calculate the baseline, so that remuneration may be fair and proportional to the provided service.

6) DR only services. Some TSOs develop DR programmes which only DR can access [19]. This guarantees a minimum participation of demand resources and it can also work as a pilot project, to identify mistakes on market design and introduce the appropriate changes before putting demand and generation in direct competition. Policy makers shall consider this principle when designing new market rules and programmes.

7) Electric Vehicle integration. If predictions of PNIEC are accurate, electric vehicles will have a huge impact on the Spanish power system [19]. Every electric vehicle includes a battery, which is able to consume and produce electricity as needed. Therefore, it can become a versatile mechanism to provide AS.

C. Transversal policies

This section contains additional proposals to accelerate and encourage DR development. Instead of dealing with the most challenging regulatory barriers, these proposals address other specific issues of the implementation of DR, such as R&D, the monitoring of DR impact on the electricity system or the promotion of pilot projects and the figure of aggregators, among others.

1) Coordination. The implementation of DR as a resource to provide AS is a slow process that requires constant monitoring and adjustments. To accelerate this process and increase the chances of success, the coordination between all the involved parties in the regulatory framework is crucial. There must be fluent communication between the supervisory[2] and the regulatory[3] bodies and, moreover, consumers, aggregators, generators, retailers and any other interested agent should be able to provide feedback, so that the regulatory body could correct unpredicted mistakes and imperfections.

2) Data availability from grid necessities. A public data hub with real time information about the demand of all the consumers and the state of the network would reveal the least efficient zones, so that the TSO and other stakeholders could focus on such areas and introduce new strategies to improve their performance [23]–[25]. Yet, this data should be completely anonymous to preserve consumers' privacy.

3) Pilot projects in sandboxes. Royal Decree – Law 23/2020 allows the use of regulatory sandboxes. This opens the door to pilot projects, on which stakeholders may test new programmes and markets, being exempt of some norms that represent a barrier in conventional markets. These pilot projects are essential for the implementation of DR programmes in many countries, since TSOs and other agents can test such programmes and modify them before opening the markets to all stakeholders, if needed [26]. Given the importance of pilot projects, the Spanish government should incentive them through final assistance conditioned to the publication of the

[1] ISO stands for International Organization for Standardization
[2] In Spain, the supervisory body is the National Commission on Markets and Competition.
[3] In Spain, the regulatory body is the Ministry of Ecological Transition.

project's results, so that all the stakeholders may learn from them.

4) DR reports. After AS markets are open to DR, its performance should be tracked and monitored to check the impact of demand resources on the electricity system as a whole. The conclusions extracted from this monitoring process shall be reported in an official document, like the Ancillary Services and International Exchanges report, prepared annually by the Spanish TSO [20].

5) Improve communication about DR benefits among consumers. Consumers have to be aware of their own flexibility and the benefits they can get by becoming DR providers. In particular, small and medium consumers should know the figure of aggregators, their roles and capacity to integrate many tiny resources in one single product. Actually, such roles still need solid definitions in the regulatory framework. The regulatory and the supervisory agents, as well as the TSO and other influential stakeholders should promote the benefits of DR and aggregators, by performing information campaigns for final consumers and other agents of the electricity system.

6) R&D. Demand side flexibility has to be identified to quantify the scope of DR's impact on the electricity system. This requires specific studies to characterise what consumers can do, which policy makers could use to design DR products adapted to their flexibility. Thus, more consumers will be technically able to provide AS. To attract scientists to perform these experiments, the government should offer financial support to researchers willing to develop them.

V. Conclusions

RES integration increases balancing needs in an electricity system, forcing TSOs to search for reliable resources to deal with its variability. On the other hand, the EC is promoting a decentralised model for electricity systems, based on demand participation, storage and DERs.

In this context, DR can manage RES variability while improving system's efficiency and security of supply, in a cheaper way than traditional generation. These advantages have motivated the development of DR programmes around the World for economic and reliability purposes, including the participation of consumers in AS.

Still, the irregular progress of demand side management has contributed to the absence of an international standardisation, that would raise confidence between stakeholders and optimise all the processes involved in the business. Moreover, DR has to deal with many other barriers of distinct types, among which the most crucial have a regulatory character.

With respect to the Spanish case, DR development is slower than in other European countries due to challenging regulatory barriers like the impossibility of consumers to participate in AS or the establishment of too demanding technical requisites.

This paper presents a short analysis of such barriers and a series of regulatory changes to overcome them. Proposals are organised in three blocks: changes in the current legislation, inclusion of new agents and procedures and transversal changes.

Some of the main changes suggested are the inclusion of terms as BSP and BRP on the operating procedures, the reduction of unnecessarily demanding technical requisites, the certification and standardisation of DR activities and the promotion of pilot projects and studies on demand flexibility through economic incentives.

These changes will help to involve consumers on the provision of AS, reducing overall costs and increasing the efficiency and competitivity of the Spanish electricity system.

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