A REFERENCE MODEL FOR EUROPEAN CAPACITY MARKETS

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EURELECTRIC is the voice of the electricity industry in Europe.

We speak for more than 3,500 companies in power generation, distribution, and supply.

We Stand For:

Carbon-neutral electricity by 2050

We have committed to making Europe’s electricity cleaner. To deliver, we need to make use of all low-carbon technologies: more renewables, but also clean coal and gas, and nuclear. Efficient electric technologies in transport and buildings, combined with the development of smart grids and a major push in energy efficiency play a key role in reducing fossil fuel consumption and making our electricity more sustainable.

Competitive electricity for our customers

We support well-functioning, distortion-free energy and carbon markets as the best way to produce electricity and reduce emissions cost-efficiently. Integrated EU-wide electricity and gas markets are also crucial to offer our customers the full benefits of liberalisation: they ensure the best use of generation resources, improve security of supply, allow full EU-wide competition, and increase customer choice.

Continent-wide electricity through a coherent European approach

Europe’s energy and climate challenges can only be solved by European – or even global – policies, not incoherent national measures. Such policies should complement, not contradict each other: coherent and integrated approaches reduce costs. This will encourage effective investment to ensure a sustainable and reliable electricity supply for Europe’s businesses and consumers.

EURELECTRIC. Electricity for Europe.
EURELECTRIC Contribution to a Reference Model for European Capacity Markets

A EURELECTRIC position paper

March 2015

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Executive Summary

Energy markets today are evolving as Europe continues to pursue its ambitious low-carbon agenda. Amid the fundamental changes taking place, EURELECTRIC believes that the full execution of an efficient integrated European energy market, i.e. the completion of the Internal Energy Market (IEM), is the cornerstone on which all further market developments should rest. This includes the implementation of the Third Energy Package and the integration of wholesale markets across all timeframes.

Energy-only markets remain the reference for the completion of the IEM. However, as in many markets the introduction of a capacity element is becoming increasingly important, EURELECTRIC recognises that properly designed capacity markets, developed in line with the objective of the IEM, are an integral part of a future market design. Conventional generation, renewable energy sources, demand response and storage should participate in energy, flexibility and capacity markets on an equal footing and should be remunerated according to their contributions to the respective markets.

Proper capacity markets value firm capacity and deliver price signals that encourage sufficient capacity to stay in the system or else attract investments for necessary new capacity to be built. Such markets will ensure that only the capacity strictly needed for long-term system adequacy is remunerated. They should not provide a safeguard for poor, non-competitive investments. Moreover, they should reach beyond national borders, optimising capacity across regions of Europe.

With this paper, EURELECTRIC presents a reference model of how European capacity markets should be designed to meet the basic principles outlined above. Most notably, in developing regional capacity markets, attention should be paid to the following elements:

- Establishing regional capacity markets requires common regional adequacy assessments;
- Capacity needs should be determined by a homogeneous, transparent methodology;
- A standard – or at least similar – product definition is needed to provide a level playing field for all capacity across regions;
- Capacity providers should have the right to free exit, i.e. entitled to freely decide when to operate/mothball/close down their assets if their capacity has not been contracted;
- Product details must be adequately defined to meet the goals of the capacity market: in particular, the lead time and the duration of capacity contracts are critical for the time dimension of capacity markets. Both should reflect long-term investment horizons where such investment is needed to achieve long-term system adequacy;
- Penalty regimes for unavailability of contracted assets should incentivise capacity providers to deliver appropriate firmness. Such penalty regimes should be established according to common principles;
- Coordination requirements for transmission system operators (TSOs) should be clear, as TSOs should be jointly responsible for managing infrastructure in a way that allows contracted assets in capacity markets to optimally contribute to the security of the regional systems;
- Capacity should always be valued in a competitive market. Capacity prices should be allowed to move freely without distortive price regulation.
Cross-border participation in capacity markets should be seen as a stepping-stone towards regional capacity markets. It should therefore be established quickly. To this effect, EURELECTRIC supports a cross-border participation model where the market participant is the cross-border capacity provider and the product being traded cross-border is availability. EURELECTRIC believes that the following set of key principles for cross-border participation in capacity markets should be respected:

- All capacity market participants should be subject to common requirements and coherent market rules (e.g. regarding certification, penalty regime, availability requirement, etc.);
- Participating with the same capacity in more than one capacity market during the same contract timeframe should not be possible (no double commitment and earnings);
- TSOs should offer a certain amount of cross-border participation, based on non-discriminatory conditions and only limited by objective physical limitations (to be approved by national regulatory authorities and ACER);
- TSOs should not be allowed to neglect existing cross-border capacity contracts in situations of system stress.

No reservation of cross-border capacity should be introduced in order not to interfere with the functioning of the forward, day-ahead, intra-day and balancing markets, which will determine the actual direction of the energy flow.

These fundamental principles, coupled with a regional approach to capacity markets, deliver security of supply cost-efficiently and in a market oriented way.
Basic capacity market design principles

Capacity markets are market-based solutions that deliver long-term system adequacy by properly valuing reliable and firm capacity and thereby providing signals for necessary existing capacity to stay online or new capacity to be developed.

The overarching goal of any capacity market must be to ensure generation adequacy, i.e. firm capacity. Other political objectives such as decarbonisation should be met through instruments like the EU Emissions Trading System (ETS) and should therefore be left out of the capacity market debate. Consequently, the capacity market should only value plant availability based on their firm contribution to system adequacy.

In order to maximise cost-efficiency and market orientation, any capacity market should follow a set of fundamental design features:

- **Market-based** – Capacity should always be valued in a competitive market. Capacity prices should be allowed to move freely without distortive price regulation;
- **Technology-neutral** – All technologies that provide firm capacity should be able to participate in the market without discrimination;
- **Open to new and existing plants** – Market access should be based on a level playing field between both new and existing firm capacity providers;
- **Regional** – The capacity market design should take regional interdependencies into consideration and allow the selection of the cheapest set of capacity on a regional basis, taking into account interconnection constraints;
- **Open to generation, demand response and storage** – All forms of capacity throughout the value chain should be able to participate in the market.

Having a market-based capacity mechanism that is open to all technologies throughout the whole value chain and that does not discriminate between new and existing plants is the most cost-efficient way to reveal which capacity providers should be remunerated to ensure long-term system adequacy.

EURELECTRIC believes that energy, flexibility and capacity are all needed and that they should therefore be properly valued in a future-proof wholesale market design, as Table 1 shows.

<table>
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<th>Table 1- Elements of market design</th>
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These three elements of market design should not be seen as opposing each other, but rather as interplaying elements of a more efficient market design to ensure continued security of supply. Nevertheless, it should be stressed that the European market integration for each of these three elements is being developed at different paces: while the integration of day-ahead markets is progressing, European intraday and balancing markets are far from being integrated and operational.

Flexibility should enable the system to respond to short-term variations in the supply/demand balance. This includes e.g. short-term reserves (generation, storage, demand) to cover potential incidents that decrease power supply to the system or to respond to short-term variations in demand and supply. In contrast, capacity should ensure long-term system adequacy in case of extreme load peaks or moments where firm capacity has to back up intermittent renewable generation.

Market participants who optimise their performance across these competitive markets will be the most commercially successful while delivering the most cost-efficient outcome. Take, for example, the market performance of a flexible capacity asset versus a non-flexible one. While both assets may obtain the same earnings in the energy market, under efficient outcomes, the flexible asset should be more competitive in the flexibility market. In the capacity market, the flexible asset should also be more competitive as it requires fewer earnings to provide its availability product. The same principle applies to capacity providers with low marginal costs: they should obtain higher earnings in the energy market and thus incentives to stay in the market. This is the type of competitive marketplace that EURELECTRIC advocates: agents that play a more efficient role within the electricity systems are incentivised to stay in the system while delivering the most cost-efficient solution for customers.

A properly designed capacity market should have no effect on the dispatch order: it prices availability/firmness, not the actual energy production or energy delivery. However, capacity markets that keep sufficient capacity in the system to ensure long-term system adequacy should experience fewer scarcity periods. Total system costs must be kept under control by correctly identifying the amount of capacity needed for long-term system adequacy. Properly designed capacity markets will only attract this pre-set amount of capacity.

The introduction of capacity markets affects both existing capacity that remains online in the system and new investments that guarantee this predetermined level of long-term system adequacy. Capacity markets will ensure that only the capacity that is strictly needed to fulfill the long-term system adequacy target is remunerated. They should not provide a safeguard for poor investments that are not competitive.

To pave the way for such an appropriate capacity market design, the proper definition of the capacity market product is of fundamental importance. Current definitions are often set in a national context, e.g. designed to address winter peak because of electric heating in France. Whereas this is to a certain extent unavoidable, the product definition should be as standardised as possible. This will help to avoid potential distortions arising from interactions of capacity markets with the common Target Model as well as ease cross-border capacity market participation and, eventually, regional capacity markets. Aspects to be considered when designing the product include:
The product is “availability”, not “energy”. Availability is required in times of system stress. In some designs, contracted capacity is called upon or triggered at certain pre-specified periods when peaks are assumed or expected or when demand exceeds a certain threshold. However, the real need for availability rather arises when the demand-supply gap is tight, which may result from large demand, low intermittent generation, or – more likely – a combination of both. Different ways of verifying ability might exist, and these practices might be different for different capacity providers (generation, demand, storage, etc.). For power plants, availability could be verified at moments of system stress by the fact that they produce energy or by the fact that they have offered at a “reasonable price” in the spot markets. To better define this availability verification, a more detailed definition of when it will be triggered/carried out is needed, as described in the next point.

Triggering criteria should reflect the tightness of the demand-supply gap. In a well-functioning market, this tightness is reflected by high prices in day-ahead, intra-day, reserve and balancing markets. In the case of an energy supply model, a low triggering price should be avoided as it could force energy into the market that would not be dispatched as the result of an efficient market outcome and/or could hinder the development of alternative solutions to electricity generation that lie higher in the merit order curve, e. g. demand response. Basing triggering on prices is a good approach from both the physical and the economic point of view, and also facilitates further integration of European capacity markets. When the market reaches the triggering price, the capacity has to be available to the market. However, the most economically efficient market participants (in the merit order list) should continue to be dispatched through the energy market price signals (day-ahead, intraday and balancing). While EURELECTRIC views triggering based on prices as the preferred option, other triggering criteria that reflect system tightness could also be accepted. However, they should always take into account supply, demand and interconnector contributions.

On the capacity provider side, the maximum amount of product (“firm capacity”) that each provider can offer could result from an ex-ante certification process carried out by the Regulator or the TSO. Alternatively, in a decentralised model, the capacity provider can decide how much of its physical capacity is sold in the capacity market. When an ex-ante certification process is in place, stakeholders should be involved in setting up and continuously amending this process. The process must reflect the technical capacity of different capacity market providers to actually be available when called. The contribution to system adequacy is the outcome of a probabilistic analysis and varies according to technology (conventional generation, hydro, renewable, demand side, etc.). Certification of different technologies should be guided by such a system-wide analysis. An adequate penalty in case of not having contracted capacity available when the trigger level is reached should prevent capacity providers from making unrealistic capacity offers (this is particularly important in case there is no certification). This principle applies to both centralised and decentralised capacity market models.

1 In central reliability option models, the trigger price is actually defined by the strike price of the option.
2 Centralised and decentralised capacity market models are discussed in more detail in the following section.
• In a decentralised system, on the capacity buyer side, an ex-post verification process is needed to ensure that sufficient capacity to cover customers’ demand has been procured according to a predefined methodology. This is especially relevant in case suppliers have the responsibility of estimating the capacity needs for their customers. A strong penalty regime should be applied whenever an adequate level of capacity has not been procured.

• Lead time and duration of capacity contracts are critical for the time dimension of capacity markets. Capacity market products are typically contracted for periods of one to several years. Duration is a critical design variable, as it needs to balance certainty for consumers and investors alike with adequate competitive pressure.
Investments in new generation capacity with a lifetime of several decades, and which ensure long-term system adequacy, would benefit from long-term and stable investment signals. Energy-only markets (EOM) rely on energy price spikes in scarcity situations, i.e. situations where demand exceeds total supply, to create an investment signal. However, this signal may be too risky to actually trigger investments in new capacity: high price spikes and higher risks of brown-outs may not be socially accepted or the associated revenue stream may be considered too uncertain and risky. Sufficient long-term stability is therefore probably not ensured and low system adequacy levels can be expected. The purpose of capacity markets is to overcome these problems by coordinating future system capacity needs.

There are two critical time variables in regard to capacity markets: lead time and contract duration, as depicted in Figure 1.

Capacity markets should coordinate system capacity needs in the medium and long term. To optimise existing capacity and to manage possible oversupply, a lead time of 3 to 4 years should be sufficient. This amount of time also makes it feasible for most new capacity providers to be available at the start of the capacity contract, as it is consistent with the amount of time associated with investment decisions. This type of lead time is preferable to lead times of, for example, one year, which would not allow new capacity providers to have their capacity built and available. For existing generation and demand response, shorter lead times could be more appropriate.

As for the duration of the capacity contract, investment decisions would benefit from long-term price signals through the capacity market. So far, energy markets have failed to develop contracts in the time horizon relevant for investments; a capacity market can provide a correction for this. In any case, the minimum duration of a capacity market should be one year and the design should allow for longer durations if new adequacy investments which are necessary do not materialise.
Elements of regional capacity markets

Establishing regional capacity markets is an ambitious goal that requires close cooperation among involved TSOs and NRAs. As interconnection capacities across Europe are finite, the location of “firm capacity” is just as relevant as the total amount. This is also the case in some systems under the jurisdiction of a single System Operator. Analysing the practices of ensuring generation adequacy within those systems may be helpful when designing regional capacity markets.

Box 2 - The Italian case: a capacity market covering different bidding zones

The Italian capacity market offers an interesting case. The Italian regulator recognises the importance of long-term price signals in order to ensure security of supply. For this reason, it has introduced reliability options with a lead time of 4 years and a duration of 3 years. In addition, considering the significant transmission constraints within Italy, auctions for the provision of capacity include a locational element (division of Italy into zones). For this reason the Italian TSO carries out adequacy assessments for the whole of Italy and for each zone. The Italian TSO is responsible for making sure that assets in one zone contribute to security of supply in another zone to the maximum possible extent. The process is streamlined because there is a single TSO responsible for all bidding zones. A similar process could be set up in other regions of Europe requiring closer TSO cooperation.

In the absence of a single European System Operator, or even a regional one, the involved TSOs should be required to set up transparent procedures that guarantee close coordination, supervised by the NRAs and ACER and closely involving the stakeholders. Specifically, the following set of fundamental elements should be defined and harmonised:

- **Regional adequacy assessments** – the establishment of regional capacity markets requires common regional adequacy assessments. The initial purpose of interconnections built in the “pre-liberalisation era” was to facilitate mutual support and energy sales between countries; performing purely national adequacy assessments would not be efficient. System adequacy assessments should also include *economic viability checks* to verify whether the generation capacity they assume to be available actually has the economic conditions to do so. More specifically, it should not only be assumed that capacity of certain providers will be available for the system just considering – for instance – its residual lifetime, but it should also be verified whether current market/regulatory arrangements lead to a viable economic situation for existing providers or new investments. TSOs must cooperate fully to conduct these assessments and a common, transparent methodology has to be set up in order to let the market understand the outcome of TSOs’ assessments.

- **Determination of the capacity needs (volume regulation)** – the adequacy assessment should result in the total necessary capacity to be procured, either through a centralised auction process or through a well-defined (and regulator approved) methodology that determines how much capacity each supplier or customer should procure in obligation certificate systems in relation to the customers’ consumption\(^3\). In any case, a

\(^3\) In certain obligation certificate systems, there is not even a need for a centrally pre-defined level of necessary capacity.
homogeneous and transparent methodology should determine the adequacy target level that the regulator (or government) wants to achieve.

- **Product definition**
  - The capacity market should put a value on firm capacity to be available at Y+L in periods of scarcity; in order to have cross-border products, the lead time “L” should ideally be the same across the region where the cross-border participation is possible.
  - There is a need to provide an accurate definition of firmness. Capacity markets should have the provision of firm capacity as their overarching goal. Thus, a clear line should be drawn between capacity markets and other markets such as balancing markets, and a product distinction should be made between the products in capacity markets and products such as reserve power procured by TSOs in flexibility markets.
  - Diverging capacity products within regions may lead capacity providers to privilege specific markets when offering their capacity within each region. Thus, while maintaining the core principle of delivering a level playing field, capacity products should be as harmonised as possible.

- **Right to free exit** – capacity providers should be entitled to freely decide when to operate/mothball/close down their assets if their capacity has not been contracted. To facilitate these decisions, secondary markets should be set up to trade the obligations that capacity providers have entered into with other market participants.

- **Product details** – elements of the capacity product to be valued in the capacity market such as its trigger price, duration and other characteristics must be well defined. The trigger event for the activation of contracted capacity should be market based, as discussed above. Contract lengths should also be defined so that they adequately reflect the need for capacity to be available for long-term system adequacy.

- **Penalty regimes** – the penalty regime should reflect the scarcity in the system. Scarcity should be revealed through market prices (i.e. exceeding the trigger price signal). The preferred option would thus be basing the penalty on market prices as well. Harmonising penalty regimes (in terms of the principles applied to derive them) prevents the risk of building capacity not where it is most needed/valued, but where penalties are lower. National regulators should coordinate amongst themselves and with TSOs to define the appropriate penalty regimes and establish common principles.

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4 The determination of the capacity needs has to rely on volume-based security of supply criteria. Different methodologies are discussed in Appendix A. The chosen methodology should represent a trade-off between an acceptable level of risk and an acceptable cost to warranty it. It has to be derived considering the local characteristics of the supply-demand equilibrium. For example, a same value of LoLP (Loss of Load Probability) of a few hours per year can in practice cover a risk of load shedding a few days in a row once every ten years or a risk of short periods of curtailment every year depending on the specificities of the system considered. It is therefore not necessary (yet preferable on a regional basis) to have completely identical values for LoLP. Values should not differ greatly though on a regional basis where the reliability expectations of customers are similar, as one market with very high LoLP could more easily rely on cross-border capacity that has been procured to serve a market with very low LoLP. This could also lead to a distortion in investment incentives in cases where both markets have capacity markets.
• **In decentralised capacity models**, suppliers need to be able to prove that they have sufficiently contracted capacity corresponding to their sales and according to a well-defined methodology. The methodology should create fair incentives to all suppliers.

• **TSO coordination requirements regarding the availability** – TSOs should be jointly responsible for managing infrastructure in a way that allows existing capacity market assets in a system to contribute to the security of the total regional systems to the optimal possible physical extent. Therefore, TSOs must cooperate closely in the case of a stress event, and it should be possible to verify if cross-border capacity within the region (both transmission and contracted capacity market assets) is was available. This requires TSOs to define transparent cross-border verification procedures\(^5\). TSOs also need to respect existing cross-border contracting of capacity resources\(^6\).

• **Price regulation** – Capacity should always be valued in a competitive market and capacity prices should be allowed to move freely without distortive price regulation\(^7\).

Beyond establishing the fundamental principles described above, the form of trading arrangement set for the capacity market must be defined. Specific allocation mechanisms to capacity providers are not of critical relevance as long as they determine the value of the capacity product in a market-based way\(^8\). EURELECTRIC has studied different options for implementing capacity markets and favours either capacity obligation certificates or capacity auctions, as they are most likely to cost-efficiently ensure long-term security of supply.

a) **Capacity obligation certificates**

Under this option, long-term generation adequacy is supported by an obligation on suppliers (and on large customers without suppliers), which induces a market for tradable capacity certificates. All capacity providers (existing and new, conventional and RES generation, demand response, storage) sell certificates in the capacity market with a view to providing availability in periods of system scarcity. Market participants (mainly suppliers and large customers) need to buy sufficient capacity certificates to make sure that there is sufficient available capacity to serve their customers or cover their own demand (with a given reliability criteria) in a way that corresponds to the amount of firm capacity determined by an overall desired level of security of supply for a

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\(^5\) All the necessary data should be available after implementation of the Network Code on Requirements for Grid Connection, the Fundamental Data Transparency Guideline, REMIT and REMIT implementing regulations on data reporting.

\(^6\) To this effect, EURELECTRIC has proposed amendments to the Draft Network Code on Emergency and Restoration, as detailed in Appendix B.

\(^7\) In some auction designs like descending clock auctions, there is a starting price that corresponds to an implicit price cap. A pre-set penalty level (on the supplier side) is also an implicit price cap in a decentralised model, as suppliers will not buy certificates if they are more expensive than the penalty. These values must be set so that they do not interfere with competitive price discovery and at a level not lower than the level corresponding to newly built capacity. If a maximum capacity price were implemented differently in regional capacity markets, it would easily result in investment distortions through cross-border participation.

\(^8\) One should however realise that the value of capacity in a capacity market strongly depends on the different product specifications, e.g. how the product is described (availability vs. delivery), how penalties are defined, detailed rules, etc. Even in two identical markets with the same available capacity and the same load profile, the value of capacity is different if these different specifications and rules are different. The lack of a precise product definition and specifications is one of the major obstacles to setting up capacity markets.
given period of time. If sold capacity is not available or if suppliers or large customers have fewer certificates than load, a penalty regime applies. The certificates’ characteristics (e.g. the obligation duration or delivery period – often 1 year – as well as the lead time during which capacity providers are certified) are regulatory parameters.

EURELECTRIC has considered two options for determining the capacity needs of a supplier:

i) There is a standard procedure to assess the capacity needs of a supplier, to ensure that all suppliers apply the same criteria. Usually, suppliers obliged to deposit certificates must do so before the delivery period (ex-ante certificate system)\(^9\). This standard procedure could then be applied by a central entity such as the TSO;

ii) Suppliers could be given autonomy to calculate how much capacity they have to buy based on their customer portfolio and within a given methodology. Usually retailers obliged to deposit certificates can do so after the delivery period (ex-post certificate system). The penalty regime in place for not presenting certificates corresponding to the customers’ load would be the main incentive for suppliers to cover their customers’ capacity needs.

The methodology in both models has an underlying central purpose: ensuring that suppliers contract sufficient capacity to ensure long-term system adequacy (at least for the year of the contracting). In both models, ex-post verification is needed to assess whether each supplier has fulfilled its obligations, and if not, to apply the relevant penalty regime.

As opposed to the obligation to submit certificates by the suppliers, the lead time for contracting between them and capacity providers is voluntary. In the case of ex-post obligation systems or ex-ante obligation system with short lead-times, there are concerns about the ability of the system to provide an adequate signal for new investments\(^10\). In regard to contract duration, for long-term price signals to arise, which might be needed for new investments in capacity, capacity providers would need to voluntarily trade long-term contracts with suppliers. Proponents expect that longer term contracts will emerge from the market – but committing to longer term contracts might be difficult for suppliers competing with each other and for suppliers who do not necessarily have a guaranteed need for certificates at a fixed price over very long time horizons like 10-15 years. If longer term contracts do not develop, sufficient investment in new capacity might not occur. The expectation of sufficient revenues from the (energy and/or capacity) market is the precondition for investment. A capacity market should help to mitigate the risks of being dependent on extreme energy prices in an EOM. It should not necessarily result in a guaranteed price for a long period. All proposals for decentralised markets so far contain a back-up provision for a supplementary measure to foster investment as a safety net\(^11\). As a consequence, there is a central entity ensuring long-term system adequacy.

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\(^9\) In an ex-ante obligations system, the deadline for certificates deposit plays a very similar role to the lead-time in central auction systems, and also implies that a forward capacity market is created.

\(^10\) These concerns might also arise in capacity auctions with short lead-times and contract duration. However, typical auction designs already take into account these issues by fixing suitable timings.

\(^11\) For example, this could be in the form of a tender for new capacity in France. For more details, see the French Decree 2012-1405, 14 December 2012, article 22 and 23 about “Dispositif de sécurisation”.
b) Capacity auctions

Under this option, long-term system adequacy is ensured by a centralised capacity market for firm capacity (generation, storage and demand response) based on fixed payments that represent a price for capacity (€/MW) resulting from an auction. The amount of firm capacity to be procured is determined by an overall desired level of security of supply, for a given period of time, to be set by a centralised body. The product could be defined as a provision of firm capacity in the moments close to scarcity in the system. Participants in the capacity auction will estimate their own firm capacity during the periods of scarcity and then bid according to their valuation in the auction. Those who are cleared will receive revenues from the marginal price of the auction (€/MW) on top of the incomes obtained for the energy and flexibility they sell in the market.

A penalty mechanism should be applied to capacity providers that, at scarcity moments, fail to have available the firm capacity they committed. The penalty mechanism should preferably be based on market prices.

If penalties are based on market prices, the system may be based on centrally organised reliability options where capacity providers sign one-leg contracts for difference with the TSO: whenever the spot market price (day ahead) is above an agreed strike price (which itself indicates that the system is tight), the seller of the reliability option will have to pay the difference between the market price and the strike price to the buyer (TSO) of the option. Unavailability at such a tight moment, and even more, lack of delivery at such a moment will thus be strongly penalised financially. An annual or monthly cap on penalties could be considered.

The auctioned capacity payments will be passed on to all consumers, e.g. in relation to their peak load. Fair distribution mechanisms should be provided so that all suppliers contribute on an equal basis to the costs of the system.

As to contract length, in a capacity auction system, the regulator can provide long-term stability by setting a long duration in the capacity auction. As a general principle, market mechanisms should be non-discriminatory. However, most existing central capacity mechanisms give longer periods of fixed revenues for new investments and/or refurbishments than for existing assets. This different treatment has been accepted by the EC on the grounds of allowing for financing of new capacity. The longer duration should be equal for all new capacity. The design of centralised models allows integrating long-term commitments from their “start”; it is then up to the participants in the auction to choose between shorter (keep an existing plant open or provide demand response) or longer (new build, refurbishment and existing plants that expect longer contracts) commitments.

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12 EURELECTRIC does not believe that decentralised reliability options, with contract by contract determined strike prices, expiration times, contract durations, etc., are well designed alternatives to a capacity auction model or to a decentralised obligation model, as they lack sufficient strongly determined elements to achieve the goal of adequacy of the system. However, market players should be free to create a secondary market to a central reliability option market to find ways to hedge their positions financially. The original seller of the reliability option however should remain financially reliable to the TSO (the buyer), and in such a mechanism, the TSO will probably add some physical underlying requirements to ensure the system adequacy on the seller, which in turn will reflect this obligation (in financial terms or physical terms) in his second hand trading.

13 The UK centralised capacity market foresees a 15-year agreement with new generators and 3 years for major refurbishments.

14 See the published version of the decision on http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=3_SA_35980
Cross-border participation as a stepping stone to regional models

Investment decisions might be distorted if poorly designed capacity market models are implemented without coordination on a regional level. Any design leading to suboptimal investment in capacity, at least at a regional level, should be avoided. The implementation of capacity markets should thus move away from today’s national piecemeal approach.

Instead, capacity markets should result from a coordinated effort to trigger the right level of investment/decommissioning decisions in order to reach the security of supply objective of the different zones at the least cost on a regional basis. To guarantee this evolution, the European Commission should push for harmonised solutions and Member States should, at the very least, coordinate among themselves and adopt market-based mechanisms that allow cross-border participation. Ideally, the preferred approach would be to adopt the same model at regional level.

In any case, trust must be reinforced in article 4.3 of the Security of Supply Directive (2005/89/EC) when it states that “in taking the measures referred to in Article 24 of Directive 2003/54/EC and in Article 6 of Regulation (EC) No 1228/2003, Member States shall not discriminate between cross-border contracts and national contracts.” Capacity markets are implemented as contracts, and should therefore fall under this article.

Cross-border participation and a seamless cooperation of TSOs will be the cornerstone of any market design adjustments. Capacity markets should be taken into consideration wherever needed. Cost-benefit analysis of interconnectors should take into account their value revealed in energy, flexibility and capacity markets. Network codes should be in line with the Security of Supply Directive. In particular, they must forbid TSOs to impede, either directly or indirectly (e.g. by reporting low interconnection capacity) firm capacity providers from honouring their commitments under capacity market contracts, delivering energy to the system relying on that capacity. Current draft Network Codes actually allow these practices if TSOs declare an alert or emergency state in their systems. Appendix B proposes amendments to the Emergency and Restoration and the Capacity Allocation and Congestion Management Network Codes, intended to ensure reliable provision of firm capacity by foreign providers.

EURELECTRIC has carried out an analysis of the different models for implementing cross-border participation of capacity markets. We propose a model where the capacity provider is the one responsible for offering cross-border capacity and where availability is the product being traded across the border.

The choice of model for active cross-border participation hinges on two fundamental options: who is allowed to participate in cross-border transactions (capacity provider or interconnector) and which product is traded (availability or delivery) – see Figure 2.
EURELECTRIC supports Model A where the cross-border capacity provider sells availability, with the interconnector getting paid for the “congestion rent”. This model minimises energy market distortions, in contrast to Models B and D, while guaranteeing that market agents, and not regulated entities, participate in the capacity market, in contrast to Model C. Delivery as a product, as in Models B and D, has the potential to distort the energy market by forcing delivery of energy that could otherwise be out of the merit order. The main drawback of Model C is also that interconnectors (in many cases owned by TSOs) participate in the capacity market in competition with market participants.

In developing Model A, EURELECTRIC believes that a set of key principles for cross-border participation in capacity markets should be respected:

- Common requirements and coherent market rules for all capacity market participants (e.g. certification, penalty regime, availability requirement, etc.);
- Participation with the same capacity in more than one capacity market for obligations in the same timeframe should not be possible (no double commitment and earnings);
- TSOs should offer a certain amount of cross-border participation based on non-discriminatory conditions and only limited by objective physical limitations (to be approved by National Regulatory Authorities and ACER);
- TSOs should not be allowed to neglect existing cross-border capacity contracts (Appendix B) in situations of system stress;
No reservation of cross-border capacity should be introduced in order not to interfere with the functioning of the forward, day-ahead, intra-day and balancing markets, which will determine the actual direction of the energy flow.\(^\text{15}\)

Preliminary indicative roadmap

**INDICATIVE ROADMAP TO A EUROPEAN CAPACITY MARKET:**

*A parallel Approach*

- **Integration at European level**
  - 2022-25
- **Coordination between regions**
  - 2018-23
- **Development within regions**
  - 2015-19
- **Several national capacity mechanisms**
  - 2014-19

\(^{15}\) However, technical price limits should be harmonised in order for capacity markets to be compatible with the Target Model, and the Target Model itself brought to completion. Alternatively, specialised transmission obligations that do not interfere with normal market operation should be explored.
Appendix A: On VoLL and reliability standards

Traditionally the way of setting a socially optimum adequacy level of has been for the regulator to establish a reliability standard. There are several possible ways:

- Firstly, it could be required a certain generation margin over the maximum expected load (e.g. generation capacity and demand response should exceed by 10% maximum load). The figure is known as the Reliability Margin (RM). It should take into account that certain generation technologies are more reliable than others (e.g. a thermal power plant is more reliable than an intermittent uncontrollable one). It may also consider flexible demand and interconnection capacity with neighbouring systems. On the pro side, it is a simple number to compute in a transparent manner. However, the RM of systems having very different generation and demand structure are difficult to compare. Ultimately it is also a very simplistic way to quantify the underlying problem (possible or actual blackouts or brownouts). For these reasons it is rarely used in academic discussions, although it is provided by most SOs, including ENTSO-E.

- A second popular possibility is by setting a probability of losing load: the Loss of Load Expectation (LoLE), also known as Loss of Load Probability (LoLP). A typical value might be three hours per year. On the pro side, it is a number relatively easy to compute for thermal dominated systems\textsuperscript{16} following standard engineering techniques. It is also closer to an accurate quantification the underlying problem. However, it does not differentiate big blackouts from small system incidents: in both cases load is lost and contribution to LoLE is the same.

- A way to correct this is by computing the Expected Unserved Energy (EUE), also known as Loss of Expected Energy (LoEE). This is the expected demand (MWh) that will not be served in a given period (e.g. 0.003% or 10 MWh in 1 year). It is arguably the more used index in theoretical discussions. It is also generally the most difficult number to compute.

These have been used since long in power system planning. Typically, they are computed several months or even years in advance (e.g. EUE in MWh/yr for the system operating during 2017 as computed in 2014). There is, however, nothing that prevents to compute them in shorter timeframes and with different lead times. A clear illustration is provided by the old English pool. LoLP was computed for each half hour when clearing the day-ahead market. Half-hourly LoLPs make up a volatile series. The figure shows capacity payments that were proportional to these computed LoLP values.

\textsuperscript{16} Not so for hydro systems.
These standards assume that demand is perfectly inelastic\textsuperscript{17}. Actually, inelastic demand must be assumed if curtailment is to happen: otherwise prices should rise up to the point that enough demand exits the market in order to clear generation. In other words: the curtailed demand implied by the traditional approaches is price inelastic demand.

Inelastic demand only makes economic sense if demand value is extremely high. On the other hand, consumers, even those whose demand is assumed to be inelastic, put a certain value on electricity. This reservation price set on energy consumption should be logically equal to the cost of not serving energy. This is why is often known as the \textit{Value of Lost Load (VoLL)}. Absent markets with active demand participation, the VoLL must be estimated through indirect methods. This is actually the case for most domestic consumers and also for huge swaths of non-domestic ones in many jurisdictions. There is considerable literature on this topic that generally fails to provide consistent and coherent figures. Nonetheless, there is a shared consensus on the following facts:

- Different customers may have very different VoLL.
- The same customer may have different VoLL at different times (e.g. during an important football match broadcasted by TV as opposed to other periods).
- The VoLL depends on the lead time with which a possible curtailment is announced, as possible compensatory measures might be undertaken.

\textsuperscript{17} With the possible exception of a small amount of flexible, price-responsive demand.
Stated all of the above, the VoLL should in principle set the reliability standard. That is, a higher VoLL should translate in a better reliability standard (e.g. lower LoLP o EUE). Working in the opposite direction, from a specific standard value an implied VoLL may be computed. Note that most countries that communicate LoLP targets have price caps that are not in line with the implied VoLL: indeed a LoLP of 3 hours would actually correspond to a VoLL of about 30000 €/MWh\textsuperscript{18}, while the administrative price caps are only set at 3000 €/MWh on power exchanges.

Whereas this computation is quite interesting, its use is also fraught with perils. The bottom line is that a largely unknown quantity (VoLL) is compared with a very difficult to compute one (the slope of the Cost/EUE curve). Specifically, EUE as computed by models can be significantly different from “real” EUE. For instance, all models assume a certain time granularity that may hide scarcity events (e.g. having enough average capacity during two hours may result in scarcity during the first hour if first hour demand is significantly higher than that during the second one).

As an another example working in the opposite direction, most models do not consider quality degrading measures as lowering transmission voltages that do decrease aggregate consumption, at a cost difficult to quantify.

Another relevant and unrelated issue is that, for a variety of reasons, regulators may decide that “social VoLL” is different and possibly higher than “customers VoLL”.

In any event, whatever reliability standard is chosen, Regulators and TSO should compute it with methodologies and tools that are publicly available.

\textsuperscript{18} Assuming that an investment would require approximately 90.000 €/MW/Y
Appendix B : Amendments to the draft Network Codes

Draft Network Code on Capacity Allocation and Congestion Management

<table>
<thead>
<tr>
<th>Article</th>
<th>Latest publicly available text (version of 29/07/2014)</th>
<th>EURELECTRIC amendments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Art. 69.1</td>
<td>In the event of force majeure or an emergency situation referred to in Article 16(2) of Regulation (EC) No 714/2009, where the TSO shall act in an expeditious manner and redispachting or countertrading is not possible, each TSO shall have the right to curtail cross-zonal allocated capacity. In all cases, curtailment shall be undertaken in a coordinated manner following liaison with all directly concerned TSOs.</td>
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</tr>
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<td>Article</td>
<td>Initial ENTSO-E Text</td>
<td>EURELECTRIC amendments</td>
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</tr>
<tr>
<td>Art. 11.2</td>
<td>[...] Each TSO shall announce and duly prepare any manual opening of an interconnector in coordination with neighbouring TSOs, ensuring that this action will not endanger the remaining interconnected system.</td>
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</tr>
<tr>
<td>Art. 11.4</td>
<td>[...] Each TSO shall provide through HVDC Interconnectors any possible assistance, provided it does not endanger its own system, upon request from a neighbouring TSO in Emergency State.</td>
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<td>Art. 17.1</td>
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</tr>
<tr>
<td>Art. 18.5</td>
<td>Assistance for Active Power shall be firm, unless the TSO providing the said assistance enters into Emergency or Blackout States.</td>
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</tbody>
</table>
EURELECTRIC pursues in all its activities the application of the following sustainable development values:

Economic Development
- Growth, added-value, efficiency

Environmental Leadership
- Commitment, innovation, pro-activeness

Social Responsibility
- Transparency, ethics, accountability