

Summary of consultation “Challenges of Defining Direct/Indirect Control Signals”

This report provides a brief summary of results of a public consultation survey. There were eight questions in total, covering various topics related to defining and broadcasting control signals for Distributed Energy Resources (DERs) to access the market. The report is concluded with the discussion by consortium on the feedback received.

1. Overview of participants

A consultation was organized related to the presentation of an analysis framework for different control signals and market designs in order to set an appropriate discussion about their advantages and challenges in Pilot B of the SmartNet project. Respondents could provide answers via the website or by email for a period of 1.5 months. Five answers were considered complete and the feedback is integrated in the report. Figures 1 and 2 give an overview of the respondents per country and sector, respectively.

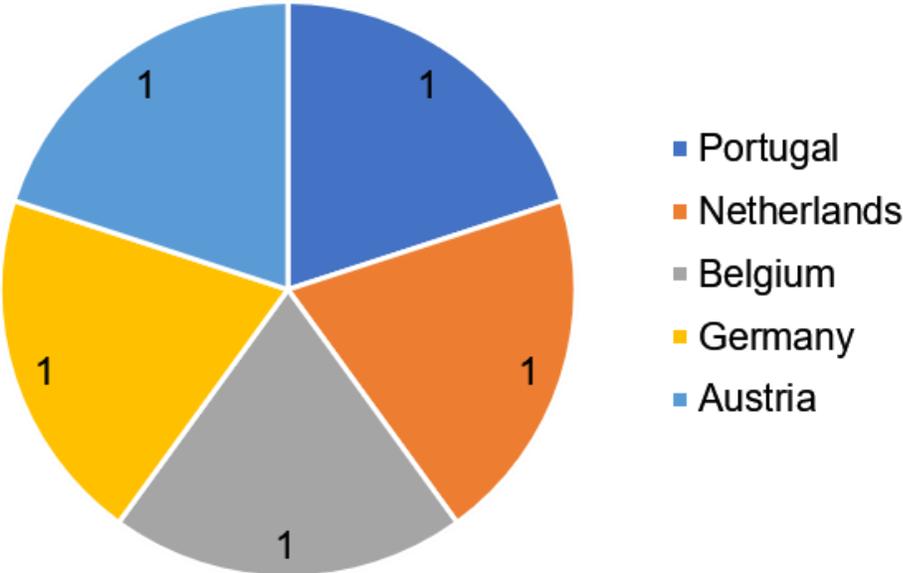


Figure 1: Overview and number of participants per country

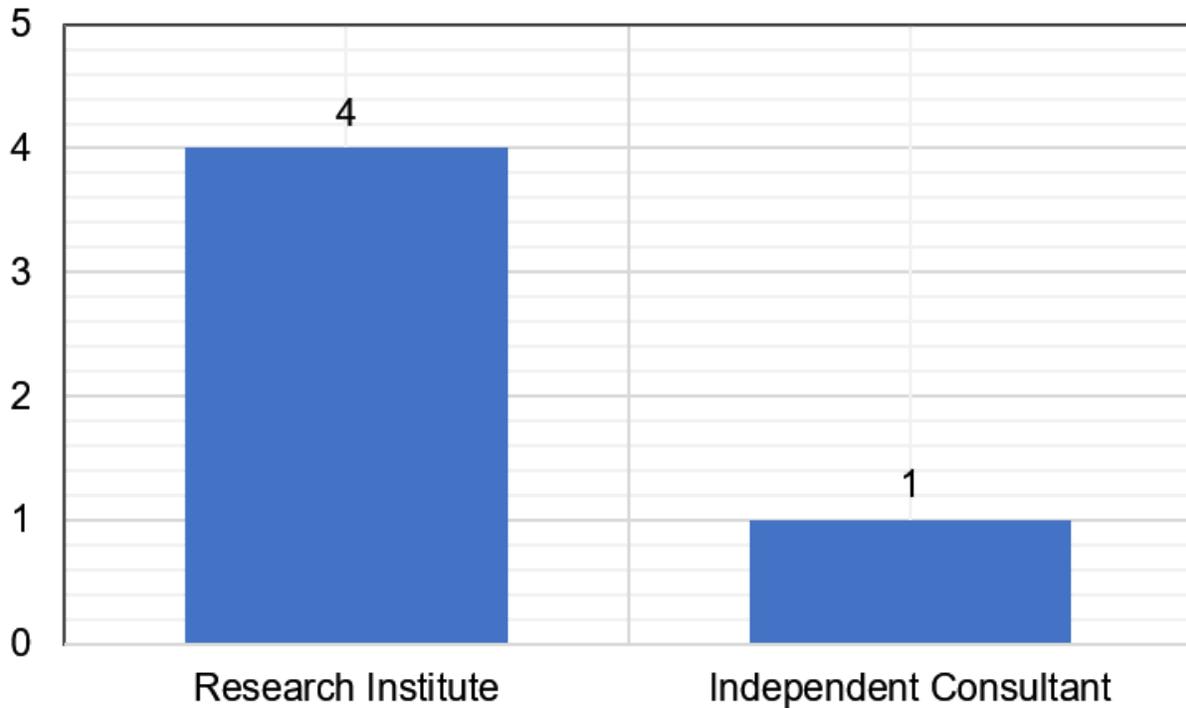


Figure 2: Overview and number of participants per sector

2. General feedback

The questions are grouped in two categories: feasibility and applicability of the proposed market designs, and design model of the price signals being broadcasted; each of them is discussed separately in the next sections. In general, the following summarizes the most important points that five reviewers raised regarding the two categories mentioned, respectively:

- Although all the proposed market designs, depending on adequate historical data, are applicable, however, considering the horizon chosen, two principles of preferability in working on a global scale and profitability in working with prices at high frequency help choose the most suitable market design. The responses varies and there is no clear tendencies but two respondents believe that the feasible design towards the integration of DERs into the power system is the direct control through the Aggregator (AGG). They also claim that market designs of indirect and direct control from the Market Operator (MO) might considerably increase the complexity of the market and thus, limit the DER participation in the market. Regarding the communication, although unidirectional communication relieves the complexity of DER participation/integration, however, majority of reviewers agree that the bidirectional communication due to having a concrete knowledge of the available flexibility over time fits with direct control through the AGG design very well.
- It has agreed that sending price signals by the MO instead of the AGG is technically feasible. But it will require a fundamental redefinition of the role of MO. Moreover, the following challenges can arise: flexibility value losing, incomplete price information in

price signals, and flexibility estimation and system balancing by MO (outside of its responsibility).

- Reviewers agree that adding an external commercial forecast provider brings more transparent and reliable forecast although increasing the complexity of DER participation in the market.
- None of the respondents finds price based control infeasible and two respondents mention that price based control is easier to handle and leaves the choice to the final consumer.
- A majority of the respondents question the incentive for the DERs to react in a scalar-based scheme. One respondent mentions that it is impossible to ensure reaction without an economic incentive.

2.1. Direct/indirect control signals in different market designs

In this category, there were five questions about the suitability of the proposed market designs, feasibility of the introduced control signal approaches and their comparison, and reaction of DERs to control signals.

Respondents confirm that all the proposed market designs, due to the variety in different market (particularly in free and wisely organized ones) and DER conditions, are feasible and suitable. A reviewer suggests that the existence and level of penalties to DERs for not complying with accepted offers can play a major role (emphasizing that the higher the penalties, the more attractive the direct control) in selecting the proper market design. Another respondent also supports the idea of direct control for short-term flexibility, where the objective is to stick to equality of production and consumption. Two respondents believe that choosing a proper control strategy is independent of the market design and only depends on the size of DER in order to cover communication costs. That is, designing a suitable business model based on this strategy is under the responsibility of the AGG and depends on many different factors, such as business objectives, regulation, internal synergies, and flexibility pool characteristics.

Most respondents are in line and highlight that both direct and indirect control strategies for AGGs to utilize flexibility of DERs in electricity markets are technically and economically feasible. A respondent believes that, from an economic perspective, indirect control for committed DERs might be a better strategy, since it avoids bidirectional communication and allows them to maximize their revenue. Another respondent also believes that indirect control through the AGG (based on price signals) enables it to sell flexibility in different markets. The remaining respondents point that, from technical point of view (e.g., real-time flexibility estimation), the scalar-based direct control through the AGG seems to be the most suited market design to integrate DERs due to the following reasons:

- Robustness in control terms
- Reduction in the risk level associated with uncertainty in DER response (note that in this case, this is the AGG, who has to undertake the necessary infrastructure cost)

- Guarantee of the highest participation of DERs (of course ensuring their data privacy)
- No technical expertise and commercial arguments for DERs to participate directly in the market
- Easy real-time flexibility estimation with respect to sufficient available historical data

It has been noted that in this design (scalar-based direct control through the AGG), with no economic incentive, no DER will follow any signal on the mid-long run. As a result, if there is a profitable contract in place between the AGG (to increase its economic efficiency when buying DER flexibility) and DERs (to decrease its costs), this model will work fine. Most respondents highlight several issues that might arise in case the DERs are controlled indirectly through the AGG, as follows:

- Possibility of leading to operational security problems under high DER penetrations given that the demand curve and over-reaction of DERs cannot be fully predicted
- Interest by DERs in relying on their aggregators to optimize their capacity and maximize their revenue, rather than managing their own capacity
- Problem of passive behavior of DERs in reacting to price signals

Some respondents argue that choosing the best suitable market design depends on the horizon, where on a short run (less than one hour, e.g., five minutes), direct signals should always be used by the Transmission System Operator (TSO) while on the long run (more than one hour) both direct and indirect are applicable. Two principles apply here:

- i) **preferability** in working on a global scale (different classes of resources in different regions) to benefit from economies of scope between assets and correlations between external factors, and
- ii) **profitability** in working with prices and settlement at these prices on high frequency to provide DERs with incentive to be individually efficient while sticking to balancing constraints on energy and services globally.

A respondent highlighted that although leaving the implementation of these principles to each AGG reduces the difficulty of the computation and data processing (by simplifying through a decentralized optimization approach along with a learning process), however, it creates a new layer of coordination among AGGs. As a result, prices and control of deviations should be revised with high frequency.

Particularly, regarding the market designs of indirect and direct control from the MO, most respondents emphasize the following critical barriers: i) no profit for DERs, which are not Balance Responsible Party (BRP), since the regulation prevents DERs' curtailment to be remunerated via grid tariff, and ii) it might considerably increase the complexity and thus, limit the DER participation in the market, respectively.

In terms of communications, a number of reviewers emphasize that the simplicity of unidirectional communication seems to be a good option, since complex bidirectional

communication (and more expensive) might prevent DERs to participate in the market as higher capital costs can be involved. Nevertheless, majority of reviewers challenge that:

- Low cost on two-way communication in the future will make feedback from DERs' reaction possible
- Increased telecommunication requirements of the direct control becomes a disincentive
- A bidirectional communication scheme is more suitable for the AGG due to having a concrete knowledge of the available flexibility over time, and avoiding the discomfort that the unidirectional telecommunication scheme may bring to DERs

With respect to the question on the interpretation method of the scalar-based signals in the indirect control scheme, most respondents agree that without a two-way communication and imposing regulation or economic incentive, one cannot guarantee that the DERs react as expected. A reviewer believes that being (probably) unable to guarantee the participation of DERs in indirect control schemes (both price-based and scalar-based) is a big disadvantage. Furthermore, one respondent also highlights that the employment of scalar signals necessitates specific contractual agreements between the AGG and DERs. It is suggested that one (e.g., the AGG) should be ready to regain the direct control of the equipment in case deviations get out of control, while checking that the indirect signal remains valid, that is only requiring limited corrections (except for major events).

As a final note in this section, respondents mention that in both indirect price-based and direct scalar-based control approaches, historical data is necessary either to adequately calculate control signals or estimate flexibility function. This requires the SmartNet to orchestrate an experimental period in Pilot B to get the necessary amount of historical data. They also raise the following concerns in response to challenges of price-based control compared to scalar-based control:

- From the system's point of view, price-based control is less robust since it leaves the final choice to DERs
- There might be a risk the price signal does not cover both energy and services or is distorted with respect to energy and services
- There is no guarantee that the indirect price-based control in the context of Pilot B: i) ensures the active participation of, and ii) brings the biggest financial advantage to DERs with the lowest impact on their comfort

In this regard, one respondent emphasizes the necessity of a clear description whether DERs will host their own optimization algorithm or will be supported by the project. If the former is not the case, their active participation might not be guaranteed.

2.2. Broadcasting price signals to DERs

In this category, the consultation asked three questions related to challenges of broadcasting price signals from the MO instead of the AGG, replacement and broadcast of imbalance cost with price signals, and origin of price forecasts for a DER to do an economic optimization.

Three reviewers believe that sending price signals by the MO instead of the AGG is technically feasible. However, two challenges will arise:

- Flexibility will be losing value by being fixed for that one market or purpose
- No clue that which price information (energy market clearing, reserve market clearing, imbalance cost, etc.) the price signal holds and how this is affecting DER's operations and contractual relationship with Distribution System Operator (DSO)

In contrast, a reviewer claims that this approach, due to the following reasons, seems infeasible:

- The MO should act as a neutral and transparent entity, thus it should not be responsible to estimate flexibility function nor calculate the control signal
- Balancing the system should not be the MO's responsibility and this is a strong disadvantage of the indirect control from the MO market design option
- The number of DERs participants makes the direct link with the MO unfeasible

Nevertheless, to initiate such control signal, the other reviewer proposes the following necessities:

- Fundamental redefinition of the role of MO from market facilitator to market participant
- Robust incentive-based regulatory framework for the MO to increase its economic efficiency when buying DER flexibility

Concerning the possibility of broadcasting the imbalance cost of the current Regulating Power Market (RPM) as a price signal to DERs to react on, we received mixed answers. On one hand, a participant argues that under the current regulatory framework, this is most probably not possible, since broadcasting the imbalance cost of the current RPM only to DERs (which is indeed not the intention of such setup in SmartNet project) is violating the level-playing field principle (due to dividing the different service providers to two separate groups) and may result in possible over-reactions by DERs to price signals. In the same line, another respondent claims that it is the system operator that knows at which time the system needs to be balanced (completely neglected in this design), where the price signal will not solve the quantity issue. The MO only provides the correct price for the service and the AGG will help get the service from the DERs. On the other hand, the remaining respondents confirm that a price signal should: i) be sent in real-time, ii) be based on marginal and not on total or average cost, and iii) include forecasts as well. Otherwise, there will be no value.

As a final note in this report, adding an external commercial forecast provider, probably where DERs participate directly into the market to have more benefits, brings the following advantages:

- More transparent and reliable forecast
- More specialized knowledge than aggregators, resulting in lower forecasting errors

The disadvantage of this addition is related to the increase in the complexity of DER participation in the market. Respondents believe that the answer to this challenge is

independent of the origin of price, and is based on the technological capabilities of the forecasting service and business models that DERs choose to follow in their contractual relationship. As a result, apparently, having the AGG providing the price forecast might be the most adequate solution. To avoid influencing price signals, it is necessary to ensure that there are no conflict of interests between DERs and the AGG. One respondent emphasizes the AGG should be penalized if strong deviations to the price forecast occur as it might result in lower revenues to DERs and system imbalances.

3. Discussion and conclusion

Authors, after carefully analyzing the feedback received and having fruitful discussions, finalize the report on consultation document with the following points:

- To have a common understanding of definitions, indirect control is enabled when incentives (e.g, price signals) are provided to DERs, but the decision is made locally while direct control is approached when the decision is made centrally (e.g., adjusting set points). In both cases, communications can be unidirectional and bidirectional.
- To benefit from the direct control through the AGG design, data privacy of DERs has to be ensured. Furthermore, more elaboration, from respondents' side, is needed to justify the reason of having the highest participation of DERs in such design is guaranteed.
- There would be a possibility that the indirect price-based control through the AGG introduces a layer of uncertainty and suboptimal choices between the AGG, as the market facing party, and DERs, as flexibility owners. Moreover, passive (reactive) behavior of DERs in response to price signals in this design should be carefully taken into consideration.
- It was discussed that the price being broadcasted is the imbalance cost. Therefore, a DER can choose to be out of balance and for instance consume more than planned at this price or consume less than planned while selling the extra energy at this price. This price takes DSO needs and grid constraints into account according to the TSO/DSO coordination scheme.
- Having the system balancing task under the responsibility of the MO requires a paradigm shift, since it is not possible to rely on individual responses by DERs. This concept requires many participants and by statistics we should be able to be more sure on the available flexibility than for few directly controlled units which can also fail. Nevertheless, there is no clear clue that how broadcasting price signals to few DERs than to many units by the MO compared to the design, in which the AGG is responsible for sending signals and controlling the DERs can be more complicated.
- In order to have price signals sent by the MO instead of the AGG, fundamental redefinition of the role of MO from market facilitator to market participant is necessary. However, it is not clear in this case who will have the role of clearing the market and maximizing welfare. This still requires to have another MO, which is not a market participant.
- It was discussed that having the AGG providing the price forecast depends very much on the contractual relationship between the AGG and DER units. If the AGG sends a

price and the DER is free to interpret it as it wants, the only contractual relationship is that the DER pays the price that the AGG sends. If the AGG sends inaccurate forecasts of this price, the DER is free to use other forecasts. It might even be that DERs do not consider the price and do the optimization according to other incentives, for instance CO2 emissions.