Towards a functioning low-carbon investment framework in Europe: the need to modernize increasingly prevalent traditional capacity remuneration mechanisms

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Foreword

Europe faces a great challenge: cost-efficiently decarbonizing the power sector in by 2050, while remaining to ensure security of electricity supply. In line with the decarbonisation goal, European member states aim to significantly increase the share of variable renewable energy in Europe's overall energy mix. In order to reach these goals, investments are not only needed in low-carbon technologies, but also in the flexible resources that help deal with the expected increase in supply variability. However, EU governments pursue additional objectives (EU energy goals: sustainability, security of supply and affordability) and adequate investments to satisfy all three are missing. Which market design can deliver these investments, and simultaneously help to reach all the above-mentioned goals most effectively is hotly debated. This report aims to enrich the debate by increasing the understanding of this complex topic among Environmental NGOs. The report analyses existing and potential capacity remuneration mechanisms (CRMs), a policy instrument capable of altering the energy market by creating additional revenue streams for capacity. Although some member states in Europe are already using certain forms of capacity mechanisms under what we call a 'traditional approach', this report builds the argument that a 'modern approach' to CRMs could be proposed. The report describes the characteristics of a 'modern approach', which is more likely to improve the current market model and would help to achieve all energy policy goals, by better taking into account the electricity systems' needs that arise as more variable renewables are integrated. It is stressed in this report that modern capacity mechanisms should not be seen as a replacement of other measures to improve the investment framework, like improving the functioning of the Internal Energy Market. Rather, we focus on the current situation in Europe, which is that CRMs are increasingly being implemented, and point to ways in which this process can be improved upon. In other words, while taking different measures (next to modern CRMs) to improve the European investment framework for low carbon technologies is certainly important, that would in itself will not solve the problems caused by the increased prevalence of traditional CRMs in Europe.

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CCGT: Combined cycle gas turbine

CRM: Capacity remuneration mechanism

CSP: Concentrated solar power

EOM: Energy only market

ETS: Emissions trading scheme

GHG: Greenhouse gas

IEA: International Energy Agency

IEM: Internal energy market

MS: Member States

OCGT: Open cycle gas turbine

VRE: Variable renewable energy

1. The investment framework for low-carbon technologies

The first part of the report provides a contextualization of capacity remuneration mechanisms (CRMs)[1]. Our starting point is the combination of policy targets which Europe today aims to achieve in the electricity sector. We will discuss the investments that are needed in order to reach these targets, and what determines whether they will be made or not. We therefore elaborate on the issue of market design reform, and touch upon some of the most important policy and regulatory uncertainties that are negatively affecting investment incentives. We conclude this chapter by arguing that CRMs potentially have a role to play in improving the future investment framework.

1.1. European Climate and Energy policy targets

EU climate and energy policy is designed to achieve a combination of targets. In 2011, a long term '2050 energy roadmap' was politically agreed to in Europe, laying out a pathway for the reduction of the EU's overall greenhouse gas (GHG) emissions by 80% to 95% (as compared to 1990 levels) by the middle of the century. As shown in figure 1, the roadmap envisions a near full decarbonisation of Europe's power sector. Additionally, under any of the different technological scenarios analyzed in this roadmap, a significant increase of renewable energy in the generation mix is needed[2].

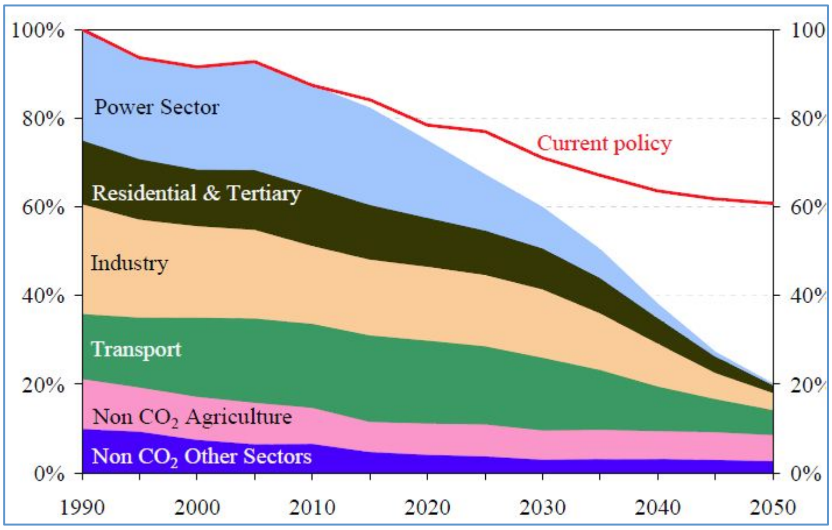

Figure 1: EU aims to nearly fully decarbonize the power sector by the year 2050. Source: (EC, 2011)

These two long-term goals (emissions reduction and a significant increase in renewable energy production) form part of the common EU triangle of energy policy goals, and they are captured by the heading "sustainability". The other two goals are equally important: to ensure that demand is met at any point in time (security of supply), and to do so in an affordable (and cost-efficient) way. Aiming to achieve all three of them in the long-term, is a considerable challenge. The three goals of EU energy policy are depicted in figure 2.

[1] Sometimes simply called capacity mechanisms.

[2] A minimum of 55% of gross final energy consumption by 2050 (EC, 2011).

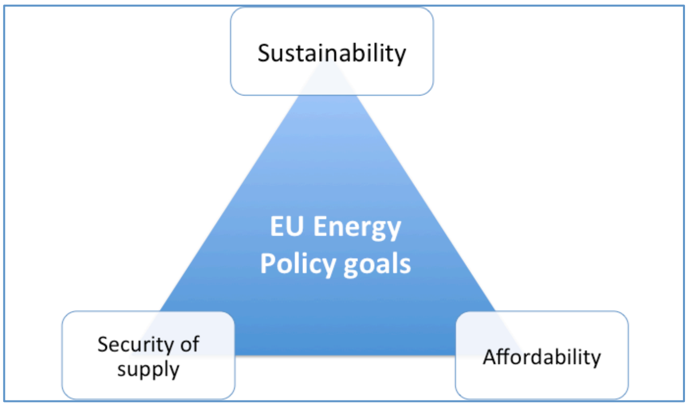

Figure 2: EU Energy policy goals

1.2. Investments required to reach EU energy policy goals

Investments determine what the future energy mix in the electricity sector will be. In order to achieve the above mentioned policy targets in practice, a number of investments thus need to be made. Investments in electricity resources can contribute to either one or more of these policy goals, but can also work at cross-purposes with another. It is possible to make an assessment of what kind of investments will be needed, without necessarily 'picking technologies' or disregarding uncertain economic and technological developments (RAP, 2013). In this report, we assume therefore that a certain *'theoretical investment optimum'* can be thought of, which represents the most optimal mix of investments that could be done in the light of the given combination of policy targets. This theoretical investment optimum represents the most cost-efficient way to achieve near-full decarbonisation in the electricity sector while maintain security of supply, and it is based on the successful integration of significantly high shares of variable renewables energy (VRE).

Since the majority of assets in the current electricity generation fleet is reaching its retirement age and needs replacing, setting the investment framework that can help delivering the agreed policy goals becomes increasingly important today. This high need for *market*-induced investments in the coming two decades is shown in a recent 'gap analysis' done by the European Commission (EC, 2013a). The investment decisions happening in the years ahead will largely determine which energy mix we have in the long term. The reason for this is the generally long lifetime of energy investments (power plants are built to last for several decades) and long investment cycles. What investments happen in the near future will have profound impact on the successful decarbonisation of the power sector.

The capital intensity of investments on the power system will significantly increase in the context of the EU's decarbonisation pathway[3]. Building the economic case for the necessary investments in a liberalized and increasingly integrated European market, and ensuring a level of system reliability in a market, which historically and geographically has been segmented, is a significant challenge. VRE

[3] Because variable renewable technologies are generally more capital intensive than the current thermal generation plants that they are aiming to replace.

sources are being rapidly added to the system; with low marginal production costs and a high degree of production variability, they are raising the need for flexibility assets.

On the basis of the given combination of policy targets in Europe, we can largely divide the required investments into two groups. First, significant investments in VRE will need to happen throughout the next few decades, providing the low carbon and sustainable assets[4]. Second, the investments that need to happen in 'everything else' (e.g. the remaining generation and demand side resources, network infrastructure, etc.). Ideally, these investments would go to assets that contribute simultaneously to the different policy targets[5]. In other words, it is important that the capacity that is fit for purpose stays in the system and that the market attracts new investment that has the capabilities needed to integrate the projected rising share of VRE in an efficient and cost-effective manner (RAP, 2013).

1.3. The factors determining investments

Which private market-induced investments will happen, is naturally determined by what *is expected* to be profitable to do and what is not. The many factors influencing this expectation can be divided into two essential parts: (A) the market design, which determines where income revenues come from (selling quantities of electricity, selling carbon emission permits, providing the capacity to deliver electricity on demand etc.) and takes into account the cost of producing energy (i.e. technology and fuel cost), and (B) the plethora of existing policy and regulatory uncertainties caused by different levels of governance (EU common policy, national policy, regulation, etc.).

1.3.1. Market design

Broadly speaking, an energy market design determines what is profitable to do and what is not. By (dis)incentivizing economic actors to invest in particular energy assets, the market outcome is ultimately altered. We here define the overall market design to consist of three main elements. The first and most important element is the energy-only market (EOM). The two additional (optional) elements are a carbon pricing mechanism, and a capacity remuneration mechanism (CRM), as shown in figure 3.

[4] The question of how near-zero-marginal-cost renewable energy producers will recover their investment as their share of the energy mix keeps increasing is a very important one, but it is out of the scope of this report.
[5] I.e. generation and demand side assets that are low-carbon, affordable and flexible to ensure reliability

*Figure 3. Main markets influencing decisions on new and existing power plant investments. * the Energy-only market is further composed by a set markets that are explained in the figure 4.*

The EOM only remunerates resources (i.e. provides them with income revenues) for delivered amounts of energy, and for ancillary services such as frequency and voltage regulation. More precisely, the EOM is the *wholesale*[6] electricity market consisting of the sum of (1) the forward markets (where electricity supply is contracted in long-term periods as long as years up to only a few hours and even minutes before delivery), (2) the balancing market (the exchange of energy after markets have closed) as well as (3) ancillary services market, where services that are necessary to ensure system security are remunerated, like frequency control and fault-ride through capabilities (see figure 4).

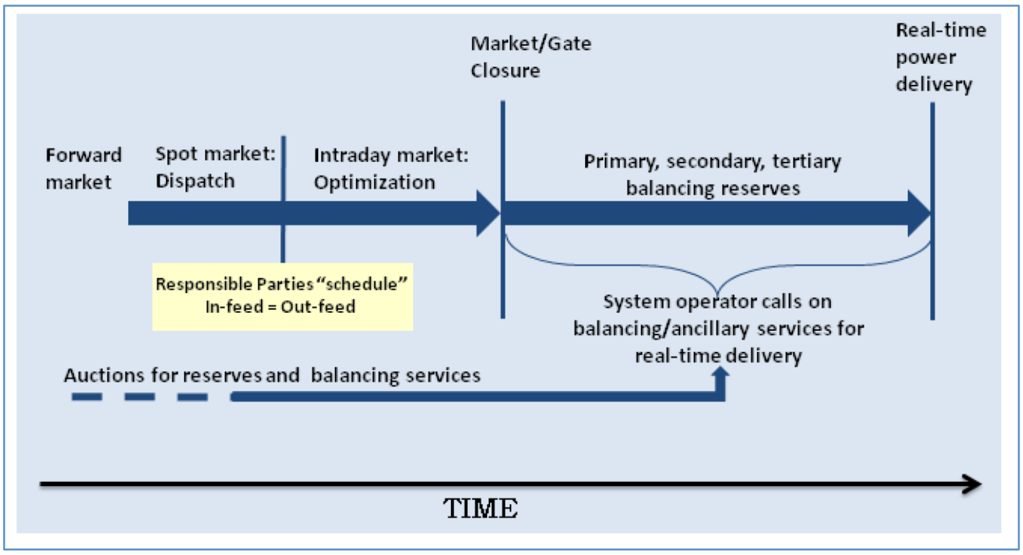

Figure 4. The Energy-only market functioning. Source (RAP, 2013)

The secondary elements of market design represent regulatory instruments that aim to alter the outcome otherwise resulting from a 'pure' EOM. For instance, a carbon pricing mechanisms puts an additional price on emitting carbon (i.e. 'internalizing' the environmental *cost* of specific

[6] The *retail* electricity markets (which include taxes and other levies on top of the wholesale prices, and is where most consumers buy their electricity) is something that we leave out of consideration in this report.

technologies). It can take the form of a carbon tax, or an emissions trading scheme (ETS), like the one that is currently in place in the Europe, covering most of the electricity sector. A capacity remuneration mechanism puts an additional price on the provision of resource *capacity,* which can be useful in the pursuit of policy targets like security of supply. In other words, the aim of both mechanisms is to re-value certain assets according to their contribution towards different policy goals, beyond the pure delivery of energy.

1.3.2. Stakeholders views on market design aspects

The 'raison d'être' of secondary market design elements is the uncertainty (amongst policy makers) about the energy-only market being able to 'deliver' the investment optimum on its own. Although there is no consensus on the need for supplementary mechanisms in order to reach this optimum, the empirical evidence on if and how the existing EOM could be sufficient to deliver necessary outcome is rather low (Öko-Institut, 2013). Some theoretical evidence however indicates that the EOM will not be sufficient to deliver. Therefore a re-design of electricity markets is likely to be necessary (RAP, 2013).

A recent European Commission consultation held on this matter showed that, among different stakeholders, views are divided as to whether the existing market framework (mainly based on the energy-only market) could deliver the necessary investments (EC, 2013c). This is shown in the figure 5. Academic literature is inconclusive too (EC, 2013a). It needs to be noted however that the functioning of the EOM is made more difficult by different policy and regulatory uncertainties (cf. infra). So, whereas some actors hold the opinion that energy-only markets are *fundamentally flawed* and that there is a need for permanent additional market mechanisms, others argue that the need for such mechanisms is mainly linked to temporary market interventions and uncertainties as the ones listed in chapter 1.3.2 of this document (EC, 2013a).

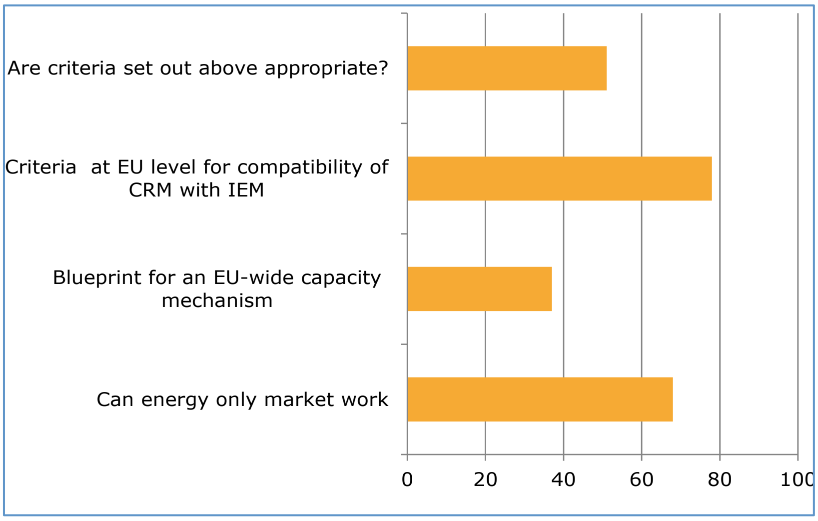

Figure 5: Split views on need for CRMs. Wide support for EU criteria/guidance. Limited support for EU mechanism. Source: (EC, 2013b, p. 9).

1.3.3. The missing money problem

A particular regulation in place today that is holding the EOM back from delivering its full potential in terms of investments is the legal 'caps' on peak wholesale electricity prices. During the few hours of peak demand, prices go up way higher than the (yearly) average wholesale price. Efficient peak prices reflect the costs of the plants (or demand-side resources) needed to meet the peak demand (IEA, 2012). In other words, for most new flexible capacity to be economically viable in the EOM, prices would have to be able to rise 'enough' during scarcity moments, thereby providing sufficient revenue to recover capital costs and incentivizing investments in flexible but expensive technologies (RAP, 2013). Allowing prices to increase to their full scarcity value may however not be acceptable in political terms, which is why in many markets, price caps have been introduced and stay in place (undermining incentives to invest in peaking generation and demand-side management)(IEA, 2012; RAP, 2013). The main goal of price caps is to protect consumers against high prices. If prices would be allowed to rise up to hundreds or even thousands of euros, this would significantly increase costs for consumers and lead to windfall profits for non-peak generators (as all suppliers offering electricity will receive the same amount of money per KWh). A secondary reason for price caps is to mitigate the use of market power during scarcity situations (EC, 2013a). If only a single market player is available to supply the system with electricity in a scarcity situation, that player has the 'market power' to let prices rise to abnormally high levels, generating windfall profits because of lacking alternatives.

The negative effect that price-caps have on investment incentives of peak power plants and demand-side response measures is known as the missing money problem. Money is missing in the sense that –in the absence of this regulation– efficient peak prices would normally provide sufficient revenues to invest. On the ground, the missing money problem manifests itself in the form of flexible gas plants struggling to remain profitable, and demand side capacity generally being absent in the market altogether. Analysis by the European Commission in fact reveals that the economics of new gas capacity may be challenging, potentially requiring additional revenues in order to recover capital costs (EC, 2013a). Some flexible gas plants in Europe –which are less carbon-intensive than coal plants– have in fact already left the system, and several others are under pressure (RAP, 2013). Moreover, this scenario is likely to worsen as the share of variable renewables increases, gas prices continue to increase and coal prices continue to decrease[7] (EC, 2013a). As electricity production from variable energy sources increases, prices are likely to become more volatile. Moreover, since these energy sources can produce at near-zero marginal cost, wholesale prices are likely to go down. This combination of price volatility and lowered wholesale energy prices is driving disinvestment from the energy resources already affected by the missing money problem (EC, 2013a; IEA, 2012; RAP, 2013). The reason for this is that their number of operating hours goes down and the revenue stream counted upon during scarcity moments further reduces, since they cannot compete with the production costs of VRE. This is reflected in the notion that 'variable renewables are pushing gas out of the market', since the number of operating hours of gas plants is negatively affected by the increasing share of VRE. This 'merit order effect' is illustrated in the figure below: as the share of low-priced renewable energy generation with priority dispatch increases, the number of hours per year with very low wholesale prices increases and the annual average price level decreases.

[7] Because of US imports.

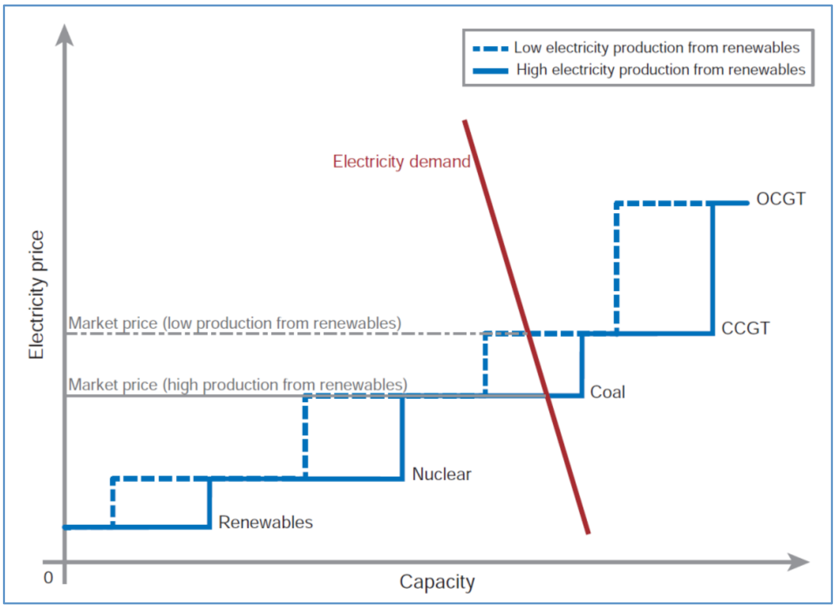

Figure 6: price effects of high renewables generation (OECD/NEA, 2012, p. 182).

An improvement of the 'normal' remuneration possibilities, such as more pan-European integrated balancing markets, shorter gate-closure times, harmonized intra-day markets across Europe, and better incentives for ancillary and reserve services would contribute significantly to solving the missing money problem. These necessary improvements are reflected in the 3rd energy infrastructure package regulation[8] and is generally referred to as the 'completion of the European internal energy market'. However, it cannot be ruled out that capacity remuneration mechanisms may still be necessary to ensure sufficient peak and flexible resources in the future low carbon European electricity system, or as a transitory measure in some individual member states in the shorter term (EC, 2013a). In chapter 3, we will further discuss how CRMs could potentially help to address the missing money problem. The likelihood of an increasingly growing missing money problem leads the IEA to conclude that work on a new market design should begin now, as it will be needed in the next decade in order to help cost-effective management of high shares of variable renewables (IEA, 2012). Moreover, a revision of the current market model stimulates prospects of further change in the market setting, which increases investment uncertainty. Therefore, the sooner there is clarity about the future market design, the better.

1.3.4. Policy and regulatory uncertainties

Next to the market design described above, policy and regulatory uncertainties influence investment decisions. If a situation of excessive uncertainty persists, it risks that competitive electricity markets

[8] For more information on the third energy package, see http://ec.europa.eu/energy/gas_electricity/legislation/third_legislative_package_en.htm.

may not provide timely and sufficient investment to achieve Europe's combination of policy targets (IEA, 2012). Policy and regulatory uncertainty is caused on different levels of government.

On the European level, several policies influence investments. Firstly, there is the ETS, which is currently failing to provide a credible carbon-pricing signal, and thereby undermining its goal of incentivizing investments in low-carbon energy resources. High-carbon energy sources are thus not being discouraged sufficiently by the EU ETS in its current architecture. The reason for the carbon price being too low (and unlikely to rise significantly in the short term) in order to drive new (dis)investments is the over-allocation of emissions permits. Policy options to address this problem include the introduction of carbon price floor, sectoral measures (e.g. aimed at the electricity market), the permanent cancellation of emissions permits or the introduction of a market stability mechanism. However, the plausibility of structural reform, both in the short and the long term (pre/post 2020) remains very uncertain. For the time being, the ETS price remains insufficient to make up for the difference between gas and coal fuel costs (RAP, 2013).

A second policy at the European level that affects investments is Europe's long-term climate mitigation target. This long-term target can result on complementary energy technology targets. What these policy targets will turn out to be (for instance, from the current debate about 2030 targets), will inevitably influence investments and thus create uncertainties. For example, uncertainty about the energy efficiency target influences the expected future demand for energy, which naturally determines the potential profitability of additional generation plants. Related to this are the newly introduced EU environmental and energy state-aid guidelines as regarding to renewables support schemes across Europe[9]. The uncertain effects of these new guidelines on the pace of VRE deployment in Europe can potentially determine the size of the missing money problem for future investments in flexible peak capacity (as explained in section 1.3.3).

A third group of uncertainties that originate at the European level are those related to the further development of the European energy market. Investors are unsure about the impacts of fully implementing the target model[10], which includes improved infrastructure and general market coupling within the EU.

Sudden *national* regulatory changes and interventions are also considered to create high uncertainty effects. The pace of development of some energy resources, such as renewable and nuclear energy, depends on government support. Sudden national government interventions lead to higher investment risk, thus lowering the availability of capital and increasing capital costs). Recent interventions that took place in Spain, Bulgaria and Czech Republic are clear examples of the negative influence of sudden changes on the investment atmosphere.

[9] For more information on the European Commission's latest environmental and energy state-aid guidelines, see http://europa.eu/rapid/press-release_MEMO-14-276_en.htm.

[10] For more information on the European 'target model' for electricity markets, see http://www.oxfordenergy.org/wpcms/wp-content/uploads/2013/05/The-EU-Target-Model-for-electricity-markets-fit-for-purpose.pdf.

1.4. Summary

As we have seen, investments are determined by a large number of factors. Those factors can be grouped under different markets (see figure 3) that are generally exposed to policy and regulatory uncertainty. This report focuses only on the *Capacity market* part of the overall Energy market debate. The following chapter look at the different types of CRMs, and how, in certain occasions may lead to a more suitable investment framework that gets Europe closer to the aforementioned theoretical investment optimum (i.e. achieving the given combination of policy goals).

Introducing CRMS could decrease policy and regulatory uncertainties for investors because they create a steady and predictable source of revenue, which can compensates for uncertainty on the other parts of the market (i.e. electricity prices in the EOM, or carbon prices in the ETS). Still, they lead to more regulatory lock-in, increasing dependency for policy intervention, and exposing investment to possible political sudden changes. The IEA, for instance, defines CRMs as only a 'second best' solution to the problem of (persisting) excessive uncertainties. The aim of this paper is to evaluate which CRM design could lead to the least market distortion while ensuring Europe reaches its long-term climate goals.

2. Overview and classification of capacity remuneration mechanisms

This chapter offers a definition of what capacity mechanisms are, and what their purpose is. Although CRMs generally have the same goal, there are still notable differences across the several types of capacity mechanisms. The types of CRMs, their design forms and their specific characteristics are presented in this chapter. Finally, we provide a short description of the potential problems associated with CRMs irrespective of design choices (i.e. inherent to all sorts of CRMs).

2.1. What a CRM *essentially* 'is' and 'does'

In essence, CRMs are policy instruments that influence investment decisions in the energy sector, primarily in order to ensure demand is satisfied at any point in time (security of supply). CRMs are introduced by governments, in close cooperation with system operators, who need to guarantee system adequacy (meaning supply is always above expected and real demand). By strengthening investment incentives (technically both for generation capacity as well as demand-side response) the market is made 'more robust' (EC, 2013a). CRMs achieve this by creating a separate bidding platform where participants can compete for an additional revenue stream, which is supposed to be more certain and stable than the energy-only market revenue that is intended to complement (RAP, 2013). It is important to note that providing additional revenue to market players in order to ensure sufficient amounts of firm capacity intrinsically represents a change in the overall market design. Implementing a policy instrument of this kind can thus be part of a policy strategy aimed at creating an 'enabling framework' for the investments that are expected to be necessary (Öko-Institut, 2012).

The objective of CRMs is not to increase the profitability of existing assets hit by economic crisis, but rather to provide the system operator with certainty that there will be enough firm capacity available in the future, either by ensuring that existing assets do not exit the market or by triggering investment in new ones (IEA, 2012). In practice, the income revenues (read: incentives) to commit capacity are usually given to both existing assets as well as to new investments (IEA, 2012). Generally, these revenues go to firm capacity committed to being available to the system operator for a specified 'forward' period, within which it may be needed in order to meet demand (RAP, 2013).

The necessity of regulating the electricity market is evident. Competitive markets need to be "well designed" in order to reach stated policy goals (such as security of supply), especially given the unique characteristics of the power market, which cannot count on significant demand flexibility and in which access to the traded commodity (electricity) is considered a basic need for citizens (IEA, 2012). Additionally, European energy goals do not only aim to ensure security of supply, but also to do so in a sustainable and competitive manner. Thus, the electricity market design needs to ensure that these goals are pursued in a balanced way.

Although *traditionally* CRMs are exclusively used as an instrument serving to guarantee security of supply, other objectives such as maintaining competition intensity, minimizing costs for electricity consumers and meeting climate policy targets can also be taken into account (cf infra). By using CRMs, a contribution to the transformation of the power supply system can be made, through supporting the construction of new, flexible and low emission power plants which complement the fluctuating electricity production of variable renewables (Öko-Institut, 2012). The facilitation of this transformation is not only needed for the obvious technical reasons, but more importantly for economical ones, as the transition itself can evidently materialize in more and less cost-efficient ways. We will elaborate on economic inefficiencies potentially created by *some* CRMs in chapter 3.

Changing the market design by implementing a CRM in effect constitutes a new market intervention, no matter which particular design choices are made (EC, 2013a). The IEA even claims that the use of CRMs constitutes "a shift towards heavy-handed regulatory intervention, in which a central entity – not the market – has to plan how much generation capacity is needed", further claiming that it might jeopardize the benefits of increased competition resulting from electricity market liberalization (2012, p. 9). However, in chapter 3, we will explain why this is not necessarily always the case, as a well-coordinated (regional) CRM approach could limit distortion effects on competitiveness and is compatible with the overall market liberalization project (cf. infra).

2.2. Classification of CRMs

Capacity remuneration mechanisms can be designed in many different ways. There are three main *types* of CRMs, which can be further distinguished, based on more specific characteristics. This section first explains the differentiation between the three main types, followed by a look at *some* of the more specific (detailed) characteristics. Because this sections reveals the complexity related to CRM design, we complete it with a summarizing table overview. Alternative ways of classifying CRM can be found in annex 1.

2.2.1. The three types of CRMs

Capacity payments can be defined as *direct subsidies*, aimed at directly strengthening investment incentives by providing (all or some) generators with a fixed payment in addition to market revenues (EC, 2013a). The IEA narrows the definition down further, to CRMs being specifically supposed to directly compensate for the shortfall of revenues for capacity resulting from price caps (missing money problem) that were previously mentioned in chapter 1. In other words, capacity payments can be defined as a mechanism aiming to *directly* address the missing money problem. In any case, a capacity payment is always a *price-based* capacity mechanism, where a central institution sets the price for capacity (IEA, 2012).

Capacity markets provide payments for capacity via market based incentive schemes (i.e. auctions or certificates)[11]. Mechanisms like capacity obligations, capacity auctions and reliability options[12] are all

[11] In capacity markets where auctions are held to arrive at a price for a defined volume of capacity irrespective of capability, the auction rules and forward time period for the payments vary considerably. In general,

considered to be capacity markets (EC, 2013a). Unlike energy-only markets, a central body defines which level of capacity is adequate and explicitly *sets* the quantity for reserve margins or capacity obligations. This constitutes a higher degree of additional regulatory intervention in comparison to using capacity payments, however, the price determination and the choice of the type[13] of capacity are left to the market, thus increasing competition and transparency of the mechanism.

Strategic reserves remunerate capacity that is kept as a reserve (which may include demand-side measures in the form of load shedding capacity) in case the market fails to provide balance between supply and demand (EC, 2013a). However, a strategic reserve contract prohibits the contracted capacities from operating in the energy-only or system services markets (Öko-Institut, 2013). The IEA classifies[14] strategic reserves under a CRM category called 'targeted reliability contracts', which incorporates the signing of (generally multi-annual) contracts with specific power plants or consumers in order to maintain reserve margins or network stability and reliability (IEA, 2012). These kinds of contracts are quick and easy to implement, which is a major advantage in the case of immediate security of supply concerns. In addition, it is easy to stop signing new contracts when the policy and regulatory uncertainty that are causing problems have been reduced and/or the market design has been improved. Strategic reserves are also (relatively) less 'intervening' and hence do not risk jeopardizing the benefits of a well-functioning energy-only market as much in the long run (IEA, 2012).

According to some, strategic reserves are only appropriate for technologies with long lifetimes, 'low dynamics'[15] (typically mainly hydro based) and used for rare peak load situations which exceed the regular capacities (Öko-Institut, 2013). This type of CRM is then claimed to be a less appropriate mechanism for dealing with the challenges of 'very dynamic' electricity supply systems, where (for example) demand growth is high, there are strong needs in terms of capacity substitution or modernization, or a strong need for increased flexibility (on both the supply and demand sides)[16]. Öko-institute emphasizes that strategic reserves do not solve the fundamental problems that may be imbedded in the market design. Especially in markets with 'high dynamics', strategic reserves should be seen as a 'wait-and-see' option that only postpones necessary action. They could potentially even weaken energy-only markets, if significant amounts of capacities are accumulated within the strategic reserve and their entry into the energy-only market could not or no longer be prevented for political or legal reasons (2013). If this would occur, it could be classified as an 'unintended consequence' such as the ones discussed in section 2.3.

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however, the auction is based on an administratively set demand curve, based on a pre-defined installed capacity target, reserve margin, and a price ceiling for capacity (RAP, 2013).

[12] Reliability options explicitly exchange an uncertain revenue (revenues above the strike price) with a fixed revenue (option premium).

[13] Demand response, existing or new generation, flexible or nonflexible generation, high carbon or low carbon generation.

[14] We do not fully adapt the classification used by the IEA, since it conflicts with the classification this report is mainly based on, which is the one from the EC paper. For example, it classifies capacity payments as necessarily being a *market-wide* capacity mechanism, whereas it can also be a *targeted* mechanism according to the EC classification. Also, the IEA's classification includes types of targeted reliability contracts that are not relevant in the context of this report.

[15] Low or no demand growth, low needs in terms of capacity renewal, and a low need for increased flexibility.

[16] Note that we have indeed mentioned earlier the high need for investments in asset replacement and modernization in the European electricity markets. Furthermore, we will later discuss the increasing need for flexibility in those markets (cf. infra).

2.2.2. CRM design characteristics

There are numerous *characteristics* further distinguishing CRM designs. Existing literature does not however neatly overlap in its descriptions and interpretations of these characteristics. We here attempt to provide the reader with an overview of the most important CRM characteristics as synthesized from different sources. This list is by no means exhaustive however, and the 'choices' made in terms of prioritized distinctions are inevitably debatable.

Price-based vs. quantity-based: Capacity mechanisms can be either *price-based or quantity based*. The difference lies in the choice of the regulator to either set prices or quantities when setting up the capacity mechanism (EC, 2013a). In the latter, the system operator determines the quantity and holds an auction to set the price, while in the former the system operator determines the price and the market responds with a quantity available *at* that price (RAP, 2013). This distinction constitutes the main difference between capacity *payments* (which can evidently only be price-based) and capacity *markets* (which are exclusively quantity based). We consider strategic reserves to be possibly *either*[17].

For price-based CRMs, a nuance must be made. Although the regulator only 'sets' the price, it does not 'ignore' the required quantity in order to consistently meet demand. Although the regulator does not set the amount of capacity in a price-based mechanism, a required *amount* of capacity is inevitably *assumed*. The regulator implicitly *aims* to reach that amount through its setting of the price. If unsuccessful, the price can be reviewed upwards or downwards accordingly.

Centralized* vs. *decentralized: A second distinction revolves around procurement of capacity being *centralized* or *decentralized*. In the former the system operator itself purchases capacity, while in the latter the retailers procure capacity in accordance with an obligation *imposed by* the system operator (RAP, 2013). In other words, the system operators can organize tenders, or capacity-obligations can be assigned on suppliers themselves (EC, 2013a).

Targeted* vs. *market-wide: A third key characteristic of CRMs is whether the application of the mechanism is *targeted* or *market-wide*. A targeted CRM applies to specific or limited capacity providers, while a market-wide mechanism applies to *all* providers of capacity (RAP, 2013). This distinction is the main basis for the IEA's categorization of different capacity mechanisms (IEA, 2012)[18]. The IEA's definition of a market-wide capacity mechanisms is "a regulatory instrument designed to create revenues for *all* capacity (…) available during a specified period, generally when system operations are tight." (IEA, 2012, p. 79).

It should be noted that the distinction between targeted and market-wide capacity mechanisms implies a policy choice for or against technology neutrality as long as additional requirements for receiving revenues are not built into the mechanism. Indeed, it is stated that market-wide

[17] Since the tendering of new strategic reserve contracts can theoretically either set a price and leave the market to reply with a quantity, or the other way around.

[18] We do not strictly take-over this categorization here because its claims regarding capacity payments and capacity markets necessarily being market-wide in nature is not fully correct according to other sources used in this text. While it is indeed the case that these kinds of CRMs are traditionally market-wide arrangements, targeted varieties are possible (EC, 2013a).

arrangements remunerate *all* capacity in a technology neutral way[19], in contrast to the inevitable 'bias' occurring when targeted mechanisms are used (IEA, 2012). Capacity mechanisms targeted at specific capacity types (technologies), such as peaking units, are in some sense therefore likely to distort incentives for investment in other technologies (EC, 2013a). For example, by improving the economic attractiveness of OCGT peakers, the economics of mid-merit CCGTs (or even base-load assets) become relatively less attractive.

National vs. regional: National (also called Unilateral) capacity mechanisms regard capacity adequacy per market area (i.e. one member state) in isolation without necessarily taking cross-border capacity and trade into account, thereby introducing new market distortions (EC, 2013a), and potentially delivering overinvestment on capacity needs. This stands in contrast with a 'best case' scenario for using CRMs, in which the instrument merely corrects market failures of the energy-only market and improves market efficiency, by fostering the use of a single energy market across Europe.

In theory however, optimally designed CRMs would not necessarily distort investments between different European Member States, even in a non-regional approach (EC, 2013a). Capacity mechanisms can reflect the structures of different regional markets (which will continue to exist for a certain period of time), avoiding major distortions between the different Member States, encouraging regional cooperation and supporting convergence of capacity mechanisms in its different dimensions (Öko-Institut, 2013). We elaborate on this issue in chapter 3.

Table 1 provides an overview of different CRM designs, as classified above[20]. Many other characteristics could however be used to differentiate mechanisms, such as the duration of the payment, cost allocation and time horizon (see annex 1 for further information).

	Capacity Payment	**Strategic Reserve**	**Capacity Markets**		
			Capacity Obligation	**Capacity Auction**	**Reliability Option**
Price based / Quantity based	Price based	Can be both	Quantity based	Quantity based	Quantity based
Centralized / Decentralized	Centralized	Centralized	Can be both	Can be both	Can be both
Targeted / Market-wide	Can be both, but typically targeted	Targeted	Can be both, but typically market-wide	Can be both, but typically market-wide	Can be both, but typically market-wide

Table 1: Overview of different CRM designs.

[19] In theory, this leads to an efficient (least cost) portfolio of technologies (IEA, 2012).
[20] The choice between unilateral (MS-level) or regional (EU-wide) capacity mechanisms does not 'fit' in a table outlying design choices of *individual* CRMs. It is rather a difference in *approach*, as we will discuss in chapters 3 and 4.

Design options regarding the inclusion of additional capability requirements for receiving capacity remuneration (e.g. in terms of flexibility) do *not* belong in this table, as they could theoretically be used with *any* design (i.e. in combination with any of the possible combinations in terms of type and characteristics). In that sense, additional requirements –which we will discuss in more detail in chapter 3– do not constitute a point of distinction here (in terms of taxonomy). We will later argue that these kinds of choices rather imply a particular CRM 'approach' (a traditional versus a modern one).

2.3. Potential difficulties & drawbacks of CRMs

Experience shows that CRMs tend to have a few potential drawbacks irrespective of the design choices laid out above (IEA, 2012; RAP, 2013). In fact, there are numerous unavoidable design issues associated with CRMs that need to be sorted when implementing CRMs. Simple designs tend to be imprecise, while more sophisticated mechanisms quickly become very complex (EC, 2013a). This constitutes a first drawback associated with CRMs, which is that **their technical complexity can potentially be burdensome and resource-intensive for regulators**. For any particular capacity mechanism, its implementation requires a range of technical and regulatory procedures that might result in an increased burden on regulatory institutions (IEA, 2012; Öko-Institut, 2012). A potential reason for this is the need to regularly review the mechanism in question, and continuously adjust it as needed in order to achieve the desired outcome (RAP, 2013). The technical questions that need to be solved when using CRMs thus put a burden on the overall governing process, thereby increasing not only its complexity but also the overall cost of implementing the policy instrument (IEA, 2012). In US wholesale electricity market organized by PJM[21] for example, where a new capacity market was introduced as early as 1997 in order to fix several problems, a lengthy and difficult process of fine-tuning the capacity markets proved to be necessary.

The fact that CRMs can quickly become very complex means also that its market impacts may be difficult to fully grasp. This brings us to the second broad drawback of CRMs, which is the problem of potential **unintended consequences** resulting from their implementation (RAP, 2013). To start with, **adverse investment incentives** could be created (EC, 2013a). An example of this are the 'secondary incentives' resulting from *the* expectation of new strategic reserve contracts, distorting market prices and leading to strategic behavior as companies withhold investment and wait for their introduction (IEA, 2012). In other words, even though strategic reserves are a relatively 'less intervening' option (in comparison with other CRM types), it can still be argued that they introduce certain market distortions. If the strategic reserve is bidding too low prices on the power market, this can result in depressing prices and discouraging investment in new peaking plants. As pointed out by the UK's Department of Energy & Climate Change (DECC), strategic reserves run the risk of plants not selected choosing to close down if they do not receive a strategic reserve contract. If this happens this could lead to the 'slippery slope' effect, whereby more and more plants must form part of the reserve to ensure it remains effective (IEA, 2012).

[21] PJM Interconnection LLC (PJM) is a Regional Transmission Organization (RTO) in the United States.

Another example of adverse incentives can be observed on the market evolution of coal-fire power plants. Since CRM remunerates the firm capacity that can be made available at the lowest cost, existing and already amortised coal-fired power plants are likely to win all the tenders for capacity. The result of a badly design policy instrument could lead to **works at cross-purposes with the functioning of the ETS and the EU energy goal of sustainability.**

Depending on the design, another possibility in terms of unintended consequences is the **creation of *excess capacity***, which is costly for consumers (RAP, 2013). From this perspective, CRMs might actually lower incentives for demand-side response measures during scarcity conditions, as they could put negative pressure on peak prices (IEA, 2012). Since a capacity mechanism traditionally ensures that there is always more than enough capacity available[22], this tends to prevent episodes where market conditions are tight, thereby reducing peak prices. This may reduce incentives to save energy or engage in demand response measures during these hours, unless these measures themselves can participate in the capacity market, which might not be possible for small players because of transaction costs (IEA, 2012) or the mechanism not being fairly open to all players. We will later return to the subject of capacity mechanisms in relation to demand-side response measures (cf. infra).

It is worth mentioning that the **potentially high transaction costs** associated with CRMs are often separately mentioned as a general drawback, as well as the **difficulty of terminating mechanisms once they are in place**[23] (IEA, 2012; RAP, 2013). For the reasons mentioned above, the IEA suggests that governments contemplating the implementation of capacity mechanisms should first carefully consider the timing of their introduction, as well as their impact on incentives (2012).

[22] To ensure reliability and security of supply.
[23] As mentioned under section 2.1, this specific drawback is generally less applicable to strategic reserve contracts.

3. The traditional versus the modern CRM approach

This chapter is divided in two sections. The first one focuses on the type of products or services that CRMs generally reward, which can simply be firm capacity, or rather capacity with specific additional capabilities. This is one of the main characteristics of CRMs, which will define whether they are considered a ***traditional CRM*** or rather a ***modern one***. The second section of this chapter focuses on the regional scope of CRMs. We will analyze the implications of implementing CRMs unilaterally and asymmetrically, or in other words, at the national level without cooperation with other countries. We will also present the benefits of addressing CRMs at the regional or even European level, again making the difference between traditional and modern CRM approaches. Figure 7 provides a graphical overview of the issues addressed in this chapter, pinpointing our conception of the modern CRM approach.

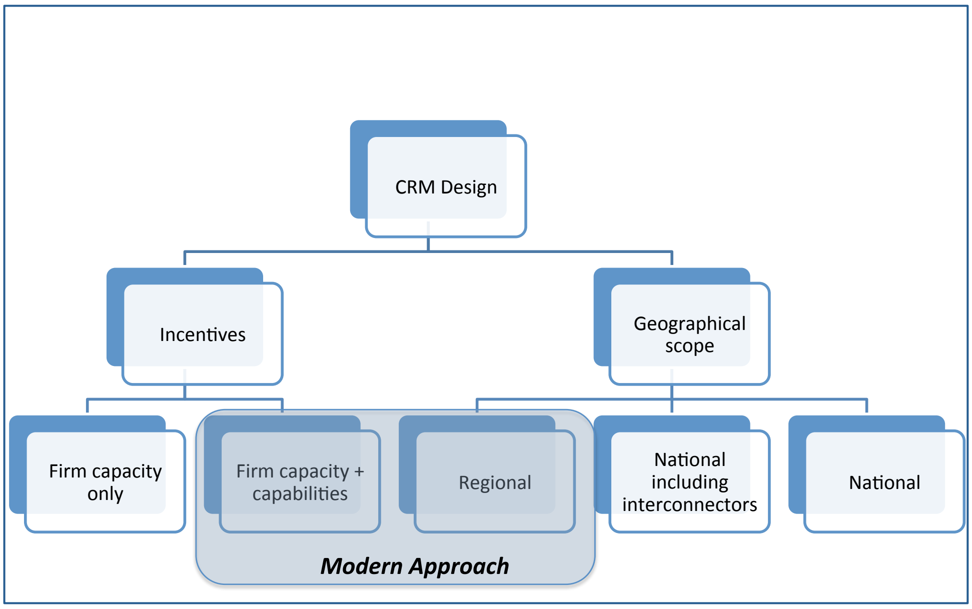

Figure 7: Overview of chapter 3, pinpointing the modern CRM approach.

3.1. The role of capabilities in CRMs

By explaining the problems related to simply rewarding firm capacity and excluding capabilities, we shed a first light on what we consider to be ***the traditional CRM approach***. Similarly, we show how possible improvements to CRM design in order to address these problems can be considered a ***modern CRM approach***.

By capabilities we broadly mean two things: (1) flexibility (e.g. ramping rates, cycling capabilities, potential for partial load operation, etc.) and (2) emissions performance (i.e. how clean –in terms of carbon emissions– is the capacity capable of performing per unit of energy produced).

3.1.1. The need for flexibility

As the share of VRE in the generation mix increases, the challenge of reliably meeting residual demand[24] is changing (RAP, 2013). System operators have to deal with ever increasing volatility (in real-time electricity balancing), while at the same time the relatively unpredictable[25] residual demand becomes increasingly challenging to anticipate (IEA, 2012). Variable renewables like wind and solar photovoltaics have this effect because their variability does not necessarily correlate with the variability of demand (i.e. it can go opposite ways), as shown in figure 8. Output from VRE assets can be going down just as demand is sharply rising (or vice versa). Therefore, the growing share of VRE necessitates an increasingly higher degree of flexibility within the portfolio of the system operator's dispatchable resources (both in generation and demand response). If system flexibility is not increased, the growing share of VRE will not be optimally integrated into the system (i.e. there will be an increasing need to curtail excess energy from VRE), and system adequacy (security of supply) will not be met in the most cost-efficient manner possible (RAP, 2013).

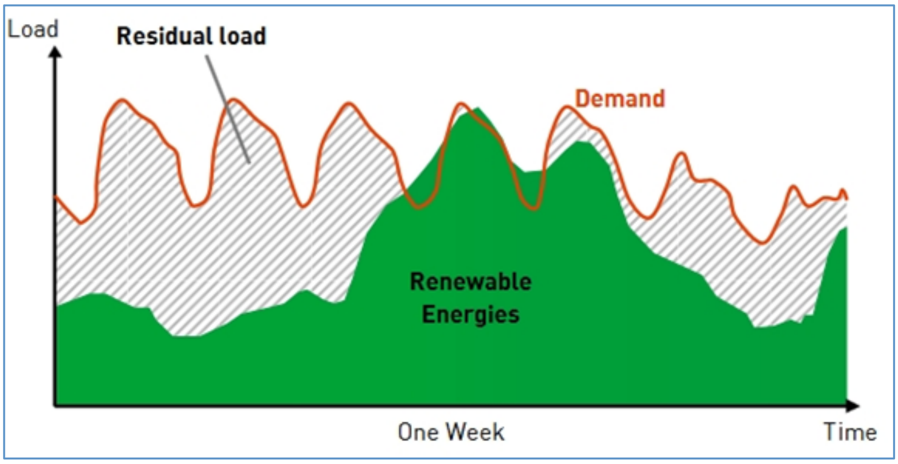

Figure 8: Residual demand/load. Source: http://grist.files.wordpress.com/2012/03/grea-renewables.jpg

System flexibility can theoretically be increased in two main ways (a third way is described in the last paragraph of this section), either by increasing the flexibility of supply, or by increasing the flexibility of demand (IEA, 2012). In other words, the generation portfolio must either become more flexible, or demand must become more responsive (preferably both). This means that the remaining generation assets on the supply side have to be capable to rapidly increase or decrease output (ramping), and to do so repeatedly over time (cycling) in order to reliably meet the residual demand (RAP, 2013). VRE can play a role in managing output as well (by making their output controllable[26]), although its contribution towards meeting peak demand with a high probability is rather low (IEA, 2012). Some (non-variable) renewables are significantly flexible (i.e. dispatchable) already, like hydro, biomass and CSP with heat storage. Hitting two birds with one stone are existing and upcoming storage technologies, which can theoretically function as both flexible supply as well as flexible demand (and

[24] Total electricity demand minus the demand covered by VRE, sometimes called also net energy demand (RAP, 2013).
[25] The predictability of VRE production is limited (IEA, 2012).
[26] In practice, wind and solar PV may have to be curtailed when overproducing, which has happened already in Spain and Ireland (IEA, 2012)

provide system services), although the economics of storage remain difficult, partly due to the lack of a market design that appropriately assigns value to the provision of system services[27].

The potential for flexibility of existing conventional power plants[28] is rather low on this front, since they are simply not designed to deal with increasing flexibility needs. Trying to force them to operate more flexibly is not economically efficient, since it negatively affects their efficiency and durability (increased maintenance costs, lowered operating lifetime, etc.)(RAP, 2013). Most of these plants were designed to provide steady base load generation, not to cover residual demand[29]. Conventional plants could be retrofitted in order to improve flexibility, but only at relatively high cost (RAP, 2013). This clearly shows why the method system operators have traditionally used to reliably meet demand (i.e. simply 'stacking up' quantities of capacity) is no longer appropriate; they also have to increasingly take flexibility capabilities of resources into account when organizing capacity.

An additional and more competitive way to increase system flexibility (next to increasing it on the supply and demand sides) is to improve the functioning and rules in the energy-only market as explained in chapter 1.3.2.

3.1.2. The traditional CRM approach: simply rewarding firm capacity is no longer effective

CRMs are generally used to ensure that a sufficient quantity of firm capacity is available to meet (projected) demand at any time. This is what we call traditional CRMs. By remunerating quantities of capacity to be available when needed, traditional CRMs ensure that firm capacity remains in the system, and/or that there are sufficient investments in new firm capacity (RAP, 2013).

Therefore, the challenge for system operators to ensure an uninterrupted supply of electricity (security of supply) has traditionally been relatively straightforward: simply 'stack up' enough firm capacity. Exclusively considering quantities when trying to ensure that demand will always be met is sometimes called 'the old resource adequacy paradigm' (RAP, 2013). Under the traditional approach, the same remuneration is paid to all firm capacity providers, irrespective of their capabilities.

This approach might have been fitting at some point in the past (or is still perceived to be fitting in the present by some policy makers), when most electricity provided was base-load (constantly dispatched and inflexible). However, the changing energy mixes and markets are demanding a different approach for the future, therefore **traditional CRMs are no longer appropriate**. As explained in chapter 1, a 2050 decarbonisation roadmap is now politically agreed and being implemented in Europe. Under any of the different technological scenarios analyzed in this roadmap, a significant increase of renewable energy in the generation mix is needed[30]. Renewable energy technologies, and in particular variable renewable energy sources (VRE) require a flexible system to maximize their output and contribution.

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[27] In other words, it could be argued that the missing money problem also applies to storage technologies.
[28] Particularly existing nuclear and coal capacity.
[29] For which the capabilities that are needed do not only high ramping rates but also short startup times and efficient partial load operation (RAP, 2013).
[30] A minimum of 55% of gross final energy consumption by 2050 (EC, 2011).

Furthermore, current low wholesale electricity prices do not provide enough incentives to certain existing power plant owners (mainly gas based producers) to keep their power plants opened and running.

Because of the changing situation, **the traditional CRM approach is not cost-efficient**. Under the traditional approach, ensuring reliability (being able to consistently meet demand) becomes increasingly expensive. When traditional CRMs are designed, insufficient consideration is given to the increasing share of VRE. By continuing to exclude capabilities while the share of VRE is significantly increasing, system operators might simply rely increasingly on curtailing the VRE when deemed necessary. Dealing with VRE as 'little used surplus generation' (added 'on top') can quickly become extremely costly, since suppliers must be paid to curtail under most markets in place today (RAP, 2013). This is not to say that renewables should never be curtailed, but excessively resorting to VRE curtailment instead of encouraging the orderly retirement of inflexible resources and increased investment in dispatchable resources with the right capabilities, leads to the systematic undermining of both decarbonisation and renewables targets and is extremely costly to consumers.

By breathing new life into existing non-flexible and high-carbon assets, **the traditional CRM approach also works at direct cross-purposes this decarbonisation and renewables targets** by possible 'locking in' capacity that is incapable of cost-efficiently and reliably operating a power system in conjunction with significantly increased VRE shares. The long lifetime of energy assets is especially relevant here: the investments happening in the near future are crucially important for decades to come. A case study in the US indeed showed that the vast majority of traditional CRMs' revenues went to fossil-fueled generators that are considered inflexible in terms of capabilities (RAP, 2013). Further regulatory intervention (*non-traditional* CRMs on top of the existing climate & energy policy frameworks) can thus be argued to be necessary, in order to ensure that future investments are not at cross-purposes with the current policy trajectory.

3.1.3. The modern CRM approach: benefits of rewarding capabilities

Under the modern approach, CRMs are designed specifically to include flexibility requirements (in terms of ramping-rates and cycling) as well as possibly emissions performance requirements. These can be justified by the clearly defined objectives (cf. agreed long-term decarbonisation and sustainability) we have today in Europe. By focusing remuneration on flexible resources, modern capacity mechanisms go hand in hand with the implementation of the 2050 energy roadmap.

Moderns CRMS should be non-discriminatory towards demand response and storage solutions, allowing them to receive revenues on an equal basis to generation assets meeting the proposed flexibility requirements.

In practice, integrating these kinds of requirements into CRMs can be achieved in differing ways, depending on the type[31] of mechanism that is used. Flexibility requirements can for example be included by adding them to the definition of a capacity obligation in order to help ensure system reliability, or they can be included into capacity markets by having the regulator define quantitative

[31] Cf. chapter 2.

flexibility objectives (IEA, 2012). An interesting but more sophisticated example of a (proposed) CRM aiming to promote both flexible generation and demand response[32] is a 'focused capacity market' (Öko-Institut, 2012). This concept of capacity market is split into two parts, with two separate auctions. One in which incumbent power plants compete with demand response measures for capacity payments of only a few years, and one in which (investments in) *new* power plants with sufficient flexibility capabilities, and storage, can compete for capacity payments of over 15 years. By using capacity payments of differing durations, the authors of this proposal aim to increase planning security for investors and plant operators, while minimizing the overall cost of the mechanism to consumers. Moreover, they claim that this CRM design can be expected to be easier to adapt and implement than other modern options[33]. A final example that could be given in this context is for strategic reserve to specifically promote the development of demand-side capacity solutions through selective contracting.

An important point to consider here is that the proposed change of CRMs from an adequacy-ensuring to a flexibility-ensuring mechanism implies that it would no longer *primarily* serve to ensure that the generation adequacy issue is solved (in strict security of supply terms). Not all generation resources would remain to be factored into the mechanism. In this regard, the IEA suggests that flexibility should rather be seen as a byproduct of adequacy, since generation capacity that is built primarily to ensure adequacy can additionally also be flexible (2012). The point we try to make here however, is that **a certain amount of *focus* on flexibility can and should be included under a modern CRM approach** (without necessarily *disregarding* the purpose of traditional capacity mechanisms).

Assigning more value to low-carbon flexible assets (as the modern approach does) can *contribute* to resolving the issue of 'missing money' for flexible generation assets, demand response, storage solutions and interconnectors.

CRMs are potentially capable of addressing the growing discrepancy between the ongoing need for flexible conventional generation and its declining utilization, which is a feature of systems with high VRE shares and overcapacity (IEA, 2012). To reiterate, money for flexible generation capacity is 'missing' in the sense that the EOM is (by design) supposed to provide sufficient revenues (through short-term scarcity pricing) to incentivize long-term investments in adequate amounts of flexible capacity, but cannot do this because of price caps. According to some actors, resolving this missing money problem should even be the 'primary purpose' of CRMs (RAP, 2013). By providing complementary revenue streams for flexibility, modern CRMs can help ensure that the right resources are available to meet demand in electricity systems coping with an increase in VRE. Figure 9 shows exactly how **modern CRMs can help fix the missing money problem for conventional peaking generation**, resulting from price caps in the EOM.

[32] I.e. 'including capabilities'.
[33] For a more detailed look at focused capacity markets, see annex 2.

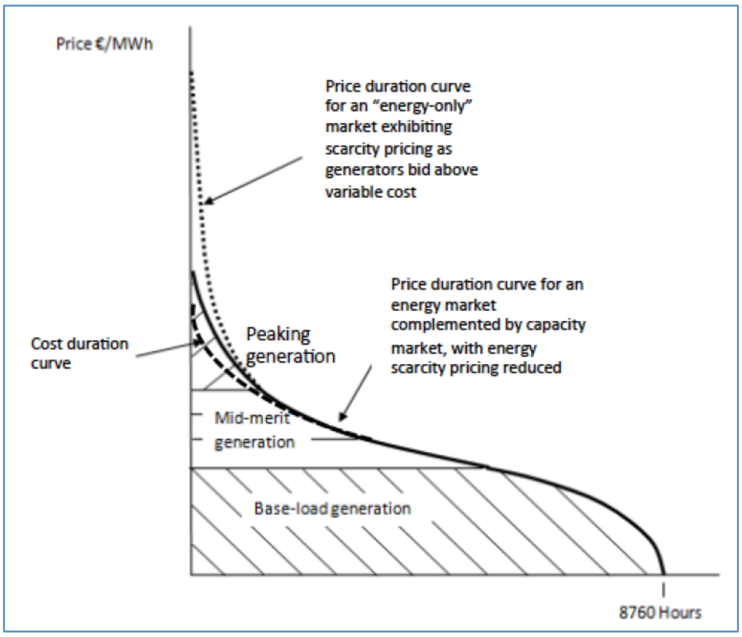

Figure 9: Displacing/augmenting scarcity pricing through capacity remuneration. Source: (RAP, 2013, p. 9)

The economic case for large-scale deployment of demand-side response capacity still has to be made, but as demand side solutions reach a sufficient degree of maturity, they could become competitive with other sources of capacity (especially with the help of modern CRMs)(IEA, 2012). In other words, **by taking capabilities into account, modern CRMs can also facilitate the use of flexible demand side assets (including storage)**. These assets are then allowed to participate equally in the mechanisms, and are provided with an additional revenue source that improves their economics. This also applies to the economics of (investments in) interconnectors, which are similarly negatively affected by the undervaluing of its potential contribution to the electricity system.

To finalize, flexibility requirements are not the only capabilities that could be included when modernizing the CRM approach. Under the modern approach, CRMs could also include requirements in terms of carbon emissions performance. This could ensure that the mechanism does not work at direct cross-purposes with decarbonisation goals by providing excessive remuneration to high-carbon assets.

In the following table, we provide an overview of the capabilities issue, as contrasted in section 3.1.

	Traditional CRM: *Only firm capacity*	**Modern CRM:** *Capabilities included*
Ensure peak demand is met?	Yes	Yes
Ensuring SoS only goal of the mechanism?	Yes	No
Cost-efficient in the long term (considering a significant increase in the share of VRE)?	No	Yes
Improves the feasibility of demand side solutions and storage?	No	Yes
Helps address the missing money problem?	No	Yes
Total costs increase?	Yes	No

Table 2: Overview of differences between the traditional and the modern CRM approach on the issue of including or excluding capabilities into the CRM design.

3.2. The geographical scope of CRMs

An important question related to CRM design is what the most appropriate geographical scope of CRM schemes is. Are Member State level CRMs optimal? Or could a CRM at a regional or even the EU level be preferable? Does it matter if different Member States implement different CRMs?

In this chapter, we explain the problems related with another aspect of the traditional CRM approach: *unilateral and asymmetric* design and implementation. The potential solutions to these problems (a more regional or even European approach to designing CRMs) are explained and argued to belong under the proposed *modern approach*.

3.2.1. The traditional CRM approach: negative implications of unilateral and asymmetric CRMs

We consider CRMs implemented by Member States in a unilateral and asymmetric to belong under the traditional approach category. With the term unilateral, we mean CRMs that are set up at the Member State level without any consultation of (or cooperation with) other Member States. By asymmetric, we mean unilateral CRMs that differ from each other, and are not specifically designed to work well in combination with CRMs implemented in other Member States. CRMs can differ from each other in many ways and on different levels (see chapter 2). Moreover, while the CRM used by different Member States could be of the same type (e.g. capacity payments), specific design parameters could still vary considerably (e.g. in terms of the scope, the level and duration of the level of the payment).

The reasoning behind the introduction of asymmetric CRMs by national policymakers is –again– mainly based on security of supply concerns, which are a national responsibility and national competence (EC, 2013a). This thinking seems to ignore however, the fact that the traditional CRM approach is likely to harm the efficiency of the European internal energy market (IEM). This while

CRMs should (in the best case) merely correct the market failures of the EOM and improve the (regional) market's efficiency (EC, 2013a). Although CRMs should not create additional bottlenecks in the functioning of the IEM, the traditional approach does this in two significant ways[34]:

- By distorting cross-border trade
- By distorting competition

A) IEM distortion 1: cross-border trade

Electricity markets are interconnected and increasingly integrated in Europe. During scarcity in one country or market, interconnectors can play a key role in ensuring system adequacy in another country (IEA, 2012). Available capacity in one zone can then contribute to meeting demand in another zone. Interconnectivity should therefore be a key design parameter when designing and introducing CRMs, since the contribution of the interconnected capacity has to be quantified, and this contribution can be remunerated or not. Traditional CRMs do not take this crucial aspect into account however, thereby introducing market distortions and negatively affecting cross-border trade. By only looking at their own market area in isolation, national policy makers undermine the benefits of a single European energy market, resulting in overcapacity and unnecessarily high costs for consumers.

A potential motivation for not taking interconnected capacity into account (when designing traditional CRMs) is the notion that it does not really contribute to mitigating security of supply concerns in the eyes of Member States, because Member States do not really trust each other for something of such crucial importance (Öko-Institut, 2012). In a crisis situation, the interconnected capacity could potentially be cut off, resulting in the destabilization of a nation's energy system if it heavily relies on it. Because of these strictly national adequacy assessments, traditional CRMs cause over-capacity (from a regional perspective); regulators overestimate the necessary domestic capacity reserve margin and underestimate the potential contribution of cross-border trade.

The negative effects of not taking interconnectivity into account when implementing CRMs grow considerably as the regional market becomes more integrated (EC, 2013a). In other words, **as the European internal energy market progresses towards completion, the traditional CRM approach becomes an increasingly serious problem**. Total costs (for Europe as a whole) keep rising as long as Member States conceive system security in a unilateral and asymmetric manner.

The integration of interconnected resources in the design of CRMs is however a complex issue. Many questions arise, such as whether to pay the TSO, who owns and manages the transmission lines, or the generators themselves on the other side of the interconnection, who are supplying the electricity (IEA, 2012). In the light of the previous chapter, it may also be questioned whether to remunerate cross-border capacity exclusively for its provided (quantities of) electricity, or also for provided flexibility capabilities. We can argue that, in order for a CRM to be truly modern, interconnected resources would be remunerated for both. A detailed analysis of different possibilities to integrate interconnectivity into CRM design goes beyond the scope of this report however.

[34] These two distortions are highly interlinked, but here discussed separately for discursive reasons.

B) IEM distortion 2: competition

A second broad effect of asymmetric CRMs on the functioning of the internal energy market is the distortion of competition between Member States. There are concerns that investments are unfairly incentivized by Member States introducing CRMs (read: traditional CRMs), thereby creating a new barrier for regional integration (IEA, 2012). Investments are likely to shift to markets with CRMs, thereby increasing total costs (and further distorting cross-border trade). Asymmetric CRMs produce this effect by making the country with the 'more generous' mechanism more attractive.

Model simulations of individual CRMs in France and Germany in fact confirm that asymmetric unilateral CRMs distort investments and trade, and lead to higher system costs (EC, 2013a). Here as well, adverse effects may even occur if different Member States implement the same type of mechanism, but with differing design parameters. Impacts on investments can significantly differ though, depending on Member States' varying capacity mixes and interconnectivity levels (EC, 2013a).

Distortion of competition between Member States creates an additional barrier to further regional integration. This means that asymmetric CRMs designed and implemented at the national level risk conflicting with EU competition and state-aid rules, as well as working at cross purposes with EU market integration policy (RAP, 2013). Decarbonisation and renewables targets are thus not the only ones that are obstructed by the traditional CRM approach.

3.2.2. The modern CRM approach: taking a more regional perspective into account

The goal of CRMs should be to correct market failures as much as possible and distort the IEM as little as possible (EC, 2013a). **In order to avoid harming the functioning of the IEM through distorting cross-border trade and competition, modern CRMs include provisions to take cross-border capacity into account and thereby facilitate cross-border trade.** In such a situation, investments would no longer be unfairly incentivized in one country or another; thus creating a level playing field.

Cross-border capacity can be remunerated directly, minimizing distortionary effects on investment incentives, or indirectly, by remunerating interconnectors themselves (EC, 2013a). Remunerating interconnections would naturally help to better incentivize investments in them, thereby facilitating further the completion of the IEM. In the future, it could even be possible to organize regionally-based auctions with firm capacity trading arrangements, in effect extending the concept of market coupling to include procurement of capacity as well as energy and balancing services (RAP, 2013). Depending on the type of CRM, different ways of facilitating cross-border trade can be identified (EC, 2013a; Öko-Institut, 2013). Just as with the inclusion of capabilities into CRMs, the way in which cross-border trade should be taken into account in CRMs thus depends on the choice of mechanism:

- When using **capacity payments**, the payments should apply equally (on the same conditions) to interconnector capacity as to domestic generation and demand response.

- In **capacity markets**, interconnector capacity should be eligible for certificates or capacity remuneration on the same conditions as generation or demand response capacity.

- In the case of **strategic reserves**, contracting generation capacity in adjacent markets requires guaranteed access to a portion of the interconnector capacity in times of stress. However, interconnector capacity should not be permanently reserved as back-up capacity. Instead, it could be treated as demand side resources in the strategic reserve, i.e. not permanently removed from the market, but as a guarantee of flow in the right direction in times of stress. In practice such agreements must be negotiated from case to case. If two adjacent markets opt for strategic reserves, the benefits of cooperation can be explored (e.g. using a common stack of balancing reserves).

Table 3 summarizes the main points of chapter 3.2. It should be noted that 'unilateral/asymmetric versus regional' is strictly speaking not simply the same as facilitating cross-border trade or not. Even in the absence of a regional CRM approach, unilateral CRMs can still take interconnected capacity (cross border trade) into account. That would then be 'partly modern' or at least not 'completely traditional'. In other words, the 'traditional versus modern CRMs' proposition is by no means a black and white one.

	Traditional *Unilateral & asymmetric*	**Modern** *Regional approach, MS-level but harmonized & coordinated*	**Modern** *Truly European approach*
Distortion of cross-border trade in the IEM	Yes	No	No
Distortion of competition in the IEM	Yes	No	No
Works at cross-purposes with EU market integration and competition/state-aid policy	Yes	No	No
Lowest total cost	No	No	Yes
Politically feasible in the short or medium term	Yes	Yes	No

Table 3: Overview of differences between the traditional and the modern CRM approach on the issue of geographical scope.

4. Overview of CRMs in Europe

4.1. Current implementation of CRMs in Europe

Capacity mechanisms have been implemented in several EU countries and are discussed or under implementation in others (EC, 2013a). The introduction of CRMs has generally been motivated by concerns about the existing generation units that are struggling to remain profitable leaving the system. In some cases, depressed prices are then (rightly or wrongly) taken as evidence that there will be little incentive to invest in new plants (including peaking units), which are expected to be needed in the future when the current ageing plants are expected to be retired (RAP, 2013).

Based on the current situation (as depicted in figure 10 and elaborated on the table presented in annex 3), we can observe that:

- Most European member states (who either have already implemented a CRM, or are considering it) are pursuing a purely national generation adequacy policy.

- Most of these member states exclusively aim at achieving generation adequacy with their (proposed) capacity mechanism. Exceptions are Ireland, Italy, Portugal and Spain. These countries *also* explicitly aim to reduce risk and price volatility with their capacity mechanisms (in order to promote investments in new generation capacity). Additionally, Portugal and Spain are the only countries that include flexibility as a capability requirement of sorts.

- Overall, the variety of CRMs used or under discussion in Europe is very high. All three main *types* of CRMs (capacity payments, capacity markets, strategic reserves) are represented, and many Member States include very specific (national) design elements into their CRM. In other words, there is no evidence to be found of any coordinated approach across Member States.

- All mechanisms are differentiated to some extent, and none are open to cross border participation[35].

There is no 'black or white' in labeling the overall EU situation as being solely traditional or modern (based on the discussions of chapter 3). Still, it can clearly be argued that (on a spectrum of traditional to modern) only *very few* CRM design elements can be found in Europe which we can consider to be significantly modern in terms of approach.

[35] Although the power exchange between Ireland and the UK is based on prices including capacity charges (EC, 2013a).

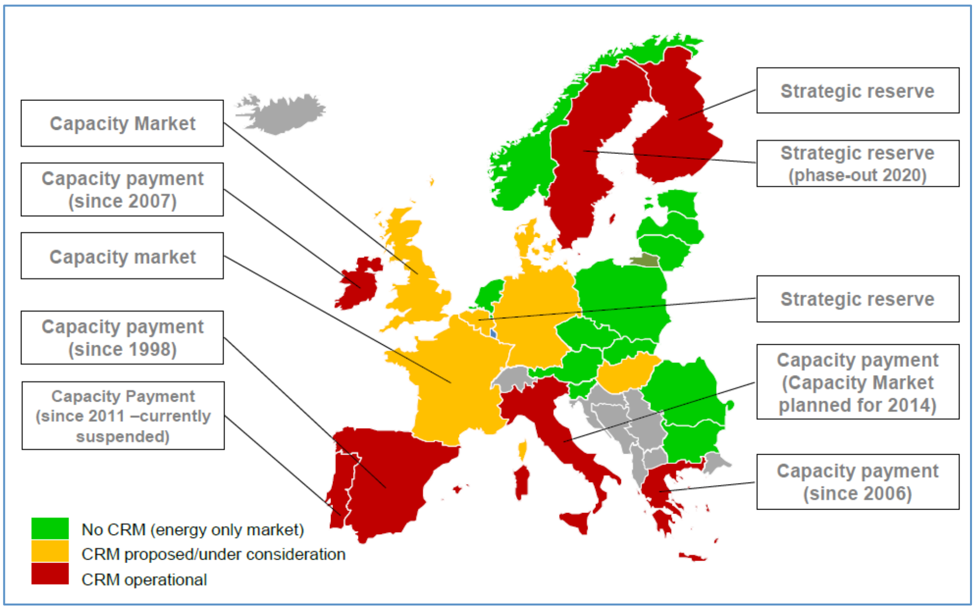

Figure 10: ACER overview of CRM status of Europe. Source: (ACER, 2013, p. 8).

4.2. Toward the implementation of a modern CRM in Europe

Although the theoretically optimal way to realize the modern approach in terms of the design being regional may be to go for a truly European approach, in line with a European single energy market, that prospect is rather unrealistic. Therefore we also discuss a (politically more achievable) alternative option; this is namely to (at least) harmonize and coordinate MS-level CRMs better. An important point to make here is that harmonizing national CRM designs in order to avoid IEM distortions implies that capability requirements (if included) should also be harmonized. This would constitute a truly modern CRM approach. This kind of harmonization has so far not taken place however. In fact, national governments across the EU have already implemented CRMs in a unilateral and uncoordinated way (cf. chapter 4). This stands in sharp contrast with the fact that European governments should ideally define common rules about CRMs before they introduce them, since the EU's internal energy market is a regional market that spans across multiple jurisdictions.

A) Regional perspective option 1: An EU-level capacity mechanism

The idea here is to have a uniform EU-wide regulation. A truly European approach could for example entail to design and implement an EU-wide CRM that is applicable to all Member States. Another possibility is to implement a specific CRM design into the European target model, or to enforce a 'target CRM' at the European level, which all Member States would be obliged to adapt individually. However, this kind of European approach (although potentially being preferable) is most likely premature for a couple of reasons:

Firstly there is the institutional allocation of responsibilities. Security of supply is a responsibility of national authorities. Since a European CRM would have a big impact on Member States' policies, setting it up might be very challenging politically.

Secondly, there is very little support among stakeholders for a European blueprint on CRMs (EC, 2013c)- (see section 1.3.2). Reasons for this may be grounded in doubts about whether or not capacity remuneration is currently appropriate in general (EC, 2013a). It can then be argued that, at this point in time, capacity adequacy in most European markets is still relatively robust, and that numerous design challenges associated with CRM design still have to be sorted out, implying that there is a need for more time to 'learn' about their implementation and use. Similarly, it can be argued that there is no conclusive theoretical and empirical evidence for the need of a European approach as described above. Some literature then argues that in the view of significant uncertainties concerning policy and market developments, it is by no means clear that the benefits of sophisticated CRMs would merit the costs associated with their implementation and operation (EC, 2013a). It should be noted however that this kind of skepticism is here considered more appropriate for traditional CRMs than it is for modernized ones. Moreover, the reasons that are given elsewhere for a truly European approach being premature are entirely different in nature (Öko-Institut, 2012). The logic there is that improving CRMs is such an urgent matter that a time-consuming process towards setting up a European CRM is currently not appropriate. It is then argued that we should waste no further time in improving Member State level CRMs, without putting their essential need into question.

B) Regional perspective option 2: better coordinated Member State level CRMs

As noted, a European CRM approach might be very difficult to realize, making improved coordination a preferable (second-best) solution at this point in time (Öko-Institut, 2012). What we call a "better coordinated approach" is a second and more pragmatic solution to the fact that traditional (asymmetric) CRMs harm the IEM.

Under this approach, it could for example be possible to identify a standard model for individual (MS-level) CRMs. However, (during the transition period) capacity adequacy challenges differ substantially across Member States, making it difficult to recommend a standard design (EC, 2013a). In other words, a "one-size-fits-all approach" may not be optimal. Thus because a standardized design might be problematic, practical solutions (to address specific problems caused by member states implementing asymmetric CRMs) might have to be found on a case-by-case basis (IEA, 2012). For example, specific cross-border capacity resources could be better made use of, thereby minimizing adverse effects on cross-border trade. Another possibility to improve coordination is for several Member States to launch a coordinated initiative (e.g. through the Pentalateral Energy Forum). A CRM covering several Member States could then be implemented on the basis of mutual agreements, without a uniform EU-wide regulation being necessary. Either way, when introducing national-level CRMs, governments should define common rules for regional markets spanning multiple jurisdictions (i.e. the EU IEM)(IEA, 2012).

The improvement of CRM coordination and harmonization across the EU is however made increasingly difficult by the fact that some Member States are already significantly further advanced in their discussions and implementation of unilateral CRMs (Öko-Institut, 2012). Although there is very limited support for a EU blueprint, support is very strong among stakeholders for EU-wide “criteria” to harmonize and better coordinate Member State-level CRMs (EC, 2013c). In other words, while better coordination may not be easy, it should be possible given the potential advantages and wide support for it. Presumably it is the ‘national mentality’ associated with the traditional approach which is blocking progress on this front.

5. Conclusions

Europe is undergoing a major transformation of its power system, and it needs to create a framework that allows a large number of new investments on generation, transmission and demand side management resources to be realized. Flexibility is a pre-requisite for the future energy system. As described in this report, flexibility can and should be triggered by i) the improvement of national energy markets (through intra-day balancing, shorter gate-closure times, more liquidity in the wholesale market) and ii) the completion of the EU Internal Energy Market (larger coupled balancing areas, coupled market prices, higher levels of interconnection capacity, etc.). CAN Europe Believes that European policy makers should concentrate efforts on the measures.

There is no clear consensus in the sector about whether these measures are sufficient on its own to trigger adequate flexibility and be sufficient to make that transformation needed happen. CRMs could therefore be a temporal solution to incentivize the required investments. As explained in this report, badly designed CRMs will lead to a number of challenges, such as overcapacity, increased costs for consumers, lock-in of high carbon infrastructure and competition distortions. In other words, CRMs may represent a solution if they were especially designed to 'steer' investments into the right direction, facilitating an increase in system flexibility and supporting a truly single European energy market. This is what we consider to be a modern CRM. If introduced, CRMs should be based on the modern approach, contributing to assigning appropriate value to system flexibility and taken the benefits of an internal energy market in account.

A system with high shares of VRE does not only require investments in flexible generation plants, but also in demand response measures and storage (which are still lacking a proper investment framework, as their benefits are not well valued in the market). The 'regional perspective on energy market reform' is also of paramount importance. The challenge facing policy makers is no longer a Member States' own challenge, especially as the European internal energy market becomes increasingly integrated. Since national CRMs are spreading across Europe, harmonizing asymmetric CRMs becomes a priority. In this case, modern regional CRMs will help create a framework that facilitates the right investments towards a decarbonized and competitive Europe.

CRMs *could* be part of a modernized electricity market design that reflects today's complex mix of policy goals. They are neither *inherently* contradictory nor supportive of the long-term policy goals for the electricity sector. What matters however is the approach taken in their design.

It cannot yet be proven empirically that modern CRMs will in fact have the positive effects identified in chapter three. However, the presented arguments against the traditional approach, in combination with the observation that European Member States *are* in fact taking nationally focused approaches, leads us to conclude that Europe has a huge challenge ahead. Ignoring or even denying the need for CRM implementation and modernization across Europe can therefore be counterproductive to the realization of climate and energy policy goals. CRMs need to be well-designed as from today, otherwise Europe will not be investing in the right assets that are needed for a future energy system based on high shares of renewable energy that is competitive and carbon free.

6. References

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ANNEX 1: Different CRM taxonomy tables and diagrams

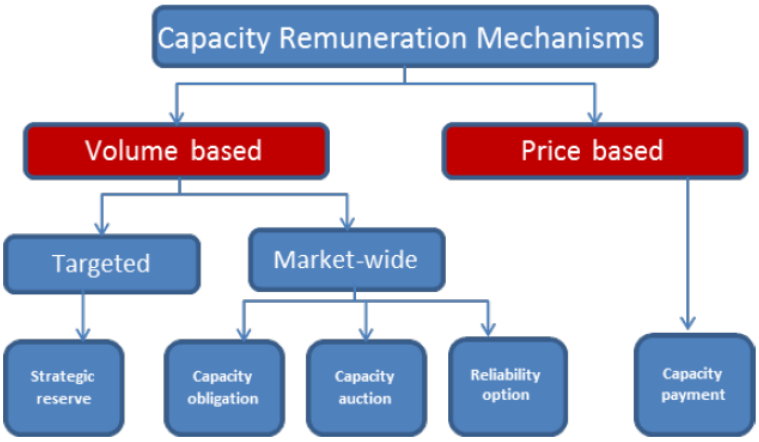
	Capacity payment	*Strategic reserve*	*Capacity markets*		
			Capacity obligation	**Capacity auction**	**Reliability option**
Market wide or targeted	Can be both Loads not included	Targeted. Loads may be included	Both, but typically market wide	Both, but typically market wide	Both, but typically market wide
Present or future obligation	May be both	May be both	May be both Incentives for long-term contracts	May be both	Future, specifically designed to strengthen investment incentives
Adequacy calculation	Not required	Required (reserve margin)	Required (reserve margin)	Required (total capacity)	Required (total capacity)
Reliability requirements	Not required	Required	Rules for approval / standard certificates	Rules for approval / standard certificates	Linked to market price (strike price)
Payment	Set by regulator May depend on peak reserve margin	By tender / auction	Market based: Bilateral contracts or certificate trade	Through centralized auction	Through centralized auction
Cost allocation	Fee on LSEs (uplift on energy charges)	System charges	Charge on energy sales by LSEs	Charge on energy sales, peak load or system charges	Charge on consumers (peak load)
Rules for activation	None. Generation sold in wholesale market	Activated on call Only loads bid in market	Expected to bid in wholesale markets	Expected to bid in wholesale markets	Required to bid in wholesale market when price exceeds strike price

Source: (EC, 2013a, p. 7)

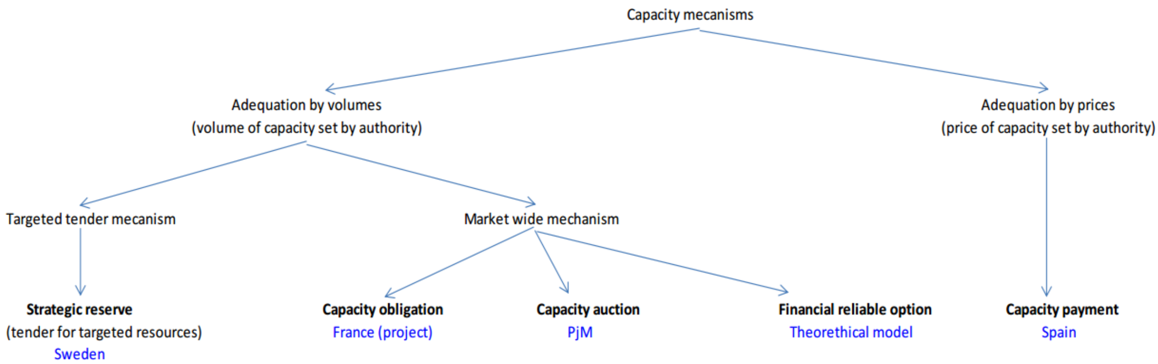
The system operator defines…	**the capacity obligations for each supplier…**	**…and runs auctions to set the price.**
short-term	short-term, decentralised capacity market	short-term, centralised capacity market
several years in advance	forward, decentralised capacity market	centralised, forward capacity market

Source: (IEA, 2012, p. 81)

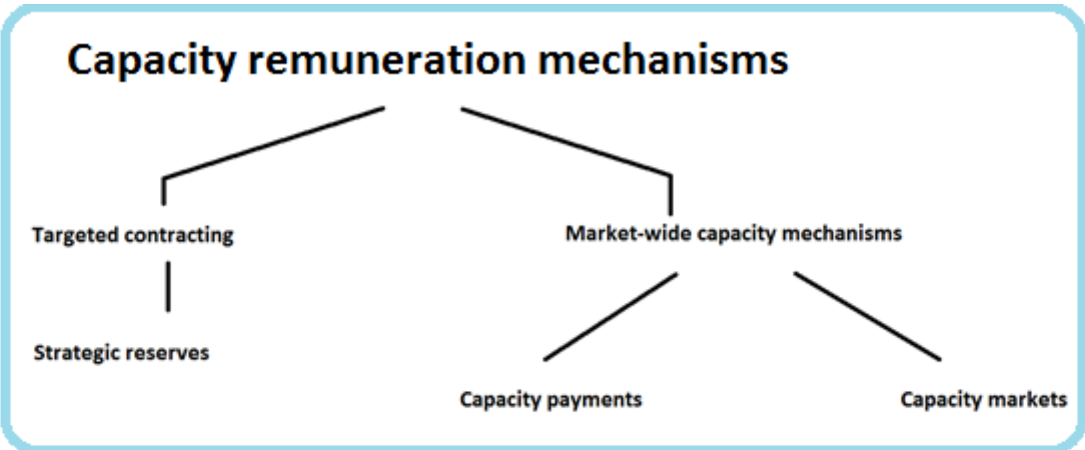
The following are three diagrams outlying the taxonomy of CRMs. It should be noted that the third diagram is self-produced (not found in the source itself), but deduced from the conceptualization found in the text.



Source: (ACER, 2013, p. 5).



Source: (CREG, 2012, p. 10).



Source: (IEA, 2012).

ANNEX 2: Focused Capacity Markets (Öko-Institut, 2012)

Looking at the problems we want to solve (cf. 'starting points') Öko-institute proposes a "**focused capacity market**" to address them (as opposed to other different capacity market models that have been put forward "such as strategic reserve or a comprehensive capacity market). This design option (FCM) consists of **two different segments**, for which **separate auctions** are carried out and in which **different power plants as well as measures for increasing the flexibility of electricity demand and storage** can participate.

- In the **incumbent power plants segment**, power plants at risk of decommissioning compete with dispatchable load (DR) for capacity payments for one or four years.

- In the **new power plants market segment**, power plants which fulfill high flexibility demands and environmental requirements and new electricity storage compete for capacity payments over 15 years.

The fact that capacity payments have different durations, increases planning security for investors and plant operators while decreasing risk premiums and thus the costs for electricity consumers.

The focused capacity market constitutes **a pragmatic and**, compared to the models of a comprehensive capacity market and a strategic reserve discussed up to now, a **very advantageous instrument for tackling the current and foreseeable challenges with regard to SoS**. **At the same time** a focused capacity market can make a **substantial contribution to flanking the transformation** of the energy system to one based on renewable energies and maintaining a high intensity of competition in the electricity market while substantially limiting the costs for electricity consumers.

Even though the implementation of the focused capacity markets requires a range of technical/regulatory procedures, focusing the capacity market on the two segments of "incumbent power plants" and "new power plants" also enables easy adaptation and implementation as a learning system. Focused capacity markets could also be implemented relatively quickly in Germany.

The distinction between the two segments:

- Makes it possible to tailor capacity payments to useful time periods
- Enables the productive incorporation of controllable loads and storage
- Extensively avoids free-rider effects

The rigorously competitive set-up of the tendering procedure:

- Generates high competition pressure
- Ensures low prices

The costs which are substantially curbed for the reasons mentioned are refinanced via the network use charges on the transmission network level.

ANNEX 3: Overview of data on national CRMs in 15 EU Member States

Country	Data on the CRM situation
BE	- Discussions about whether or not to implement a CRM are ongoing (EC, 2013a). - CRM proposed/under consideration: strategic reserve (ACER, 2013). - The CRM is solely focused on adequacy, meaning that it only aims at ensuring *sufficient* generation capacity in the electricity system to meet demand at all times, including at peak load periods. (ACER, 2013) - Energy only market in the sense that there are no capacity payments to power plants in the day-ahead and intraday markets, but balancing market reserve capacity is contracted in advance (CREG, 2012).
DE	- Discussions about whether or not to implement a CRM are ongoing (EC, 2013a). - In 2012, the regulator in Germany approved a contract to maintain gas capacity in southern Germany after shutdown of 8GW on nuclear. - CRM proposed/under consideration (ACER, 2013). - The CRM is solely focused on adequacy, meaning that it only aims at ensuring *sufficient* generation capacity in the electricity system to meet demand at all times, including at peak load periods (ACER, 2013). - Proposal for new capacity elements: A study of March 2012 done for the German government proposes a full-scale mechanism, put political opinion is still open (CREG, 2012).
DK	- In Denmark (& Spain), the TSOs have contracted with thermal power plants needed to maintain voltage stability during periods of low load and high RES generation (IEA, 2012). - CRM proposed/under consideration (ACER, 2013). - EOM (CREG, 2012).
EL	- Currently using capacity payments (EC, 2013a). - CRM operational: capacity payment since 2006 (ACER, 2013). - The CRM is solely focused on adequacy, meaning that it only aims at ensuring *sufficient* generation capacity in the electricity system to meet demand at all times, including at peak load periods (ACER, 2013). - Major capacity mechanism: capacity obligation mechanism since 2005 (CREG, 2012).
ES	- Currently using capacity payments (EC, 2013a). - In Spain (& Denmark), the TSOs have contracted with thermal power plants needed to maintain voltage stability during periods of low load and high RES generation (IEA, 2012). - Spain has had a capacity charge system since market liberalization in 1996. The original price for capacity of 7.8 EUR/MWh was chosen as part of the stranded cost compensation that the government guaranteed to generators, which has decreased progressively to 4.8 EUR/MWh between the years 2000 and 2007. In 2007, after investment increased rapidly, the government introduced a new capacity charge. It acts as a "long-term investment incentive" consisting of a payment for ten years, restricted to new plants with a capacity above 50 MW (existing plants are eligible in case of significant refurbishment investment)(IEA, 2012). - CRM operational: capacity payment since 1998 (ACER, 2013). - The CRM is focused on three things: (1) adequacy, meaning that it only aims at ensuring *sufficient* generation capacity in the electricity system to meet demand at all times, including at peak load periods, and (2) reducing risk and price volatility, meaning that the mechanism aims at de-risking new investment and avoiding the price volatility associated with generators that run only periodically recovering their fixed costs over a short period of time, and (3) flexibility, meaning that the mechanism aims at maintaining sufficient system flexibility to balance the electricity system notably in response to (sudden) demand variations or unexpected outages (ACER, 2013). - Partial capacity mechanism: Capacity payments for new units and to existing coal, gas, oil and hydro capacity (CREG, 2012).
FI	- Currently operating a strategic reserve (EC, 2013a). - In 2003, Finland (& Sweden) asked their TSO's to produce "strategic reserves" to be activated in times of scarcity. Motivated mainly by the need for peak capacity during periods of drought (low hydro capacity), and by the perceived failure of the EOM to deliver enough capacity (IEA, 2012). - CRM operational: strategic reserve (ACER, 2013). - Energy only market in the sense that there are no capacity payments to power plants in the day-ahead and intraday markets, but balancing market reserve capacity is contracted in advance (CREG, 2012). - Capacity reserves for spot market deficits only (CREG, 2012). - The CRM is solely focused on adequacy, meaning that it only aims at ensuring *sufficient* generation

	capacity in the electricity system to meet demand at all times, including at peak load periods. (ACER, 2013)
FR	- Decided to implement a capacity mechanism (EC, 2013a). - France has opted for a capacity obligation scheme supported by certification of capacity and demand response, where certificates can be traded. The obligation will be set for one year at a time. Cross-border participation is possible, but requires inter alia allocation of interconnector capacity and that the capacity is not counted as part of the host country's capacity availability (EC, 2013a). - In France, a tender to build a new power plant (initiated because of forecasts of shortage) resulted in the building of a new CCGT plant in Brittany (IEA, 2012). - CRM proposed/under construction: capacity market (ACER, 2013). - The CRM is solely focused on adequacy, meaning that it only aims at ensuring *sufficient* generation capacity in the electricity system to meet demand at all times, including at peak load periods (ACER, 2013). - Proposal for new capacity elements: Capacity purchase obligations are planned to be implemented by 2016, but new government could change NOME law (CREG, 2012).
HU	- The CRM is solely focused on adequacy, meaning that it only aims at ensuring *sufficient* generation capacity in the electricity system to meet demand at all times, including at peak load periods (ACER, 2013).
IE	- Currently using capacity payments (EC, 2013a). - CRM operational: capacity payment since 2007 (ACER, 2013). - The CRM is focused on two things: (1) adequacy, meaning that it only aims at ensuring *sufficient* generation capacity in the electricity system to meet demand at all times, including at peak load periods, and (2) reducing risk and price volatility, meaning that the mechanism aims at de-risking new investment and avoiding the price volatility associated with generators that run only periodically recovering their fixed costs over a short period of time (ACER, 2013). - Major capacity mechanism: Ireland and North-Ireland have capacity payments since 2005 (CREG, 2012).
IT	- Currently using capacity payments (EC, 2013a). - CRM operational: capacity payment. However, capacity market planned for 2014 (ACER, 2013). - The CRM is focused on two things: (1) adequacy, meaning that it only aims at ensuring *sufficient* generation capacity in the electricity system to meet demand at all times, including at peak load periods, and (2) reducing risk and price volatility, meaning that the mechanism aims at de-risking new investment and avoiding the price volatility associated with generators that run only periodically recovering their fixed costs over a short period of time (ACER, 2013).
NO	- Currently operating a strategic reserve (EC, 2013a). - EOM (no CRM)(ACER, 2013). - EOM (CREG, 2012).
PL	- Currently operating a strategic reserve (EC, 2013a). - EOM (no CRM)(ACER, 2013). - Proposal for new capacity elements: nodal pricing and a capacity market may be implemented in 2014 (CREG, 2012).
PT	- Currently using capacity payments (EC, 2013a). - CRM operational: capacity payment since 2011, but currently suspended (ACER, 2013). - The CRM is focused on three things: (1) adequacy, meaning that it only aims at ensuring *sufficient* generation capacity in the electricity system to meet demand at all times, including at peak load periods, and (2) reducing risk and price volatility, meaning that the mechanism aims at de-risking new investment and avoiding the price volatility associated with generators that run only periodically recovering their fixed costs over a short period of time, and (3) flexibility, meaning that the mechanism aims at maintaining sufficient system flexibility to balance the electricity system notably in response to (sudden) demand variations or unexpected outages (ACER, 2013). - Partial capacity mechanism: capacity payment for new units (CREG, 2012).
SE	- After liberalization, fuel oil units previously used for back-up were being closed down because they were no longer economic to run. Because this made regulators uncertain about reliability, a strategic reserve mechanism was introduced in 2003, in order to attract investment in capacity that would provide the desired safety margin for ensuring reliability (RAP, 2013). - Currently operating a strategic reserve (EC, 2013a). - In 2003, Sweden (& Finland) asked their TSO's to produce "strategic reserves" to be activated in times of scarcity. Motivated mainly by the need for peak capacity during periods of drought (low hydro capacity), and by the perceived failure of the EOM to deliver enough capacity (IEA, 2012). - CRM operational: strategic reserve, although it is planned to phase-out by 2020 (ACER, 2013). - Energy only market in the sense that there are no capacity payments to power plants in the day-ahead and intraday markets, but balancing market reserve capacity is contracted in advance (CREG, 2012). - Capacity reserves for spot market prices only (CREG, 2012).

UK	- Details about the current CRM *proposal* in the UK (RAP, 2013):
	    ▪ Only rewards firm capacity, not any capabilities. Primarily only the balancing market to incentivize capabilities.
	    ▪ Favors existing resources since the auction is short-term.
	    ▪ DSRs *can* participate potentially, but depends on set-up of incentives for SO to ensure their participation.
	    ▪ Earning from the CRM vary according to availability during peak, not according to provided capabilities.
	    ▪ Carbon content of participating assets is not taken into account. Possibly incentivizing further procurement of inflexible capacity, possibly leading to significantly increased curtailment of VRE generation.
	    ▪ Unclear whether the proposal will work as a temporary fix in times of need (when there's a capacity shortage), or as a *permanent* change of the market rules.
	    ▪ Not clear how it will attract major new investment.
	    ▪ The CRM proposal doesn't address the way it will deal with increased interconnectivity and market coupling, or potentially larger (shared) balancing areas across borders.
	- Decided to implement a capacity mechanism (EC, 2013a).
	- The UK has opted for a centralized, market-wide capacity auction. Inclusion of cross-border capacity by basing the exchange on prices including capacity charges is under discussion (EC, 2013a).
	- UK is facing urgent generation adequacy constraints (IEA, 2012).
	- CRM proposed/under consideration: capacity market (ACER, 2013).
	- The CRM is solely focused on adequacy, meaning that it only aims at ensuring *sufficient* generation capacity in the electricity system to meet demand at all times, including at peak load periods (ACER, 2013).
	- Proposals for new capacity markets: developing full-scale capacity auctions, legislation to be ready in 2013 (CREG, 2012).