consentec

Market Study on a Common Market for Primary Control Reserve in the Netherlands and Germany

Market Study for

TenneT TSO B.V.

Utrechtseweg 310, NL-6800 AS Arnhem

Final report

October 29, 2012

Consentec GmbH

Grüner Weg 1
52070 Aachen
GERMANY

Tel. +49. 241. 93836-0
Fax +49. 241. 93836-15
E-Mail info@consentec.de

www.consentec.de

Content

Abbreviations

ENTSO-E	European Network of Transmission System Operators for Electricity
OH	Operation Handbook of ENTSO-E Regional Group Continental Europe
PCR	Primary Control Reserve
TRM	Transmission reliability margin

1 Background and Aim of Market Study

The markets for ancillary services in Europe undergo continuous development. For example, in the Netherlands the current regime of mandatory delivery of primary control reserve (PCR) by all production units with an installed capacity of more than 5 MW is supposed to be replaced by a market-based procurement mechanism. In Germany the regulator (Bundesnetzagentur) has recently changed tendering conditions for all reserve qualities with the intention to further improve competition on the German reserve markets.

Furthermore, various efforts to internationalize reserve markets have been undertaken. For example, a common cross-border PCR-market has already successfully been established between Germany and Switzerland. Since February 2012 the Swiss TSO Swissgrid and the German TSOs have procured a 25 MW-share of Swiss demand and of the complete German demand in a common auction. It is a general European goal to improve the cross-border provision of control reserve.

Considering the upcoming, necessary changes in the Dutch procurement system for PCR, Tennet TSO B.V. (TenneT) considers different options on how to design a future Dutch PCR-market. One option is to set up a common market for PCR between the Netherlands and Germany by means of the Netherlands joining the German procurement system. In a common market, market participants from both countries would be allowed to place bids for the common PCR demand (i.e. the sum of the German and Dutch demand). To cover the common demand, the least expensive bids would finally be chosen.

In order to evaluate consequences, potential benefits as well as risks and requirements of such a common market, TenneT has issued this market study.

Section 2 of this study describes the general concept of a common PCR-market and explains the main advantages of a common market. Furthermore, we show which requirements have to be fulfilled to establish a common market and to actually achieve possible benefits from a common market to a large extent.

The more general considerations from section 2 are applied to the specific situations in the Netherlands and Germany in sections 3 and 4. The current situation regarding the procurement of PCR in both countries is analyzed in section 3. Consequences of similarities and differences between both countries for a common market are discussed in section 4. Furthermore, it is discussed in particular to which extent a participation of Dutch suppliers to a com-

mon market can be expected, as this is an important aspect evaluating possible consequences of a common market between the Netherlands and Germany. This evaluation is partially based on the results of a survey carried out among potential Dutch suppliers of PCR within the scope of this market study.

2 Concept of a Common PCR-Market

2.1 General description and advantages of a common PCR-market

Currently, in the continental European interconnected system a total of 3,000 MW of PCR have to be available at all times. By means of the rules of the European Network of Transmission System Operators for Electricity (ENTSO-E), mainly described in the ENTSO-E operation handbook (OH) [1], each country[1] has to take responsibility for a specific share of the total demand. Each country's national PCR demand is calculated each year based on the electricity generation in the specific country in the past year. For 2012 the Netherlands have the responsibility for providing 117 MW of PCR. The responsibility of Germany is currently 567 MW.

In the status quo, the national PCR demand, i.e. the share of the total PCR demand that each country is responsible for, is usually covered nationally. This means, that only national supply is used to cover national demand. However, the ENTSO-E OH in general allows that one country can take over – within particular limits discussed in section 2.2 – at least parts of the responsibility for covering PCR from another country.

A common PCR-market is a market-based approach to make use of this opportunity to cover the demand from two or more countries not by using national supply separately but by covering the common demand by using supply from all participating countries.

In a common auction between two countries the demand from both countries participating are being procured within in one auction. The common demand is tendered in one single auction to which market participants from both countries equally have access according to identical conditions. As a result of such a common auction, regularly the demand from one country is (partially) covered by supply provided by the second country. Hence, as a result of a common auction, one country is regularly taking over at least parts of the responsibility to provide PCR

[1] In fact, in the more technical terms of the OH, rules actually all apply to control areas / blocks instead of countries. However, as the Netherlands form a single control area and the four German control areas– in this context – are also considered as one control area, we will use, for the sake of readability, here and in the following the terms analogously unless otherwise stated.

from the country. Summing up, both countries still fulfill their common responsibility to provide a share of the overall PCR demand.

The main advantage of a common market is an increased efficiency of the PCR procurement. Compared to a separated PCR procurement, a common market can avoid misallocations. In separate markets costly offers from one country cannot be substituted by more economic excess supply from the other country because supply from one county may only be used to cover demand from this country. In a common market, excess supply from the neighboring country is inherently used to substitute less economic supply from the own country. This allows achieving an overall efficient procurement of the PCR demand considering both countries with overall lower costs for the procurement of PCR. To this extent, the concept and advantages of a common PCR-market are comparable to the concept of market-coupling between power exchanges at the day-ahead wholesale markets for electricity.

Furthermore, in a common market more suppliers are in competition to each other. Due to the comparably high technical requirements which units have to be fulfilled in order to provide PCR, the competition at PCR markets is significantly lower compared to for example the competition at the wholesale / spot markets for electricity. Hence, it can be expected that a common PCR-market can lead to significant increase of competition at this market. In general, it is expected that increased competition can lead to fairer and in consequence lower prices.

Besides the aspect of an increase of efficiency in the procurement of PCR, from the point of view of the TSOs which have to take care of fulfilling each nation's responsibility to provide PCR, a common market increases the potential supply, to which each TSO has access to cover its demand. This reduces the risk of a supply shortage. Furthermore, compared to a situation with separate markets and hence separate auctioning systems, in a common market only one common auctioning system is necessary, which reduces the overall costs for necessary IT-systems, etc. to operate the PCR-market.

Also for potential PCR-suppliers, a common PCR-market creates advantages. A common market increases the relevant market size for suppliers as in a common market they can not only provide PCR for their domestic demand but can also take over parts of the demand from the neighboring country in case they are competitive. This increases the supplier's sale opportunities on the one hand and on the other hand might incentive new market entries in case for some potential suppliers the size of the separate, national market was considered too small to

take efforts to participate in the PCR-market. Such new market entries could also increase overall efficiency and competition in procuring PCR.

For the particular case of the Netherlands, with a currently non market-based procurement approach, a common market also unlocks the general advantages of a market-based PCR procurement. As such are in particular considered a higher efficiency of the procurement and lower overall costs[2].

2.2 Requirements of a common PCR-market

Establishing a common PCR-market and achieving the general advantages of a common market as discussed above, several regulatory and conceptual requirements and conditions have to be met. These are discussed in the following.

As already explained in the previous section, the basis of a common market is being formed by the ENTSO-E OH, which allows that one control area can increase its domestic PCR provision in order to cover demand from neighboring control areas and hence take over at least parts of their responsibility for the provision of PCR. The OH limits to which extent PCR can be increased above the domestic / national demand in one control area to 30%, but allows a minimum increase of 90 MW. For the particular situation of the Netherlands, with a required PCR-provision of 117 MW in 2012, and Germany, with a required PCR-provision of 567 MW, this means that the maximum amount of PCR provided within the Dutch control area, i.e. from Dutch units, may be 207 MW and hence Dutch suppliers may – in addition to covering the domestic demand of 117 MW – cover up to 90 MW of the German demand. The German PCR provision is allowed to be increased by a maximum of 30%, i.e. by 170 MW to up to 737 MW. Hence, in a common market it would be possible that German suppliers take over the complete Dutch responsibility of 117 MW in addition to the national German demand. In this situation, German supply would still be able to cover the demand of other

[2] In [2] a general discussion on the advantages of a market-based procurement of PCR in the Netherlands can be found.

neighboring control areas to up to 53 MW[3]. Restrictions and possibilities to cover parts of foreign demand in a common Dutch/German PCR-market are illustrated in Fig. 2.1.

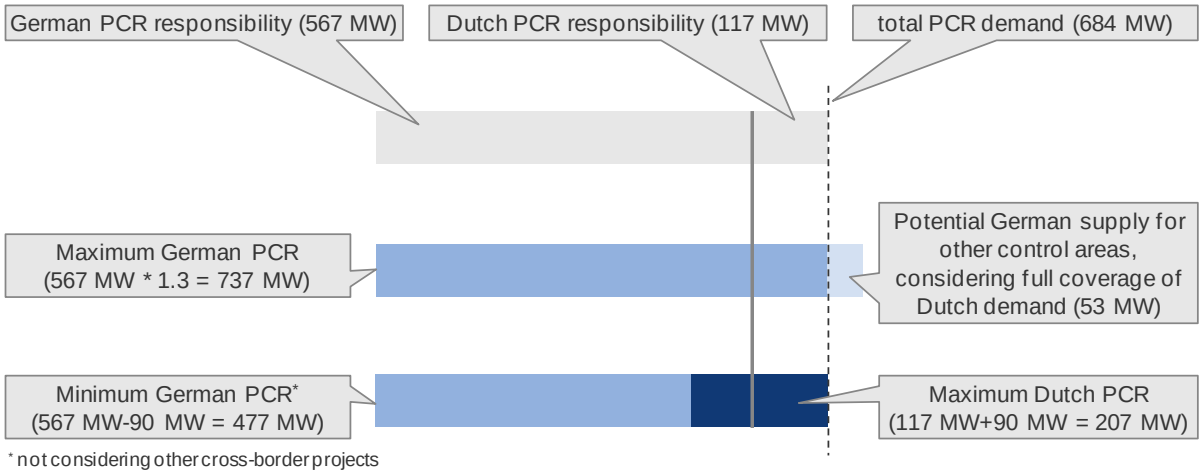


Fig. 2.1 Restrictions and possibilities according to ENTSO-E OH to cover parts of foreign demand in a common Dutch / German PCR-market for suppliers

In a common auction the total demand is tendered in one single auction. This obviously requires fully harmonized market rules for suppliers from both participating countries as there is only one market. In this study we assume that in a common PCR-market between the Netherlands and Germany the current German market rules are adopted for a common market. Otherwise, also the market rules in German would have to be changed which is expected to complicate the process of introducing a common market. Also other investigations (cf. [2]) discuss German market rules as model / prototype for a future Dutch market-based PCR-procurement approach. From the Dutch point of view, adopting German market rules for the common market does in general not increase the complexity of introducing a common market, as new market rules have to be established in the Netherlands anyway coming from a non-

[3] Currently, Germany is also carrying out a partially common auction with Switzerland in which 25 MW of the Swiss demand are procured in a common auction with the complete German demand. Even if the amount PCR provided from Germany was increased by 25 MW due to covering this part of the Swiss demand, this would not restrict German supply to cover Dutch demand. However, in the future other cross-border projects could lead to a potential further increase of the German supply when also taking over responsibility for other neighbor's PCR requirements. This could imply a conflict with the rules from OH. Hence, compliance with operation handbook needs to be checked in case of further common market projects.

market based procurement. However, it is unclear to which extent Dutch suppliers would participate in a common market according to German market rules. In order to unlock efficiency gains and other advantages described above, a substantial participation of Dutch suppliers in a common market is necessary, as otherwise e.g. no increase in competition between suppliers could develop. Section 4 of this study will discuss the potential contribution of Dutch suppliers to a common market.

Furthermore, technical requirements which production units have to fulfill in order to provide PCR, need to be at least widely aligned in order to create a level playing field among all market participants[4]. To which extent this is already fulfilled by today's rules in both countries is discussed in section 3 of this document.

Creating a common market for PCR implies a close co-ordination and co-operation not only between involved TSOs but also between regulators which have exerted influence on the design of the national PCR markets in the past. A single, border-crossing market requires that regulators in both countries fully align their interventions regarding rules for the PCR market. Unilateral interventions will only be possible with the consequence of giving up the concept of a common market and returning to national markets again.

Discussing consequences of a common cross-border market sometimes the question arises whether this has a consequence on the allocation of cross-border capacity which is available to the long-term and short-term wholesale energy market, e.g. within market-coupling. For the specific case of PCR it needs to be considered, that taking over the responsibility for providing PCR from a neighboring country does not mean that in the case, PCR is activated, this amount of PCR needs to be physically exported to this neighbor. PCR, in opposition to other

[4] Ideally, also technical requirements and framework contracts between TSOs and suppliers should be fully harmonized. However, in the beginning it might be considered acceptable that such rules and regulations are widely but not fully aligned as long as this does not systematically benefits suppliers from one country. In a transition phase from a separate to a common cross-border PCR-procurement this can help to start a common market on the one hand without high transaction costs (e.g. for testing units according to only slightly changed technical rules) and on the other hand without threatening a level playing field between market participants.

reserve qualities, such as secondary or tertiary reserve, is jointly activated by all TSOs in the synchronous area as soon as an imbalance occurs at any point in the interconnected system[5].

Take, as an example, the case of a generator outage in Italy. In this case all PCR in all control areas of the synchronous ENTSO-E system is activated in order to restore a balance of production and consumption. This leads to an import of power to Italy from all other control areas. The resulting physical flows are subject to physical laws. Within the process of capacity allocation these unpredicted power flows are considered by means of the transmission reliability margin (TRM). If, for example, Germany takes over parts of the Dutch responsibility to providing PCR, in the case of a generator outage in Italy, the corresponding increase of production (by means of activation of PCR) in Germany would be accordingly higher. However, this increased amount of PCR activated in Germany needs not to be transported to the Netherlands first and then to Italy but it will directly be exported from Germany.

It does, though, change the unintended physical flows in the interconnected system due to an activation of PCR depending on the overall feed-in and load situation. These changes are, however, expected to be small compared to the margins that need to be taken into account for calculating the TRM, in particular since the maximum amount of PCR, which can be covered for other control areas, is small compared to the total PCR-demand within the synchronous system., because the rules from ENTSO-E OH regarding the distribution of PCR across the interconnected system avoid a concentration of PCR in one or only a few control areas.

Hence, no additional cross-border transfer capacity between Germany and the Netherlands needs to be reserved between both countries in case of a common PCR-market, and no further restrictions arise for a common market with respect to available cross-border capacities for the wholesale market.

2.3 Alternatives to a common PCR-market

General advantages of a common PCR-market have been discussed above. In case further analyses on e.g. the comparability of technical requirements or the expected contribution of

[5] Opposed to this, secondary and tertiary control reserve are used to balance imbalances within a control area and, hence, need in general to be activated in the control area, in which the imbalance occurs.

Dutch suppliers to a common market, lead to the conclusion that in the specific case of the Netherlands and Germany a common market would not unlock all expected advantages, other models of cross-border market integration can be thought of.

Opposed to a fully-integrated common market, in which the maximum allowed exchange of PCR according to ENTSO-E OH is considered in the auction, it is also possible to limit the amount of PCR, which can be covered by a neighboring country to an amount which is lower than the limit set by the OH. In a situation, in which there is considerable high uncertainty with respect to the reaction of market participants to a common market, such an approach can help to sense, how market participants react to a common market, and hence limit the risk of a low liquidity, etc. in a common market. Step-by-step these limitations can be reduced up to a situation in which a fully-integrated common market is established. Even though in this case a fully-integrated market is not established from the beginning, parts of the advantages of a common market are already unlocked. E.g., the use of only one common IT-system is necessary and also fully harmonized market rules are required which are also a prerequisite for a fully-integrated common market. Also overall efficiency gains are to be expected.

Other models, such as a cross-border market opening, in which market participants from one country are allowed to participate in the auction of the neighboring country, or TSO-TSO models, in which TSOs in both countries still carry out separate auction but exchange their excess supply, can be considered as helpful in the particular case that a full harmonization of market rules cannot easily be achieved. As we expect this not to be the case for the specific situation between Germany and the Netherlands we will not further elaborate on these models in the following.

3 Analysis of Current Mechanisms of PCR-Procurement in the Netherlands and Germany

The following describes the current mechanisms of PCR-procurement in the Netherlands and Germany. On one hand this comprises technical aspects, i.e. technical requirements that units have to fulfill, which are provide PCR, and the way these technical requirements are tested. On the other hand the procurement system is described, i.e. for the Netherlands the obligations for generation units to provide PCR and for Germany the tender conditions of the current PCR auctions. This analysis is basis for the evaluation of consequences of a common market in section 4.

3.1 Description of current Dutch mechanism of PCR-procurement

3.1.1 Technical aspects

Technical requirements for units, which provide PCR, are described in the Dutch grid code ("Systeemcode Electriciteit", [3]). In the current Dutch procurement system for PCR all generation units with an installed nominal capacity of 5 MW or more are obliged to provide PCR (see section 3.1.2). Hence, technical requirements only exist for such units[6]. Due to the obligatory system these technical rules have to be fulfilled by all generation units with an installed capacity of 5 MW or more. Exceptions only exist for generation from non-disposable energy sources (in particular renewable energy sources, such as large wind turbines) and industrial producers. Such units do not have to provide PCR. Generation from non-disposable energy sources also do not have to fulfill the technical requirements which are described in the grid code and tested according the rules in the Dutch grid code[7].

[6] Generation units with an installed capacity of less than 5 MW or consumers currently do not provide PCR in the Netherlands. No technical requirements have been defined so far.

[7] Industrial producers do not have to deliver PCR, however, the generation units still have to fulfill the technical requirements from the grid code.

Regarding the technical requirements in the Dutch grid code it is distinguished between units with an installed capacity of 60 MW or more and units with an installed capacity between 5 MW and 60 MW.

Units of more than 60 MW installed capacity need to be able to provide up to 5% of the installed capacity as PCR. This applies to upward as well as downward regulation. PCR has to be fully activated in case of frequency deviation of +/- 200 mHz and within 30 seconds. In case only 50% or less of the PCR is activated, this needs to be deployed within 15 seconds. For any activation from 50% to 100% the maximum deployment time rises linearly between 15 seconds and 30 seconds. The sensitivity / accuracy of frequency measurement needs to be better than or equal to +/- 10 mHz. Each units needs to be able to provide PCR for at least 15 minutes. Dead bands are not allowed for units with 60 MW or more installed capacity. According to TenneT real-time operation measurements of frequency and power output of the unit have to be made available to the TSO with a time resolution of 4 seconds (or less). This is to allow the TSO to verify the correct PCR activation in real-time operation. These rules comply with the rules described in ENTSO-E OH.

Units with an installed capacity between 5 MW and 60 MW have to fulfill the same rules as described above with the exception of an allowed dead-band of 150 mHz.

Upon commissioning of a generation unit and afterwards each eight years, units with an installed of more than 60 MW are tested by an independent test laboratory. These tests intend to prove that these units fulfill the technical requirements described above. According to the Dutch grid code, it needs to be explicitly tested that units fulfill the requirements regarding maximum deployment times, range of available PCR (up to 5%) and availability of PCR. Tests are carried out for activation of upward regulation power and a minimum activation time of 10 minutes. Units with an installed capacity of less than 60 MW do not have to perform explicit tests.

3.1.2 Procurement system

As already stated above, in the Netherlands PCR is currently procured by a non market-based, obligatory system. Each unit with an installed capacity of 5 MW or more is obliged to reserve between 1% and 3% of its capacity as PCR, whenever the unit is running. There is no obligation, however, for the unit to be running.

This obligation comprises upward as well as downward regulation. TenneT, as TSO, is allowed to set this obligation at any value between 1% and 3%. Currently, the obligation is set to 1%.

As a consequence of this approach, the actual amount of PCR, which is available within the Netherlands, depends on each point in time on the number of generation units running.

3.2 Description of current German mechanism of PCR-procurement

3.2.1 Technical aspects

Opposed to the Netherlands, there is no obligatory system for providing PCR. Hence, it is the unit's operator's (economic) choice whether or not to provide PCR. Suppliers, which intend to use units for the provision of PCR, have to run through a pre-qualification process with each unit that is intended to provide PCR.

Technical requirements tested within pre-qualification process for each single technical unit providing PCR are described in [4] and comprise the following:

- minimum range of primary control: according to prequalification the German pre-qualification rules +/- 2% of the installed capacity of the tested unit, however, a minimum of 2 MW, needs to be provided as PCR. However, according to the current regulations of the German regulator BNetzA regarding the tender conditions for PCR, no minimum PCR-capacity is required anymore [5]. Hence, no minimum range of primary control is currently applied in Germany.
- deployment time / activation speed: provided PCR has to be fully activated in case of frequency deviation of +/- 200 mHz and within 30 seconds
- activated PCR needs to be available for at least 15 minutes
- a dead band (insensitivity range) of +/- 10 mHz is allowed
- accuracy of frequency measurement needs to be +/- 10 mHz or better

These rules comply with the rules described in ENTSO-E OH.

Tests are being carried out by the suppliers themselves, possibly in the presence of the TSOs. TSOs require the supplier to provide a test protocol according to [6] which explicitly shows that units fulfill the requirements regarding maximum deployment times, the maximum avail-

able PCR and availability of PCR. Tests are carried out for activation of upward and downward regulation power and a minimum duration of activation of 15 minutes. Furthermore it is tested, whether the unit is able to activate PCR two-times after each other with a short time period of no activation in between (sometimes referred to as "Doppelhöcker"). The latter test is a tightening of the ENTSO-E OH rule requiring units to be able to activate PCR for at least 15 minutes. This rule does not imply a direct requirement to be able to provide PCR twice after each other.

Real-time measurements (frequency and power feed-in of unit) need to be provided to the TSOs upon request with a time resolution of two seconds.

3.2.2 Procurement system

In Germany PCR is procured in a marked-based tender by means of an auction. The main characteristics of the German tender conditions are as follows:

- Tender period: one week (Monday to Sunday)
- Commitment period: complete week (no time slots)
- Product type: one product for both upward *and* downward regulation (i.e. symmetric product, positive and negative PCR have to be offered at the same time)
- Auction time: each week (auction is held on Tuesdays for the following week)
- Minimum bid size / tick: min. bid size 1 MW, bids can be increased in steps of 1 MW
- Availability: suppliers have to make sure that the offered amount of PCR is 100% available (i.e. by making use of backup capacity) during the complete delivery period
- Pooling:
  - pooling of units is allowed within one control area[8]

[8] This means that pooling is *not* allowed across the four German control areas but only within one control area. Transferred to the Dutch case, this would mean that pooling is allowed between units in the Netherland, cross-border pooling would, however, not be allowed.

  - pooling of units to supply a symmetric product is allowed, i.e. upward regulation power and downward regulation power can be delivered from different units to fulfill the requirements of providing PCR symmetrically
  - assignment of units to a pool can be changed at the beginning of each 15 minute time interval within the delivery period
  - within a pool it is allowed to change the units, which actually provide PCR, at all times within the delivery period

- Payment: suppliers are paid according the bid price (€/MW) they offered ("pay-as-bid"), payment is only for PCR capacity, i.e. not for actually activated PCR energy. There is no compensation for imbalance.
- Availability: suppliers sign a framework contract with TSO in which they confirm that they are able to activate PCR for whatever time is necessary (according to frequency deviation) within their pool. Hence, within the pool, but not on the basis of each technical unit, there is no upper time limit for the activation of PCR. Analysis of the historic frequency behavior in 2011shows that continuous activation (one direction) was necessary for up to 140 minutes.
- Penalty: in case a supplier is not able to provide to PCR, the premium, which the supplier received for providing PCR, is curtailed proportionally to the amount of PCR not provided and the time period in which PCR was not provided. In case this has happened once, the TSO is allowed to impose a penalty of ten times this amount in case it happens again. However the TSO has to announce beforehand to the supplier that he will do this. Furthermore, pre-qualification can be revoked.

The current tender volume in Germany is 567 MW. Additionally in the German auction 25 MW of the Swiss demand are procured. Suppliers from Switzerland are allowed to participate in the German auction.

4 Evaluation of potential effects of a common market

In the following we evaluate possible consequence and effects of a common market for PCR-procurement between the Netherlands and Germany. Starting point for this evaluation is a comparison of the current mechanisms of PCR-procurement in both countries. This comparison in particular shows to which extent the prerequisite of at least widely aligned technical requirements for units providing PCR in both countries is fulfilled. Furthermore, this comparison provides a basis for an assessment of the potential contribution of Dutch supply to a common PCR market. A substantial participation of Dutch suppliers in a common market has to be considered an important condition in order to actually unlock the general advantage of a common market with respect to competition and efficiency of procurement.

4.1 Comparison of both mechanisms of PCR-procurement

4.1.1 Technical requirements

In general, technical requirements, which units providing PCR have to fulfill, are comparable in both countries. In particular, technical rules in both countries are in line with the requirements defined in ENTSO-E OH. This does, however, not apply to units with an installed capacity of less than 60 MW in the Netherlands with an allowed dead-band of +/- 150 mHz. Such units currently do not fulfill the minimum requirements set forth in ENTSO-E OH[9].

Smaller differences in the technical requirements relate to a tightening of rules from ENTSO-E OH and to rules not covered ENTSO-E OH. The Dutch grid code does not allow any deadband for units larger than 60 MW, whereas in Germany a dead-band of +/- 10 mHz, in compliance with the minimum requirement of the ENTSO-E OH, is permitted. Furthermore, in both countries different requirements apply regarding the minimum time resolution of real-time measurements. In the Netherlands the minimum time resolution must be 4 seconds or better, in Germany 2 seconds or better. ENTSO-E OH does not specify any minimum time resolution for these measurements, as the ENTSO-E OH does not set forth any

[9] ENTSO-E OH allows an insentivity range of +/- 10 mHz.

specific rules regarding the monitoring of PCR besides the general rule that the monitoring of the activation of PCR is a responsibility of the involved TSOs.

Besides differences in the technical requirements described in the Dutch and German grid-code, differences exist in the actual test units have to perform to prove their compliance with the particular technical rules. Differences also exist regarding the minimum duration of activation that is tested. Even though both grid codes require a minimum duration of 15 minutes per technical unit, in the Netherlands tests only cover a time periods of 10 minutes[10]. Furthermore, in the Dutch tests only upward regulation of the units is explicitly tested, whereas in Germany both upward and downward regulation is tested. Opposed to the Netherlands, where tests are carried out by an independent institution, in Germany tests are performed by the suppliers themselves (sometimes in the presence of a TSO) and have to be carried out only once, whereas in the Netherlands tests have to be renewed each eight years.

The comparison of technical requirements shows that Dutch units with an installed capacity of more than 60 MW and units pre-qualified in Germany both fulfill the minimum requirements set forth in ENTSO-E OH as a common basis. Even though, some smaller differences in the technical requirements exist, we consider – in a starting phase of a common market – compliance with ENTSO-E OH as an acceptable basis for TSOs in the Netherlands and Germany to mutually accept the pre-qualification of units in the neighboring country[11]. We acknowledge the testing of units as an essential part of the TSO's responsibility to secure a high quality of PCR provision. Hence, as there are currently differences in the tests performed on units providing PCR, we suggest that a group of experts from both German and Dutch TSOs discusses in detail – based on actual test protocols – whether tests performed by units in the neighboring country are acceptable for each TSO. We do not, however, assume that remain-

[10] Exemplary Dutch test protocols show, however, that test runs of PCR activation usually cove more than 10 minutes. Still, this analysis of exemplary tests protocols does not allow concluding that a specific time period longer than 10 minutes is systematically tested.

[11] Also the criteria for units prequalified in Switzerland differ slightly from the German prequalification rules. Still parts of the Swiss and German demand are covered by means of a common auction. The same is the case for a partial common auction between Switzerland and France where pre-qualification criteria are not fully aligned.

ing differences should result in major obstacles for a mutual acceptance of a pre-qualification of units by a neighboring TSO.

Even though, for a starting phase of a common market it is acceptable that units from both countries have to fulfill in detail different technical requirements, we recommend to fully harmonize technical requirements and in particular the testing of units in the long-run as only this guarantees a level playing field among all market participants[12].

Considering units pre-qualified in Germany as well as units in the Netherlands with an installed capacity of more than 60 MW, from a technical perspective a common Dutch / German market has to access to an inventory of approx. 5,000 MW to 5,500 MW of pre-qualified PCR-capacity in Germany and approx. 800 MW of PCR-capacity in the Netherlands[13]. Further potential might exist in the Netherland from units smaller than 60 MW and e.g. consumers, which would, however, have to go through a pre-qualification before being able to participate in a common market.

[12] In the Netherlands there is in any case a need for units smaller than 60 MW to perform tests in order to prove their compliance with technical requirements and their ability to provide PCR with a dead-band of +/- 10 mHz or smaller. We suggest that these tests are already performed according to a harmonized testing procedure. Furthermore, new commissioned generation capacity in the Netherlands should be tested according to harmonized testing procedures. The renewal of tests, which has to be performed by existing units each eight year, should also be done according to a harmonized testing procedure. As of today, TenneT is planning to change to the testing requirements for all newly tested units (also smaller 60 MW) in the future. A 15 minute activation as well as up- and downward delivery of PCR will be tested, which further aligns the testing requirements between the Netherlands and Germany.

[13] The approximated amount of German PCR-capacity results from an estimation of the German TSO's on the pre-qualified units. The approximation of the Dutch PCR-capacity is done on an analysis of information on the Dutch generation fleet. According to [7] production sites with an installed capacity greater than 60 MW sum up to 19.5 GW. Assumed that not at all production *sites* also all single production *units* also have an installed capacity of more than 60 MW, we considered – as a conservative approximation – only production sites with an installed of more than 400 MW as sites with units of a capacity of more than 60 MW. The installed capacity of such sites accumulates to 16.6 GW. All of these units proved upon commissioning to be able to provide 5% of their installed capacity as PCR, which results in an overall PCR capacity of 800 MW.

4.1.2 Procurement systems

Obviously, procurement systems in the Netherlands and Germany currently differ substantially. As explained above, in this study it is assumed that for a common market the current German procurement system, in particular tender conditions, would be adopted. Hence, a common market would especially affect Dutch suppliers.

In general, a market-based procurement approach is also favorable for suppliers, as production units can be used more efficiently, since the *option* to provide PCR instead of an *obligation* gives more flexibility to suppliers. A possible downside of any market-based approach is that participation in market requires efforts to gain access to that market with corresponding transaction costs. Also, having to fulfill requirements of a particular PCR-product makes PCR-provision more sophisticated from a Dutch supplier's perspective[14]. These aspects are, however, not characteristic of a common market but hold for any market-based approach (see also [2]).

For the specific case of a common PCR-market between the Netherlands and Germany it needs to be evaluated whether the German tender conditions are in general suitable for Dutch suppliers. This is to a large extent the case. In particular, the Dutch generation mix is not substantially different than in Germany. Compared to Germany there is only a low share of nuclear generation and no lignite production in the Netherlands which is the typical base load production in Germany. However, in the Netherlands hard-coal power plants have average full load hours of more than 6,000 hours (see [7]) and also new and highly efficient combined cycle natural gas turbines operate with high full load hours. Hence, it can be assumed that also in the Netherlands there is a substantial amount of base-load production. For such units providing PCR is comparably easy even without pooling. However, it will be a question of economic optimization of the suppliers, how much capacity they will supply to a common market. It is in particular a question to what extent Dutch suppliers could provide PCR com-

[14] As an example for the increase in complexity take the following example. Today Dutch suppliers provide PCR, whenever their unit is running and hence providing PCR is an implicit outcome of their unit-commitment decision but no particular restriction in his unit-commitment. In a market-based approach e.g. providing a weekly product, requires that a supplier has to have units (at least within a pool) running during the complete tender period of one week. Also suppliers have to take care of backup capacities, which is not the case in the current obligatory system.

petitively, i.e. cheaper / at the same price compared to German suppliers. In order to further investigate this question, we have carried out a questionnaire among Dutch suppliers. Results are discussed in section 4.2.

Besides effects on Dutch suppliers, also German suppliers are affected by a common market. In particular, a common market increases the market-size and hence their sale opportunities by the current Dutch demand of 117 MW. Furthermore, in case Dutch suppliers significantly participate in the common market, German suppliers are subject to increased competition.

Overall, it is expected that a common market will not have negative effects from a German perspective. Instead positive effects due to an increase of sale opportunities for German suppliers and an increase in the efficiency of the PCR-procurement should be expected in case Dutch suppliers substantially contribute to a common market.

4.2 Potential contribution of Dutch supply to a common PCR-market

In section 4.1 is has already been discussed that the there is a significant amount of potential PCR-capacity available in the Netherlands, which fulfills sufficient technical requirements. Furthermore, no general objection against the assumption, that German tender conditions are suitable also for Dutch suppliers, exist. However, the actual participation of Dutch suppliers to a common market essentially depends on the supplier's view on a common market. Hence, we carried out a questionnaire (cf. Annex A.1) among potential Dutch suppliers, including producers with units smaller than 60 MW and consumers, to evaluate this.

We have received replies from five out of six large Dutch producers with an installed generation capacity of more than 1,500 MW. Furthermore, seven smaller producers, including operators of combined heat and power (CHP) power plants, have answered the questionnaire as well as large consumers. The answers we received cover approx. 15 to 20 GW of the Dutch generation capacity.

The answers show that producers expect for the production capacity of an installed of 60 MW or more, to be able to provide the same amount of PCR according to German pre-qualification criteria as currently in the Dutch obligation system. The answers regarding the expected amount of PCR which can be provided according to German pre-qualification criteria and

tender conditions accumulate to 145 MW[15], when considering the current Dutch regime in which 1% of the installed capacity needs to be reserved. However, these units have been tested to be able to provide up to 5% of their capacity as PCR. Hence, it can be concluded that the expected amount of PCR capacity technically available in the Netherlands is at least 725 MW[16]. Smaller producers see a potential of 20 to 100 MW to provide PCR according to German pre-qualification criteria. Consumers / load currently do not see any potential for providing PCR.

In particular, smaller producers consider it necessary to be able to make use of the possibility of pooling to actually provide the stated amount of PCR. Only two out of the five large producers that have answered the questionnaire expect to make use of the possibility for pooling with other generation companies. Using pooling would increase the potential supply of PCR from large producers by 20 MW to 30 MW.

This results in a technical potential of PCR capacity according to German pre-qualification criteria and tender conditions from the Netherlands of 765 MW to 855 MW. Considering that suppliers need to provide a backup for units delivering PCR and furthermore considering that – as a worst-case estimation – 50% of the available PCR-capacity is used as backup, as a lower bound 380 MW to 430 MW of PCR capacity should be available from the Netherlands to a common market. According to our considerations in 4.1.1, a substantial amount of this capacity could be provided to the common market without any significant efforts for additional testing / pre-qualification.

Besides the question, how much capacity is technically available to a common market, an essential question for the evaluation of potential consequences of a common market is related to the competiveness of the Dutch PCR-capacity compared to German suppliers. In the questionnaire potential Dutch suppliers were asked to estimate how much of their technically available PCR-capacity would be provided from an economic point of view considering the historic market situation in the last 12 months. In particular, suppliers have been asked how

[15] This value includes an extrapolation of the answers from the five large producers to the capacity of the larger producers which has not answered the questionnaire.

[16] This number results from an extrapolation of 145 MW (considering 1% of installed capacity as PCR) to the assumption of 5% of installed capacity as PCR.

much of their capacity would have been offered in the last 12 months considering the price level of the German PCR-market and considering a range of prices of +/- 25%.

Four out of six larger producers have been able to give answers regarding competiveness of their units to provide PCR according to the German price level. It should be noticed that most of the large producers have assets in Germany and already participate in the German PCR-market. This experience with German market rules can be considered as helpful for their potential participation in a common market according to German market rules. Three producers have assumed that they would be able to provide up to the maximum amount according to the historic German price level. This accumulates to a potential supply to a common market of 100 MW to 200 MW[17] from Dutch suppliers on a competitive basis. One producer expects that he cannot bid all of his capacity competitively. This producer has, however, not been able to give a value for the expected amount that could be provided competitively. Small producers do not expect that the current German price level is attractive enough for offering PCR and also gives no sufficient incentive for making efforts to pre-qualify their units.

It is expected – and already has been expressed by the regulator – that German tender conditions for PCR will be further developed in the future. In the questionnaire, we have also asked potential Dutch suppliers which changes in the tender conditions are considered to be most helpful in order to expand their supply of PCR or to reduce costs for the provision of PCR. Most suppliers stated, that they would prefer daily instead of weekly auctions. However, only small increase of the bidding volume for a daily auction is expected by suppliers. One supplier has suggested separation of the weekly product in product covering working days and a product covering the weekend. One potential supplier would prefer separate products for up- and downward regulating power.

[17] The explicit answers given by the suppliers in the questionnaire refer to the assumption of the current Dutch rules of only reserving 1% of the installed capacity as PCR. As discussed above, it is reasonable to extrapolate this to the actual technical capability of the units, which is 5% of the installed capacity. For a conservative estimation we assumed that suppliers would reserve up to 3% to 5% of their capacity as PCR, in case price levels give reasonable incentives.

5 Summary and Conclusions

The markets for ancillary services in Europe undergo continuous development and various projects and efforts to internationalize reserve markets are ongoing. In particular, in the Netherlands the current regime of mandatory delivery of primary control reserve is supposed to be replaced by a market-based procurement mechanism.

TenneT TSO B.V. considers different options on how to design a future Dutch PCR-market. In line with the current European efforts to harmonize market rules at European reserve markets and to facilitate cross-border use of reserves, one option is to set up a common market for PCR between the Netherlands and Germany by means of the Netherlands joining the German procurement system. In a common auction between two countries the demand from both countries participating are being procured within in one auction. The common demand is tendered in one single auction to which market participants from both countries equally have access according to identical conditions. As a result of such a common auction, regularly the demand from one country is (partially) covered by supply from the other country.

The main advantage of a common market is an increased efficiency of the PCR procurement. Compared to a separated PCR procurement, a common market can avoid misallocations. In separated markets costly offers from one country cannot be substituted by more economic excess supply from the other country because supply from one county may only be used to cover demand from this country. In a common market, excess supply from the neighboring country is inherently used to substitute less economic supply from the own country. This allows achieving an overall efficient procurement of the PCR demand considering both countries with overall lower costs for the procurement of PCR. Furthermore, in a common market more suppliers are in competition to each other. In general, it is expected that increased competition can lead to fairer and in consequence lower prices.

A common market requires fully harmonized market rules for suppliers from both participating countries as there is only one market. In this study we assume that in a common PCR-market between the Netherlands and Germany the current German market rules are adopted for common market. Furthermore, it is necessary that technical requirements, which units have to fulfill in order to provide PCR, are at least widely aligned in order to create a level playing field among all market participants. In addition, to actually unlock the general advantage of a common market with respect to competition and efficiency of procurement, it is

necessary that suppliers from both countries will substantially participate in the common market.

A comparison of the current technical requirements in both countries shows that Dutch units with an installed capacity of more than 60 MW and units pre-qualified in Germany both fulfill the minimum requirements set forth in ENTSO-E operation handbook (OH) as a common basis. Even though, some smaller differences in the technical requirements exist, we consider – in a starting phase of a common market – compliance with ENTSO-E OH as an acceptable basis for TSOs in the Netherlands and Germany to mutually accept the pre-qualification of units in the neighboring country. However, there are currently differences in the tests performed on units providing PCR. As the testing of units is an essential part of the TSO's responsibility to secure a high quality of PCR provision, we suggest that a group of experts from both German and Dutch TSOs discusses in detail based on actual test protocols whether tests performed by units in the neighboring country are acceptable for each TSO. Even though, for a starting phase of a common market it is acceptable that units from both countries have to fulfill in detail different technical requirements, we recommend to fully harmonizing technical requirements and in particular the testing of units in the long-run as only this guarantees a level playing field among all market participants.

Considering that Dutch units with an installed capacity of more than 60 MW currently fulfil sufficient technical requirements for a common market and, a substantial amount of capacity could be provided to the common market by Dutch suppliers. Results from a survey / questionnaire among Dutch suppliers show that a technical potential of PCR capacity according to German pre-qualification criteria and tender conditions from the Netherlands is in the range of 765 MW to 855 MW.

Regarding the competiveness of Dutch supply compared to German suppliers, a quantification is only possible with substantial uncertainties. However, the questionnaire, which has been carried out among Dutch suppliers, shows that Dutch suppliers expect to be able to deliver significantly to a common market. Based on assessment of the historic market situation in Germany in the last 12 months, Dutch suppliers are expected to be able to provide 100 MW to 200 MW of PCR-capacity competitively to a common market. It is expected that the current price level does not give sufficient incentives for smaller producers and consumers to activate their technical PCR-capacity.

This assessment shows that for a common market it can be expected that Dutch suppliers can contribute substantially. It can be expected that the contribution of Dutch suppliers to a common market will be in the range of the current Dutch PCR-demand. This can be considered as an essential precondition for the common market to be able to unlock the expected overall gains in efficiency and competition without leading to negative effects for one of the countries in the common market.

However, as already explained, the assessment is subject to substantial uncertainties, in particular due to the fact that currently Dutch suppliers provide PCR in an obligatory, non market-based system. In order to allow Dutch suppliers to get adjusted to a market-based procurement system and ease their future participation in a fully-integrated common PCR-market, it can be considered helpful to start with a common market in which the amount of PCR, which can be covered by a neighboring country, is limited. In a situation in which there is considerable high uncertainty with respect to the reaction of market participants to a common market, such an approach can help to sense, how market participants react to a common market, and hence limit the risk of a low liquidity, etc. in a common market. We suggest in this case to step-by-step reduce these limitations to a situation in which a fully-integrated common market is established after first positive experience with a market-based procurement in the Netherlands have been achieved. Even though in this case a fully-integrated market is not established from the beginning, parts of the advantages of a common market have already been unlocked. In particular, fully harmonized market rules, which are a prerequisite for a fully-integrated common market, are established in a partial common-market. Also overall efficiency gains are to be expected in this approach.

Bibliography

[1] European Network of Transmission System Operators for Electricity
Operation Handbook, P1 – Policy 1: Load-Frequency Control and Performance [C]
www.entsoe.eu

[2] Frontier Economics Ltd.
Qualitative assessment of balancing market design for the Netherlands
Study for *Energiekamer*, www.nma.nl

[3] Energiekamer, Nederlandse Mededingingsautoriteit (NMa)
Systeemcode Electriciteit per 14 maart 2012
www.nma.nl

[4] Verband der Netzbetreiber VDN e.V.
TransmissionCode 2003, Anhang D 1: Unterlagen zur Präqualifikation für die Erbringung von Primärregelleistung für die ÜNB (Stand August 2003)
www.regelleistung.net

[5] Bundesnetzagentur
Beschluss der Beschlusskammer 6 (Aktenzeichen: BK6-10-097)
www.bundesnetzagentur.de

[6] Deutsche Übertragungsnetzbetreiber
Musterprotokoll zum Nachweis der Erbringung von Primärregelleistung
www.regelleistung.net

[7] Energie Nederland
Energie in Nederland in 2011
www.energie-nederland.nl

Annex

A Annex

A.1 Questionnaire distributed to Dutch market participants

We kindly ask potential suppliers of PCR in the Netherlands to answer the following questions. Please answer the questions in the attached *excel file*. If appropriate, comments going beyond the specific question can also be stated in the "comment" column of the excel file. Answers are evaluated anonymously and handled in a confidential way. In the excel file reference is made to the numbers of the questions as stated beneath.

Q.1) Capacity reference

Q.1.1) This questionnaire is sent to all potential suppliers of PCR in the Netherlands. To avoid counting parts of the capacity twice – because answers from different suppliers refer to the same physical unit (e.g. in case of co-owned units) – please specify / explain to which capacity your answer refers (e.g. "Capacity refers to units from company ABC bv and company XYZ bv").

Q.2) Current PCR-capacity of Dutch assets

Q.2.1) How much PCR-capacity is your company able to provide technically at present according to the current Dutch rules, i.e. considering the obligation to provide up- and downward PCR from all units > 5 MW? (Please state here and also later – except when explicitly stated otherwise – the actual PCR-capacity in MW, not the installed capacity / rated power of the units providing PCR.)

Q.3) Potential PCR-capacity under German conditions

Q.3.1) The German pre-qualification criteria for units providing PCR differ with respect to the required dead band. Dutch units with a rated power between 5 MW and 60 MW are required to fulfil a dead band of 150 mHz, whereas in Germany all units are required to fulfil a dead band of less than 10 mHz. To what extend would the values from Q.2.1) change if your assets would have to fulfil the German pre-qualification criteria? Please state the amount of available PCR-capacity according to German pre-qualification criteria.

Q.3.2) Considering the outlined German tender conditions (see chapter 1), how much PCR-capacity could you technically, i.e. without considering the price level, offer to a common market according to the German rules, especially considering the need for backup capacity to fulfil the requirement of 100% availability?

Q.3.3) According to the German rules a pooling of units between different companies to cover the offered PCR is allowed.

Q.3.3.1) Do you consider pooling PCR capacity with other companies?

Q.3.3.2) To what extend would the values from Q.3.2) change when offering PCR in a pool with units from other companies? Please state the total amount of PCR-capacity that your company could offer.

Q.4) Experience with German auction

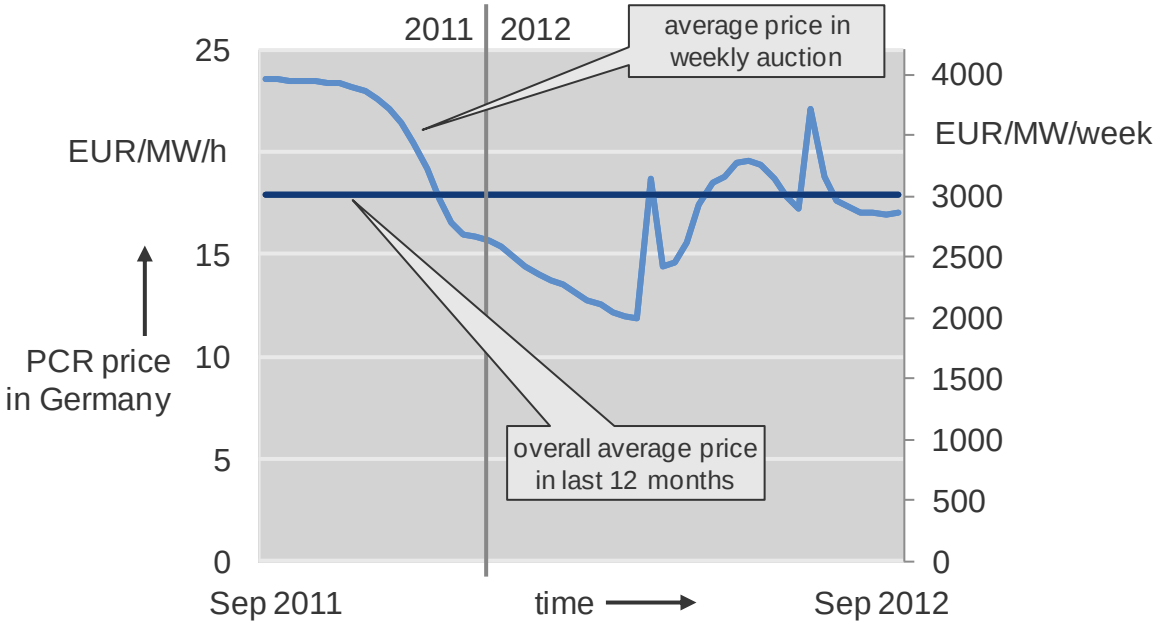
Q.4.1) Does your company have assets in Germany or Switzerland that could provide PCR?

Q.4.2) Does your company currently participate in the German/Swiss auction regularly?

Q.5) Economic attractiveness of current German price level

Q.5.1) From an economic point of view the fundamental rationale of a company to provide PCR is a comparison of the expected revenues from the PCR auction on the one hand and on the other hand the lost revenues when providing PCR from other marketing opportunities (i.e. in particular day-ahead spot market) plus extra costs to fulfil the product requirements (e.g. in case a unit has to run in hours where the spot market price is lower than short-term marginal costs).

How much PCR capacity would your company be able to provide competitively according to the current average price level in Germany (see figure, average price in last 12 months: approx. 3,000 EUR/MW/week or 17.90 EUR/MW/h)?



Q.5.2) In case that in a common market PCR-prices would change (e.g. due to the increase of demand and supply in a common German/Dutch market, new/different suppliers, increased competition, etc.), to what extent would the amount of PCR, which your company can provide competitively, change (compared to Q.5.1)) given that other price determining factors (e.g. spot market prices) stay the same? Please state amount of competitive PCR-capacity at a price level...

Q.5.2.1) ... 25% below the current price level in Germany?

Q.5.2.2) ... 25% above the current price level in Germany?

Q.5.3) What do you consider as the main drivers for the (opportunity) costs of supplying PCR (e.g. spot price level, transaction costs [e.g. for market access / operation], costs for backing up marketed PCR capacity, different costs for upward and downward regulation)?

Q.6) Future developments

Q.6.1) Does the amount of available PCR-capacity (compared to the value in Q.3.2)) change in the next 3-5 years (e.g. due to new-built or de-commissioning of power plants)?

Q.6.1.1) How much PCR-capacity will be shut down?

Q.6.1.2) How much new PCR-capacity will be available?

Q.6.2) It is expected that the German tender conditions will be further developed in the next years. It is likely that in particular the tender period of today one week will be shortened to one day. How much additional PCR-capacity could your company provide in an auction with a tender period of one day? Please state the total amount of PCR-capacity that your company could offer.

Q.6.2.1) Compared to the value in Q.3.2) ?

Q.6.2.2) Compared to the value Q.3.3.2) (i.e. considering pooling with units from other companies)?

Q.6.3) Consider that the bid size is not restricted anymore, i.e. the restriction regarding a minimum bid size of 1 MW is dropped.

Q.6.3.1) How much PCR-capacity would your company technically be able to offer (compared to Q.3.2))?

Q.6.3.2) Considering costs and necessary investments to make such capacity "PCR-ready", e.g. to fulfil monitoring requirements or costs for market access,

how much PCR-capacity would your company be able to offer competitively, i.e. at the current German price level, to a common auction (compared to Q.5.1))?

Q.6.4) Do you have suggestions to improve PCR tender conditions?