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Europe and the Emerging Geopolitics of Electricity Grids

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INTRODUCTION

In a decarbonising world, the role of electricity, along with its infrastructure, including power plants, grids, transmission and distribution lines, and especially cross-border interconnections (known as interconnectors), will significantly increase in importance. With the green energy transition gaining momentum and electricity demand growing rapidly due to decarbonisation of end-use sectors, the share of (green) electricity in satisfying global energy demand is expected to more than double, rising from about 20 per cent of final energy consumption today to 50 per cent by 2050 (International Energy Agency 2023). Particularly in Europe, electricity consumption is projected to increase by around 60 per cent between now and 2030 (European Commission 2023: 1) as part of the net-zero 2050 goal.

As a consequence, infrastructure becomes essential. Electricity networks are the backbone of future electrified energy systems. They need to expand and modernise to accommodate demand increases as well as support the transition to green electricity and the production of green gases like hydrogen. Furthermore, cross-border interconnectors emerge as a linchpin for success. They play a pivotal role in achieving a decarbonised economy, as cross-border electricity trade can facilitate the optimal transport of renewable energy across regions while eliminating regional supply surpluses and deficits.

Geographic realities, political decisions, and geostrategic preferences will shape this new global electricity landscape. The geographical distribution of resources will be less of a determinant, but still play an important role in defining a new geography of energy interconnections: major electricity consumers like Europe might not be able to meet their own green electricity demand due to limited sun and wind expansion capacity or high generation prices. Thus, they will depend on imports from neighbouring countries.

Unlike with oil and gas, though, where trading links are almost exclusively dictated by geographical location and geology, worldwide cross-border electricity interconnections are taking form primarily on the basis of political decisions. Even inter-regional electricity grids which connect national grids into so-called grid communities are materialising. Unlike oil and gas, electricity flows are not necessarily characterised by asymmetric interstate import-export relationships; instead, "electricity flows almost at the speed of light in both directions" (Westphal et al. 2021: 9). However, an interconnector linking two electricity grids or even two grid communities with different values and regulatory premises can entail geopolitical risks and potentially create new vulnerabilities.

This is particularly true for Europe. Europe significantly accelerated electrification and cross-border electricity trade in the wake of Russia's invasion of Ukraine in 2022 as a means to both boost energy system resilience and speed up decarbonisation. However, above and beyond a common market, a regulatory framework, and a synchronised system of interconnected subregional grids, further expansion and connection inside and outside the common legal-regulatory-commercial space are needed and, in fact, planned.

The EU is striving to deepen intra-European physical electricity connectivity, but also to establish interconnectors with countries and regions located in geographic proximity – from the Baltics to Ukraine, Eastern and Southeastern Europe and the MENA region. While interconnectors inside the EU are still insufficiently developed, neighbouring regions in direct geographic proximity outside the EU are characterised either by different legal, technical, and regulatory systems and are exposed to internal fragility and geopolitical instability or their interest in integrating within the European grid community is being driven by distinct geopolitical considerations.

Ensuring the security of the EU's electricity infrastructure will become more challenging as geopolitical factors increasingly come into play. While they might hinder the EU's ability to expand its physical, technical, regulatory, and legal framework beyond its own grid community, the EU's lack of well-established internal physical interconnections able to accommodate the increasing demand for green electricity further undermines its resilience. As a result of these two factors, grid interconnections could turn into risks for a country's own (supply) security rather than being "merely" an instrumental part of the equation.

Currently, the EU's ambitions are largely being driven by climate goals and characterised by a technical-economic approach. However, the EU lacks a geopolitical perspective on electricity interconnections and, consequently, an electricity foreign policy. This paper therefore seeks to investigate the geostrategic dimension of electricity grids in the broader context of a decarbonised European economy: How can decision-makers ensure reliable, affordable and secure electricity while not impeding the energy transition in the face of the dual challenge of increasing surging electricity demand and mounting geopolitical tensions? How can policymakers shape the power grids of the future in key regions in and around Europe where geopolitical motives and conflicts are on the rise?

GEOPOLITICS AND THE (GEOSTRATEGIC) RELEVANCE OF ELECTRICITY: GRID COMMUNITIES AND INTERCONNECTORS

The geopolitical dimension and the strategic role of electricity are – with few exceptions – understudied and underdiscussed (Westphal et al. 2021; Fischhendler et al. 2016; Jaffe et al. 2024).

While research on natural resources frequently seeks to understand policy outcomes through a geopolitical prism, when it comes to electricity studies, the prism is primarily economic or technical. Traditionally, the geopolitics of energy has been largely defined by the use of concentrated fossil resources and technologies for political purposes. The distribution of concentrated fossil resources, along with technological change, as well as the need to secure supplies, have traditionally redefined paths of power and wealth between producing and consuming countries (Van de Graaf and Sovacool 2020: 53f). Meanwhile, the geopolitical environment, including the distribution of power, the nature of the world order, and the presence or absence of functioning governance mechanisms, has also impacted energy market dynamics: a less cooperative world order, weak governance institutions, or growing geopolitical tensions at the global or regional level might prove more conducive to the *weaponisation* of asymmetrical fossil energy dependencies (Pepe et al. 2023: 7f).

In a decarbonising world, electricity grid interconnections at the regional and inter-regional levels are gaining relevance. Meanwhile, geopolitical conflicts are intensifying, and the post-World War liberal order and its institutions are eroding in favour of more fragmented, regionalised and conflictual relations and weak governance mechanisms. Against this backdrop, greater attention should be devoted to the emerging but overlooked geopolitics of electricity.

Admittedly, the geopolitics of electricity differ in some respects from the geopolitics of oil and gas. The geopolitical dimension of electricity grid interconnections can be grasped less immediatey than is the case with concentrated natural resources, and its implications are more nuanced. It requires a greater technical understanding to define its characteristics.

Interconnectors (cross-border transmission lines with connecting points at the borders – called nodes) and grid communities (synchronised electricity networks, where both voltage and frequency work in unison so that all states share the same risks, chances, duties, and rights) are at the core of the geopolitics of electricity (Scholten and Bosman 2016: 273). Whereas synchronised grids represent the deepest and most advanced form of cross-border electricity grid connectivity, interconnectors are the first step needed in the path to a synchronised grid community. However, they do not necessarily lead to it.

Technically, there are two kinds of interconnectors: three-phase alternating current transmission lines with high voltage capacity between 220 and 380 kV (kilovolt) allow for smoother transport across borders and deeper network integration, as they do not require converter stations. Also, alternate current can easily step voltage up and down, enabling flexible redirection and distribution. They are commonly used to transport electricity across borders of neighbouring, territorially contiguous countries (for example, within the EU) and for shorter distances. They are naturally conducive to the synchronisation of two or more national grids into a grid community.

However, to transport electricity over greater distances (generally over 750 km) or to connect geographically non-contiguous electricity systems, High Voltage Direct Current Lines (HVDC) with voltage between 380 kV and 800 kV are generally preferred, as they reduce electricity losses over longer distances. HVDC lines need stations to convert direct current into alternate current to be fed into the national grid. By nature of their technical features, HVDC lines can be used to connect two national or regional grids without necessarily synchronising the two systems simply by using a back-to-back connection.

Whether to synchronise two or several national grids (deeper integration) or only use HVDC lines and back-to-back connections to allow physical electricity exchange, but not deeper integration, or to entirely avoid any connection with other national or regional grids is not only an economic-technical decision, but an eminently political and geostrategic one.

Undoubtedly, the benefits of cross-border interconnections and national grid synchronisation are several. In particular, an integrated, synchronised network can reduce economic costs, increase reliability of the supply, improve the efficient allocation of resources, facilitate the development and transport of renewable energies, and diminish emissions. Finally, it can increase energy security and social gains, "as it provides greater availability, affordability, and reliability of electricity for households and commercial users" (Fischhendler et al. 2016: 534).

From a geostrategic point of view, fully interconnected grids create a web of interdependencies, fostering diplomatic ties and ideally mitigating geopolitical tensions through shared energy resources. Since electricity cannot be stored, it requires a high degree of synchronisation to maintain a continuous balance between demand and supply. Countries that decide to synchronise their national power grids are bound in a grid community that might enhance regional peace while sealing itself off from the rest of the world.

In fact, as electricity flows in all directions, supply disruptions might have dramatic economic, social, and political cascading effects on each member of the community, disincentivising the weaponisation of electricity and thus making asymmetrical dependencies less probable. Green grid communities can even foster off-grid solutions that further increase grid resilience and provide supply continuity in the event of damage (Vakulchuk et al. 2020).

However, to harness the anticipated positive gains, it is essential to cultivate stable political relations, foster political trust and, ideally, encourage shared values among countries. This collective effort aims to construct a cohesive grid community, but also requires a stable geopolitical environment at the regional level to nurture. Synchronised networks can significantly reduce geopolitical risks related to potentially asymmetric relationships, but are hard to achieve (with the partial exception of the EU) and need to be carefully managed in a geopolitically tense environment.

Conversely, simple HVDC lines can interconnect two power grids, but do not necessarily require the creation of a grid community. They can thus help mitigate risks of asymmetrical dependencies even when political trust is lacking, while allowing for electricity exchange and (limited) trade. Nevertheless, a high dependence on grid stability and security from one or more external interconnectors can expose countries to geopolitical blackmail.

Thus, in the case of both, grid communities and interconnectors, two crucial elements need to be considered to define whether cross-border electricity connections can be weaponised and constitute a geopolitical risk factor: first, the internal robustness and resilience of the respective grid. This includes the ability to guarantee the grid stability and the ability to resist both "the material control over access, availability, and use of electricity sources and the flows of electricity" from external players (Westphal et al. 2021: 8) as well as external technical-operative-normative influence (through, for example, imports of key components or foreign acquisition of grid operators). Second, external attractiveness. This is the ability to attract external actors in an (existing) grid community, while expanding not only regulatory-technical standards, but also projecting political-diplomatic power.

Both internal robustness and external attractiveness are mutually reinforcing and both dependent on the socio-economic density of an electricity space. Electricity grids are generally built to serve industrially, socially, and economically dense regions. The denser the economic-industrial distribution in a region, the more interlinked the grid is via transmission and distribution lines, and the more robust the supply will prove. The supply within a grid can remain robust and resilient without international/inter-regional interconnections. If a grid community is internally robust and resilient, its attractiveness increases, and technical-regulatory, operative, and legal standards can even expand – along with the physical interconnections – to include and synchronise other external national grids. In this case, electricity grid expansion implies a certain level of (geo)political power projection and convergence. Conversely, regions with uneven or scattered distributed economic activity and/or a lack of transmission lines within the region are more vulnerable in terms of supply stability and more dependent on external interconnections. This factor makes them prone to geopolitical weaponisation by external players if they are forced to establish electricity interconnections to stabilise the electricity system. For their part, depending on the grid robustness, planning and regulatory authority, technological and industrial know-how, and geopolitical agenda, external actors can either exert influence by controlling dispatching centers/frequency or even flow of electricity (Russia in the former Soviet Space), or by exporting equipment and components, and with it (different or concurring) norms and standards (China via the BRI) within a national or regionally integrated grid.

As interconnected power grids require full synchronisation of frequency and voltage to create grid communities, the lack of political trust, an aversion to asymmetrical dependencies, a lack of shared values, standards, and norms, and/or a confrontative and unstable geopolitical environment require major diplomatic-political efforts to align values, interests, regulatory frameworks, and technical-physical connectivity. Meanwhile, whereas synchronisation might not always be possible or desirable, the decarbonisation of energy systems and the increase in green electricity might still dictate a necessity to build interconnections with external countries/regions to secure electricity supply, even in the presence of persisting diverging political values, lack of trust, or an unstable geopolitical environment. Under such circumstances, state actors might also be interested in expanding physical interconnections with neighbouring countries to maximise their geoeconomic leverages and project political-regulatory power. In this case, worsening geopolitical conditions at the global and/or regional level offer greater incentives to use asymmetrical electricity interdependence for geopolitical goals if a national system is inherently unstable and less robust.

Interconnected and synchronised electricity grids have the power to reshape and reorganise the role of territories/spaces at the macro-regional level, but also shift power dynamics. The main factors to be considered when discussing (international) grid expansion are thus not only the ongoing energy transformation, socioeconomic development, and grid stability, but also geopolitical interests attached to it and the geopolitical environment they are embedded in.

Against this backdrop, internal robustness of the grid and external ability to set regulatory, normative, technical standards and manage diplomatic relations in neighbouring countries are necessary to mitigate risks and maximise gains.

ASSESSING THE EU ELECTRICITY NETWORK EXPANSION PLANS: INTERNAL AND EXTERNAL DIMENSION AT THE CORE OF CLIMATE AND ENERGY SECURITY

National electricity grid expansion and cross-border interconnections are at the core of the EU's plans to reach climate goals and ensure energy security resilience, particularly since the 2022 Ukraine war.

To tackle climate change, the European Parliament adopted the European Climate Law in 2021, which raises the EU's target of reducing net greenhouse gas emissions at least 55 per cent by 2030 (from the current 40 per cent) and makes climate neutrality by 2050 legally binding. Most recently, the European Commission has proposed to set a new 90 per cent emission-reduction target for 2040 (European Commission 2024). With the energy sector responsible for more than 75 per cent of the EU's greenhouse gas emissions, increasing the share of renewable energy across the different sectors of the economy is therefore a key building block to reaching the goal of reducing net greenhouse gas emissions. To reach these goals, the revised Renewable Energy Directive, adopted in 2023, raises the EU's binding renewable energy target for 2030 to a minimum of 42.5 per cent, accounting for almost twice as much as the existing share (European Commission n. d. a).

As a consequence, wind and solar generation capacity must increase from 400 GW in 2022 to at least 1,000 GW by 2030. This also includes a significant increase in offshore wind capacity to be connected to the shore (European Commission 2023a: 1). On top of this is a significant increase in green electricity needed to produce 10 million tons of green hydrogen as planned in RePowerEU. This would nearly equal total EU-27 electricity generation from wind and solar power in 2021 combined (Ansari et al. 2022).

Meanwhile, following the outbreak of the Ukraine war, electrification and green gases are considered even more instrumental to rapidly decrease reliance on fossil fuel imports in the short- to mid-term and mitigate risks of supply disruptions (Agora Energiewende 2019: 50). However, with an increasing share of renewables, the geography of electricity generation, consumption and transport shifts dramatically both within the EU and in its periphery: power generation centres will shift toward the most attractive regions in Southern and Northern Europe, as well as in the Middle East and North Africa, if an optimal cost path is followed. Conversely, energy-intensive industrial regions in Central Europe will increasingly become dependent on imports from both within and outside the EU.

Thus, to reach climate and energy security goals and accommodate increasing expected electricity demand, a significant upgrade and expansion of cross-border transmissions within the EU itself as well as of distribution lines in the national networks to connect large amounts of decentralised green electricity generation will be needed. To this end, the EU has recently presented a Grid Action Plan. Meanwhile, the EU plans to increase electricity connectivity from single interconnectors to grid synchronisation with several neighbouring regions, reaching from the North Sea and the Baltics to the Eastern Mediterranean and North Africa.

Against this backdrop, internal robustness and stability of the system and the build-up of additional interconnectors to connect with neighbouring regions are both essential to secure present and future electricity demand if the decarbonisation path is to be realised, while electricity supply has to be shielded against potential geopolitical risks. These range from hybrid warfare attacks to national grids which are to be synchronised with the European system to disruption of single trans-regional interconnectors. Ultimately, the ability to increase the robustness of the EU-synchronised networks goes hand in hand with the ability to tackle, mitigate and prevent geopolitical risks in neighbouring regions, while expanding physical interconnections along with normative, technical and regulatory standards.

IMPROVING THE INTERNAL ROBUSTNESS OF EUROPE'S GRID COMMUNITY: STATUS QUO, STRUCTURAL OBSTACLES AND EXPANSION PLANS

At the physical level, the EU and some of its immediate neighbours are linked via a web of five interconnected, synchronised networks. The Continental Europe Synchronous Area – which includes continental EU-Europe, the Western Balkans, Türkiye as well as the Maghreb countries form the core of this web. The Nordic Grid Network, Ireland and UK synchronised grids are all connected to the CESA via HVDC back-to-back lines (Westphal et al. 2021: 14),

At the technical-reglementary and operational level, the EU's third energy package (European Commission n. d. b) has created new institutions like the European Network of Transmission System Operators for Electricity (ENTSO-E) as well as the Agency for the Cooperation of Energy Regulators. These institutions aim to allow greater convergence among national operators and a legislative-regulatory harmonisation to enable institutionalised cooperation and better wholesale energy market transactions (Meeus 2020).

At the commercial level, starting with the third energy package, the Directive on Common Rules for the Internal Market for Electricity (European Parliament and European Council 2019a) and the Regulation on the Internal Market for Electricity (European Parliament and European Council 2019b), along with the step-by-step integration of the internal market has led to an unbundling of vertically integrated natural monopolies, different levels of liberalisation of national markets and the creation of an internal electricity market. Following the difficulties in the EU energy market experienced in 2022, with particularly high and volatile prices and serious concerns about security of supply, a provisional political agreement was reached in November 2023 to better shield consumers and industry from price spikes, allowing electricity prices to be less dependent on the price of fossil fuels and governments to regulate retail prices (European Council n. d.). However, the reform does not significatively undermine the market design principles and its integrity. In sum, the existing physical interconnection, the regulatory-legal framework and internal market design power make the EU one of the most densely integrated electricity areas in the world.

However, as the EU moves toward a decarbonised and electrified economy, the expected growth in demand and the need for an expansion of generation capacity pose major, acute challenges, while structural obstacles persist. The latter undermine the reliability and robustness of the synchronised networks in the face of of external (geopolitical) shocks like cyberattacks, attacks on physical electricity infrastructure or a growing presence of external players like China in the ownership structure of national grid operators.

In fact, Europe faces several structural obstacles hindering the further seamless integration of electricity grids under present and future conditions. The regulatory, organisational and structural challenges to jointly operating and managing an increasingly complex and decentralised grid, guaranteeing the security of system operation (Westphal et al. 2021) and the functioning of the market are growing considerably. A lack of harmonisation across Member States, electricity monopolies, different paths toward market liberalisation, a lack of harmonised legal frameworks when it comes to HVDC converters, a dearth of integrated planning for overland and offshore lines, and deficits in cross-jurisdictional authority are generally identified as major stumbling blocks (Buchmann and Jones 2021). On top of all this, the current regulatory framework generally privileges public TSO over private entrepreneurial investors when it comes to building interconnectors.

As a result of these regulatory-organisational obstacles, the underdeveloped level of cross-border interconnectors emerges as the greatest bottleneck to a further expansion of the synchronised networks in order to accommodate the expected growth in demand and additional renewable energy capacities, but also to an enhancement of system robustness. Between 2015 and 2020, the Commission recognised this as a major stumbling block and revised a series of laws, including both directives and regulations, to enhance the functioning mechanisms and the design of an integrated electricity market fit for the energy transition and the expanded use of renewables, but also to become more resilient to external shocks. While an integrated electricity market has been successfully implemented, the key aspect of interconnector expansion – crucial to allowing an uninterrupted electricity flow and accommodating increased electricity needs – has remained largely unaddressed. The Clean Energy Package adopted in 2019 (European Commission n. d. c), set the ambitious, though non-binding, goal of achieving cross-border interconnections of at least 10 per cent of each Member State's installed electricity production capacity by 2020, rising to 15 per cent by 2030. However, construction of additional cross-border electricity interconnectors has remained largely unachieved, with only 17 out of 28 Member States having reached the 10 per cent goal by 2020 (Sutton 2021). As a result of investment needs not being met, the EU experienced a so-called green funding gap (Buchmann and Jones 2021: 1285). To counter this, in 2021 the Commission adopted the 5th PCI (Projects of Common Interests) list in the form of a delegated act, in force since 2022 (European Commission 2021). The list identifies 98 projects of common interest: 67 electricity transmission and storage, 5 smart grid deployment, 20 gas, and 6 cross-border carbon dioxide network projects, with the goal of facilitating their permission and construction, including with funding from the Connecting Europe Facility.

With the revised 2022 TEN-T Regulation (European Commission n. d. d) and the 2023 European Grid Action Plan (European Commission 2023a), the EU is trying to ensure that cross-border and local European electricity grids operate more efficiently and will be rolled out further and faster thanks to better and more extensive funding.

Specifically, new priority electricity corridors have been identified under the Revised TEN-E-Regulation from June 2022. Especially in the core network of the synchronised continental Europe CESA, priority is being assigned to interconnections and internal lines in north-south and east-west directions to complete the EU internal energy market and integrate renewable energy sources (north-south electricity interconnections in Eastern and Western Europe) but also increase connectivity with neighbouring regions (European Parliament and European Commission 2022). Some of the key priority projects identified aim at better connecting the EU CESA with other synchronised grids or with other countries and regions not yet connected/synchronised, especially in the North Sea/Baltics, Eastern Europe and the Mediterranean. These projects include both on- and offshore interconnectors, single lines as well as a completion of the synchronisation process both within the European electricity space and with other regional electricity areas and will be discussed in detail in the next chapter.

For its part, the European Grid Action Plan, building on the identified PCI, aims at accelerating its implementation, improving long-term grid planning for a greater share of renewable energies, better integration of on- and offshore network planning, introduction of regulatory incentives for grid build-out and incentivising a better usage of the grid (European Commission 2023a: 20).

However, despite notable progress, the planning and implementation of interconnected grids within Europe and neighbouring regions remain beset by delays and uncertainties. Persisting financing challenges, and differing national priorities are contributing to sluggish progress in realising a fully integrated and decarbonised energy landscape and will presumably continue to do so.

However, many of the dilemmas that European grids are facing are not merely of a regulatory-financial, but rather of an eminently political nature, even within a well-developed grid community. In the case of the European Union, these dilemmas are clearly rooted in the shared competences between the EU and Member States when it comes to energy policy, often reflecting national preferences for energy sovereignty (Pepe 2023: 8). The slow implementation of cross-border interconnectors thus represents the biggest internal weakness of the EU's grid community. This is particularly true when it comes to implementing external connectivity with geopolitically fragile regions in direct neighbourhoods.

INTEGRATING THE PERIPHERY – INTERCONNECTORS AND SYNCHRONISED GRIDS IN THE EU NEIGHBOURHOOD: DISTINCT GEOPOLITICAL CHALLENGES

Parallel to national and intra-European interconnectors, the European Union has listed several new projects in the PCI's list which are aimed at connecting the EU's synchronised networks with three major subregions: North Sea/Baltic Sea and Baltic countries, Ukraine and Eastern Europe/Black Sea and Southern Europe/Mediterranean. To this end, the EU identifies 12 offshore hybrid and radial projects in the North Sea, Baltic Sea and the Atlantic, and ten Projects of Mutual Interest (European Commission 2023c) which are to pave the way for electricity, hydrogen and CO^2 networks with Ukraine, the UK, Switzerland, the Western Balkans, North African countries as well as Norway and Iceland. Similarly, a few specific projects are being planned for the Black Sea and the South Caucasus.

Implementation of these projects poses an eminent geopolitical challenge for the Union, however: due to the shifting geography of renewable energy resources, and the new security environment created in Europe by Russia's invasion of Ukraine, these spaces are gaining in relevance for the future electricity and energy supply of continental Europe. However, the physically interconnected and synchronised European electricity area (including the Western Balkans, the Nordic Grid and the UK) is not necessarily congruent with the legal-regulatory and commercial boundaries of the European Union: the EU regulatory-legal power and the internal robustness of the electricity system thus fades away the more it moves from the continental centres toward its eastern and southern periphery and overlaps with other normative-legal, (geo)political, and economic spaces in neighbouring regions (Westphal et al. 2021). For example, non-EU members like some Balkan states or Türkiye are already synchronised with the continental electricity grid and are observers in the ENTSO-E, while EU members in the Baltics are yet to be synchronised. Conversely, some North African countries like Morocco, Algeria and Tunisia are synchronised with the European grid, while other countries in the Eastern Mediterranean particularly are not. Finally, as a consequence of the war, Ukraine as well as the Baltics have accelerated synchronisation of their network with the CESA.

Besides technical aspects, a grid synchronisation , let alone new interconnectors, not only present financial barriers, but also geopolitical risks and challenges that the EU has scarcely been able to tackle so far due to its limited diplomatic, political and military capabilities.

NORTH SEA / BALTIC SEA AND THE BALTIC COUNTRIES: GEOPOLITICAL BORDERLANDS

Well before the Ukraine war, the Baltic countries Estonia, Latvia and Lithuania agreed to synchronise their electricity grids with the European grid by early 2025 (European Commission 2023b). Their reasons are eminently political, as currently the three Baltic republics are still connected with the Russian IPS/UPS synchronised network. Needless to say, due to their historical experience and the current war in Ukraine, the three Baltics states have been actively seeking to disentangle from Russia's electricity grid and synchronise with Europe to diminish their asymmetrical dependence on Moscow. As Russia could seek to leverage its control over grid frequency in the Belarus Russia-Estonia-Latvia-Lithuania (BRELL) power ring to influence operation of the electric power system in the Baltics, the EU is called upon to carefully balance deeper integration of the Baltic grid with the need to guarantee the resilience and robustness of its own grid should Russia retaliate. Similarly, other offshore electricity projects in the North and Baltic Sea which could be exposed to Russian aggression need to be protected (Fang et al. 2023).

For its part, the Baltic/North Sea has significant offshore renewable energy potential with several offshore wind parks and undersea interconnectors planned or already on stream. The Baltic Sea region is also the location of the first hybrid interconnector in the EU: the Kriegers Flak interconnection. The project connects a number of offshore wind farms to the power grids of both Germany and Denmark (50Hertz n. d.). Due to the geographic proximity between the European continental, Nordic Grid and Baltic grid network on the one side and the Russian synchronised network IPS/UPS on the other, the relevance and security of this electricity space for the EU is growing. Accordingly, the EU PCI in energy infrastructure in the Nordic and Baltic Sea region lists several key projects to be finalised or developed further (European Commission 2022a). Among these are, for example, the Aurora Line (EU grant of EUR 127 million) between Finland and Sweden to strengthen the resilience of the Finnish grid (Rapacka 2022). For their part, the Baltic desynchronisation from the Russian IPS/UPS system and synchronisation with the CESA have been considered a strategic priority for EU energy policy since 2013, leading to the inclusion of some of the necessary grid infrastructure reinforcements into the list of PCIs eligible for EU funding. Since 2016, key electricity infrastructure projects have been developed, such as Estlink 1 and 2, Nordbalt and the LitPol Link, connecting the three Baltic States with Finland, Sweden and Poland, respectively, significantly improving the Baltic countries' integration in the EU energy market as well as their security of supply (European Commission n. d. e). Interconnections between Member States in the Baltic region and the strengthening of internal grid infrastructure to end the energy isolation of the Baltic States and to foster market integration, including working towards the integration of renewable energy in the region, have been ongoing since then. These are, to cite a few examples, the North Sea Energy Cooperation Action Agenda 2023–2024 (European Commission 2023d), the Baltic Energy Market Interconnection Plan in electricity (BEMIP) (European Commission n. d. e), and related interconnectors in the North Sea, Irish Sea, English Channel, Baltic Sea and neighbouring waters. They all have the aim of regional transmission network reconstruction and reinforcement as well as the additional construction of single interconnectors like the Harmony Link between Lithuania and Poland.

However, while almost no electricity is traded between the three Baltics, Belarus and Russia at present, the regional grid remains synchronised with the Russian IPS/UPS, leaving Moscow with powerful geopolitical leverage to disrupt the regional grid until full synchronisation with the CESA is completed in 2025–2026. Here, the major challenges being faced by the EU are how to secure system stability, speed up interconnectors for internal robustness and develop "effective cooperation frameworks to deter, detect, prevent, and respond to suspected acts of sabotage and/or to minimise the consequences of such acts" (Tuohy et al. 2018: 4). These range from cyber to physical attacks, both on land and offshore, until full synchronisation is achieved and beyond it. This relates not only to the three Baltic countries, but also to the offshore electricity infrastructure in the Nordic space.

UKRAINE & BLACK SEA REGION: GEOPOLITICAL FAULTLINE

In Central and Eastern Europe, Ukraine (and Moldova) assume a prominent position in the EU's grid expansion plans. Ukraine's sustainable integration in the EU's grid community constitutes probably the greatest technical and geopolitical challenge for the EU's electricity system in the coming years and a test for the EU's ability to integrate neighbouring regions under daunting geopolitical conditions.

Since 2017, when the grid operator for Ukraine (Ukrenergo) along with Moldova's Moldelectrica signed an agreement on their future connection to Europe's grid with ENTSO-E, the EU and Ukraine have been developing plans to connect and synchronise Ukraine with Europe's continental electricity area. Similarly to the Baltics, Ukraine's motive was of a preeminently geopolitical nature: since the country was part of the Russia-controlled synchronised grid IPS/UPS, Russia controlled the frequency and maintenance of the system, even without physical trade between the two countries. This gave Russia major political leverage over Ukraine. Integration in the EU continental electricity network and market area was aimed at creating more energy security, geopolitical independence and supporting the political reorientation toward the West. This would also have positive economic side effects: profiting from lower production costs due to integration in a broader, liquid Eastern European electricity market and potentially reducing CO^2 emissions. For Europe, the interest was clearly both political and economic: firmly anchoring Ukraine in the EU's internal energy market while the countries' renewable potential made it an attractive source of green electricity and hydrogen.

However, until shortly before the war, establishing the necessary grid connections was considered technically complicated and geopolitically risky, while it required profound reforms to the Ukrainian electricity sector (Feldhaus et al. 2021). Technically, synchronisation with the continental area could only happen after Ukraine had separated itself from the Russian grid, and after a testing period where the Ukrainian network would work as a self-sufficient island. Technical problems ranged from grid stability to regulatory convergence with the ENTSO-E operative framework to substantial market reforms so as to allow not only for physical interconnections, but for electricity trade as well. The Ukrainian electricity system was (and is even more so today) barely able to generate enough electricity for its own needs and is characterised by oligopolies and political influence. Hence, only after a long testing period and the necessary internal reforms was a more extensive integration in form of a synchronisation conceivable. From a European perspective, the decision to integrate Ukraine in the EU's grid community was fraught with geopolitical dilemmas relating to its relations with Russia and Moscow's potential asymmetrical reaction.

All this changed after the outbreak of the war: As far back as in March 2022, the Ukrainian and Moldovan grid were successfully synchronised with the continental area, even though this was an emergency solution to guarantee stability of the electricity system under massive Russian attacks (European Commission 2022b), while work on regulatory-technical convergence with the ENTSO-E started immediately afterwards. Ultimately, Ukrenergo, the Ukrainian TSO, has step-by-step achieved compliance with the key technical requirements necessary to enable a permanent interconnection between the power systems of Continental Europe and Ukraine (ENTSOE-E 2023). Meanwhile, initial analysis of the impact of synchronisation on continental areas has found a high fluctuation and changes in flows, but not substantial instability (Böttcher et al. 2022).

However, while technical-regulatory integration incredibly enough succeeded under wartime conditions, some of the long-term structural problems related to Ukraine's electricity market reform, and especially to the issue of long-term grid stability and cascade effects on the continental area, have yet to be tackled. From the point of view of grid operation, necessary reinforcement measures must be taken to ensure stable frequency in the long term. In addition, Ukraine will have to become a part of the various data platforms for market exchange. It is also a member of the Energy Community, whose aim is to transfer the EU's acquis communautaire on energy to the Member Countries, including climate protection regulations (Nies 2022). While limited electricity trade between the two systems started in June 2022 (European Commission 2022c), the major challenge will be to increase this trade, while securing the stability of the Ukraine grid and reforming the sector.

While in the future Ukraine might be technically, physically and commercially able to export electricity (and hydrogen) to the EU, continuing Russian attacks on key energy infrastructure, and the presence of Russia's invading troops in some of the most renewable resource-rich regions remain a major challenge and vulnerability.

Synchronisation as the most extended form of integration creates a grid community: while it increases the possibilities for mutual support, it also increases the potential for contagion in the event of problems. In the case of Ukraine, the EU's major challenge will be to guarantee the stability and self-sufficiency of the grid and avoid cascade effects on the continental grid in case of a system collapse induced by Russian attacks. Synchronising the Ukraine grid with the continental area will constitute a factor of latent instability challenging the internal robustness of the European grid community for the time being.

Geopolitical risks as a by-product of the Ukraine war are also extensive in another Faultline region where the EU is aiming at expanding physical electricity interconnectivity, even though not necessarily aiming to extend integration (synchronisation). The EU is planning a major interconnector across the Black Sea to Georgia: The Black Sea submarine cable is to connect the South Caucasus region with South-Eastern Europe, linking the electricity systems of Azerbaijan, Georgia, Romania, Bulgaria, Hungary and continental Europe (European Commission 2022d). In the current stage, the Georgian company GSE and CESI have taken the first concrete steps, carrying out a feasibility study on the project (CESI 2023). Even in this case, however, security risks related to the situation in and around the Black Sea are a major challenge for the project, so it might only be realised once military operations in and around the Black Sea come to an end.

In the Northern/Baltic and Eastern/South Eastern European space, the chance to exploit the renewable energy potential via electricity grid expansion and interconnections to satisfy the EU's growing electricity demand vary significantly, with the Northern/Baltic region offering a more realistic, short-term option due to a mix of resource availability, greater regulatory convergence, and infrastructure build-up than Ukraine or the Black Sea. However, geopolitical realities and long-term potential on the ground justify efforts in both directions. Additionally, the security situation dictates the geopolitical interests of the regional players, aligning them with those of the EU. Yet, without building up internal grid and external (military) deterrence and defiance capacities, they face major risks: the proximity and contiguity to Russia as well as still-existing interconnections with the Russian grid increase the risk of external physical attack or sabotage on regional grids exponentially in the case of the Baltic countries – in the case of Ukraine there is even physical disruption.

THE MEDITERRANEAN BASIN AND NORTH AFRICA: INSTABILITY, FRAGMENTATION AND INTRA-REGIONAL GEOPOLITICAL RIVALRIES

Given the substantial, but still untapped, renewable energy potential of the Mediterranean Basin, fostering electricity connectivity in this region has a quintessential economic rationale for the EU. Meanwhile, "the promotion of renewable energy infrastructures across the Mediterranean can emerge as a valuable instrument for sustainable and inclusive economic growth, regional trade, and cooperation" (European Economic and Social Committee 2023: 5).

However, multilateral and bilateral projects have been facing a set of geopolitical challenges for years, in part differing from those of the two other regions, which the EU has yet to address. In the Baltics and Eastern Europe, challenges arise from ongoing deeper grid integration in the European grid community of borderland or frontline states and regions, i. e. spaces where geo-technical, normative-regulatory, infrastructural and geopolitical spheres of influence of major actors like the EU and Russia traditionally overlap, and where military confrontation is a real possible outcome. To tackle these challenges, the internal robustness of an expanding European continental area and the ability to protect the grid amid risks of military or asymmetrical attacks from an external actor like Russia is paramount. Conversely, the risks in the Mediterranean do not originate from an external actor, but lie in the volatile intra-regional, geopolitical dynamics among local actors, along with regulatorily inhomogeneous, commercially fragmented, and infrastructurally underdeveloped local electricity markets. To date, "although Türkiye and the Maghreb countries Morocco, Algeria, and Tunisia are connected with the Continental European Synchronous Area (CESA), other south and east bank countries have insufficient interconnections and synchronisation difficulties that have proven to be major hurdles to the implementation of large-scale solar and wind project and for development and the attainment of climate goals" (Yu and van Son 2023: 116). While greater regional grid integration between all the south and northern shore countries is the first step needed towards a greater integration/synchronisation within the EU synchronous area, at the present stage, geopolitical realities and political instability act as constraining factors when it comes to the construction of a network of single bilateral interconnectors (Yu and van Son 2023: 116).

Beyond the regional initiative for greater intra-regional homogenisation of the regulatory and operative practices of transmission network operators like Med-TSO, several single infrastructure projects are being implemented or are planned with direct or indirect EU financial or technical support along the North-South axis. In the central and eastern Mediterranean, these projects involve particularly Italy and Greece to respectively connect with Tunisia and Egypt. The most advanced project in central Mediterranean is the ELMED-TUNITA project between Italy and Tunisia. An agreement for a € 300 million grant has been signed by the Connecting Europe Facility (CEF) to be allocated to the project (Terna 2023; Elmed Project n.d.). The development of the project involves the construction of an electricity cable between Italy and Tunisia, developed by Terna and the Tunisian company STEG. This is expected to be completed by 2028. The grant agreement marks the first time the CEF is financing an infrastructural project between an EU Member State and a partner country, and shows the growing attention being devoted by the EU to the Mediterranean region and its role in the energy transition. However, Tunisia's inherent political-economic instability, the weakness of the North African and Tunisian grid (Ben-Kilani 2019), as well as a complex regional geopolitical environment constitute major supply and geopolitical risks.

This is even more so in the Eastern Mediterranean, where two major interconnection projects, EuroAfrica and EuroAsia, with the latter also having been confirmed on the new PCI list, should have long since connected Greece and Cyprus to Egypt and Israel, respectively. However, sovereignty disputes over maritime borders between Cyprus, Greece, and Türkiye along with the Turkish-Cypriot conflict still pose significant obstacles to the projects' development (Cassetti and Annunziata 2023). On top of this, the security situation in the Levante is precarious at present, which could further worsen relations between Israel and Egypt and delay the projects (Eminel Sülün 2023). Greece also has plans to directly connect with Egypt via sub-marine HDVC: the GREGY cable is in its design phase and has also been included among the new PCIs. The GREGY sub-marine cable extends over a thousand kilometers on the seabed between Egypt and Greece, with a capacity of 3000 MW (Cassetti and Annunziata 2023; Copelouzos Group n.d.). Meanwhile, plans to complete the second 400 kV interconnection between Greece and Türkiye by 2029 are in place (Aposporis 2023; Independent Power Transmission Operator 2023). The latter project – given Türkiye's already existing synchronisation with the continental electricity area – could prove instrumental in significantly increasing the country's importance once the new nuclear power plant in Akkuyu is operational. However, conflicting claims over their Eastern Mediterranean EEZ's and territorial boundaries in the Aegean might prove a major obstacle to finalising these plans. Finally, in the western Mediterranean several projects involve particularly Morocco, the UK and Portugal, but their implementation is still at an early stage.

Doubtlessly, major legal and regulatory barriers encompassing non-liberalised market structure, regulatory gaps in taxation and transmission tariffs, and the private sector's access rights constitute major obstacles to greater bilateral and multilateral integration of electricity grids in the vast Mediterranean basin, which includes both countries synchronised in the CESA, well harmonised in the regulatory, operational and legal framework of the ENTSO-E and ACER, and some other countries where physical connectivity is scarce and electricity markets are fragmented and dominated by monopolies (Cassetti and Annunziata 2023).

Generally, in the Mediterranean basin's vast and inhomogeneous space, it is local political instability and bilateral geopolitical conflicts along with financial and technical barriers which affect the realisation of several interconnectors – both within the region and with the EU – which need to be factored in if the EU plans to support projects to bring about a more extended regional grid interconnection (Yu and van Son 2023).

From this brief overview of interconnectors and grid integration plans in several neighbouring regions at the EU's northern, eastern and southern periphery, it clearly emerges that, whereas in the EU the development of interconnectors is a normal part of institutionalised network planning and is designed to serve further market integration, outside of the EU geopolitical tensions are either fostering an acceleration of integration within the EU grid community and specific interconnectivity vectors are being pushed at the technical-operational level as part of particular geopolitical policies or are hampering the development of political-regulatory measures that would increase system compatibility and interoperability. Hence, a common geopolitical approach as well as a set of instruments tailored to the region are needed.

CONCLUSION & POLICY RECOMMENDATIONS: TOWARD AN EU ELECTRICITY FOREIGN POLICY?

Transregional and international electricity grid interconnections are taking on enormous relevance for the EU as it decarbonises its economy, increases electrification and faces a need to secure reliable and resilient energy supply amidst major geopolitical instability. However, electricity grid interconnection is overlaid by frequently overlooked geopolitics. Due to its technical features, greater grid interconnectivity can help achieve stability, resilience and greater cooperation. However, the decision to integrate or interconnect national electricity grids is an eminently political one. Therefore, electricity interconnections, be it in the form of single transmission lines or as part of a deeper integration in a grid community, are associated with a potential risk of asymmetric relations, weaponisation of dependency or instability if only approached with an economic-technical prism and not carefully managed.

The present paper has briefly identified two major criteria with which to assess the geopolitical dimension from a European perspective and to identify if and when geostrategic risks could arise from deeper and extended transregional grid integration: internal robustness and the ability to integrate external regions, not only via regulatory-technical instruments or by single physical interconnection projects, but also by factoring in the peculiar geopolitical and historical context of each region and engaging diplomatically with regional actors, their motives and interests, in order to prevent, manage or react to potential risks.

The EU should in other words pursue the important goal of promoting cohesion of the European integrated electricity grid and legal area, while at the same time play a greater role in actively shaping interconnectivity on its periphery not only at the physical-technical-normative level, but also through support for political-diplomatic initiatives and deterrence capabilities.

In terms of internal robustness, a high level of integration and coordination at physical, commercial and operational-regulatory level inside the European electricity area is a major asset, but might not be sufficient to cope with the new challenges, especially when it comes to integrating other electricity systems and national grids beyond the legal-regulatory boundary of the EU. Here the need to overcome structural obstacles, expediting planning and implementation, and adopting forward-looking policies to speed up the buildup of cross-border interconnectors are not sufficient, but nonetheless imperative pre-conditions to achieve sustainable and interconnected energy within the synchronous area. Doing so would increase the internal robustness and security of the European synchronised grid system in the case of internal or external instability, blackouts, symmetrical or asymmetrical attacks against strategic infrastructure.

Meanwhile, European decision-makers must prioritise collaboration, innovation, and strategic diplomacy to leverage power grids as instruments for both energy transition and geopolitical influence in the immediate periphery in Northern, Eastern and Southern directions. In doing so, different specially tailored tools need to be developed. Whereas in the North and the East – for the time being – the internal robustness and external protection of the grid from potential (military or cyber) attacks via deterrence and defiance capabilities is essential, along with the completion of internal transmission and distribution lines, the task in the Southern direction is rather political-diplomatic in nature. Here the EU should aim at preventing crisis and mediating in regional bilateral conflicts in order to bring about an alignment between the political parties involved.

Against this backdrop, the EU should pursue a two-pronged approach:

INTERNAL DIMENSION

a. **Standardisation and regulatory convergence:** European decision-makers should prioritise the harmonisation of regulatory frameworks and standardisation of grid technologies. A unified approach will streamline cross-border electricity trade, enhance grid compatibility, and encourage private investments both within and outside the common electricity areas.

b. **Interconnectors buildup within the EU synchronous areas:** While the recent Grid Action Plan is an important step in the right direction, it is obvious that the Connecting Europe Facility has not yet delivered on expectations (European Commission n. d. f). The EU States should consider additional budgetary resources and dedicated funds to finance the construction of interconnectors which market participants would otherwise not consider viable. Moreover, as already pointed out, "key cross-border interconnectors of European or at least regional relevance should be under supervision or even under direct management and operation of the ACER rather than of national TSO" (Pepe 2023: 15).

c. **Innovation and research:** Encouraging research and innovation in grid technologies will be essential to overcoming technical challenges. Investing in smart grid technologies, energy storage solutions, and digital infrastructure can enhance the efficiency and reliability of interconnected grids.

EXTERNAL DIMENSION

d. **Regional collaboration and infrastructure investment:** Policymakers must foster closer collaboration among European nations and neighbouring regions to expedite grid interconnections. Strategic infrastructure investments, supported by public-private partnerships, can bolster the development of a resilient and interconnected energy grid. However, the sustainability of the projects, particularly in the Mediterranean basin "requires a level of political alignment among the involved parties in the region. Each project should be approached and designed with a broad perspective, taking into account such technical considerations as the national energy systems. Additionally, it is crucial to consider the historical context of bilateral/multilateral cooperation patterns in the realm of energy policy" (Eminel Sülün 2023).

e. **Security/military dimension:** Protection of single interconnectors as well as of the European synchronised grid is one of the most pressing tasks going forward, particularly since sabotage of the Nord Stream 2 pipeline has underscored the vulnerability of critical (maritime) energy infrastructure in the North Sea and Baltic Sea. Considering the role of electricity-related infrastructure in the region, the internal robustness of the grid once the Baltics are fully synchronised will be of paramount importance (Voelsen 2024: 27–37).

f. **A foreign electricity policy:** In light of the above, the EU needs to develop an electricity-focused foreign policy in relation to each region's specific challenges, interests and environment. Ideally, besides securing the technical feasibility of projects, it is vital to engage in bilateral discussions, negotiating agreements and aligning policies to facilitate the successful development and operation of interconnectors. This applies particularly to the Mediterranean region. Here, cooperation between energy ministers, regulatory authorities and other relevant stakeholders could be fostered by enhancing effective regional governance mechanisms. In doing so, the EU should also intensify its engagement in regional governance mechanisms of the Mediterranean basin, while avoiding neo-colonial approaches, "extractivism" or ill-suited "green pedagogism".

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