THE BELGIAN CAPACITY MARKET: NUCLEAR PHASE-OUT, RELIABILITY OPTIONS AND THE CLEAN ENERGY PACKAGE

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Introduction

In 2002, the discussion of the Belgium draft law on nuclear energy exit recognized the energy challenges the country would face in the future: maintaining economic growth, ensuring generation adequacy, liberalizing the electricity market, meeting greenhouse gases emission under the Kyoto Protocol, replacing nuclear and coal, improving energy efficiency, and increasing the contribution of renewable energies. Almost 20 years later a lot has been done on some elements while very little on others. This paper focuses on generation adequacy and the implementation of a Capacity Remuneration Mechanism (CRM) to ensure adequacy and in particular cope with the nuclear phase out in Belgium.

To address generation adequacy, the Belgium Parliament in April 2019 approved a Bill on a CRM. The objective of the CRM is to encourage new investments after Belgium's nuclear exit end of 2025. Once the CRM will be approved at European level the first auction is planned for October 2021 with a first delivery of capacity in November 2025. Without anticipating the final decision at European level the two first years of design of the Belgium CRM have led to several controversial debates and provide already interesting lessons for other markets in Europe.

First an overview of the nuclear phase-out background is briefly discussed with a specific focus on lifetime extension (or Long-term operation - LTO) of existing nuclear reactors. The specificity of the Belgium electricity market will be discussed beyond the issue of nuclear exit. Secondly some key elements of the proposed design will be discussed in the light of international experiences and the clean energy package: reliability options, resource adequacy, cost of the CRM, pay-back obligations, Pay-as-bid Versus Pay-as clear, intermediate price cap…etc. The different perspectives of stakeholders will be highlighted.

The Belgium' CRM is the first one analyzed in the context of the new European Clean Energy Package (CEP). The CEP is a robust framework but at the same time creates an additional complexity layer. Two years after the CRM law, significant progresses have been made in the design, several important questions remain unresolved, and some early lessons can be drawn.

[1] *The statements, opinions, and ideas expressed within this paper are the sole responsibility of the author. Engie is not responsible in any way, manner or form for these statements, opinions, and ideas.*

2012 & 2015: Nuclear long-term operation (LTO) to ensure security of supply

Belgium has seven reactors commissioned between 1974 and 1985 (see table below). They represent together almost 6 GW of installed capacity producing roughly around 50% of electricity consumption in Belgium. In 1999, the "green" parties joined the federal coalition for the first time and the coalition agreement mentioned that *"Belgium must commit to a gradual nuclear phase-out"*. The "green" parties in Belgium have been historically opposed to nuclear energy and played a key role in the nuclear phase out law. In 2003 the nuclear phase out law was adopted. No economic, ecological nor technical reasons were presented in the memorandum attached to the draft law proposal. Actually, no reasons for nuclear phase-out were explicitly mentioned either. The state secretary nevertheless provided in the hearings organized during the law discussions three main reasons: risk of nuclear accident, nuclear weapon proliferation risk and waste management (Belgium senate 2003). Those reasons were heavily challenged already in 2003 by political parties and several experts. The law put a limit on the operating lifetime of nuclear reactors to 40 years… however also mentioned that the issue of security of supply is the absolute priority of the Belgium energy policy, allowing temporary derogations to the law.

	First power	Expected shutdown	Lifetime (years)
Doel 1	1974	2025	**50**
Doel 2	1975	2025	**50**
Doel 3	1982	2022	40
Doel 4	1985	2025	40
Tihange 1	1975	2025	**50**
Tihange 2	1982	2023	40
Tihange 3	1985	2025	40

Regardless of the rational and the politics behind exiting nuclear, it only remains one part of the equation. Phasing out nuclear is one thing. A structured and quantified plan to replace it, is a different thing. It was already clear in 2003 that renewables would not be sufficient, and that natural gas would be (significantly) needed. In 2003 the report provided by a group of experts (the "AMPERE" Commission) was quoted with respect to renewables' potential. The report estimated the renewables potential around 8 TWh (= 10%~of electricity demand). In 2020 renewables produced almost 20% of electricity consumption in Belgium. On one hand this shows that in 2003 the potential and technological developments for renewables were significantly underestimated. On the other hand, even when adding a margin of error of 100% the total amount of electricity produced from renewables comes nowhere near the amounts needed to replace nuclear. Energy efficiency was mentioned as being of utmost importance. However, the AMPERE report mentioned that all existing demand scenario for electricity were showing a power demand increase. Hence from 2003 it was clear that gas based power generation would be the adjustment variable for ensuring adequacy.

In order to ensure security of supply, the law was first amended in 2012 with the first 10 years lifetime extension (or Long-term operation - LTO) of Tihange 1. The amendment also confirmed the shutdown of the two oldest units (Doel 1 & 2) by 2015…. but in September 2014 the Belgian government considered the option of LTO for Doel 1 & 2 and the Federal Agency for Nuclear Control (FANC) developed conditions for such a scenario. The law has then been amended a second time in 2015 to give 10 years LTO to those two oldest units allowing them to operate until 2025. This extension was also justified by concerns over security of supply. Doel 1 & 2 were therefore effectively shut down during 2015 but restarted in December after a positive opinion of the FANC. Those LTO led to major technical works on the two power stations to upgrade them and ensure compliance with safety standards. It represented a significant investment around €700 million. The extension happened without a proper Environmental Impact Assessment (EIA) and a national and transboundary public consultation process, as prescribed by the European Directive 2011/92/EU. Ironically, this led Belgium to do such a consultation several years later in 2021, 6 years after the LTO decision and 4 years before the phase out.

Nuclear debates are fundamentally political (and passionate) debates where a vast scope of elements are considered: safety, economics, waste management, CO2 emissions, flexibility, centralized VS decentralized system, weapon proliferation…etc. It is up to policy makers to make such decisions. One could always find arguments in favor or against a nuclear phase out law. The final decision is therefore always questionable. Belgium is no exception. However, in the case of Belgium it is rather unquestionable that the nuclear phase out was not accompanied with a comprehensive plan defining how nuclear would be replaced. Arguably it was assumed that 12 years (2015 being the first year of phase out) would be sufficient for technologies to gain maturity, energy efficiency to develop, and investment to take place. It did not happen, and policy makers had to rely on successive, last minute, LTOs to address the issue of security of supply. Ironically the oldest units will operate for 50 years while the most recent ones will stop operation after 40 years.

2015: A CRM to ensure security of supply?

At the very same moment as Doel 1&2 restarted operation in December 2015, the Federal Energy Minister asked the Belgium Transmission System Operator (Elia) to perform a study on system adequacy. This study has been published in April 2016 and provided some first estimate of the needed capacity to replace nuclear: at least 3.6 GW of new capacity. Two months later, based on this study and a large consultation, the federal energy directorate advised to initiate the work on the development of a Capacity Remuneration Mechanism (CRM) in Belgium. A detailed study was then published in March 2018. In April 2019 the federal parliament approved the law introducing a capacity remuneration mechanism based on a "reliability options" approach.

After 16 months of negotiation after the 2019 election, the federal government in its coalition agreement confirm the nuclear exit by 2025…but kept the nuclear option open. The agreement specifies that in November 2021 a report on the future of electricity production in Belgium will be submitted to the government. This is one month after the result of the first CRM auction. This report will analyze security of supply and the electricity price impact of electricity of phasing out nuclear power in 2025. If this report shows that there is an unexpected security of supply problem, the government will take appropriate measures such as adjusting the legal timetable for up to 2 GW of nuclear capacity. In the end of December 2020, the nuclear operator announced that November 2021 was too late for deciding on a new LTO due to technical and legal constraints.

Nuclear exit has arguably been a "shadow" hanging over the CRM design process. The nuclear LTO option has been regularly presented by different stakeholders as an alternative to the CRM. The discussions have mainly been about the possible lifetime extension of the 2 most recent units (Doel 4 and Tihange 3). The proponents of nuclear lifetime extension put forward mainly three arguments: nuclear allows to (1) limit CO2 emissions by reducing the level of investment in new gas plants, (2) keep overall cost under control (directly via wholesale prices, indirectly by reducing overall CRM cost), (3) improve energy independency by limiting import from neighboring countries. This last element is of particular importance since several countries have announced plans for nuclear and coal phase out. For instance a study made by the Belgium research center Energyville, sponsored by the nuclear operator, concluded that extending two units (2 GW) for 10 or 20 years would (1) reduce the need for investment in new gas assets by 1.1 and 1.8 GW respectively, (2) therefore saving 25 and 45 Million tons of CO2 respectively and lower net import by 10-20%. The study showed that direct impact on wholesale power price remains rather limited (~ 1€/MWh) since 2 GW of capacity in the overall Central Western Europe electricity market is rather negligeable.

Nuclear phase out is considered by anti-nuclear as a way to push the federal and regional governments to promote energy efficiency measures, flexibility services, distributed generation and renewable production. For the anti-nuclear, nuclear exit is considered as essential to provide a clear signal to investors in renewables projects. Many of them argued that nuclear is hampering the deployment of renewables in Belgium. This argument remains regularly used by (some) advocates of renewables despite a lack of empirical evidence. According to the Energyville study a nuclear lifetime extension of 2 GW would have no impact on wind deployment (onshore & offshore) and a marginal impact on PV deployment. It would mainly impact the volume of gas assets needed and the level of import. Similarly, for several renewables developers, lengthy and complex administrative procedures and in particular appeal procedures are the main barrier to renewables deployment.

The discussion around nuclear phase out continue to consider traditional arguments of anti-nuclear advocates: safety and the risk of potential major disaster (i.e. Chernobyl, Fukushima) as well as the issue of nuclear waste treatment which remain radioactive for hundreds or even thousands of years. On those issues the 2003 arguments of pro-nuclear generally remain similar. They argue that Belgium's nuclear power plants are extremely safe and that technical solutions for nuclear waste treatment and storage exists. On both elements anti-nuclear disagree. To some extent almost 20 years later the political debate on nuclear continue with very few significant progresses on both sides. The main difference is that the clock is ticking with the first nuclear plant exiting the system in 2022.

Nuclear phase out as a trigger for the CRM, but not only

In practice, all countries adapt their CRM to their local specificities. These specificities are numerous in Belgium. Beyond the significant supply shock and political controversies with the phase out of nuclear power, several elements should be noted:

- Belgium is strongly interconnected with its neighbors, meaning that discussion on adequacy are strongly dependent on supply demand balance and political decisions in neighboring countries.

- A strong political will to impose a part of the energy mix by 2025 and beyond, in line with the ambitions to develop renewable energy,

- The Belgium CRM is the first one to be examined in the framework of the new European Clean Energy package, the rise of the green deal and the overall strengthened European ambitions in terms of CO2 reductions,

- A tight timing with a first law voted two years before the first auction,

In addition to these elements, there are elements that are more related to the opinions and convictions of different stakeholders:

- A significant difference in diagnosis in terms of capacity needs and solutions to be implemented between the various players, in particular the regulator and the federation of industrial consumers (Febeliec) on the one hand and the network operator and the federation of energy producers and suppliers (Febeg) on the other hand,

- The strong conviction of the Belgian regulator that it is not possible to assess whether there is an adequacy problem according to the European regulations (2019/943) and therefore that a capacity market cannot be introduced (CREG 2020),

- A legitimate concern about the cost of the mechanism in view of the scale of the nuclear phase-out. This concern is combined with a mistrust in the competitive process to ensure security of supply at the lowest cost. This mistrust is reflected in the definition by the legislator of a whole set of additional constraints in the design of the CRM (e.g., different price caps, conditions for granting long-term contracts, pay-as-bid auctions, etc.),

- The possibility in the federal government agreement to possibly review the nuclear phase if the situation after the first CRM auction required it.

Without being exhaustive, this list enables to appreciate the complexity of the legislator's task. The question is therefore whether the mechanism as it stands today, will be able to meet the main objective of ensuring security of supply at the lowest cost while taking all these related elements into account.

The Clean Energy Package: a structuring element of the Belgium discussion

The Clean Energy Package (CEP) was adopted in 2019. The full package in an extensive set of regulations and directives shaping the European electricity market(s). The CEP offers not only a revision of different exiting directives and regulations but also aims at offering better consistency between several pieces of existing legislation. The CEP covers energy security, the internal energy market, energy efficiency, renewables, decarbonization, cross border trade, consumers rights…Etc. With respect to security of supply and decarbonization, the CEP provides several rules for capacity markets including CO2 performance limit for power plant eligible to receive subsidy. The CEP defines conditions for Member States before introducing Capacity Remuneration Mechanisms (CRM) in regulation EC 2019/943. The regulation build upon the results of the sector enquiry launch in by the European commission in 2015 (EU 2016).

According to the sector inquiry many member states did not assess rigorously the issue of security of supply. The CEP defines through regulation EC 2019/943 common rules for adequacy assessment, reliability standards and design principles. The commission also specified that CRM should be considered as a last resort solution while priorities should be first on market reform to improve the functioning of existing markets based on the “energy-only” model. In addition, any CRM should be approved by the Commission to assess compatibility with EU state aid rules.

From a decarbonization perspective, the new regulation introduces for the first time a CO2 emission performance limit for power plants eligible to receive subsidies under a CRM. In short, new assets that emit more than 550g CO2/kWh will not receive capacity remuneration. This limit is then reduced to 350kg CO2/kW per year as of July 2025. Such a rule excludes coal plants from capacity mechanism schemes. While being a step forward these thresholds have been heavily criticized by green politicians and activists who would have prefer lower thresholds to exclude gas generation.

The CEP played a key role in the overall discussion around the Belgium CRM and led to several controversial debates on the capacity gap, CRM versus “Energy Only”, favoring renewables, keeping cost under control.

The capacity gap and the resource adequacy assessment

The very first question is whether Belgium needs a CRM or not. This is a direct consequence of the Clean Energy Package: a rigorous resource adequacy assessment is needed before implementing a CRM. The whole nuclear fleet (~ 6GW) will retire between 2022-2025, removing around 50% of Belgium generation output. In 2019 ELIA (the Transmission System Operator -TSO) performed an adequacy study updating its 2016 study. In this new study the gap increased from 3.6 to 3.9 GW of new capacity. The analysis call for the implementation of a capacity remuneration mechanism as soon as possible to build new power plants. The Regulator (CREG) argued that only 2.2 GW was needed. The regulator considered that Elia was too conservative in its assumptions and fundamentally questioned the need for a Capacity Remuneration Mechanism (CRM). Hence, two key stakeholders disagree about how much should be built.

Traditionally adequacy studies aim to analyze the balance of supply and demand. On the supply side, a whole set of assumptions are considered in terms of interconnections with neighboring countries, new developments of renewables production (e.g., new offshore wind farm), openings and closures of power plants. In addition, several assumptions

on the development of cogeneration, storage, demand response, and on the production means available in neighboring countries (e.g. closure of nuclear and coal in Germany, France, the Netherlands...). On the demand side, different assumptions are made about energy efficiency (decreasing power demand) and electrification (increasing power demand). These assumptions are well documented in TSO's report (> 100 pages) which itself refers to other reports also well documented in terms of assumptions. E.g. analysis from the European Network of Transmission System Operators (ENTSOE). Finally climatic hazards (cold winter VS hot winter, High wind VS low wind conditions…etc.) and system hazards (unforeseen unavailability of one or more power plants) are added.

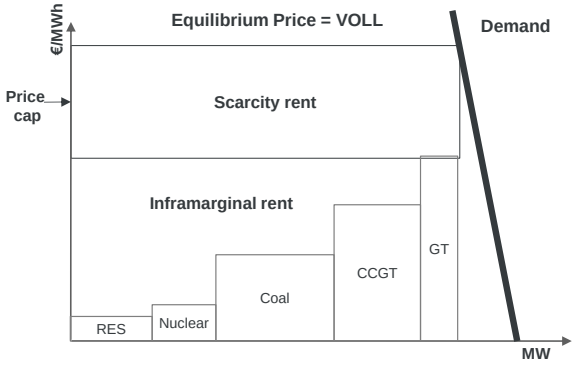
The Clean Energy Package is quite prescriptive in terms of methodologies to be used. The resource adequacy assessment should consider national implementation plans for measures to remove regulatory distortions, consider where applicable the flow-based approach, apply probabilistic calculations, compute "expected energy not served" (EENS), and "loss of load expectation" (LOLE), follow EU methodologies developed by ACER for different elements such as the "value of lost load" (VOLL) and the "cost of new entry"(CONE). Almost all those parameters have been subject of discussion between the regulator, the TSO and different stakeholders in Belgium.

The regulator has been challenging several assumptions made by the TSO. For instance, the regulator argued that the availability of reserves in neighboring countries should be considered. He also suggested more aggressive assumptions on the extension of gas-fired power stations that are more than 20 years old. The regulator also asked for a review of the climate years assumptions used by the TSO, arguing that climate change led to milder winters.

All in all, the debate on the level of capacity needed, has been a hot discussion in Belgium which to some extent can be seen as a battle of assumptions. On one hand it appears as a healthy debate on such a crucial issue. The regulator was playing its role in protecting the interests of consumers by preventing subsidies for unnecessary investments. On the other hand, it has been quite confusing for many policy makers and market players. Indeed, while it is rather common to have different perspective between a TSO and a regulator, in the CRM debate the discrepancy has been quite large. The most important implication can be found in the EC opening decision about the Belgian CRM. After analyzing the different perspective the EC share its doubt about whether Belgian Authorities identified precisely the size of the adequacy problem with a particular concern for a potential overestimation of the problem.

CRM versus "Energy Only"

The European default design for electricity market is based on the "energy only" principle. According to the CEP, priorities should be given on implementing all necessary market reforms before implementing a CRM. A CRM being not only a "last resort option" but also a "temporary measure". According to traditional peak load pricing theory (pioneered by Boiteux -1960) there is *in theory* no need for a CRM. An energy only market is sufficient to ensure adequacy. Price spikes should provide sufficient signals and revenues to investors. In theory this leads in having a mix of assets: some assets with high investment cost but low variable costs (for base-load), and some assets with low capacity costs but high variable costs (mid merit and peak) to be used in the peak-load hours. Investment costs are recovered when assets are inframarginal and during peak-load hours. Assets receive an inframarginal rent when the price is set by other generators with higher variable costs. They receive a scarcity rent when the price is determined by demand. Theoretically the price is set at the level of Value of Lost Load (VOLL) where supply cannot cover demand, which is the price level at which demand can be reduced (figure below).



The economic literature has however highlighted that several market failures may limit scarcity rents in an energy-only market. This in turn induces insufficient investment to reach a desired level adequacy. The first market failure is fundamentally the lack of price-responsive of short-term demand – (i.e. absence of a slope curve for demand). In practice the price is often defined by a price cap potentially lower than the theoretical Value of Loss Load (VOLL). Secondly (politically defined) reliability standards may prevent scarcity.

A CRM aims to replace the traditional price peak investment signal with a more stable payment hence reducing investment risk. This insurance premium has positive effects on the energy market for consumers. The insurance

ensures a certain level of investment and avoids certain price spike in shortage situations and avoids load shedding in extreme situations with significant economic and societal costs. Conversely it is essential to not over dimensioned the CRM which could lead to overcapacity and associated extra costs.

Beyond those traditional limitations of “energy only” markets in practice, the most important element impacting the functioning of electricity markets in Europe over the long term is the decarbonization ambition. In a world where decarbonization is of utmost importance, increasing capacities of renewable productions forced into the electricity systems exacerbate the problem of remuneration of investment. While those assets make perfect sense to decarbonize the power system when replacing fossil fuel they create a real challenge for price formation: (1) Those assets are often (although less and less) financed outside of the electricity via subsidy schemes hence they do not react to wholesale prices, (2) their introduction depress further power prices (the so called “merit order effect”), (3) they produce according to weather conditions which is very poorly correlated to power demand. There is therefore a need for “back-up” capacity. In the long term, with renewables penetration aiming to cover 50, 70 and up to 100% of power generation by 2050 in some scenarios it remains to be seen how current market need to evolve. CRM are a structural solution to those different issues, at least in a transition phase. This element was well recognized by the European Commission in the sector inquiry.

The academic debate around “Energy only” versus CRM has been present in the Belgium discussions with advocates of both camps. Twenty years ago, the "energy only " approach was largely dominant in Europe. Today, many countries have joined the "CRM " camp, notably the United Kingdom, Ireland, Poland, Italy, France, Greece…. Similarly Germany also has different support schemes to ensure security of supply. Spain recently also started to consider a CRM approach. The European Commission is attentive to the problems of state aid and distortion of competition that these mechanisms may represent. Belgium will suffer a supply shock with half its production disappearing. Even in Japan, before Fukushima, nuclear power only represented 30% of production. There is therefore a double constraint in Belgium: a significant volume of capacity must be replaced AND quickly.

Besides the TSO and the regulators, several players have contrasted opinions on the topic. It is not surprising that the players in the electricity generation and sales sector represented by FEBEG are rather in favor of the introduction of a capacity remuneration system - which reduces uncertainty and facilitate investment. The large consumers are in the camp of the "energy only" market approach and are opposed to such a mechanism. They consider a CRM as unnecessary, would prefer a nuclear lifetime extension and are concerned about the cost of the CRM. The demand side management (DSM) players are also very attentive to the implementation of such a mechanism which could have a very significant impact on their activity. Some DSM players are rather positive and sees it as an opportunity to valorize flexibility, some others are concerned about the complexity of the mechanism.

Fundamentally the CRM is an insurance for Belgium that a certain volume of investment will be made. Those volumes could be built without the insurance…or not. As with any insurance, one is entitled to ask whether it is needed. Everyone has his own opinion and beliefs; it is therefore up to the policy makers to decide whether to take such insurance. The Belgian government made that choice, this is a political choice and fundamentally it should be. Not surprisingly, the Belgium discussions did not manage to settle once for all the debate “energy only” VS “CRM”.

CRM and other political objectives: limiting CO2 & favoring Renewables developments

Security of supply is only one element of any energy policy. A whole range of objectives impact (or are impacted by) the implementation of a CRM. First of all, there are the ambitions of decarbonization. A first rule of the CRM consists in excluding capacities that emit a lot of CO2, in line with the Clean Energy Package. This is the case with the maximum threshold defined at 550 gCO2/kWh to be eligible for remuneration under the CRM. This constraint *de facto* eliminates certain inexpensive but polluting technological options. This seems legitimate even if for some stakeholders, this threshold should have been lower. A lower threshold would have excluded natural gas power plants by 2025 and limited the options to ensure security of supply. At European level, this threshold has been considered to facilitate the replacement of coal by gas units. This element is a very controversial issue in Belgium where the construction of new gas power plant emitting CO2 is not for replacing coal but nuclear. This sensitive point has been addressed in the last market rules of the Belgium CRM: market parties should realize feasibility studies on CO2 reductions by 2026, provide intermediates reductions target by 2035 and 2045 to reach carbon neutrality by 2050. Nuclear advocates have been very vocal on this point arguing that the best way to limit CO2 emissions…was to extend the most recent nuclear reactors.

In line with the European regulation, Member States are all seeking to encourage investments in renewable energies but also in the more flexible electricity generation, interconnections, demand flexibility, distributed generation and energy storage. The Belgian CRM takes into account certain volumes of renewable energy anticipated for 2025, but also a volume of batteries and "desired" demand flexibility. For instance 1 GW of batteries are taken into consideration by the grid operator in 2025, representing a significant development volume compared to the current situation. These

ambitions potentially conflict, for example, with the principle of technological neutrality, which prohibits favoring certain technologies at the expense of others. There is therefore technological neutrality "to a certain extent".

CRM designed to keep costs under control?

In the explanatory memorandum of the Belgium CRM law (as in the European regulation-2019/943) it is clearly mentioned that *"a capacity remuneration mechanism is introduced, which operates through recurrent auctions [...] the mechanism is designed to make its cost as low as possible"*. Recurrent auctioning is unambiguously a recourse to competition. Auctions are a well-known mechanisms for obtaining a product or service at the lowest cost, for example through tendering. The second part refers to the design of the mechanism. The question is then: how can a design element reduce a cost? The "cost to society of the CRM" is undoubtedly one of the most controversial subjects in Belgium. Several estimate ranging from simple to triple (from less than 300 to more than 900 million €/year) have been heavily discussed. Four design choices, amongst others, illustrate this ambition in Belgium to "keep cost under control": reliability option, pay-as-bid, Intermediate price cap, the 200 hours rule. The open question is whether those choices will concretely reduce the cost of the CRM or backfire and make it more expensive "all other things being equal".

The objective of keeping costs affordable is a key element, especially in the context of an economic crisis. Electricity bills in Belgium have risen sharply over the last ten years due mainly to the addition of multiple taxes and contributions. When drafting the CRM law in February 2019, the legislator paid attention to the risks of windfall profits for capacity providers. This point was important in the **choice of reliability options**: they avoid double remuneration through both a capacity payment and a remuneration during price spikes. Thus, any capacity contract holder in the Belgian CRM will be exposed to a payback obligation if market prices exceed the strike price of the reliability option. This does not pose any problem if the capacity holder has actually received a remuneration associated with these high prices. Similarly, it is legitimate that the unavailable capacity holder despite his commitment get financially sanctioned. The situation is different if the capacity holder is available (and producing) but has already sold the electricity in advance (at a price below the price observed on the spot market) for hedging purposes. Hedging is an industry standard in Europe. It ensures a certain level of remuneration for producers. Symmetrically, for a supplier hedging ensures a predefined price level for its customers. The capacity holder may then have to pay back an amount that he has not received in the first place. This has been heavily criticized by energy producers. This is a risk to be assessed and managed, which necessarily has a cost for the system.

Belgium decided to implement **pay-as-bid auctions** while all European CRMs currently operate on a pay-as-clear basis. This is rather surprising at a first glance: pay-as-clear auctions have been approved by the European Commission as a way to limit windfall profits. As early as 2018, the report by PWC for Belgium notes that *"A separate price for existing and new capacity could theoretically be considered, but has not been found anywhere"*. This report recommends a pay-as-clear mechanism...without excluding a pay-as-bid mechanism. Pay-as-clear has the advantage of providing a transparent, non-discriminatory price signal (the same price is paid to all players offering the same service) and can technically go down to very low levels, or even to zero in a capacity surplus situation. From an economic point of view, such a mechanism creates an incentive to offer at the lowest price with the prospect of possibly receiving more if other needed capacities are more expensive. Nevertheless, Belgium choose to deviate from other European countries and decided to implement **pay-as-bid**.

Pay-as-bid auctions respond to the intention of the legislator to take into account an initial situation. In the first auction, a large amount of new capacity will have to compete with existing assets. Existing assets are expected to require much lower capital investment. It is thus considered "unreasonable" by the legislator to remunerate new and existing capacity at the same level. The risk from the legislator's point of view is that the first auction would result in a high price being paid to all capacity (new and existing asset). By differentiating the price paid per type of capacity, the intention is to lower the bill for the consumer.

There is a vast economic literature on the subject of pay-as-bid and pay-as-clear auctions applied to electricity markets. The advantages and disadvantages of both mechanisms remain controversial. Even if capacity mechanism auction (MW) is not fully comparable to electricity markets auction (MWh), the main conclusions remain valid. In particular, the literature emphasize a key assumption that is often omitted in the rationale for pay-as-bid auctions: participants will bid the same in both systems. This point has been made for over 20 years by Kahn et al (2001): *"The critical assumption is that generators will bid just as they had before. They will not"*.

Ironically the superiority of a pay-as-clear mechanism - from a dynamic point of view - is recognized by the Belgian legislator. The legislator has foreseen that potentially after two years of pay-as-bid, a pay-as-clear could be put in place. Such a change would be considered after presentation to the House of Representatives of an evaluation report following the first two years of delivery of the CRM. There is therefore a double specificity to the Belgian CRM on the auction mechanism: a pay-as-bid choice in the first phase and then a possible change after two years to a pay-as-clear mechanism.

On the one hand, the objective to take advantage of the benefits of both mechanisms depending on the security of supply situation is understandable. For investors, the announcement of such a potential change is also a positive point. On the other hand, it is more difficult for investors/new entrants to position themselves in a pay-as-bid mechanism which is a first of a kind for a CRM in Europe… A potential change of rules after 2 years is also additional uncertainty. It is not clear that a discriminatory pay-as-bid auction will reduce the cost of CRM. It will be interesting to see if DG Comp comes back to this point in its in-depth analysis. If the two-phase approach is adopted, this will be a first of a kind and could set a precedent for future CRMs.

In addition to the pay-as-bid rule, the Belgium CRM also include an **Intermediate Price Cap rule** (IPC). Existing capacities will not only receive the amount of their bid even if other more expensive capacities have been selected, but are also subject to an intermediate price cap. This combination of pay-as-bid and intermediate price cap is also a novelty in the design of a CRM. Although this IPC may be well intentioned by the legislator, it is not without potential perverse effects. The IPC is a discrimination between existing and new power plants. Again the aim is reducing the cost of the CRM. According to the Belgian authorities, the IPC aims to prevent the market power of certain players and limit potential excessive remuneration. The difficulty of the exercise is to define a level that is neither too high to avoid "windfall profits", nor too low to prevent a fair remuneration of the investor or even simply prevent certain players from participating in the mechanism. A too low level may even create an exit signal for some players. The difficulty of the exercise is to find the right level. Two values were mainly discussed (20 and 28€/kW/year), the lower one was retained.

For the Belgian authorities, an IPC appears as an attractive tool to reduce the total bill for consumers. By setting the lowest possible intermediate price cap, the legislator seeks to reduce the cost. Beyond showing a lack of confidence in the competitive mechanism, the legislator creates several perverse effects. If it is too high, the IPC is useless. If it is too low, the IPC makes it more difficult for new capacities to compete with existing ones. On one hand some players can no longer participate, on the other hand the remaining players have no real incentives to compete and offer below the IPC. This point was rightly noted by the regulator during his hearing in the Chamber's Energy, Environment and Climate Committee in February 2021 (CREG 2021). Competition becomes severely limited or even eliminated.

There is a fundamental difference between excessive profits and a fair return on investment. The line between the two concepts is sometimes thin... and often depends on who is holding the pencil. The starting point of the IPC is the idea that there is no need to "subsidize" an existing plant as much as a new one. On this point, the report by the consultant Haulogy commissioned by the Federal Minister on the cost of CRM provides instructive evidences that some assets would need revenues to compensate for their "missing money" in the short term market in excess of the IPC. The European Commission in its first analysis of the Belgian CRM refers to the State Aid Guidelines and questions the compatibility of the IPC with these guidelines. The question is whether the IPC in the CRM does not undermine investment decisions in production that predate the establishment of the CRM (point 233 c). This is one of the issues that will have to be clarified in the coming months before the Europe Commission approve the mechanism.

Since the IPC has been considered as point of attention, potentially impacting competition, by the European Commission a derogation mechanism has been established. Such a mechanism adds an additional uncertainty because the players do not know ex-ante whether they will obtain a derogation or not. In addition, the methodology proposed to judge the merits of the derogation request is conceptually very questionable. The idea is to check whether the request for derogation is justified. To do so, the regulator will look at the amounts of “missing money” requested and will assess whether they are justified in view of the expected market revenues. Unfortunately, this is an impossible task because the regulator cannot know ex ante in 2021, what market revenues a specific asset will exactly receive over the period 2025-2040. It will therefore be quite interesting to see how the regulator will justify whether a derogation can be accepted or not.

By setting up an IPC mechanism to reduce the cost, the legislator potentially create incentives that are harmful to competition. A derogation mechanism has been put in place which is itself complicated and uncertain. Everyone may then ask for a derogation. What is the point of a rule if everyone asks for a derogation from that rule? If the regulator is able to define the level at which each player must/may offer, what is the point of setting up a competitive mechanism in the first place? Why not simply regulate the price of each participant?

One last design element of the Belgium CRM provides an interesting illustration of the political ambition not only to keep cost under control, but also to favor renewable deployments: the **200h rules**. In its traditional form, a CRM consists of defining a volume of capacity (MW) necessary to cover a peak demand in order to meet a reliability criterion. In most European mechanisms, this volume is auctioned according to two time horizons: 4 years in advance (T-4), 1 year in advance (T-1). These two horizons allow capacities with a significant construction time to participate in the auction. It also allow to adapt the need for capacity one year in advance. When the law of March 2019 was discussed, an amendment appeared during the debate. This amendment appeared without prior analysis and had a structuring impact on the bill. The amendment states that the volume in T-1 is defined as the *"volume to be reserved [in T-1] is at least equal to the capacity having, on average, less than 200 operating hours per year in order to cover*

the total peak capacity". This amendment refers to an analysis by the regulator which identified a low utilization of 2700 MW of capacity. The amendment is justified as follow *"Providing this capacity by means of new generation will undoubtedly result in very low plant profitability. However, this capacity can be covered by demand side management, batteries and electric vehicles which can provide capacity to the grid"*. The rule should prevent new gas-fired power plants from being built unnecessarily, and *"should not hamper innovation and that there should be sufficient margin for demand-side management and storage in particular"*. So there is both the political will to minimize cost and also the ambition to influence and facilitate innovation.

From an economic point of view, several questions arise. How can the volume of assets that will run for less than 200 hours be estimated 4 years in advance? What are these assets: demand side management, storage, old power plants, small decentralized production facilities, new power plants? This is where the problem lies: how can new power plants run for 200 hours? Those plants will by definition be more efficient than the old ones. They will undoubtedly operate in baseload mode at the beginning of the horizon as a replacement for nuclear power. Their operating hours will gradually decrease with the development of renewable energy. In the Energyville study published in September 2020, even in scenarios of high renewable deployment AND nuclear extension (unfavorable to new gas-fired power plants), gas-fired power plants run more than 3000 hours in 2030. The probability that these plants will run less than 200 hours is therefore almost zero.

From an innovation point of view, it is not clear that this rule is likely to favor certain technologies. If it is understandable that a part of the flexibility of demand can hardly be contracted 4 years in advance, one can nevertheless imagine that this is not the case for all the flexibility of demand. For example certain electro-intensive industries - with experience in demand side management for less than 200 hours – should be able to offer part of their flexibility 4 years in advance. Similarly, battery projects could participate in the auction 4 years in advance and consider operating for 200 hours. Securing a capacity contract 4 years in advance would allow these batteries to finance their projects well in advance with the possibility to benefit from technological improvements. Finally, paradoxically, the capacities running less than 200 h in a market are often very old plants used as back-up... which are not really innovative solutions.

A well-design competitive mechanism is in theory sufficient to ensure that capital-intensive assets are not built for very short operating hours. With the 200 h rules, the legislator has artificially imposed a parameter that the market naturally defines in all other CRMs. The resulting volume is substantial (~1500 MW in T-1). Combined with the interconnection volume (~1000 MW) which is also auctioned in T-1, this is more than 25% of the volume that will be auctioned in T-1. Other European CRMs are generally below 5% in T-1. This is an ambitious choice for some "leaving room for innovation in T-1", a risky bet for others "what if in T-1 we do not find enough capacity, at what price?". The answer will come in 2024 with the T-1 auction.

Conclusion

The Belgium CRM remain in its infancy stage. The experience to date however combines several interesting challenges: exiting nuclear, putting in place a mechanism in line with the recently adopted Clean Energy Package, political ambitions in terms of decarbonizations, keeping the cost as low as possible…in a tight timeframe.

The most important lesson is that any material phase-out law (nuclear or coal) should be accompanied with a comprehensive plan to replace the capacity leaving the market. Implementing a CRM is a long process. While some preliminary work started in 2015 in Belgium, the CRM law was voted only two years before the expected first auction. This is clearly extremely challenging. The long time lag necessary to (1) design a CRM mechanism under the clean energy package (taking into consideration all local specificities, political objectives, legislative process at national and EU level), and (2) construct new generation capacity and/or to extent lifetime of existing nuclear assets, should not be underestimated.

The second lesson is that a CRM should be a competitive, clear and transparent mechanism. Competition is at the heart of implementing a CRM since it is generally considered as more efficient than any regulated schemes. In the case of Belgium several doubts exist about the ability of competition to deliver at the lowest cost and therefore several additional rules have been suggested. The risk is to end up with a complex mechanism with too many parameters defined ex-ante limiting competition...getting back to an almost “regulated” scheme. One risk is to define ex-ante several parameters that the market could have defined. There is a strong belief in Belgium that in addition to competition, the design can play a significant role in lowering the cost of the system. This is arguably mistaken. It may eventually backfire and increase the overall cost through limiting competition, changing bidding behavior, increasing costs…against the initial intention.

A third lesson is that decarbonization is creating an additional challenge for designing a well-functioning CRM. As soon as additional objectives enter into the design, there is a risk of overcomplexity and conflicting objectives. It is understandable that politicians and regulators want to not only ensure security of supply at the lowest cost but also

promote other political objectives. However, there should be trade-off between putting additional rules on top of an already complex tool. Killing two birds with one stone is not an easy task…and may lead to kill none.

A final lesson is that the Clean Energy package provides a rather robust framework for setting up a CRM but is far from defining a standard market design for CRMs. There remains a lot of room for interpretation by member states. It is a suitable feature because countries are different, initial conditions are different and national energy policies are different. Designing electricity markets in general is a complex exercise, CRM are no exceptions. Since it is very difficult to get everything right at the outset, monitoring of the results of the first auction will be key to address potential flaws.

Under the most optimistic scenario DG comp will approve the Belgium CRM and all players will be able to compete on a level playing field. After the first auction, it will be possible to assess the actual performance of the CRM and in particular its ability to provide sufficient capacity at the lowest cost while keeping CO2 emissions under control. Under a more pessimistic scenario, the approval could be delayed, the nuclear option could still be re-open without any clear view on it actual feasibility. Additionally, due to its complexity several players could bring to court legal actions against the CRM which would further delay implementation and seriously jeopardize security of supply by 2025.

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