# Market integration VS Temporal granularity: how to provide needed flexibility resources?

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***Abstract*—The aim of this paper is to study the implications of the decision of the French regulator to join the FCR Cooperation, a common platform for cross-border procurement of primary reserve. Two aspects will be analyzed: 1) cost of procurement and increase of social welfare by cross-border procurement and 2) implications for entry of new entrants like aggregators of Electric Vehicles. Our results are that joining the FCR Cooperation will impact negatively participation of aggregators and might not result to lower costs for procurement of reserve.**

***Index Terms*—Primary Reserve – Market Integration - Aggregator**

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# 1. INTRODUCTION

Due to major concerns on climate change, governments committed during COP21 in Paris to reduce their greenhouse gas emissions, to achieve a 2°C warming target. In the electricity sector, decarbonization would be achieved by switching from fossil fuels generation to renewable generation, mainly wind and solar. To cope with this target, the International Energy Agency (IEA) has evaluated that 60% of the electricity generation should come from Renewable Energy Sources (RES) by 2040 (International Energy Agency, 2016a). In the transportation sector, it would be achieved by promoting zero emission vehicles such as Electric Vehicles (EVs). The IEA sets a target of 140 million vehicles on the road by 2030 to follow the 2°C scenario (International Energy Agency, 2016b).

These two trends will create major issues in the entire value chain of the electric system; for example, balancing generation and consumption will be more challenging, due to volatility of RES generation. Transmission System Operators, who are responsible for managing this balance, have contracts with different actors - generators or consumers, called Balance Service Provider (BSP), who must respond to signals to re-establish balance. Reserve requirements are assumed to increase in the coming years due to the increase of variable RES in the energy mix (Hirth, Lion; Ziegenhagen, 2015)(Brouwer et al., 2014). Moreover, while centralized units, i.e. nuclear or fossil fuel power plants are challenged by decentralized generation, new sources of flexibility should be considered. Indeed, there might be periods while electricity is almost only produced by decentralized resources and few spinning centralized units are available (Bertsch et al., 2016)(Ummels et al., 2007).

Decentralized energy resources, such as variable decentralized generation, storage, EVs and active consumers, are technically able to provide such type reserve (Codani, 2016)(Vandael et al., 2013)(Galus et al., 2011). Depending on their technical characteristics, they would be best fitted for one or another market (Eid et al., 2016). However, economic and technical rules and regulations are not adapted to the provision by these types of new actors and future revenue of the aggregator depends much on these rules (Codani et al., 2016).

Design of the rules for provision of reserve are therefore essential to ensure that the Transport System Operator (TSO) purchase the entire reserve it needs at the least cost. Rules can impose administrative barrier, not allowing consumer units, storage… to participate to the market. Rules might also be designed in a way, which restricts the participation of this type of resources. Existence of these barriers were identified for demand response in US electricity markets in (Cappers et al., 2013). The impact of such rule was analyzed in (Borne et al., 2016). Authors develop a framework to identify different types of barriers to entry. This framework can be used to assess when a country decides to change its market design for increasing or decreasing barriers to entry in these markets.

In October 2016, France has chosen to change completely its market design for the provision of primary reserve to adopt the Frequency Containment Reserve (FCR) (Commission de Régulation de l'Energie, 2016), which give the opportunity to test this analytical framework on a real case. Before the actual change, the French TSO used to procure reserve through mandatory provision by centralized large units, with an annual fixed regulated tariff. Other actors could sell reserve to large units, after pre-qualification agreement of Réseau de Transport d'Electricité (RTE), with a negotiated price. French regulator had asked RTE to change its rules to implement a call for tender, to comply with requirements of the ENTSO-e Network Code (Commission de Régulation de l'Energie, 2015).

Some choices were possible; among them one was to create a national call for tender, based on original French rules. Second option was to join an existing reserve market. RTE decided to join the FCR Cooperation. This Cooperation is a common platform for Germany, Switzerland, Netherland and Belgium to procure primary reserve. The French regulator pointed out the limits of this option: The duration of the reservation product (one entire week from Monday 0 a.m. to Sunday 12 p.m.) was judged too long by the regulator and some of the French actors (RTE, 2016a). However, he judged that it will in better position to change rules while being in the Cooperation and that market integration was priority to procure reserve at the least cost.

The aim of this paper is to assess this arbitrage. In Section II, we will look in detail at former French market design and FCR Cooperation market design and analyze it based on the framework of (Borne et al., 2016). Section III will explain the rationale beyond market integration. Section IV is a case study on an aggregator of Electric Vehicles to assess implications of the French decision and propose some improvements to the FCR Cooperation market design. Section V gives an overview of the on-going consultation process in the FCR Cooperation for evolution of the rules and Section VI concludes.

# 2. ANALYSIS OF THE FRENCH PARTICIPATION TO FCR COOPERATION

In this section, we will first give a description of former French market-design for primary reserve delivery and of the FCR cooperation market design. We will analyze this change with framework exposed in (Borne et al., 2016) to understand its implications for aggregators.

## *2.1. French Market Design before 2017*

Former French mechanism (RTE, 2016b) is characterized by an administrative tariff for the delivery of primary and secondary reserve. It is mandatory for each generation unit to provide reserve at a yearly flat tariff. The total amount of reserve is allocated by RTE across the different BSPs pro rata their production. RTE give the schedule of delivery one day ahead, with a 30 minutes time-step.

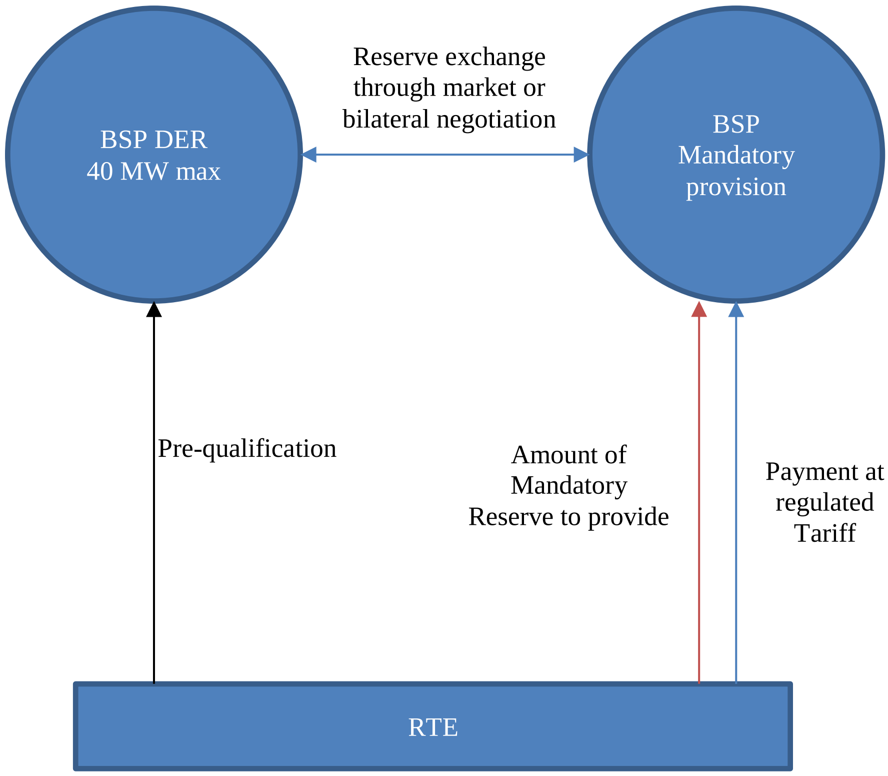


FIGURE 1: ORGANIZATION OF FCR PROCUREMENT IN FRANCE BEFORE 2017

Other actors, e.g. storage, consumption units and distributed generation, can provide reserve if they pass the prequalification test. However, the total amount of reserve which can be prequalified is limited to 40 MW for primary and secondary reserve. This type of actor cannot be pooled with generation units. The allocation of these certifications is based on a "First Come, First Served" rule. When prequalified, these actors can sell their reserve on a secondary market organized by RTE or by bilateral negotiation, which is notified to RTE. Exchange of reserve can be notified until one hour before delivery.

## *2.2. FCR Cooperation Market Design*

FCR Cooperation is a joined call for tender for FCR procurement. It is based on the German market design for FCR procurement ("regelleistung.net," 2017). Switzerland was the first to join German platform in 2012, followed by Netherlands in 2014, Austria in 2015, Belgium in 2016 and finally France in 2017.

Primary reserve is procured through a weekly call for tender, market clearing being each Tuesday. Procurement is made for the next week with a unique product (symmetric, from Monday 0am to Sunday 12pm).

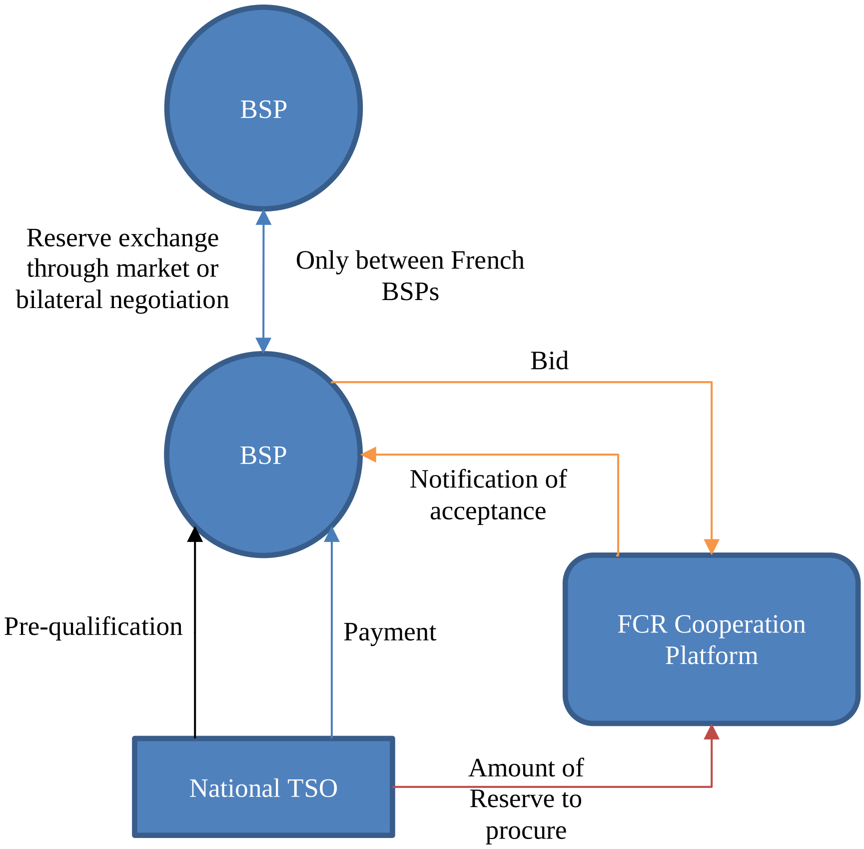


FIGURE 2: ORGANIZATION OF FCR PROCUREMENT IN THE FCR COOPERATION

National TSOs are still in charge of prequalification tests and contracts with reserve providers (post assessment, penalties for non-delivery), which are not harmonized among countries. France keeps it limitation of 40 MW of DERs that can be prequalified by RTE. TSOs give their reserve requirements to the platform. BSPs can make offer on the platform until market clearing. Offers are selected based on Merit-Order. Exports are limited to 30% of the size of the national reserve (15% for France) whereas imports are not limited.

Exchange of reserve between BSPs from different countries is not allowed. However, France keeps its mechanism of notification, which still allows French BSPs to exchange reserve at a negotiated price.

BSPs are remunerated with “pay as bid” rule. Costs are allocated to the TSOs pro-rata their reserve requirements at the average cost of reserve.

## *2.3.Implications for Aggregator*

We will now analyze implications for aggregators of the French decision.

Framework developed in (Borne et al., 2016) gives an opportunity to understand the implications. This framework is based on an analysis of the rules for provision of reserve, divided in three different modules. In each of these modules, rules were identified. They are described and implications for aggregators are analyzed.

| | | |
|---|---|---|
| Aggregation of DERs | A1 | Technical discrimination |
| | A2 | Interoperability Among DSOs |
| | A3 | Level of Aggregation |
| Definition of the products on the market | B1 | Minimum size |
| | B2 | Time definition |
| | B3 | Distance to real-time |
| | B4 | Symmetry |
| Definition of the payment scheme | C1 | Nature of payment |
| | C2 | Extra-bonus |

TABLE 1: RULES FOR FCR PROCUREMENT

Authors had evaluated each of these rules for four different markets, including France and FCR cooperation. This evaluation is presented in Table 2.

| | *RTE* | *FCR Cooperation - Germany* |
|---|---|---|
| *A1* | +/- | + |
| *A2* | + | + |
| *A3* | + | + |
| *B1* | + | + |
| *B2* | + | - |
| *B3* | + | +/- |
| *B4* | + | - |
| *C1* | - | +/- |
| *C2* | - | - |

TABLE 2: ASSESSMENT OF THE RULES IN FRANCE (BEFORE 2017) AND IN THE FCR COOPERATION

By joining FCR cooperation, France is adopting week-long, symmetric product. It will be disadvantageous for aggregator. Even if it will still be possible to transfer reserve from one BSP to another, with shorter products and closer to real time, this secondary market may not be sufficiently liquid and cross-border exchange is forbidden.

France keeps its volume limitation for aggregators, so no improvement is made on the first module. In the third module, improvement is made by adopting a market solution, even if pay-as-bid is not the most performing one (Kahn et al., 2001).

By applying the above-mentioned framework, it seems that France will impose new technical barriers to entry (Module B) for aggregators, not removing administrative ones (Module A), to remove a barrier in Module C.

<table>
<tr><td>Module A</td><td colspan="2">Status quo</td></tr>
<tr><td rowspan="4">Module B</td><td colspan="2">Status quo: 1MW</td></tr>
<tr><td>30 minutes</td><td>168 hours</td></tr>
<tr><td>Day Ahead</td><td>Week Ahead</td></tr>
<tr><td>Asymmetric</td><td>Symmetric</td></tr>
<tr><td rowspan="2">Module C</td><td>Administrative Tariff</td><td>Pay-as-Bid</td></tr>
<tr><td colspan="2">Status Quo</td></tr>
</table>

TABLE 3: CHANGES IN THE RULES WHEN JOINING THE FCR COOPERATION

However, changes in Module B and Module C will not be balanced. Indeed, the framework is a decision tree. Improvements in the Module C will have less impact for aggregators if Module B is disadvantageous for them.

By analyzing the decision through this framework, we have shown that this new market design is not in favor of aggregators. But this is not the only parameter to consider when assessing the implications of this decision: by joining the FCR Cooperation, it is now possible for French producers to export reserve when or for RTE to import. This will also allow provision of reserve at a better cost, as we will see in the next section.

There was therefore a trade-off for France between time granularity, which allows new innovative technologies to participate to the market, and market integration, which allows higher liquidity on the market and import/export of reserve.

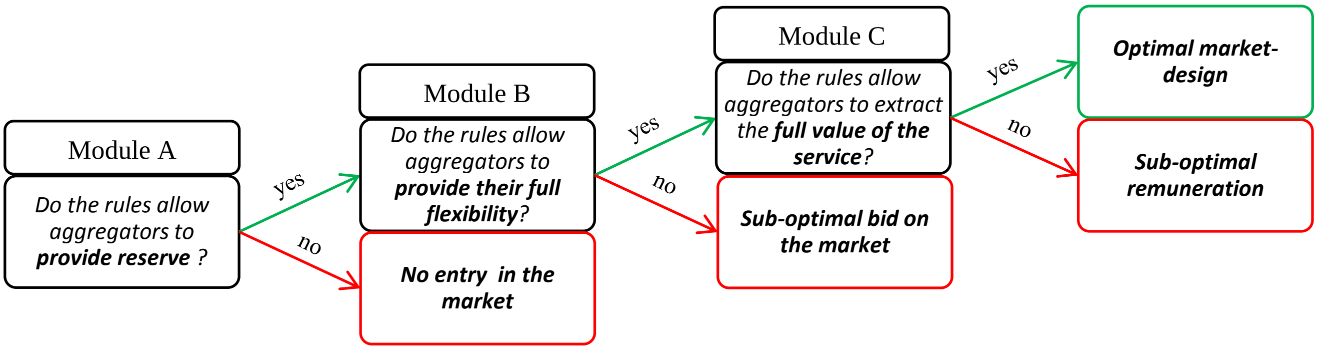


FIGURE 3: DECISION TREE FOR AGGREGATORS TO PROVIDE FCR

# 3. Rationale Behind Market Integration

In its deliberation, the French regulator argues that joining the FCR Cooperation would allow to decrease costs to procure ancillary services such as primary reserve while ensuring security of supply and allowing better integration of RES (Commission de Régulation de l'Energie, 2016). This is in line with the willing of European Commission to create integrated markets for electricity, expressed again in the Winter Package (European Commission, 2016).

Efforts had first been concentrated on wholesale electricity markets, by coupling different markets (France, Belgium, and Netherlands in 2006, joined by Germany in 2010), to allocate implicitly cross border capacities, and minimize price differences between different countries (Newbery et al., 2016)(Meeus et al., 2009). This process is still going on in Europe. European Commission is now pushing for the implementation of common markets for ancillary and balancing services such as primary reserve, which is still lagging behind. In (Mott MacDonald, 2013), authors estimated potential welfare gains joining Great-Britain and France balancing services to €50 million/year. (Flinkerbusch and Heuterkes, 2010) had evaluated potential cost reduction achieved by joined procurement of balancing reserves of four TSOs in Germany to 17%. In (Drees and Moser, 2016), potential savings of market integration of balancing services in Central Europe, with the introduction of core portions (portion of the balancing service which must be supplied by the national market) was estimated to €87 million/y. Market integration would also foster competition between actors and reduce market power of dominant actors. However, these studies are concentrating on secondary and tertiary reserve and there is no study evaluating potential cost reduction of joint auction for primary reserve.

The rationale behind market integration is maximization of the sum of social welfare across all countries. Let's take a simple example of two countries and compare the situations without and with cooperation (Figure 4):

- Country 1 wants to procure 500 MW of primary reserve. There are three producers: first one can supply 300 MW of reserve at a price of 5€/MW, second one is able to provide 300 MW at 10€/MW, third is able to provide 300 MW at 15€/MW
- Country 2 wants to procure 600 MW of primary reserve. There are two producers: first one is able to supply 200 MW of reserve at a price of 12€/MW, second one is able to provide 500 MW at 20€/MW

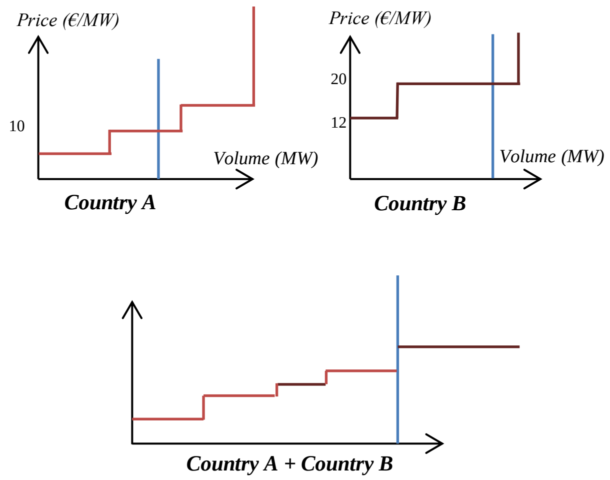


FIGURE 4: MERGING PROCUREMENT OF RESERVE IN TWO COUNTRIES

When TSO are in autarky (Reference case), there is no exchange of reserve between two countries:

- If remuneration scheme is pay-as-bid (Reference 1), cost of procurement for TSO A will be 3.5k€, and 10.4k€ for TSO B. There is no surplus for producers, assuming they bid their marginal cost.
- If remuneration scheme is marginal pricing (Reference 2), cost of procurement for TSO A will be 5k€, and 12k€ for TSO B. Surplus of producers will be 1.5k€ for producer in A and 1.6k€ for producers in B.

When merging, Country A will export 2 MW of reserve to country B.

If TSOs implement a pay-as-bid scheme when merging (solution 1), total cost of reserve is 11.4k€. There is a decrease of 2.5k€ in the cost to procure reserve, as producer in country B is partially replaced by producer in country A, which is cheaper.

Costs can be allocated to the TSO in two different ways:

- Solution 1.1: Costs are allocated based on the average price (here 10.36€/MW) and the reserve requirement of TSO (500 MW for TSO A and 600 MW for TSO B). In this case, TSO A would pay 5.18k€ and TSO B 6.22k€.
- Solution 1.2: Costs are allocated as if TSOs were in autarky, importing TSO paying for reserve it is importing from other countries. In this case, TSO A would pay 3.5k€ and TSO B would pay 7.9k€.

If marginal pricing were used (solution 2), total cost for both TSOs is 16.5k€. Costs are allocated among TSO based on the marginal price and the reserve requirement of each TSO. TSO A will pay 7.5k€ and TSO B will pay 9k€. Surplus for producer in country A will be 4.5k€ and 0.6k€ in country B.

Whatever the chosen scheme, there will be an increase of 2.5k€ in the total surplus of {TSO A + TSO B + Producer A + Producer B}.

| | **Cost for TSO A** | **Cost for TSO B** | **Surplus of Producer A** | **Surplus of Producer B** |
|---|---|---|---|---|
| ***Ref 1*** | 3.5k€ | 10.4k€ | 0 | 0 |
| ***Ref 2*** | 5k€ | 12k€ | 1.5k€ | 1.6k€ |
| ***Sol. 1.1*** | 5.18k€ | 6.22k€ | 0 | 0 |
| ***Sol. 1.2*** | 3.5k€ | 7.9k€ | 0 | 0 |
| ***Sol. 2*** | 7.5k€ | 9k€ | 4.5k€ | 0.6k€ |

TABLE 4: COST FOR TSO AND PRODUCER SURPLUS WITH DIFFERENT REMUNERATION SCHEMES

Depending on the chosen solution for cost allocation and remuneration, the increase of total surplus will not be allocated to the actors the same way. With Solution 1.1, there is a welfare transfer from the country where average cost is the lower to country where the average cost is the higher. It is the solution chose in the FCR

Cooperation. With solution 1.2, surplus increase is entirely allocated to country B. With solution 2, surplus increase is divided between country A and country B.

| | {TSO A +Producer A} | {TSO B + Producer B} |
|---|---|---|
| ***Sol 1.1-Ref*** | -1.68k€ | +4.18k€ |
| ***Sol 1.2 – Ref*** | 0k€ | +2.5k€ |
| ***Sol. 2 – Ref*** | +0.5k€ | +2k€ |

TABLE 5: INCREASE OF SOCIAL WELFARE IN COUNTRY A AND COUNTRY B WHEN MERGING

To generalize this example, with Solution 1.1, there would be a transfer of social surplus from countries exporting reserve and with a lowest average price than the average price of the entire market to countries importing reserve and with a higher average price than the entire market.

However, it should be noted that actors would not bid their marginal cost with a pay-as-bid solution. They would rather bid what they guess would be the price of the last selected offer, to maximize their revenue. This would result in lower transfers of social surplus among countries.

As solution 1.1 was chosen in the Cooperation, if France is exporting its reserve and has a low average price, it could negatively impact its total surplus, while allowing other countries to increase their surplus.

# 4. Case Study On An Aggregator of an Electric Vehicle Fleet : Comparison between French and German Market Design

This section aims to quantify the implications of market-design changes for an aggregator. An aggregator of an EV fleet is chosen for multiple reasons:

- Technical feasibility for providing primary reserve by an EV fleet was already demonstrated (Codani, 2016)
- Unidirectional EVs (allowing only flows from the grid to the vehicle) are already available assets, and bidirectional EVs (allowing reverse flows from the vehicle to the grid) could be available in a near future.
- Amount of available reserve is much dependent on the behavior of the users since a vehicle will be only able to provide reserve when it is plugged in. The amount of reserve the aggregator will be able to offer will thus depend a lot on the time duration of products and the auction frequency.

Business models of different actors of the value chain and commercial relationships had been discussed in (San Román et al., 2011). The aggregator is defined as the actor who would "manage EVs with V2G capability to buy and sell energy at the day-ahead and real-time markets to provide regulation reserves under supervision and control of the ISO […].The EV aggregator will be compensated by the ISO or TSO for the services provided and he will compensate the EV owners too".

Provision of secondary reserve had already been studied in (Jargstorf and Wickert, 2013), who found that EVs were not suitable for providing such reserve, potential revenues being limited 4€ per vehicle per month. However, FCR is less constraining for EVs, as much of the time, a small part of the reserve is actually used, frequency deviation being limited.

For simplification of the evaluation, some restrictions will be made;

- We consider only working days, meaning that EVs will commute from home to work in the morning and from work to home in the afternoon. We do not consider not-working days, i.e. end of the weeks or bank holidays, because behavior of users is more unpredictable on these days.
- We consider that each EV is commuting in the morning and the afternoon. A trip distance is affected to each user according to Weibull distribution, based on the analysis of the "Enquête Nationale Transport et Déplacement 2008" conducted by French government. This trip distance is fixed from one day to another. Departure hours are affected according to a normal distribution and may vary for one EV from one day to another Table 6 gives parameters of these distributions

- Aggregator has perfect foresight, meaning it will be able to forecast exactly the amount of reserve available at each time-step. In particular, it has perfect foresight of the trip patterns of the vehicles.

| | *Type of Distribution* | *Parameters* | |
|---|---|---|---|
| *Distance from home to work (km)* | Weibull Distribution | $\lambda = 21.8$ | $k = 1.3$ |
| *Hour of Departure from Home (hour)* | Normal Distribution | $\mu = 8$ | $\sigma = 2$ |
| *Hour of Departure from Work (hour)* | Normal Distribution | $\mu = 17.5$ | $\sigma = 2$ |

TABLE 6: PARAMETERS OF STACHASTIC DISTRIBUTIONS

Different set of Electric Vehicle Supply Equipment (EVSE) are studied:

- Fleet 1: An EVSE of 3 kW is installed at home, which is able to control charging process. There is no EVSE at work
- Fleet 2: An EVSE of 3 kW is installed at home and a EVSE of 10 kW is installed at work
- Fleet 3: An EVSE of 7 kW is installed at home and a EVSE of 22 kW is installed at work

We will use the algorithm used in (Codani et al., 2016) to evaluate available capacity. This is a decentralized optimization algorithm, built to maximize at each time-step the amount of reserve provided while ensuring that there is enough energy in the battery when the user wants to use the vehicle and the State Of Charge (SOC) does not cross limitations of the battery. More sophisticated algorithms can be found in the literature. However, the aim of this study being more to catch some orders of magnitude rather than have a precise evaluation of the maximum revenue that can be made by the aggregator, we preferred to use a simple algorithm, easy to implement and with low computation time

To consider limited energy stock in a battery, we use specific requirements used in Germany (German TSO, 2015)(Hollinger et al., 2015). It states that the amount of energy available in the battery must be sufficient to sustain maximum delivery (corresponding to a frequency deviation of ±200 mHz) during 30 minutes. Then, the aggregator has two hours to reconstitute its stock of energy. This means that we use a period of 30 minutes to update the Preferred Operating Power (POP) of the EVs.

Simulations are performed with different sizes of fleet because of market-design changes could be different in function of the number of EVs the aggregator is controlling. Three different sizes are analyzed:

- 50 EVs, which allows to have more than 100 kW of reserve available at each time-step
- 500 EVs, which will allow to have more than 1 MW of reserve available
- 5000 EVs which corresponds approximately to the maximum reserve which can be provided by distributed reserve in France (40 MW)

Table 8 is showing average power bid over one week. One hundred simulations are run for each scenario (number of vehicles in the fleet and market design), each simulation being performed with a different frequency recording.

| | **FCR Cooperation** | **Former French Market Design** | **Evolution** |
|---|---|---|---|
| ***50 EVs*** | 0 | 0 | -0% |
| ***500 EVs*** | 2.8 | 4.02 | -30% |
| ***5000 EVs*** | 32.46 | 43.90 | -26% |

TABLE 7: AVERAGE PROVISION OF RESERVE FOR AN EV AGGREGATOR (MW)

It shows that with a small fleet (50 EVs), aggregator cannot enter the market, either with former French rules or with FCR Cooperation rules, due to minimum bid of 1 MW which is not reached.

For bigger fleets, minimum bid is reached allowing the aggregator to enter the market. However, moving from French rules to FCR Cooperation rules, more than the quarter of its potential bid is lost due to the change in time granularity.

To allow entrance in the market and better provision of flexibility, we formulate different propositions of evolution:

- Reference: actual FCR Cooperation rules
- Proposition A: reducing volume resolution to 0.1 MW.
- Proposition B: A + reducing minimum bid to 0.1 MW.
- Proposition C: B + off peak /peak products (peak being from 8am to 8pm). This solution is already implemented for secondary reserve in Germany
- Proposition D: B + off peak/peak and daily auction
- Proposition E: B + 4-hour products and daily auction. This solution is already implemented for tertiary reserve in Germany
- Proposition F: B + 1-hour product and daily auction.

Figure 5 is showing the offered reserve during one week, with different set of rules, for a fleet of 500 EVs with a power plug of 3 kW at home and 10 kW at work. In blue, reserve available is represented. It is the maximum reserve which can be offered at each time-step. With this scenario, power bid in the Reference case is 1MW. If the bid increment is lowered at 0.1 MW, the aggregator will be able to bid 1.3 MW. With proposition C, he will offer 1.3 MW between 8pm and 8 am and 1.5 MW between 8 am and 8 pm.

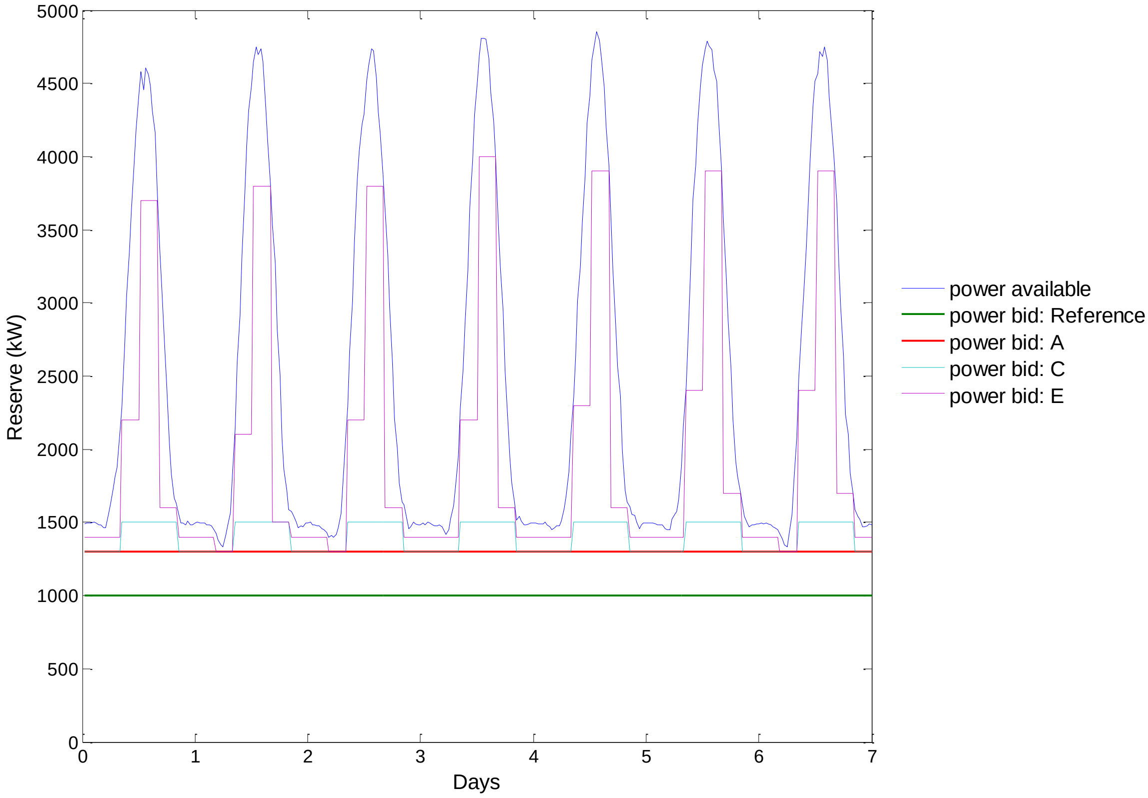


FIGURE 5: RESERVE AVAILABLE AND RESERVE OFFERED FOR DIFFERENT PROPOSITION OF RULES 500EVS, POWER AT HOME: 3 KW, POWER AT WORK 10 KW

We look first at the implications of volume granularity. Figure 6 shows the reserve offered by the aggregator per vehicle in function of the number of aggregated vehicles in the fleet. We look at Fleet 2 for this first study.

For the Reference and the Proposition A, where the minimum bid is 1 MW, there is a threshold of approximatively 400 EVs to enter the market. For Proposition B, this threshold is around 40 EVs. With Reference, once this threshold is reached, new aggregated vehicles do not contribute to the offered reserve before reaching the next threshold of 2 MW. Therefore, the offered reserve per vehicle is decreasing, as well as the potential revenue. This effect is still visible for larger size of fleets: a fleet of 1500 EVs can offer 2.6 kW per vehicle in average, whereas a fleet of 1800 EVs can offer only 2.22 kW of reserve per vehicle. Potential revenue per vehicle is much more dependent on number of vehicles aggregated than for Proposition A and B, making the profits of the aggregator much more uncertain.

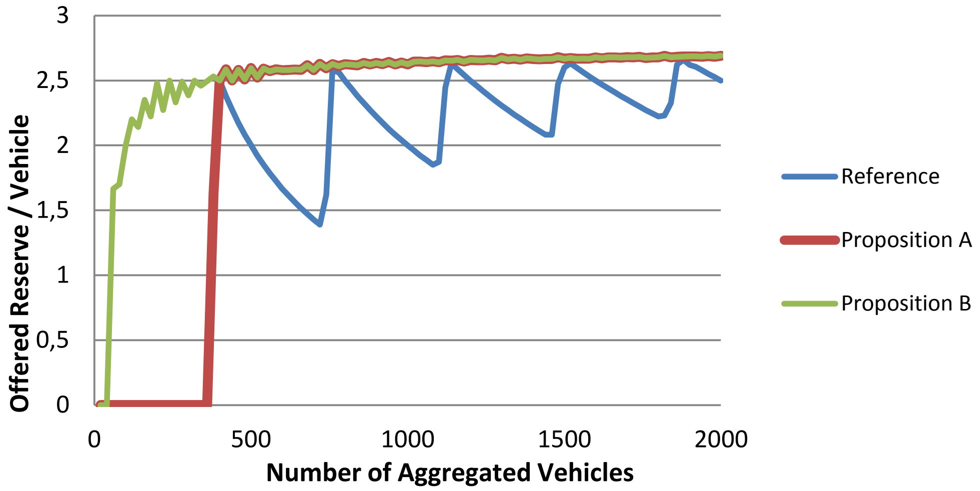


FIGURE 6: OFFERED RESERVE / VEHICLE FOR FLEET WITH DIFFERENT VOLUME GRANULARITY

We then look at implications of temporal granularity on potential revenues for the aggregator. Results are presented in Figure 7. Left y-axis shows the amount of reserve offered in average for 100 weeks. Right y-axis shows the corresponding remuneration for one vehicle per year, with a price of 15.6 €/MW/h, which is the average price in FCR Cooperation from January to May 2017. For simplicity, it is considered that the aggregator is price-taker and would not affect the average price on the market. However, if a high number of EVs is providing reserve, the price would drop and revenue would decrease.

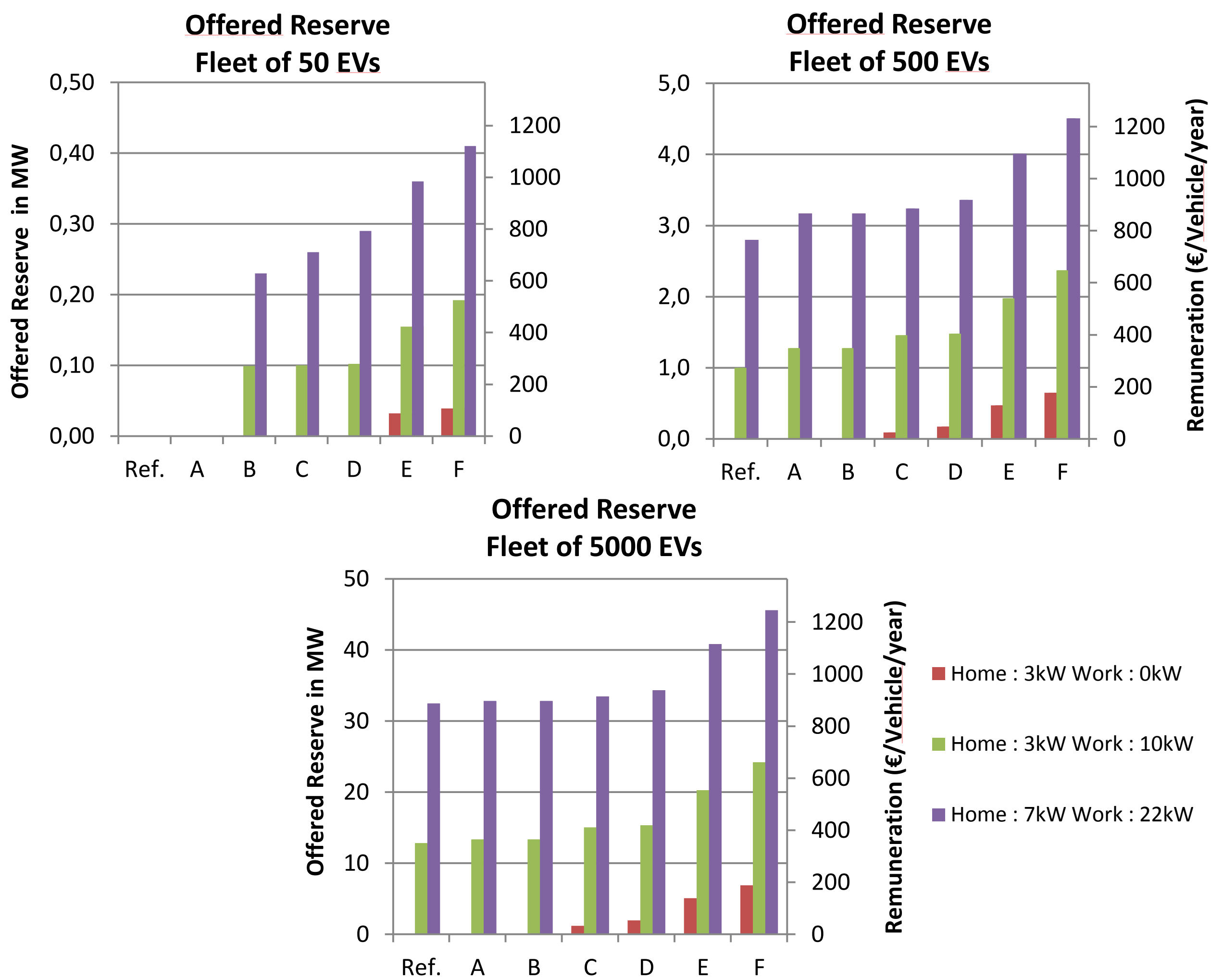


FIGURE 7: AVERAGE POWER BID IN THE MARKET FOR DIFFERENT SIZES OF FLEET AND DIFFERENT MARKET DESIGNS

As stated earlier, a small aggregator cannot enter with Reference rules, while medium and large aggregator can. Moving to Proposition A (volume resolution of 0.1 MW) does not allow small aggregator to enter, but it allows better provision of medium aggregator. Moving to Proposition B (minimum bid of 0.1 MW) allows entrance of small aggregator, while it has no impact on medium and large aggregator.

Creating off-peak/peak products (Proposition B and C), allows small aggregator to make higher bid, but has limited impact on medium and large aggregator. However, it should be remembered that we have only considered working days, and that off peak/peak products would allow better differentiation between working and not-working days, which would increase the impact of this type of products.

When looking to high time granularity (Proposition E, with 4-hour products and Proposition F with one-hour products), each aggregator is impacted in a similar way and able to bid more on the market.

# 5. On-Going Discussions Between Stakeholders

On 9th January 2017, TSOs involved in the FCR Cooperation launched a consultation to every stakeholder on the potential market-designs evolutions in the FCR Cooperation (50 Hertz et al., 2017a). Various aspects were covered in the consultation, including auction frequency, product duration minimum bid, bid resolution and TSO-BSP Settlement.

Results of the consultation and positions of TSO on these subjects were published on 31st May 2017 (50 Hertz et al., 2017b). 29 BSPs prequalified for more than 20 MW and 28 BSPs prequalified for less than 20 MW responded to the consultation.

Big BSPs were more in favor of keeping weekly auction, with week-long products, whereas small BSPs asked for daily auctions with 1hour products.

When looking at minimum bid, most of stakeholders (78%) did not ask to reduce it. However, as most of stakeholders were already prequalified, they had no interest in reducing the minimum bid. It should also be noted that depending on the type of technology, results were very different: 4 out of 7 storage units and 4 out of 8 aggregators of consumption units asked for a lower minimum bid whereas 29 out of 31 generation units asked for keeping this minimum bid. The proposition to keep a minimum bid of 1 MW and to lower bid increment was not in the consultation.

For TSO-BSP settlement, 53% of stakeholders asked for marginal pricing. Surprisingly, none of the aggregators of consumption units asked for marginal pricing, whereas most of storage units asked for it.

Based on this consultation, TSOs proposed a target market-design:

- Within 9 months, go for marginal pricing
- Within 18 months, implementing daily auctions with 4 hours product, while keeping 1 MW minimum bid.

The reason invoked by stakeholders and TSOs for keeping a 1 MW minimum bid is that “there is hardly a business case below 1 MW” and that pooling resources would allow reaching this 1 MW threshold easily. We think this argument is fallacious, since it is not the role of TSOs to decide where possible business are and that pooling of resources can be limited for some new innovative actors who does not own any generation asset.

Moreover, a large majority asked for a harmonization of different market rules, such as prequalification criteria, penalty scheme and monitoring, to create a level-playing field for all stakeholders among all countries. It should be implemented in a third step.

# 6. Conclusions

France has chosen to join the FCR Cooperation to procure its primary reserve. This cooperation is now a major platform for the procurement of primary reserve, as almost half of the CWE Synchronous area is now procured in this platform.

This movement towards market integration for ancillary services is driven by the European Commission, ACER and ENTSO-e. French regulators and market actors identified some rules in FCR Cooperation market design, which may hinder participation of new innovative entrants, especially the length of the products.

However, it was claimed that it would allow France to export and import reserve when economically efficient. We proved that the actual rule of allocation of costs would not be in favor of France if it was exporting reserve.

Although offering new trading opportunities for actors, actual rules are really constraining for aggregators: temporal granularity being very limited (products of 168 hours), assets with varying availability would provide a limited fraction of their possible reserve. It is the case with EVs, as they might not be always connected to the grid, or to power plugs with different rated power. Increasing granularity would allow offering more reserve, thus increasing potential revenues and allowing business cases to be more viable.

Volume granularity is also a major challenge for aggregators. Not only minimum bid, but also bid increment could constitute barrier to entries, as the revenue per unit would depend on the number of units aggregated. It would be more difficult in this context to decide how to share the profits, how they would be much more uncertain. In case TSOs are not willing to lower minimum bid due to complexity issues, we think it would however be possible to lower bid increment to solve this issue.

Ongoing discussions between stakeholders are positive, as TSOs are now ready to change product duration and auction frequency. National Regulation Agencies will give their opinion on these changes in the coming months. However, volume granularity issues were not removed. The position of TSOs on this issue is questionable, as it is not the role of TSOs to decide if business model are viable or not.


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