Commission de Régulation
de l'Électricité et du Gaz

CREG

# Note

(Z)1986
12 September 2019

## Note on the implementation of a scarcity pricing mechanism in Belgium

carried out pursuant to Article 23, §2, second paragraph, of the Law of 29 April 1999 on the organisation of the electricity market

Non confidential

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# 1. INTRODUCTION

1. The introduction of renewables generation created new challenges in the design of electricity markets. Renewables are characterised by their intermittency, their low variable costs and no or limited inertia [see Cramton page 607]. The massive introduction of large amounts of renewable energy has led to overcapacity and could exacerbate the missing money problem, reflecting the difficulties of remunerating the marginal generation unit in an energy-only market with a marginal pricing principle. This introduction has contributed to push out of the market more classical units with higher variable costs (mainly CCGT) providing reserves, voltage support, inertia,… This phenomenon renders necessary an adequate remuneration of these services necessary to ensure system reliability.

2. In order to provide a better remuneration of reserves answering to the challenges mentioned in the previous paragraph, the CREG is considering the implementation of a scarcity pricing mechanism in Belgium.

3. In a nutshell, this mechanism (based on the Operational Reserves Demand Curve – ORDC – as implemented in Texas) provides scarcity prices remunerating all generation/demand units active or providing reserves in periods of scarcity through the addition of a price adder to the balancing price and of two prices adders valuating reserves available in real-time (balancing) in periods of scarcity.

4. A first study on this issue has been finalised in May 2016. Main results may be synthetized as follows: in 2013 and 2014, Belgium was importing a lot of energy and some scarcity was experienced, while at the same time large negative Clean Spark Spreads were observed during the period. The adder of the examined scarcity pricing mechanism provided a long-term price signal enough to invest in new CCGT units or in the transition towards a new energy system. Its results are published on the CREG website:

http://www.creg.info/pdf/Divers/Z1527EN.pdf

5. A second study on the same issue has been published in December 2017. Main results of this second study indicated that, in conditions of abundant capacity resulting from the restoration of nuclear capacity (period going from September 2015 to March 2016), the ORDC adder has a negligible effect on energy prices. See on CREG website:

https://www.creg.be/sites/default/files/assets/Publications/Notes/Z1707EN.pdf

6. These two studies clearly demonstrated the built-in 'pay for performance' attribute of the scarcity pricing mechanism, which constitutes a notable difference between scarcity pricing and capacity mechanisms. This adaptive nature of the adder explains why a scarcity pricing mechanism constitutes a no regret measure for the improvement of the functioning of the market.

7. This note introduces the third study made by the CORE Department of the Université Catholique de Louvain on scarcity pricing mechanism with a focus on a possible design for implementation in Belgium. The objective of the third study was to propose a general design for the implementation of a reserve scarcity pricing mechanism in Belgium based on the ORDC approach, to justify the proposed design and identify the main constraints/modifications required to existing mechanisms for its implementation. The CORE study is provided in appendix.

8. Main elements of CORE proposed implementation are presented in the chapter 4 below.

9. All the elements given in CORE study and in this note indicate why the implementation of a scarcity pricing mechanism should be considered as a measure which importance will grow in the future when electricity prices will continue to drop as a result of the integration of more renewables in the market. In addition, this mechanism should also help market players to invest in Belgium as an

answer to the closing of Belgian nuclear power plants. Scarcity pricing mechanisms may coexist with a capacity remuneration mechanism.

10. This note was approved at CREG's Board of the 5th of September 2019. The CORE study is presented in the Annex.

# 2. THEORETICAL BACKGROUND

11. The main elements of the theoretical background have already been provided in the previous studies (see links above). Nevertheless, with the adoption of the Clean Energy package and the renewed support to the energy transition towards a decarbonised generation of electricity, it is good to recall here the challenges faced by the energy only market design based on decentralised investment decisions triggered by adequate price signals.

12. And in order to explain the benefits of a scarcity pricing mechanism, it is interesting to provide here the view of an academic not directly involved in the developments of this kind of mechanism who has produced several papers on Capacity Remuneration Markets (CRMs), Peter Cramton.

13. As indicated in [Peter Cramton paper on Electricity Market Design]: *"In broadest terms, regulators seek a market design that provides reliable electricity at least cost to consumers. This can be broken down into two key objectives: The first is short-run efficiency: making the best use of existing resources. (…)* ***The second objective is long-run efficiency****:* ***ensuring the market provides the proper incentives for efficient long-run investment. This has proven to be the most challenging objective****. In the simplest theory, efficient long-run investment is induced from the right spot prices. But this is complicated by the reliability requirement.* ***Reliability requires a reserve to satisfy demand when supply and demand uncertainty would otherwise lead to shortage****. In other industries, reliability is not an issue. Prices rise and fall to assure supply and demand balance, but in current electricity markets there is typically insufficient demand that responds to price, and* ***consumers are unable to express a preference for reliability. Thus, there is a need in current markets for the regulator to determine how this preference for reliability is expressed****. As we will see, one approach to reliability is to rely solely on spot prices but to include administrative scarcity prices at times when reserves are scarce.* ***The preference for reliability is imbedded in the scarcity prices****. Setting higher scarcity prices enhances reliability in providing stronger investment incentives.* ***An alternative approach is to more directly coordinate investment with a capacity market, although this is best done as an addition to, not a substitute for, administrative scarcity pricing, since it is the scarcity price that motivates capacity to perform when needed."***

14. CREG shares Cramton's view that the preference for reliability should be reflected in a scarcity price trough an appropriate mechanism before a recourse to a capacity market.

15. Further in the same paper, it is indicated that *"In Texas* (where the ORDC mechanism under consideration for Belgium is implemented)*,* ***the high scarcity pricing motivates the forward contracting*** *that limits risk and induces investment.* ***The scarcity price is the key instrument for resource adequacy.*** *One reason this may work well in Texas is substantial industrial load that makes the market for forward contracts more liquid***."**

16. On the importance of an adequate price signal for ensuring generation adequacy, we also refer to Paul Joskow who has produced several papers in the past on the question of "Reliability and

competitive electricity markets"[1] with Jean Tirole and more recently a paper on "Challenges for Wholesale Electricity Markets with Intermittent Renewable Generation at Scale: The U.S. Experience"[2]

17. In this paper [Paul Joskow] highlights the new context linked to the increased penetration of renewables and the importance of an improved price signal for ensuring generation adequacy in the current context of renewable integration: ***"High penetration of intermittent generation with zero marginal operating costs creates challenges for wholesale market designs. And it is both intermittence and zero marginal operating cost that are important****. To oversimplify, wholesale markets as they are now structured in the U.S. perform two related resource allocation functions --- short run and long run. First, they provide for the efficient real-time operation of existing generating capacity, clear supply and demand at efficient wholesale prices that represent the marginal cost of supply at any moment, and do so while maintaining the reliability of the system.* ***Second, market prices and price expectations are supposed to provide efficient long run profit expectations and incentives to support efficient decentralized investments in new generating capacity and efficient retirements of existing generating capacity****. Wholesale market designs in the U.S. that evolved since the late 1990s now do a reasonably good job supporting the first set of short run resource allocation tasks under most states of nature.* ***However, they have been challenged in providing adequate financial incentives to support efficient entry (investment) and exit decisions consistent with reliability criteria established by system operators. That is, the short run price signals do not lead to long run price expectations that adequately incent efficient investment and retirement decisions****.* ***The disconnect emerges primarily as a result of energy and ancillary price formation during tight supply and other stressed conditions****. Prices under these conditions do not rise high enough to reflect the scarcity value of the generation due to price caps, limited demand-side participation in the wholesale market, and out-of market actions by system operators during network security emergencies."*

18. CREG shares the view that an increased penetration of renewables may lead to a price signal that will not allow efficient investment and retirement decision in the markets.

19. In the same paper [joskow 2019] we also find: *"Note that scarcity pricing is not a departure from the basic principle of short run marginal cost pricing. Rather, movements along the appropriate demand curve when capacity constraints are binding reflect consumer valuations of sudden reductions in available generating capacity (reliability) and represent consumers' short run marginal opportunity cost of having more or less generating capacity. While there may be few hours when capacity constraints are binding, energy prices would likely go to very high levels as demand is price-rationed and yield substantial revenue for all generators which would allow them to recover their capital costs in a long run equilibrium"*.

20. On the issue of capacity markets, Paul Joskow *indicates "Capacity markets have been redesigned frequently as their imperfections have been revealed and efficient scarcity pricing will not be feasible without reforms of retail pricing.* ***While the ongoing refinements to capacity markets have improved their performance, they too have been based on conceptual models for electric power systems which rely primarily on dispatchable generation. But, it is not at all clear how a capacity market mechanism can be implemented with intermittent generation at scale. Capacity payments are made based on performance commitments that require generators to be available to supply when the system operator determines they are needed. How would this work for intermittent generators*** *that cannot predict whether and how much capacity will be available at a particular hour on a particular future date?"*

[1] https://economics.mit.edu/files/1927
[2] https://economics.mit.edu/files/16650

21. CREG shares the view expressed in the paragraph above that the implementation and the dimensioning of capacity mechanism will become even more complex with the introduction of more renewables.

22. It is good to recall here the importance of decentralised investment decisions. The market, and not a central planner, should decide to invest or not: this is at the core of the liberalisation process, and **price signals are the key instruments to reach that goal**. More on this can be found in [Paul Joskow paper] page 20: "**That is, "the market," rather than integrated resource planning by the vertically integrated utility, interest group interventions, plus regulatory oversight, would determine entry and exit decisions by decentralized owners** of generating plants and lead to an efficient portfolio of generating capacity over time. **Investors would bear the risks of changes in market conditions**, construction cost overruns or construction efficiencies, etc., **rather than consumers as was the case when all "prudent" generating costs were passed on to consumers through regulated rates**. Decentralized entry of generating capacity based on market price signals, rather than regulated integrated resource planning, reflected one of the hidden goals of restructuring and reliance on competitive wholesale markets: get the interest group politics out of the regulated utility's entry, exit, and fuel supply decisions. However, this goal assumed implicitly that market mechanisms would also be introduced to deal with the most important externalities through some form of efficient emissions pricing."

# 3. NEW EU LEGISLATION OF THE CEP

23. The most relevant articles related to scarcity pricing mechanisms of the REGULATION (EU) 2019/943 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of June 5, 2019, on the internal market for electricity (the Regulation below) are recalled below. Extracts of the Regulation are in italic, and CREG comments in normal text. Bold fonts are from CREG.

*24. Whereas:*

*(23)* ***While decarbonisation of the electricity sector, with energy from renewable sources becoming a major part of the market, is one of the goals of the Energy Union****, it is crucial that the market removes existing barriers to cross-border trade and encourages investments into supporting infrastructure, for example, more flexible generation, interconnection, demand response and energy storage. To support this shift to variable and distributed generation, and to ensure that energy market principles are the basis for the Union's electricity markets of the future, a renewed focus on short-term markets and scarcity pricing is essential.*

*(24) Short-term markets improve liquidity and competition by enabling more resources to participate fully in the market, especially those resources that are more flexible.* ***Effective scarcity pricing will encourage market participants to react to market signals and to be available when the market most needs them and ensures that they can recover their costs in the wholesale market****. It is therefore critical to ensure that administrative and implicit price caps are removed in order to allow for scarcity pricing. When fully embedded in the market structure, short-term markets and scarcity pricing contribute to the removal of other market distortive measures, such as capacity mechanisms, in order to ensure security of supply. At the same time, scarcity pricing without price caps on the wholesale market should not jeopardize the possibility of offering reliable and stable prices to final customers, in particular household customers, small and medium-sized enterprises (SMEs) and industrial customers.*

*(45) Before introducing capacity mechanisms, Member States should assess the regulatory distortions contributing to the related resource adequacy concern. Member States should be required to adopt measures to eliminate the identified distortions, and should adopt a timeline for their implementation. Capacity mechanisms should only be introduced to address the adequacy problems that cannot be solved through the removal of such distortions.*

*…*

***Article 3 Principles regarding the operation of electricity markets…***

*(g)* ***market rules shall deliver appropriate investment incentives for generation, in particular for long-term investments in a decarbonised and sustainable electricity system****, energy storage, energy efficiency and demand response to meet market needs, and shall facilitate fair competition thus ensuring security of supply;*

*(n) market rules shall allow for entry and exit of electricity generation, energy storage and electricity supply undertakings based on those undertakings' assessment of the economic and financial viability of their operations;*

***Article 7 Day-ahead and intraday markets***

*2.**Day-ahead and intraday markets shall**:*

*(d)* ***provide prices that reflect market fundamentals, including the real time value of energy, on which market participants are able to rely when agreeing on longer-term hedging products****;*

The above paragraphs highlight the importance of adequate price signals reflecting market fundamentals and scarcity.

*25. CHAPTER IV RESOURCE ADEQUACY*

*Article 20: Resource adequacy in the internal market for electricity*

*3.Member States with identified resource adequacy concerns shall develop and publish an implementation plan with a timeline for adopting measures to eliminate any identified regulatory distortions or market failures as a part of the State aid process.* ***When addressing resource adequacy concerns****, the Member States shall in particular take into account the principles set out in Article 3 and shall consider:*

*(a) removing regulatory distortions;*

*(b) removing price caps in accordance with Article 10;*

***(c) introducing a shortage pricing function for balancing energy as referred to in Article 44(3) of Regulation (EU) 2017/2195;***

…

26. This new legislation constitutes a new and clear support to the implementation of a scarcity pricing mechanism. The term "function" is important in the paragraph above, as this clearly departs from scarcity bidding. In addition, as the mechanism is not described in detail, this leaves a lot of freedom for its implementation, provided that the other legal requirements are satisfied. Therefore, CREG also considers that the implementation of this "function" should not be made impossible through decisions already taken by the competent regulatory authorities.

27. Even more, this article foresees the introduction of a scarcity pricing mechanism as a precondition for the implementation of a capacity market. The idea of implementing a scarcity pricing mechanism before moving towards the implementation of a capacity market can also be found in Peter Cramton's statement[3] already indicated in § 13 above.

[3] An alternative approach is to more directly coordinate investment with a capacity market, although this is best done as an addition to, not a substitute for, administrative scarcity pricing, since it is the scarcity price that motivates capacity to perform when needed.

# 4. PROPOSED MECHANISM

28. The Terms of Reference of the last study requested in particular that the study should:

1) Provide a general design for the implementation of a mechanism for the remuneration of the scarcity of reserves based on the ORDC approach as implemented in Texas;

2) Discuss and justify different design options. Simulations are welcomed but not mandatory;

3) For the day ahead time frame, propose a method for the valuation (pricing) of reserves (before the day ahead market-coupling, through the day-ahead market coupling, using co-optimisation and specific products in Euphemia, or after the clearing of the day-ahead market);

4) Take into account the constraints linked to the Belgian balancing system (and its possible evolution) and the day-ahead flow-based market coupling (Euphemia), and propose adaptations if needed;

5) Examine the need for co-optimisation of energy and reserves in day-ahead and/or in real time and if appropriate, propose a design, with the assumption that a cross-border exchange of reserve capacity will not be possible in a first stage;

6) Examine the need of virtual bidding (for energy and/or reserves) between the day-ahead and the balancing time frame, and propose a design if appropriate;

7) Define the data required for the implementation of the proposed mechanism.

29. The study provides an answer to the different requirements.

30. In a nutshell, CORE proposes the implementation of a real-time market for reserves and the definition of 3 adders, one for the energy component and one for the valuation of each type of reserves (aFRR and mFRR).

31. The introduction of a real-time market for reserve capacity is considered by CORE as the lowest-hanging fruit in the Belgian market design: it is the easiest measure to implement, and it is expected to have a great effect on the long-run incentive to invest in flexible resources.

32. The effect of this mechanism is that (i) it rewards flexible resources for being available, even if not activated, and (ii) it rewards flexible resources for reacting to system imbalances when the system is short on flexible capacity.

33. The design proposed by CORE is based on a simulation of the Belgian system.

34. As indicated in the CORE study, the introduction of scarcity pricing as an adder to the real-time energy price alone is not expected to have any material impact on the price of reserves or the profitability of flexible resources.

35. Reserves (aFRR and mFRR) can be procured on the basis of a daily auction in day-ahead and cleared before the closing of the DA market coupling.

36. The implementation of a co-optimisation of energy and reserve in day-ahead and the introduction of virtual trading are considered as more disruptive measures, as this involves changes in the Euphemia algorithm, the performance of which is already challenged today. In an environment of risk-neutral agents, co-optimisation and virtual trading, simulations performed by CORE indicate that

they are also expected to have a minor impact relative to the introduction of a real-time market for reserve capacity in terms of back-propagating scarcity prices.

37. Thus, the design focused on real-time, i.e. on balancing arrangements, with the creation of a pricing of reserves available in real time, where some degree of freedom relative to the implementation of balancing platforms may still be available.

38. More specifically, concerning balancing, the proposed design recommends a single marginal price mechanism, for balancing up and down, and applying the same energy (adders for reserves only concern BSPs) price for BRPs and BSPs, in order to provide adequate incentives and avoid gaming opportunities.

39. There is only one adder and one price for the balancing energy produced, as this corresponds to one product in economic terms when the energy is produced, regardless of the generation means. Two adders are proposed for the reserves, as they correspond to different products differentiated by their ramp rate and maximum time for delivery (7,5 and 15 minutes respectively), so they should be priced differently.

40. Data required for the construction of the adders were identified and indicated to ELIA. On this basis, ELIA should publish, at the beginning of October 2019, on its webpage, the evolution of the values of the 3 adders during the day before;

41. The value of adders spikes when the real-time reserve (reserves available at the end of each 15' period, after the activations made by the TSO) is scarce.

42. A more detailed description of the proposed mechanism is presented in the CORE study.

# 5. WHY THREE ADDERS? WHY ONE ENERGY PRICE?

43. The study recommends one price (one adder) for energy in balancing, but two prices (two adders) for the two types of reserves considered here. From an economic perspective, energy, when produced at a given time and at a given location corresponds to one product. This general statement is especially valid for the balancing time frame and should therefore have only one price[4]. On the contrary, reserves with different characteristics (ramp rates) may be valued differently.

44. This leads to BRPs and BSP facing the same price for the energy produced/consumed, as price differentiation here may result in inefficient arbitrage from market players.

[4] Note that even if some requirements of the balancing guideline may indicate the opposite, then the question arise how to reconciliate this with the many requirements included in the new Regulation requesting that energy price should reflect offer and demand, and this is valid for all times frames. Which demand should pay which price?

# 6. PROFITABILITY OF CCGT OVER THE STUDY PERIOD

45. Detailed numerical analyses of the Belgian market have demonstrated the potential of scarcity pricing to overturn the financial viability of flexible technologies in Belgium, and also to create a strong investment signal for mobilizing demand response.

46. The table below presents the estimated profit results in € for the 8 CCGT units that were active in the market during the test period September 2015 until March 2016 for the different scenarios.

47. Two models, indicated as REP-0.1 and REP-0.1-inelastic, represents the best proxy of the current situation, and envelope the possible interpretations of the existing provision of reserve capacity. RCP-0.1 corresponds to the proposed design. CCGT investment costs are estimated from 6.03 €/MWh to 8.66 €/MWh. Generators that are below 6.03 €/MWh are indicated in bold font and correspond to generators that should be unable to recover their fixed costs, even under optimistic assumptions about fixed costs. Generators that are in the range of 6.03 - 8.66 €/MWh are indicated in italic font and correspond to units that earning a profit within the range of investment costs. Units indicated in normal font are earning a profit above, 8.66 €/MWh, and are therefore covering investment costs even under pessimistic investment requirements.

| | SCV | RCV | RCP | RCP-0.1 | REP-0.1 | REP-0.1 inelastic |
|---|---|---|---|---|---|---|
| G1 | 7.37 | 7.37 | 7.37 | *7.40* | **2.59** | 16.15 |
| G2 | 20.68 | 20.66 | 20.68 | 20.79 | 15.07 | 31.80 |
| G3 | 8.06 | 8.06 | 8.06 | *8.09* | **2.64** | 19.03 |
| G4 | 12.04 | 12.04 | 12.04 | 12.08 | **3.84** | 28.62 |
| G5 | 21.07 | 21.05 | 21.07 | 21.18 | 15.45 | 32.26 |
| G6 | 8.30 | 8.29 | 8.30 | *8.32* | **2.66** | 19.42 |
| G7 | 21.45 | 21.43 | 21.45 | 21.56 | 15.82 | 32.57 |
| G8 | 20.58 | 20.56 | 20.58 | 20.69 | 14.93 | 31.67 |

# 7. PROFITABILITY FOR DEMAND FOR PARTICIPATING INTO THE MECHANISM (PROVIDING RESERVES)

48. The table below shows the benefits in € for demand when participating in this mechanism, i.e. when providing reserves, for the different mechanism simulated in the study. RCP-0.1 corresponds to the proposed mechanism.

49. The second column presents the decrease in the profits of loads, relative to REP-0.1, under the assumption that loads do not offer any reserve to the market. Note that this is the total increase in the consumer bill from the introduction of scarcity pricing, divided by the total average demand during the study, which amounts to 7442 MW. The third column is the monthly increment in profit that loads enjoy by offering an additional MW of ramp capacity into the system. This increment is the result of

their ability to offer the additional capacity for secondary and/or tertiary reserve. The fourth column is the amount of reserve capacity that the loads would need to offer to the reserve market in order to offset their losses from the increase in energy prices.

| | Load profit decrease (€/MW-month) | Δ Profit / Δ Reserve (€/MW-month) | Break-even reserve capacity (MW) |
|---|---|---|---|
| REP-0.1 | - | - | - |
| REP-0.1-inelastic | 5,676 | 52,819 | 926.4 |
| RCP-0.1 | 5,227 | 57,154 | 680.6 |
| RCP | 5,111 | 66,010 | 576.2 |
| RCV | 5,109 | 66,126 | 575.0 |
| SCV | 5,120 | 65,877 | 578.4 |

50. This table shows that, on average[5], loads would pay (5227/756) = 6,9€ /MWh if they do not participate in the mechanism. Providing 1 MW of reserves during one hour to the system will give an additional profit to loads of (57154/756)= 75,6€/MW and that, on average, if a load provides (680,6/7442) = 9,1 % of its demand as reserves, the 3 adders should have no impact on his total costs.

51. Note that demand is paid "only" for the availability of the reserves: these reserves do not need to be activated in order to be remunerated.

[5] The average values in the study are computed by considering 88 scenarios of system imbalance for each hour of system operation, which includes certain low-probability scenarios which are nevertheless highly stressful for the system. The probability distribution of these scenarios is obtained from an ELIA study, which has been published in the academic literature: De-Vos, K., Stevens, N., Devolder, O., Papavasiliou, A., Hebb, B., MatthysDonnadieu, J., 2019. Dynamic dimensioning approach for operating reserves: Proof of concept in Belgium. Energy Policy 124, 272–285. See https://perso.uclouvain.be/anthony.papavasiliou/public_html/Supplement.pdf for additional information.

# 8. NEXT STEPS

52. If the proposed mechanism is to be implemented, the possible interaction with neighbors has to be examined and the possibilities of exchanging energy and reserves in balancing have to be taken into account. In particular, the integration of the proposed mechanism in the ongoing implementation of the Picasso and Mari platforms has to be studied carefully and the design should be adapted accordingly.

53. From the 1st of October, Elia shall publish one day after real time the value of the 3 adders of the currently proposed mechanism for the previous day. Interaction with stakeholders on the impact of the adders will constitute a critical step in a possible implementation of the mechanism.

54. Based on the necessary modifications to the design resulting from the interaction with neighbor countries and balancing platforms and given the results of the publication of the three adders made by Elia, and the feedback from stakeholders, the final design of the adder should be validated by additional parallel runs before a possible implementation at the end of 2021.

For the Commission for Electricity and Gas Regulation:

Andreas TIREZ
Director

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Acting President of the Board of Directors

# ANNEXE 1

## Study on the general design of a mechanism for the remuneration of reserves in scarcity situations