Vulnerability in the utility industry: perspective, experiences and lessons from the European Union[1]

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Abstract

The European Union is taking initiatives to increase its security of supply, reduce operational vulnerabilities and respond to the threats. This article presents examples, with a focus on the Risk Preparedness Regulation, and the Baltic synchronization plan.

European Union energy crises

The extreme cold spell that hit the southern part of the United States and northern Mexico in February 2021 resulted in disruptions of gas supplies, massive electricity blackouts and interruptions, and destructions of water systems especially in the State of Texas. The events provided a sharp reminder of the vulnerabilities of our infrastructures, especially to extreme events.

The European Union (EU) is no stranger to major incidents on its security of energy supply. Prominent examples are the Russia – Ukraine gas disputes which on occasion led to disruptions of Europe's gas supply: one of the most significant disruptions occurred on January 2009, when Russian gas flows to the Ukraine and the EU were stopped after a trade dispute between Gazprom and the Ukrainian company Naftogaz, depriving EU Member States of 20% of their gas supplies in coincidence with a cold spell in many parts of Europe.[2] Another major gas incident occurred in 2017, when an explosion at a major European gas hub in Baumgarten, Austria, caused several neighbouring countries issuing early warnings or declared a state of energy emergency.

Regarding electricity, most of the transmission grids in Continental Europe are electrically connected to operate synchronously at the nominal frequency of 50 Hz (see Figure 1). On 8 January 2021, the Continental Europe synchronous area was separated into two regions (see Figure 2). According to the interim report on the event elaborated by the European Network of Transmission System Operators for Electricity (ENTSO-E, 2021), the separation event was triggered by a disconnection in the Ernestinovo substation in Croatia (by overcurrent protection) at 14:04 CET. This led to outages of several transmission network elements in a very short time, resulting in the separation of the Continental Europe synchronous area in two synchronous areas: a North-West one with a surplus of load (frequency decreased) and a South-East area with a surplus of generation (frequency increased). The event caused the activation of several automatic and manual countermeasures aimed to stabilize and speed-up the resynchronisation of the system. These included the activation of system protection schemes, activation of reserves, activation of interruptible services in France and Italy, disconnection of non-conforming generation, loads and network elements and countertrading measures. While the resynchronisation of the system occurred about an hour later at 15:07 CET, nevertheless, the incident

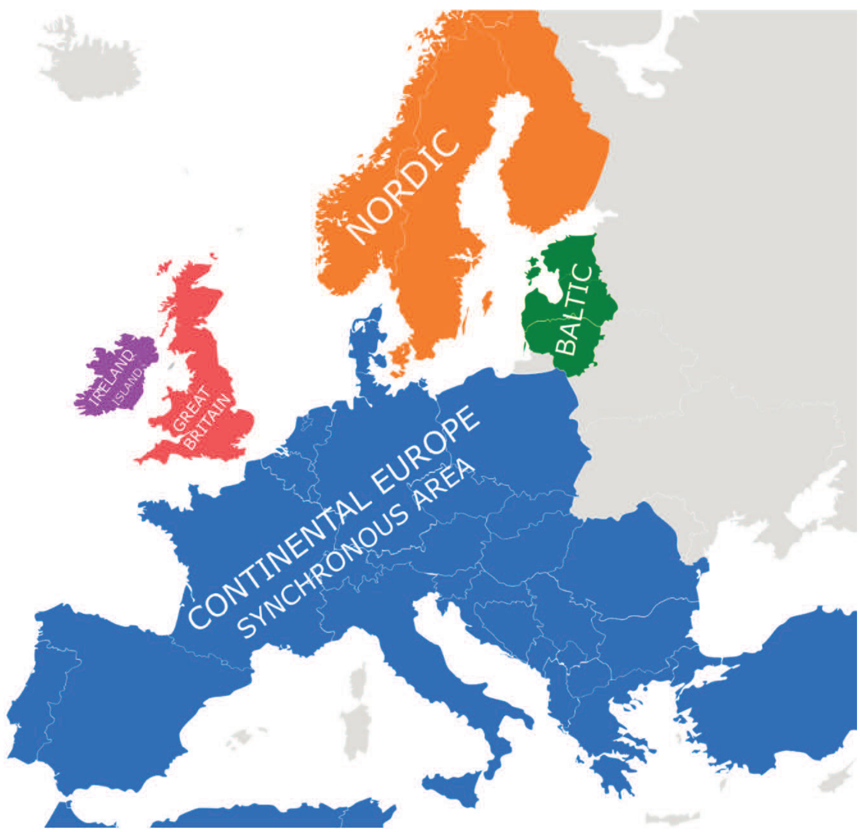

Figure 1. Synchronous power grids of Europe - the Baltic power system is part of the larger BRELL (Belarus, Russia, Estonia, Latvia and Lithuania) power grid. Source: JRC elaboration of ENTSO-E data.

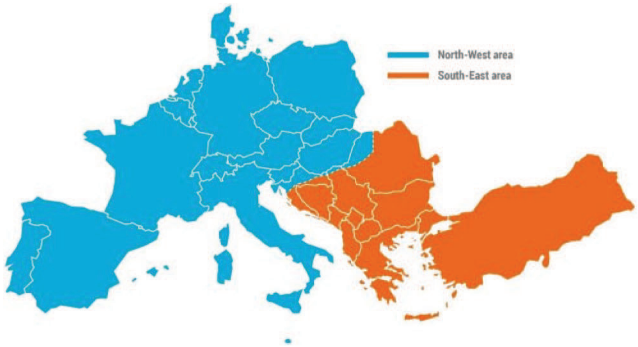

Figure 2. Separation event of 8 January 2021. Source: ENTSO-E (https://bit.ly/3g2BaOb)

resulted in discomfort for several European customers such as localised blackouts in some regions such as North-West Romania.

During the same period of the cold spell in North America (February 2021), a comparable incident occurred in Athens, Greece (and its suburbs), where extreme snowfall caused around 1500 trees, and heavy branches, to collapse on power lines resulting in weeklong blackouts and problems in water systems (frozen pipes that broke etc.). While originally the blame was solely put on the unusual high quantity of snow and the overlapping responsibilities for the clearing of trees around and above the lines, ex-post the National Observatory of Athens published an analysis where they argue that Athens experienced 'wet snow', a rare phenomenon for the area which usually experiences 'dry snow' (Meteo, 2021). Wet snow is about seven times heavier than dry snow (30 kg/m^2 versus 4 kg/m^2) and about four times heavier than normal snow (about 12 kg/m^2). Thus, the heavy snowfall of heavy snow led to the collapse of hundreds of trees catching the authorities by surprise.

In what follows, we provide some examples of how the EU is responding to the various threats and a more in-depth analysis of the Risk Preparedness Regulation, and the situation in the Baltics.

European Union initiatives

The EU aims to be climate neutral by 2050, as part of its obligations stemming from the Paris Agreement. To achieve this ambitious goal, the European Commission (hereafter, the 'Commission') launched in December 2019 the European Green Deal, a comprehensive policy package which also outlines investments needed and financing tools available and explains how to ensure a just and inclusive transition.[3]

This plan will rely on a steady increase of renewable energy sources (RES) and with the participation of various actors in the Internal Energy Market: decentralised markets with more players, better interconnected systems, etc. In this context, uncertainties and **vulnerabilities can potentially increase,** especially given the adoption of innovative technologies, changes in electricity demand, (hybrid) threats, etc.

To mitigate such risks, decrease the impact of events and for increasing resilience, several legislative, regulatory and policy initiatives have been taken at the EU level and more are to follow. Examples include the System Operation Guideline,[4] the Trans-European Networks for Energy (TEN-E) policy focused on linking the energy infrastructure of EU countries,[5] the measures to safeguard the security of gas supply,[6] the recent proposal from the Commission for a Directive on the Resilience of Critical Entities which would consider a variety of systems (energy, transport, water etc.), facilitate the coordination of responses and the calculation of cross-border and cross-sector risks,[7] and other tools. All policies are in coordination with the national plans and actors, while highly specialised European stakeholders and agencies facilitate their drafting and implementation. These include the ENTSO-E and ENTSOG (gas) established in 2008 and 2009 respectively, the (decentralised) EU Agency for the Cooperation of Energy Regulators (ACER) established in 2011, the European Climate, Infrastructure and Environment Executive Agency (CINEA), and others.

While measures are being constantly adopted to avoid risks, for several years the EU has also been promoting **increasing resilience,** which the Commission originally defined as *"the ability of an individual, a household, a community, a country or a region to withstand, adapt and quickly recover from stresses and shocks"*.[8] In effect, as not all events are avoidable, one must be ready to bounce back as quickly as possible. This policy of building-up resilience is being promoted across all sectors: energy, finance, transport etc. To this end, one EU initiative is the Recovery and Resilience Facility which just entered into force (February 2021), and will make €672.5 billion in loans and grants available to support reforms and investments undertaken by Member States, according to their national plans.[9] Each national plan will have to include a minimum of 37% of expenditure for climate investments and reforms. Furthermore, the Joint Research Centre, the Commission's in-house science and knowledge service, conducts several research activities concerning resilience[10] and foresight[11], among other activities.

When dealing with risks of any kind, complacency is always the silent enemy. One must be vigilant and be ready to challenge not only their planned actions, but also the underlying goals. In the context of this article, we can refer to the **EU's electricity interconnection target,** defined as import capacity over installed generation capacity in an EU Member State. This target was originally set and redefined by Expert Groups (Commission Expert Groups are formal bodies formed of externals, working under strict rules and with transparency). In 2014, the target was set at 10% by 2030, and in the same year increased to 15%. In 2017, the singular target was replaced by a methodology which is based on three indicators: a. Price differential between EU countries, with an aim to reduce it below 2 EUR/MWh; b. Ratio between nominal transmission capacity and installed RES capacity, with a target of past 30%; and c. Ratio between nominal transmission capacity and peak load, with a target of past 30%.

In the remainder, we present two examples of EU initiatives to mitigate operational risks, among other goals, which are the Risk Preparedness Regulation, and the Baltic synchronisation project.

EU experiences/responses

EU risk-preparedness

Although efficient electricity markets and well interconnected power systems are key to ensure security of electricity supply, a residual risk of an electricity crisis stemming from natural disasters, extreme weather conditions, fuel shortages or malicious attacks cannot be eliminated. Additionally, the effect of such threats could immediately affect a wide region or, in case they start locally, rapidly spread across national borders. In this context, Regulation (EU) 2019/941 on risk-preparedness in the electricity sector[12] (hereafter 'Risk-preparedness Regulation') part of the wider Clean energy for all Europeans package[13] sets a common framework of rules on how to prevent, prepare for and manage electricity crises in the EU, setting up standards for cooperation among EU Member States (bilaterally or at regional level) under the principle of solidarity of the EU.

The areas of action of the Risk-preparedness Regulation, currently under implementation, are:

a. Common risk assessment methodology: EU Member States shall use common methodological frameworks for the identification of regional and national electricity crisis scenarios, and of short-term and seasonal adequacy issues.

b. Risk-preparedness plans with regional cooperation: Based on regional and national electricity crisis scenarios, Member States shall prepare public risk-preparedness plans under common rules and including national, regional and bilateral measures.

c. Crisis management rules: A crisis should be addressed taking into consideration of cross-border cooperation and assistance and by using market measures first, with non-market measures foreseen as last resort only.

d. Information sharing and transparency: In case of an electricity crisis in course or an issue of an early warning, Member States shall provide explanation about the reasons of the crisis, describe measures taken to prevent or mitigate it and detail needs of any assistance from other Member States.

e. Enhanced monitoring at EU level: Member States shall perform ex-post evaluations of electricity crises and security of electricity supply must be systematically monitored by ACER on a regularly basis.

The Baltic synchronisation project

In the aftermath of the February 2021 crisis in North America, a recurring question is whether Texas would have experienced fewer issues if it were better connected with the rest of the US grid, instead of being an 'electricity island'. Practitioners may recall that this issue was also considered after the 2011 cold spell which affected the same region but with fewer consequences.

Alike the US, Europe also has its own 'electricity island' of sorts, which are the electricity grids of Estonia, Latvia and Lithuania (hereafter 'Baltic States'), former Soviet Republics and now EU Member States, are still part of the BRELL common synchronous area together with Belarus and Russia (see Figure 1). The fact that the Baltic States are dependent on one external operator for the operation and balancing of their electricity network has been recognised as an energy security of supply concern by various actors including the Commission.[14]

In 2007, the political desire for the region to join the European synchronous area was formally declared by a Baltic Prime Ministers' decision. In addition, for Estonia, our own research found a high societal appreciation for security of energy supply (Longo et al., 2018), and a staunch support (high willingness-to-pay) for long-term security of supply policies (Giaccaria et al., 2018).[15]

In June 2019, the 'Political Roadmap on implementing synchronisation of the Baltic States' electricity networks with the Continental European Network via Poland' was signed by the Commission and the Republics of Lithuania, Estonia, Poland and Latvia.[16] The synchronisation of the Baltic States' grid with the continental European network is foreseen to be completed in 2025.

Already, recently established electricity lines with Poland (LitPol Link), Sweden (NordBalt) and Finland (Estlink 1 and Estlink 2) have connected the Baltic States region with European partners. However, the electricity grid is still in a synchronous mode with the Russian and Belarusian systems.

From a technical perspective, the synchronisation plan and the Baltic energy market interconnection plan (BEMIP)[17] in general, consist of many projects, many relevant for internal grid reinforcements. These include new AC lines, synchronous compensators, voltage stabiliser units etc. Among others, these additions are expected improve transient and frequency stability in Baltic States (Purvins et al., 2016).

One of the major infrastructure projects for the plan's implementation will be the (new) **700 MW HVDC 'Harmony Link',** a 330 km (205 mile) undersea cabling system that will connect Lithuania with Poland. This interconnector will increase system adequacy in Baltic States, mitigate risk of power failures, will have black start capabilities, enable the integration of further renewable energy capacities, and reduce price differentials between Baltic States and EU as traders and producers of electric power will be able to sell electric power everywhere in Continental Europe (L'Abbate et al., 2015).

The interconnector was approved (final investment decision) in early June 2021 by the transmission system operators of Lithuania and Poland and will be the second one between the countries. The first is the above mentioned LitPol Link, a 341 km (212 mile) overhead line with a current rating of 500 MW which is planned to be doubled in the coming years (see Figure 3).

One of the past deterrents for the implementation of the Baltic synchronisation project may have been the associated costs which are estimated at EUR 1.6 billion (about USD 1.94 billion), potentially a tall order for the three countries with a combined population of about 6 million (or one-fifth of Texas). However, the EU is providing major support and about 1 billion euros have already been given from the EU's Connecting Europe Facility (CEF) to Estonia, Latvia, Lithuania and Poland.[18]

It should be further noted that the synchronisation plan is just one element of BEMIP which aims to achieve an open and integrated regional electricity and gas market between EU countries in the Baltic Sea region. The initiative's members are Denmark, Germany, Estonia, Latvia, Lithuania, Poland, Finland and Sweden, while Norway is an observer.

Figure 3. Baltic power system development plan (new and upgraded power lines). Source: JRC elaboration of ENTSO-E data (TYNDP, Europe's Network Development Plan, Baltic States Synchronization with Continental Europe).

Summary

The recent experiences on both sides of the Atlantic show that, not only do vulnerabilities still exist, but risks are seemingly increasing due to extreme weather events, geopolitical considerations, the introduction of innovative technologies, the transition to a climate-neutral society etc.

In this text, we presented various EU initiatives to address operational vulnerabilities and security of energy supply, and presented the examples of the EU Risk Preparedness Regulation, and the ongoing Baltic synchronisation project. For the latter, we focused only on the technical elements. However, one must acknowledge that there is also an especially important political dimension on the synchronisation plan, as is in Texas, albeit the politics appear to lead to opposite results for the two regions.

Finally, on the Baltic synchronisation project, there's yet another consideration with a technical and political dimension, which concerns Kaliningrad Oblast (or Kaliningrad Region), a semi-exclave of Russia found on the coast of the Baltic Sea, between Lithuania and Poland (Figure 3). With a population of about one million, the region is physically isolated from the rest of Russia but a part of the BRELL synchronous area. The question stays whether the Kaliningrad Oblast will be operating in synchronous mode with Baltic States and EU, or in asynchronous mode. In the latter case, while the region has enough generation to meet its needs, Europe would once again have a distinct energy island, although much smaller than before.

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Footnotes

[1] Disclaimer: The views expressed are purely those of the author and may not in any circumstances be regarded as stating an official position of the European Commission.

[2] SWD/2017/0294 final https://europa.eu/!Gr76vu

[3] European Commission – A European Green Deal https://europa.eu/!Tr74bn

[4] Regulation (EU) 2017/1485 https://europa.eu/!gx39pb

[5] European Commission - Trans-European Networks for Energy https://europa.eu/!Xq78qK

[6] Regulation (EU) 2017/1938 https://eur-lex.europa.eu/eli/reg/2017/1938/oj

[7] COM(2020) 829 final https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2020%3A829%3AFIN

[8] More broader definitions have also been adopted by the Commission, but for the purposes of this article we'll rely on the definition in the text (for an alternative see the "EU global strategy" https://europa.eu/!yp36QV).

[9] https://europa.eu/!jt78Jr

[10] European Commission - EU Science Hub https://europa.eu/!xv88By

[11] "Commission unveils its first Strategic Foresight Report: charting the course towards a more resilient Europe", 9 September 2020, https://europa.eu/!qV76Pk

[12] Regulation (EU) 2019/941 (p. 1–21) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.158.01.0001.01.ENG

[13] European Commission - Clean energy for all Europeans package, https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en

[14] SWD(2014) 330 final https://europa.eu/!PR63Jg

[15] Of the three Baltic countries, only Estonia was included in the research activity.

[16] https://europa.eu/!HD89mp

[17] European Commission - Baltic energy market interconnection plan https://europa.eu/!DN49Ux

[18] Litgrid https://bit.ly/2RuBsnz