Electricity Security of supply and Capacity Remuneration Schemes

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Introduction

Europe has enjoyed a secure electricity supply for decades associated with very high grid security standards. In the context of liberalisation and the creation of a European electricity market, security conditions underlying the supply of electricity need to be reconsidered.

Security of European interconnected systems also needs to be forecasted in light of the decommissioning of electricity generation assets (equivalent to 150 GW of thermal capacity[1]) and the growth in the share of renewable energy sources in electricity generation that is projected to reach 45% in 2030, according to the European Commission's 2030 energy package.[2]

European legislation on Security of Supply (Directive 2005/89[3] or Security of Supply Directive) sets forth a general definition of security of electricity supply - "the ability of an electricity system to supply final customers with electricity" - and provides the foundations of security of supply at Member States' level, based on a long term projection of electricity generation capacity and demand estimates (generation adequacy plans).

European legislation also requires cooperation and transparency between Member States in the field of security of supply. Under the Security of Supply Directive (Article 4.3[4]) cross border trade of electricity and any restriction to cross border flow shall not be used as a way to guarantee capacity or the flow of energy for national security purposes[5]. The Third Package Legislation 714/2009 provides an additional basis for coordination of cross border interconnections between Member States[6].

This Hot Energy Topic addresses the stakes related to EU electricity security of supply. It reviews general characteristics of capacity remuneration schemes and puts into perspective existing national developments (balancing obligations, capacity mechanisms,

[1] "A European Energy Only Market in 2030", Stattnet Report, October 2015.
[2] SWD 2014/15 Final: "A policy framework for climate and energy in the period from 2020 to 2030"
[3] Directive 2005/89/EC of the European Parliament and of the Council, of 22 June 1998, concerning measures to safeguard security of supply and infrastructure investment, OJ 2006/L 33/22 of 4 February 2006
[4] Art 4.3: "Member States shall not discriminate between cross-border contracts and national contracts"
[5] "Capacity Remuneration Mechanisms in the context of the European internal energy market", Paolo Mastropietro, Pablo Rodilla, Carlos Batlle, April 2014
[6] Art16.1 for instance states that "Network congestion problems shall be addressed with non-discriminatory market based solutions which give efficient economic signals to the market participant and transmission system operators involved". Art 16.3 provides that maximum capacity made available at cross border level shall comply with safety standards and secure network operations.

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strategic reserves) in France, Portugal, Italy, Germany, Poland, Netherlands and Croatia. It illustrates cases of regional coordination in relation to electricity security of supply policies[7].

Security of Electricity Supply definitions

Security of electricity supply is the ability of the electrical power system to provide electricity to end-users with a specified level of continuity and quality in a sustainable manner, relating to the existing standards and contractual agreements at the point of delivery. Security of electricity supply derives from the interaction of several factors as shown in Figure 1.

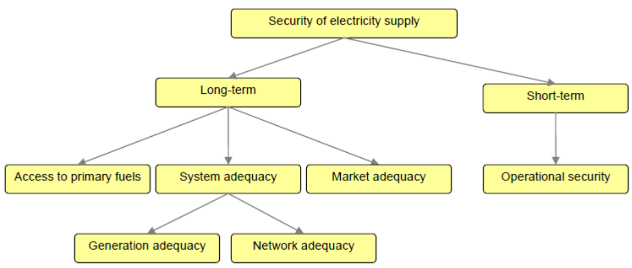


Figure 1. Security of supply – main factors – Source: Eurelectric

There is a clear distinction between long-term and short-term security of electricity supply.
Short-term security of electricity supply refers to the **operational reliability** of the system as a whole and its assets, including the ability to overcome short-term failures of individual components (generation facilities, power lines, grid equipment, etc) of the system. Operational reliability also refers to specific cases where system security is threatened by grid related physical congestions[8]. Cross border trade at interconnections are often areas of congestions. A significant share of the physical capacity is kept as a precaution or safety margin for possible outages and loop flows (Transmission Reliability Margin)[9]. Additionally, the commercial capacity at cross-border (Net Transfer Capacities, NTC) can be reduced due to internal congestion inside national borders. A number of specific cross-border connection points where congestion can frequently occur have been highlighted by ACER (Agency for Cooperation of Energy Regulators)[10].

Long-term security of electricity supply is the simultaneous **adequacy of access to primary fuels, generation, networks and markets**. Access to primary fuels means that electricity producers are allowed to choose freely from primary energy sources[11]. System adequacy is the ability of the electricity system to convert primary fuels into electricity and transmit that electricity to end-users in a sustainable manner[12]. It consists of generation adequacy (Annex 1) and network adequacy. In the long run (> 10-15 years), the electricity system needs to be able to provide sufficient electricity to meet demand at all times and in all parts of the system[13],[14]. In most cases, long-term security of supply depends on market design and on business decisions of investors[15]. Regarding the issue of market design, Insight_E research on power plant dispatch at EU level shows that the integration of renewables may lead to lower remuneration

[7] Relevance of established bidding areas for European power market integration – an approach to welfare oriented evaluation, Frontier, Consentec, October 2011
8. Physical congestion means any network situation where forecasted or realised power flows violate the thermal limits of the elements of the grid and voltage stability or the angle stability limits of the power system.
[9] Difference between the scheduled and actual power flow
[10] ACER Market Monitoring Report 2015, November 2016, Page 153
[11] Fuels: Coal, natural gas, petroleum, uranium
[12] Security of Electricity Supply, Roles, responsibilities and experiences within the EU, Eurelectric, 2006
[13] Hot Energy Topic : Electricity Market Design
[14] ITRE Market Design Report
[15] Security of Electricity Supply, Roles, responsibilities and experiences within the EU, Eurelectric, 2006

of conventional power plants[16], preventing the formation of an electricity rent, i.e. a contribution margin component reflecting a price signal to support long-term investments in new facilities or refurbishment. This is why in the context of generation adequacy, Capacity Remuneration Mechanisms (CRMs) are discussed as a supplement to Energy Only Markets (EOMs). An Energy Only Market (EOM) procures the remuneration of an energy component (kWh) on the wholesale electricity market under different time-scales. Both CRMs and EOMs constitute different forms of electricity market designs[17].

Who is concerned?

Different system and/or market actors may be involved in situations of inadequate or deteriorating security of electricity supply.

Directive 96/92 'Common rules for the internal market in electricity' - Article 7 - provides Transmission System Operators (TSOs) with the responsibility to ensure real-time balancing of the system**. TSOs** should undertake transparent network planning, monitor and report system adequacy in order to facilitate the functioning of the market, ensure real-time balancing, and maintain adequate transmission reserve capacity[18]. In the case of occurrence of scarcity at the same time in two neighbouring countries, the situation is dealt with using operational measures (redispatch, remedial actions) inside national borders or across borders, possibly involving a coordinated action of TSOs.

Generators should fulfil contractual obligations towards customers and networks, provide data for monitoring, abide by corresponding market rules and provide ancillary services under market conditions.

Consumers should participate in demand response programmes. As market participants, they should be able to use available instruments in the market fairly and to their best advantage[19].

Demand and storage participation in ancillary services - Country Cases:

Demand response and storage are allowed to participate in ancillary services including emergency (milliseconds to minutes) in the following countries: Belgium and Denmark (Tertiary Frequency Control), Italy (instantaneous interruptible services management and emergency programs) and Germany (Virtual Power Plants serving in reserve or balancing market).

CRMs – Main characteristics

Capacity remuneration mechanisms are generally introduced to overcome one or more shortcomings of energy only markets. As the name suggests, CRMs foster investments into new generation capacity[20].

EU Commission guidance on public intervention provides Member States the possibility to implement a CRM if there is evidence that the new scheme will support security of supply (generation adequacy) and is "technologically neutral" i.e. open to alternative options, such as demand response,

[16] Rapid Response Energy Brief, Quantifying the "merit-order" effect in European electricity markets, Insight_E, Paul Deane, October 2015
[17] Rapid Response Energy Brief, Electricity market design options for promoting low carbon technologies, Insight_E, Rupert Hartel, KIT, April 2015
[18] Article 7 – Directive 96/92 Common rules for the internal market in electricity

[19] EC public consultation on risk preparedness in the area of security of electricity supply, Eurelectric, 2015
[20] RES integration and market design: are Capacity Remuneration Mechanisms needed to ensure generation adequacy, Eurelectric, 2011

interconnections and storage[21]. European legislation therefore recommends demand response or storage units to be activated as sources of flexibility to complement intermittent generation.

CRMs are clustered as volume based schemes (capacity auction, subscription, obligation, reliability option, capacity reserves) and price based mechanisms (capacity payment). Capacity reserves allow covering fixed/variable costs independently from the EOM. They all include the oversight of TSOs and/or NRAs in setting either volumes (capacity reserves) or the objective (adequacy, Loss of load expectation), envisaged under a market instrument. (See Annex 4)

National CRMs – Case examples

Decentralized capacity obligations: France

France is planning the introduction of decentralized capacity obligations[22],[23],[24] in 2017. Under this scheme, each supplier of electricity to the French market is under an obligation to hold a certain amount of capacity guarantees. The necessary amount is calculated each year (by RTE, the TSO), based on the peak consumption of the supplier's clients[25]. Until a specified date (set yearly by RTE) the capacity guarantees can be traded. Operators of the certified capacities will be subject to a penalty to the cost of building a new capacity. The capacity obligation framework established under decree of the Council of State for application of the NOME law is part of the sector enquiry by DG Comp launched on 29th April 2015[26].

Capacity Payment Schemes: Italy and Portugal

Italy introduced targeted capacity payments for dispatchable generators in 2003[27]. Each year, the Italian operator for electricity transmission (Terna) assesses the critical periods in which additional generation capacity is expected to be required, and selects the providers that are offering their power capacity in critical periods. In case a provider fails to generate the offered capacity, the Italian NRA (AEEGSI) can impose a fine ranging from 25,000 EUR/MW to 50,000 EUR/MW[28]. The cost of the capacity mechanism is borne by the end consumers through the electricity bill. AEEGSI also recognizes the importance of long-term price signals in order to ensure security of supply[29] and has introduced reliability options based on centralized auctions to start in 2019/2020.

Portugal introduced capacity mechanisms in 2010 operating two targeted capacity payment schemes. An 'availability incentive' scheme remunerates thermal plants for their availability; an 'investment incentive' scheme aims to incentivise investments in new hydro

[21] Generation Adequacy in the internal electricity market - guidance on public interventions {C(2013) 7243 final}

[22] http://legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000026786328&dateTexte=&categorieLien=id

[23] http://legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000023174854&dateTexte=&categorieLien=id

[24] A capacity Market in France, RTE, http://publications.elia.be

[25] Recent EU Developments on Capacity markets, Fabio Genoese, March 2015

[26] France Interim Report - {SWD(2016) 119 final}

[27] http://www.sviluppoeconomico.gov.it/images/stories/normativa/decreto_approvazione_capacity_payment.pdf

[28] Capacity mechanisms: Reigniting Europe's Energy Markets, Linklaters, 2014, linklaters.com/capacity mechanisms

[29] http://www.eurelectric.org/media/169068/a_reference_model_for_european_capacity_markets-2015-030-0145-01-e.pdf

generation and in the repowering of existing pump storage units.

Eligible power plants can only benefit from these incentives if they comply with a minimum coefficient of final availability ("Cdf"). The Cdf also determines the annual incentive amount to be awarded. If a power plant subject to availability tests fails to reach a certain value of hourly average power, a penalty is applied depending on the degree of the failure in relation to the Cdf[30].

Strategic Reserves: Poland and Germany

Poland has been operating a fully-fledged targeted capacity mechanism (strategic reserve) since January 1st 2014. A strategic reserve comprising 830 MW of generation capacity ('cold contingency reserve') is created for two years starting in 2016 (possibly extended for an additional two years). Capacity providers in the strategic reserve are allowed a number of planned outages (up to 1440 hours in every two consecutive years, additionally up to 360 hours each year before any penalties are due). However, the demand response-specific capacity mechanism remunerates demand only if actual curtailments are carried out by the TSO (i.e. per MWh payments instead of per MW payments). Moreover, during actual scarcity periods, the TSO can curtail demand administratively (without remuneration) rather than through the mechanism.[31]

Germany: A capacity reserve decree was passed in June 2016. The capacity reserve (also called Winter reserve) is situated outside of the energy only market. Similar to petroleum or gas strategic reserves used as power plant fuels, these reserves are deemed to be activated under specific circumstances ie scarcity circumstances if the day-ahead market cannot be cleared. Additional costs are accounted as grid costs for end – users. Strategic reserves have been used in other countries like Sweden (tender for targeted resources R4 reserves). The capacity reserve deals with bottlenecks, grid stability, and redispatch.

Capacity tender: Croatia

Since the sector enquiry on capacity mechanisms, Croatia has not implemented any capacity mechanism. However, Croatian authorities notified a tender for new capacity launched by the State owned electricity company. Discussions between the Commission and Croatian authorities are ongoing on whether this measure should indeed be considered a State backed capacity mechanism.[32]

CRM sceptics: The Netherlands

Netherlands developed a strategic reserve model in 2003 but does not yet apply it[33]. The Dutch government is of the opinion that capacity mechanisms are a "second-best" option. Furthermore, it indicated that it should be assessed, whether alternative market-based mechanisms to ensure security of supply such as demand response can be implemented as in other Member States. The extension of interconnection capacity[34], bearing in mind the highly interconnected level of the Dutch electricity market and the impacts from surrounding markets[35], is another option.

[30] http://linklaters.com/pdfs/mkt/london/6883_LIN_Capacity_Markets_Global_Web_Spreads_Final_1.pdf
[31] Interim Report of the Sector Inquiry on Capacity Mechanisms, SWD(2016) 119 final, April 2016
[32] Interim Report of the Sector Inquiry on Capacity Mechanisms, SWD(2016) 119 final, April 2016
[33] The rise of the capacity mechanisms: are they inevitable in the European Union?, Royal Institute for International Relations, September 2015
[34] Capacity Mechanisms in the EU Energy Market: Law, Policy and Economics, Oxford, September 2015
[35] Projections of the price of wholesale

Regional Cooperation

In line with the third legislative package, the EU network codes are based on regional cooperation between TSOs and remedial actions in case of emergencies[36]. Regional cooperation is crucial - it can ensure uninterrupted energy supplies and affordable prices for consumers. Regional cooperation will help achieve EU-wide market integration and further contribute to unlocking the full potential of renewables in the energy system.

The IGCC (International Grid Control Cooperation)[37] is an initiative aimed at integrating balancing reserve markets over different control areas. The initiative was raised by German TSO's under the German Grid Control Cooperation[38]. IGCC mainly relates to the operation of thermal generation units and provides ways to activate shared reserves (secondary control reserves) in situations of occurrence of peak demand in different hours in neighbouring countries.

Cross border participation and regional cooperation

Cross-border participation and a seamless cooperation of TSOs will be the cornerstone of market design adjustments. Cross-border participation in capacity markets should be seen as a stepping-stone towards regional capacity markets. It should therefore be established quickly. There are a number of possible approaches to include cross-border participation in capacity mechanisms:

- taking into account the statistically likely contribution from interconnectors,
- allowing actual cross-border exchange of capacity/foreign participation,
- harmonising and coordinating national capacity mechanisms,
- implementing an EU-wide capacity mechanism[39].

Interaction of CRMs with cross-border capacities

Mechanisms for achieving security of supply are just starting to develop throughout regional cooperation. However, if capacity mechanisms are not designed properly, they can distort cross border trading, as illustrated in the Russia - Finland case.

In 2011, major reforms in Russia liberalised the electricity sector, including the implementation of a capacity market to attract investment in new generation. However, following its implementation, Finnish stakeholders observed unprecedented trading patterns on the Russia - Finland interconnector with significant impacts on spot prices in tight periods. A detailed assessment of the interaction between the two neighbouring markets showed that the capacity market rules in Russia were hindering cross-border electricity trade between the Nordic and Russian markets despite the fact that the price spread between the two markets should have justified cross-border trading. The reason for these reductions in exports was that during certain daytime hours on weekdays, the capacity market in Russia incentivised participants to reduce exports in order to avoid capacity costs in the Russian system.[40]

electricity in the Netherlands, Pöyry Management Consulting, July 2015

[36] ENTSOe- Operational Network Codes: Operational Security Network, Operational Planning & Scheduling , Load Frequency Control & Reserves, Operational Procedures in an Emergency

[37] Denmark, Netherlands, Swiss, Belgium, Austria, Germany, Czech Republic, France

[38] Regelleistung.net,www.regelleistung.net

[39] Renewable energy and security of supply: Finding market solutions, Eurelectric 2014

[40] Capacity mechanisms. Reigniting Europe's energy markets, Linklaters, 2014

Regional adequacy assessment: BEMIP case study

The Memorandum of Understanding[41] on the reinforced Baltic Energy Market Interconnection Plan (BEMIP)[42] was signed by Estonia, Finland, Germany, Latvia, Lithuania, Poland, Sweden and Norway (Denmark will sign at a later stage) in June, seeking to end the energy isolation of the Baltic Sea Region and to integrate it fully into the EU energy markets. The countries extended the scope of the BEMIP initiative by adding to the already existing areas of cooperation – internal energy market, interconnections and power generation – new areas, such as energy efficiency, renewables and security of supply[43]. Those countries agreed on working together to enhance regional cooperation on risk assessment, including a regional system for security of supply adequacy assessment and emergency preparedness. In the first stage, the work will concentrate on regional system and security of supply adequacy assessments in the electricity sector. Representing a region that is highly vulnerable to potential gas disruptions, based on the principles of solidarity, the interested parties agreed to put in place a consistent preventive strategy and emergency response systems to address potential disruptions of gas supply — particularly in the power and district heating sectors — and to develop regional preventive action plans and emergency plans. They recognise the potential for increasing security of supply through energy efficiency measures and fuel switching in the heating sector[44].

[41] MoU stands as a bilateral or multilateral agreement between two or more parties. It expresses a convergence of will between the parties, indicating an intended common line of action.

[42] https://ec.europa.eu/energy/sites/ener/files/documents/BEMIP%20Memorandum%20of%20Understanding_2015.pdf

[43] http://europa.eu/rapid/press-release_IP-15-5142_en.htm

[44] https://ec.europa.eu/energy/sites/ener/files/documents/BEMIP_Action_Plan_2015.pdf

Conclusion

The policy measures for security of supply in electricity need to distinguish between the short term and long term. Policy measures envisioned in the form of capacity remuneration schemes need to be complemented by an enhanced cooperation and coordination at regional level.

Capacity Remuneration Schemes: Lessons learnt from national experiences

Strategic reserves referred to in this paper (in Poland and Germany) can be considered as "mid-term" schemes to an endangered security of supply to 2020. Meanwhile, other capacity remuneration schemes (capacity payments) have not been fully adopted; awaiting the "green light" from the European Commission (France, Italy, Croatia – DG Competition Study - (2015) 2814 final). France is planning to implement the first larger CRM scheme in 2017.

Enhanced cooperation and coordination

Cross-border participation and a seamless cooperation of TSOs will be the cornerstone of EU's electricity market design adjustments and, hopefully, one way to ensure coordination in system security procedures for the EU[45].
When it comes to ensuring security of supply, the aforementioned examples of cooperation agreements reflect past experience that a higher level of security of supply can be achieved through cross border cooperation and mutual assistance. Therefore, the degree of solidarity between Member States (managing market based congestion at interconnection levels and reserve response) need to be further defined.

Regional adequacy assessment (for example: common Loss of Load Expectations standards) can be considered an important component of coordination and an area of future research.
Electricity security of supply should also be considered in a wider energy security context encompassing different elements of the fuel mix (notably gas security of supply as shown in the Baltic Energy Market cooperation (BEMIP)).

[45] ACER, Regional initiatives status review report 2015, February 2016

Annex 1: Adequacy Definition & Assessment

Generation adequacy is the availability of enough generating (and import) capacity to meet peak demand. Network adequacy (covering both transmission, distribution and cross-border interconnections) is the availability of sufficient network infrastructure to meet peak demand. Market adequacy means the ability of the market to establish and maintain efficient rules between producers and consumers of electricity.

Generation adequacy refers to different load growth assumptions[46]. It is traditionally performed under deterministic approaches at different load hours. Under this analysis, an increase of intermittent generation leads to reduced operating hours of dispatchable generation and therefore a deterioration of the level of security at generation level[47].

A probabilistic approach is being rolled out by TSOs like RTE in France, Elia in Belgium, Tenett (Netherlands and Germany), Statnett and the Pentateral Energy Forum[48], together with ENTSOe[49]. This approach analyses the distribution and adequacy of generation to cover peak load, and, therefore, provides a more accurate view of hourly distribution. It introduces new types of risks like weather (offshore storms, eclipse) into reserve analysis. It also allows the assessment of long term statistical risks attributed to the unavailability of the fleet of power generation units like phase out schedules in Germany or Belgium[50] or gas supply risk interruption in Central Eastern Europe.

[46] Council of European Energy Regulators, CEER, Assessment of electricity generation adequacy in European countries, March 2014

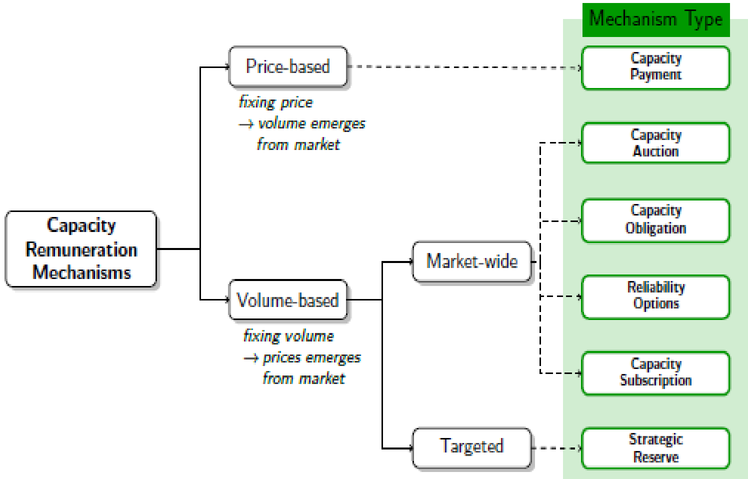
[47] Generation Adequacy Report on the electricity supply-demand balance in France, RTE, Avril 2016

[48] Austria, Belgium, France, Germany, Netherlands – Luxembourg, Switzerland, Netherlands, - Pentalateral Adequacy Probabilistic Assessment – Support Group 2 – March 2015.

[49] ENTSOE – "Mid Term Adequacy Forecasts – 2016" - Event Presentation: https://www.entsoe.eu/Documents/Events/2016/MAF_02_03_04_05_%20Presentations.pdf

[50] Etude de l'adéquation et estimation du besoin de flexibilité du système électrique belge – 2017 – 2027, Elia, Avril 2016

Annex 2: Categorization of Capacity Mechanisms



Source: Hans Perter Höschle, Workshop on Fact Sheets KU Leuven

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Annex 3: Capacity Mechanisms in a sample of EU countries (Source: Ifri)

Country	Capacity Mechanism Categorization	CRM Oversight	Details	Technology	Demand Response Participation	Size	Timing	Objective
France	Capacity Market Obligation	TSO + NRA	Certificate obligation awards		Yes		2017, 2018, 2019	Mitigate growth peak d.
Germany	Capacity Reserve + Strategic Reserves	NRA + TSO	Capacity Reserve (CR) + Strategic Reserves (SR)	Techn. Neutral (CR) + Lignite (SR)	Independant from reserves	4,4 GW (CR) + 2,7 GW (SR)	2019	Phase out lignite generation
Croatia	-	-	-	-	-	-	-	-
Italy	Reliability Options	TSO + NRA	To Start 2019/2020	Techn. Neutral			-	Adequacy
Netherlands	Strategic reserve (not activated)						2003	Promote interconnections
Poland	Operating and Strategic reserves	TSO + NRA	Operating reserve (OR) + Strategic reserve (SR)	Thermal	200 MW contracted	4,15 GW / hour or 18% reserve margin (OR) + 830 MW (SR)	2014	Security of Supply - Allow outages
Portugal	Capacity payments		Available incentive + Investment scheme	Thermal + Hydro / Repowering			2010	Support available thermal generation

Annex 4: Reliability indicators

Under scarcity conditions, it is important to consider the reaction of all system agents to possible supply interruptions. This is measured by reliability standards. These standards can be either capacity related (capacity margins in Sweden, Spain and France) or probabilistic indicators[51]. In the latter case, they measure the acceptance towards a loss of load event (LOLE)[52] or the probability to keep the number of such events at below a certain level. Effective LOLE varies between Member States (three hours/year in Belgium, France and Great Britain). The cost related to electricity supply interruption[53][54] expressed in the Value of Lost Load (VoLL) measured in Euros / MWh[55][56] constitutes an important indicator of security of supply limitations in the system. It also supports investment decisions in transmission lines' reinforcement.

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[51]Loss of Load Expectation (LOLE in %): Defined as the expected number of hours per year for which available generating capacity is insufficient to serve the demand);
Loss of Load Probability (LOLP in %) = LOLE / period; Expected Unserved Energy (EUE in MWh, as an
average amount of unserved energy per year).
[52] "The costs of electricity interruptions in Spain. Are we sending the right signals? ", Linares, Rey, 2012 - Tasgosz and Manson, 2008
[53] "Estimating the socio-economic cost of electricity supply interruption", Abhishek Shivakumar, Insight_E, November 2014
[54] "The Value of Lost Load (VoLL) for Electricity in Great Britain", Final Report for Ofgem and DECC, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/224028/value_lost_load_electricty_gb.pdf
[55] "The costs of electricity interruptions in Spain. Are we sending the right signals?", Pedro Linares, Luis Rey.
[56] Trengereid (2003)