A CONTINUOUS EVOLUTION OF THE FLEXIBILITY MECHANISMS IN THE FRENCH ELECTRICITY SYSTEM

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ABSTRACT

This paper presents the French experience concerning the use of flexibility in the electrical system. We particularly focus on use of flexibility of loads managed by aggregators to offer services to the TSO but also its impact on distribution network and the opportunities this flexibility offers to manage network congestions at Transmission or Distribution level. .

INTRODUCTION

With respect to electricity system needs, customer requirements and regulatory policy, the electrical system has to evolve towards Smart Grids and to adopt new sources of flexibility of demand and generation, both at transmission and distribution level.

The two major constraints for an efficient development of active demand are:

- Maintaining a high degree of availability and quality of service of the grid.
- Organizing the relationships between actors so that the cost of the electrical system will be optimized for society as a whole, but also for each individual player (each actor having a viable business model).

The regulation of the electrical system in France is evolving to facilitate the use of flexibility. Some new rules are already in application and some others are still being discussed.

This paper presents the experience of the French TSO, the major DSO and a flexibility aggregator, and their view on possible evolutions. The paper was prepared in the framework of "Smartgrids France"[1], an alliance of French regional cluster promoting research, demonstration and business for Smart Grids technology.

NEEDS OF THE ELECTRICAL SYSTEM

Needs of the electric system could be divided in two aspects: Production/consumption balancing management at national level, and network congestion management at transmission and distribution level.

Physical balance between supply and demand in real time requires:

- an anticipation of generation and load shedding capabilities at any time horizon (from few years in advance up to upcoming hours);
- a mobilization capacity of these capabilities by the system operator according to techno-economic criteria. Different time horizons market mechanisms must be set to prepare and carry out physical balancing in real-time.

For network issues, Network Operators plan developments to guarantee networks safety, wave quality, assets and user's security. In the old fit and forget approach, this was the only way to solve the different constrains.

The transmission network was never designed for powering consumers from any production facility. Plan to feed a country from the only means of production located in the North for example would lead to an oversized network. This optimised design of the network hence reveals constraints. It is usually quite easy, in the generation programming phase (D-1) but also in real time (dispatching) to adapt generation plans to avoid these constraints.

Distribution networks, originally designed to transmit electricity generated by power plants connected to the transmission network up to millions of customers in an exclusively descendant schema, are today being adapted to maximize renewable energy integration and consequently contribute to governmental objectives achievement. In France, RES facilities are connected to the distribution network, LV and MV, in 95% of the case. The network architecture therefore changes from a radial and one-way structure to a more complex structure, bidirectional, combining consumption and production.
Other major developments, such as electric vehicle development or demand response, also imply a transformation of the electric network operations.

So, taking into account evolution dynamics of the distribution network use, all levers must be mobilized to achieve these goals. In particular, to manage voltage plan and network congestion risk, or to improve the economic efficiency of investments related to the network design, additional means will be required tomorrow to act locally on offer and demand. [2]

NATIONAL MARKET MECHANISMS

The next chapter describes national (French) market mechanisms. Both use of consumers, producers and storage flexibility on distribution networks, is developed in the following chapters.

Effective production/consumption balancing mechanisms

Balancing Responsible Party (BRPs) mechanism requires that production or consumption of each premise connected on the transmission network or distribution network) is attached to an actor, called Balancing Responsible Party.

This mechanism makes BRP actors responsible for balancing, through a penalty of differences, the injection and demand attached to its portfolio (generation groups attached to its portfolio, import of energy, energy purchases for injection and physical racking, exports of energy, energy sales sites, for demand).

French energy markets are not enough however to ensure a perfect real time balance. On a horizon close to real-time, RTE (TSO) acts on generation programmes or uses available load shedding in order to adjust as much as possible production and consumption. The next chapter presents the tool that allows RTE to make these generation or consumption changes.

Balancing Mechanisms

In real time, the electrical system balancing is provided by automated control systems of generators and consumers. These regulation systems, known as ancillary services, allow modulating the injection (and demand) to stop frequency deviation due to an imbalance, and as a consequence restore the frequency to its nominal level (50 Hz).

The Balancing Mechanism allows RTE to adjust generation programs or enable consumption load shedding close to real time (from 15 minutes to several hours). These adjustments have two purposes serving RTE: to balance the electrical system (or act on the projected balance at 15 minutes) and to lift the congestion on the transmission network by changing the location of the generation. The mechanism works as a permanent tender where players deposit their offers and where RTE activates them using the economic merit order principle.
Generators connected to the transmission network have a legal obligation to propose all their available power to RTE on the balancing mechanism. Consumption on both transmission or distribution sites and the sites of injection on the distribution network may participate on a voluntary basis. For operational reasons, balancing offers must be at least 10 MW power high.

Balancing Responsible Party mechanism and energy market

Each Balancing Responsible Party is a financial guarantor of balance on its perimeter.
NEBEF mechanisms allows demand response offers to participate on energy market

From 2014, a demand response service operator can integrate into its portfolio a consumer supplied in energy by any energy provider. The NEBEF mechanism (Notification d'Echange de Blocs d'Effacement, Notification of Exchange of Blocks of Load Shedding) establishes the transfer of an energy block from the BRP of the consumer's energy provider to the demand response service operator and then to the target markets.
The contribution of this mechanism is to allow the bid of demand response offering on the energy market by a third operator distinct of the energy provider.

If these mechanisms allow short term matching with existing means, they do not guarantee security of supply over long term. This security comes with peak generation and demand response resources and requires appropriate economic signals. France is thus about to implement the Capacity Mechanism to secure medium long term peak capacity and associated funding.

Capacity Mechanism

In the French Capacity Mechanism, a supplier will have to collect capacity certificates (whether these capabilities are production or demand response) in the amount of the contribution of its customer's portfolio to the consumption peak.
This requirement may be fulfilled by the possession of real assets or the purchase of a certificate to a holder of capacity. All generation or demand response capacity, connected to the transmission or distribution network must be certified.

LOCAL FLEXIBILITY MANAGEMENT

Driven by information and communication technologies development as well as energy regulations evolution, consumers' premises involvement into balancing markets and ancillary services offers new sources of flexibility on a large-scale.

Large industrial and commercial consumption modulation participation into available mechanisms is effective for several years in France and is increasingly integrated in European electrical networks management. Among other services, this participation contributes today to the balance of the electrical system by the French TSO RTE through the balancing mechanism.

Most of the energy players (generators, transmission and distribution operators, suppliers and aggregators) are impacted by the development of opportunities to modulate the electricity consumption. In particular, development of flexibilities connected to the distribution network will affect DSOs (creating both, risks and opportunities). Rules and mechanisms to coordinate these actors are essential and the definition work is ongoing. Activity of research and demonstration in France for the use of the load flexibility connected to the distribution network intense and advanced features are being put in place.

From Consumer to "Prosumer"

Demand response principle consist in modifying power consumption of one (or several) premises which flexibility sources come from the customer's ability to modulate his consumption profile in reaction to an external signal. Modulation on the customer premise will come from different sources, ranging from industrial processes or devices (automatically controlled or not), decentralised production to any storage system. Our study focuses only on dispatchable demand modulations ie which can be activated by the TSO in less than 30 minutes.

With few exceptions, a single customer premise is generally not able to produce flexibility in a suitable format for markets (does not reach the required power thresholds, ...). It will therefore go through an aggregator (which can be the energy provider or an independent actor) who, on the basis of a set of client sites (portfolio), will be able to build the 'blocks' of flexibility, with the associated characteristics (shape, time activation, warranty, volume, etc.) and bid them on the markets/mechanisms. Furthermore, for customers who would be able to produce demand side modulation suitable for use on flexibility markets and mechanisms (some big industrial sites), they may prefer to go through an operator on markets, rather than assume this operator role themselves.

Aggregator role

An aggregator is an actor to promote flexibilities on the different markets and mechanisms for balancing supply-demand, from system security of supply to security of operation. As such, it constitutes and manages a portfolio of aggregated and mutualised customers within a pool, to resell aggregated products on energy markets and/or flexibility mechanisms. Aggregators help their consumers' pool to identify consumption flexibilities and optimize revenue for the markets.

The aggregator becomes the interface between the flexibilities markets (which see only "blocks" to the different characteristics expected, and are not interested in the way in which they are created), and customer sites with which it contracts to physically implement the modulations of demand profiles.

From the electrical system point of view, the aggregator helps reduce power and energy demand/supply gaps, upward and downward during any congestion periods.
This mechanism, initiated by RTE entered live in 2009,. Volumes committed by RTE in France on demand response tenders increased regularly reaching 800 MW in 2014. On April 5, 2013, RTE called for demand response contracts to obtain additional capacity of 510 MW and ensure balance and the security of the electrical system.

Distribution network impact of third party activated flexibilities

Activation of flexibilities in the distribution network modifies local transits and can generate congestions (voltages, current,...). Network studies conducted by DSOs allow anticipating these constraints. DSO can identify the fact that a flexibility offer, if enabled, generates risks with regard to network security.

In order to facilitate DSOs adaptation and to facilitate activation of flexibilities on the network for the benefit of all the parties, it is necessary that DSO have, before any activation of flexibilities, access to relevant information about any connected sites and their components. With this information the DSO will be able to limit or to oppose the activation of a flexibility pool, or individual premises, when it is likely to generate constraints on their network.

The regulatory framework should nevertheless clarify economic conditions associated with any limitations or opposition conducted by DSOs as well as the conditions of transparency to ensure a strict compliance with proven needs of networks. It will minimize the costs and financial risk referred to other actors.
Finally, in continuous improvement logic, it is necessary to analyse ex-post the potential impact of flexibility on the distribution by quantifying rebound and synchronisation phenomena.

Use of the flexibilities connected to the distribution network by DSOs

DSOs can be interested in activating flexibility to solve network constraints affecting the distribution network.

Flexibilities can already take part in the energy markets or contribute to different mechanisms, where coordination rules are essential. It is therefore necessary to consider all existing markets architectures, as well as potential developments, in order to determine optimum conditions for insertion of an additional mechanism.

Coordination of access processes to flexibilities connected on distribution networks by the TSOs must take into account different dimensions. It is necessary to define a coherent regulatory framework to ensure coordination between network managers on the use of distribution flexibilities

Generally, to compete for economic optimisation of the system, a single flexibility must be aggregated in different meshes in order to be included in an offer adapted to the need of every network operator or energy market player: local mesh for DSO, national or regional mesh for the TSO, national mesh for balance responsible party

The goal is to determine conditions in which market players and network operators can access to available

flexibilities connected on the distribution networks.

In this context, ERDF together with RTE and other market players are involved in different demonstrators studying these issues like Smart Grid Vendée[3], Nicegrid[4], evolvDSO[5], ADVANCED[6], ... The objectives of this demonstrators are :

- Study different market mechanisms frameworks: independent and coordinated or coupled as for example a scheme in which flexibilities aggregators make offerings corresponding to relevant aggregation scale for different network operators) or a scheme in which operators turn their offers to DSOs, which would then become the single actor to interface with the TSO regarding flexibility connected to the distribution network
- Study the different services that active demand can provide to the DSOs.
- Determine the evolutions of the roles of DSOs and market rules allowing the use of the flexibility to solve constraints on the distribution network
- Make a cost/benefits analysis of tested solutions and analyse different issues raised by the activation of flexibilities by DSO, among them the interaction with existing mechanisms and cooperation between DSO/TSO.

Value creation and sharing between participants

Flexibility operation is based on two different contractual layers

- At the consumer premise level, an aggregator contracts implementation modalities of actions that will contribute to modify individual consumption patterns. The aggregator freely manages its contractual relationship with its consumers and compensates his supplier. With regard to energy – for residential customers - consumer continues to pay his supplier as its meter indicates.
- At the Energy Markets level, these flexibilities are proposed like energy blocks (with specific characteristics - form, activation time, volume, etc.) by the Balance Responsible Party.

Main actors of the demand response are: network operators, consumers, aggregator, and Supplier/Balance Responsible Parties.

BRPs are involved to the extent that the exchanged energy in case of activation of their clients just changes their balance. Suppliers are also involved because flexibility is based on an actual energy injected into the network, which must be paid to the actors that bought it initially. If the provider/BRP has not agreed to give the commercial relationship of his client with a third-party aggregator, it is natural to pay for energy which has been deleted - and disposed of the penalties of the imbalance in its perimeter.

In the balancing mechanism, activated offers subject to compensation at the price proposed by actor fit.

Relations between the various partners are based on the interests of each party in direct support of the collective interest, on the basis of balanced trade relations.

The most significant part of the value creation naturally returns to the consumer who brings the raw material - availability of power, flexibility and exchanged energy. Aggregator is being paid for the complement of value added. Different modes of remuneration may be considered, depending on availability, volumes, etc.

CONCLUSION

Services that flexibility can bring to the electrical system actors are known, so an economic evaluation is now needed to assess interest of a deployment. The evaluation of the economic potential of different flexibility solutions is a complex problem due to interdependence of various technological sectors through networks. An approach particularly suitable for such an evaluation of technology clusters at national and supranational scales is a cost-benefit analysis.

Conclusions of a study conducted for storage [7] show that as a first step, it allows evaluating the benefit of adding different flexibility solutions. Calculations are usually performed under several forward-looking scenarios (for example those established by RTE generally at the 15 or 20 years horizon for France) to cover various assumptions of intermittent RES penetration and different consumption profiles. The benefit is calculated for the community as a whole, outside of any regulatory constraint or incentive mechanism.

In a second step, this benefit is compared with the cost estimation of the several flexibility solutions at the same time horizon. Finally, it is possible to assess revenues collected by private flexibility aggregators according to regulatory constraints and study conditions.
The potential earnings from the new flexibility solutions is then calculated by comparing the costs to the community for an optimal management of the energy system with and without additional flexibility and taking into account the OPEX and CAPEX avoided in other sectors.

The use of flexibility is a key solution for the future networks, also called smart electrical networks (Smart Grids).

Solutions implemented in France are the result of years of developments, tests and consultations between stakeholders. They have now reached a good degree of maturity and they take into account constraints of various actors seeking to optimise the general interest.

Demonstrations and projects are underway to refine the technical tools but especially for measuring the users'

willingness for these solutions and to assess their economical and environmental benefits in real conditions.

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