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EMBEDDING CLIMATE RESILIENCE IN REGULATION

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Executive Summary

Europe's electricity and gas networks are facing growing pressures from climate change. Heatwaves, floods, droughts, wildfires, and storms are occurring with greater frequency and severity, exposing vulnerabilities in energy infrastructure and raising the spectre of cascading failures across interconnected systems.

While European energy policy has long concentrated on efficiency, decarbonisation, and security of supply, systematic attention to climate resilience is only beginning to emerge. Regulatory frameworks at both EU and national levels still struggle to capture the value of resilience investments. Traditional tools such as cost–benefit analysis often fail to account for high-impact, low-probability events, leaving adaptation undervalued. Without reforms, Europe risks underinvesting in measures that could protect households, businesses, and critical services from climate-driven disruptions.

In this issue paper, we examine how resilience can be embedded in the governance of energy infrastructure. We explore policy and regulatory options across both EU-level and national frameworks, concentrating on transmission and distribution system operators. We identify gaps in current regulatory practice and set out possible approaches for reform.

Key themes include:

- Climate risks: Europe's energy systems face intensifying hazards, from heatwaves and droughts in southern regions to storms and icing in the north. These events disrupt generation, transmission, and distribution, with impacts exacerbated by cross-sector interdependencies.
- Regulatory gaps: Although EU policy and regulation acknowledge resilience, concrete regulatory tools remain underdeveloped. Cost–benefit methodologies and performance incentives do not systematically account for climate risks, and mandatory climate risk assessments are fragmented.
- Embedding resilience: Options include strengthening project evaluation through scenario analysis and catastrophe modelling; ensuring cost recovery for capital and operational adaptation measures; refining performance-based incentives; introducing more systematic climate risk disclosure; and improving access to insurance and risk-sharing mechanisms.
- Coordination: Because Europe's energy systems are interconnected, resilience planning cannot stop at national borders. EU-level stress testing, joint emergency planning, and stronger cross-border coordination will be essential.

The analysis suggests that there is no single solution. A combination of approaches may be needed, ranging from reforms to EU-level legislation and project assessment guidelines to national incentive schemes and insurance frameworks. The challenge is to balance consistency across Europe and flexibility for regulators to respond to diverse local risks.

Investment in resilience can be seen as a form of insurance: costs incurred today to reduce the likelihood of greater losses tomorrow. How these costs are recognised in regulation, how responsibilities are divided between EU and national levels, and how risks are shared between operators, consumers, and insurers are questions the answers to which will shape Europe's ability to safeguard its energy systems under a changing climate.

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About CERRE

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CERRE's added value is based on:

- its original, multidisciplinary and cross-sector approach covering a variety of markets, e.g., energy, mobility, sustainability, tech, media, telecom, etc.;
- the widely acknowledged academic credentials and policy experience of its research team and associated staff members;
- its scientific independence and impartiality; and,
- the direct relevance and timeliness of its contributions to the policy and regulatory development process impacting network industry players and the markets for their goods and services.

CERRE's activities include contributions to the development of norms, standards, and policy recommendations related to the regulation of service providers, to the specification of market rules and to improvements in the management of infrastructure in a changing political, economic, technological, and social environment. CERRE's work also aims to clarify the respective roles of market operators, governments, and regulatory authorities, as well as contribute to the enhancement of those organisations' expertise in addressing regulatory issues of relevance to their activities.

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1. Introduction

Europe's energy infrastructure faces increasing climate-related risks. Higher temperatures, more frequent extreme weather, and changing hydrological patterns are stressing electricity and gas networks. These systems, which underpin the functioning of modern economies and societies, are vulnerable to both physical threats – such as damage to substations, transmission lines, and pipelines – and systemic events such as cascading failures across interconnected networks. In addition to the immediate effects of extreme weather events, there may also be longer-term effects due to asset deterioration from changing weather patterns.

While climate mitigation has long been important in European energy policy, adaptation and resilience[1] have only recently begun to receive systematic attention. The regulatory frameworks governing energy infrastructure – at both EU and national levels – are not yet fully aligned with the emerging risk landscape. Existing regulatory instruments – particularly cost–benefit analysis (CBA) methodologies and incentive frameworks – often fail to capture the benefits of resilience investments, leaving adaptation undervalued in decision-making. This creates a need to examine how climate resilience can be more effectively embedded in regulation, planning, and investment decisions.

In this Issue Paper, we take stock of the regulatory landscape and explore policy options for strengthening the integration of climate resilience into the governance of Europe's energy infrastructure. We consider how regulation can incentivise adaptation, improve risk assessment, and support coordinated resilience strategies across borders and sectors. We do not intend to provide firm recommendations but rather to frame key issues, highlight trade-offs, and outline possible approaches.

The approach taken is analytical and policy-oriented, with particular emphasis on transmission system operators (TSOs) and distribution system operators (DSOs).[2] We draw on recent climate events, regulatory developments, and emerging best practices to identify gaps in current frameworks and explore options for reform. The analysis follows a simple conceptual framework linking climate hazards, infrastructure vulnerabilities, regulatory instruments, and system outcomes. In this framing, regulation acts as a central link between physical climate risks and societal outcomes: it determines how risk is identified, mitigated, and shared across actors. We examine both prescriptive and incentive-based regulatory models and consider the appropriate division of responsibilities between EU institutions and national regulators.

The structure of the paper is as follows: The section "Climate Risks to Energy Infrastructure" reviews the climate risks that electricity and gas infrastructure in Europe face, drawing on recent events and climate projections. The section "Current Regulatory Frameworks" contains a broad outline of the current regulatory frameworks at national and EU levels, noting where resilience has begun to enter

[1] In this paper, resilience refers to the ability of energy systems to anticipate, absorb, recover from, and adapt to disruptive events, including those driven by climate extremes and long-term climate change. It extends beyond reliability, which focuses on short-term continuity of supply under normal operating conditions, and beyond adaptation, which emphasises long-term structural or behavioural changes in response to evolving climate risks.

[2] In a more comprehensive approach, one would like to broaden the scope to include other relevant players, such consumers and generators, and how to influence them. Specifically, one would want to consider mitigating the impacts of climatic hazards on customers through behind the meter hybrid solutions, such as battery and photovoltaic for specific electrical needs, and hybridization for heat needs in buildings and industrial sectors.

but remains underdeveloped. In the section “Embedding Resilience in Regulation”, we examine ways to embed resilience more systematically in regulation, including reforms to project evaluation, cost recovery rules, performance incentives, risk assessments, insurance mechanisms, and cross-border coordination. In the section “Policy and Regulatory Options for Improving Climate Resilience”, we set out a series of policy and regulatory options for improving resilience, contrasting command-and-control and incentive-based approaches, and weighing the respective roles of EU-level and national measures. In the Conclusions, we highlight the broader implications for Europe’s adaptation and energy-policy agendas.

2. Climate Risks to Energy Infrastructure

Climate change is exerting growing pressure on Europe's energy systems, with adverse consequences for the reliability of electricity and gas networks. Extreme weather – heatwaves, floods, droughts, wildfires, icing, and severe storms – occurs more often and with greater intensity (European Environment Agency 2019; European Environment Agency 2024). These events disrupt operations, damage critical infrastructure, and raise costs for energy providers and, ultimately, for consumers.

There is no shortage of examples. The *heatwaves* of 2024 and 2025 sharply increased cooling demand across southern and central Europe (Ember 2025; Financial Times 2025). Higher peak demand and higher temperatures placed significant stress on energy networks. In Italy, overheated cables led to power outages. In France, nuclear plants scaled back output due to cooling water temperature constraints. Higher air and water temperatures make the cooling of thermal power plants more challenging. However, heatwaves also coincide with high solar electricity generation, which has the potential to mitigate the negative impacts.

During the 2022 *drought* in Spain, hydroelectric output – important for balancing variable renewables generation – declined by nearly half, undermining grid stability and contributing to sharp increases in wholesale electricity prices (REE 2022). Similarly, the 2022 drought in Europe had a significant adverse impact on France's hydropower and nuclear generation fleet. Less directly, droughts can affect thermal generation negatively due to the lack of cooling water (UNEP 2024).

The 2021 *floods* in Western Europe had severe impacts on energy infrastructure. The flooding submerged power system substations and distribution systems in regions of Germany, Belgium, and the Netherlands (Koks et al. 2022), and critical assets became inoperable for days or even weeks, interrupting electricity supply to households and businesses. Floodwater also damaged gas pipelines and control systems in low-lying areas. Comparable disruptions have been reported during localised flood events, which repeatedly demonstrate how regional floods can trigger electricity outages and infrastructure damage across Europe's energy networks (Karagiannis et al. 2019a).

Global warming notwithstanding, *icing* and – more generally – winter storms still pose risks to electric power systems in northern and eastern Europe. Atmospheric icing can accumulate rapidly on overhead lines, adding significant weight that leads to conductor failures and, in severe cases, the collapse of transmission towers. Such failures often result in widespread outages, particularly in remote areas. In recent years, icing events in Latvia, Poland, Finland, and Iceland have left tens of thousands of households without electricity for days and sometimes weeks. Impacts can extend beyond loss of electricity: heating systems, water supply, and critical services have also been affected, increasing the human and economic costs of such events (Karagiannis et al. 2019b; Rockas et al. 2025).

2025 is expected to set a historical record for *wildfires* in Europe in terms of area burnt: by August 2025, the total area had already exceeded that of 2017, which was the previous record year. This year, Spain and Portugal have been hit hard, with two-thirds of the area burnt in Europe located in those two countries (BBC 2025a). Greece and Cyprus also had devastating wildfires, which caused the evacuation of thousands of people from their residences (BBC 2025b). A recent study (Liu et al. 2025) finds a rising trend in prolonged and intensive extreme fire weather conditions globally and relates it to global warming. Southeastern Europe is among the areas in the world that have been most affected.

Wildfires are a potential risk to energy infrastructure located in or near fire-prone areas. (Conversely, faults in power lines and substations can emit sparks, which cause wildfires.) Wildfires in California in recent years and the demise of PGE is a well-known example of the risks associated with the juxtaposition of electricity infrastructure and wildfires (see the case study in Baldursson et al. 2023a). There are also examples of disruptions to electricity supply from wildfires in Europe, such as the 2021 wildfire in southern France, which resulted in a separation of the Iberian Peninsula from the rest of mainland Europe, documented in Baldursson et al. (2023a).

Gas infrastructure faces a similarly growing set of challenges. Pipelines, compressor stations, and LNG facilities are vulnerable to raised temperatures, river erosion, and flooding. However, impacts could be smaller than for electricity due to substantial precautionary investments made in the past (GRDF 2025). In the next decades, as sea levels rise, tidal flooding may become a risk (National Gas 2024). The operational interdependencies between electricity and gas systems amplify the risk to energy supply. Compressor stations, LNG handling and safety systems rely on electricity, while gas-fired generation provides balancing power during low renewable-energy production periods (Jung et al. 2022).

Looking ahead, climate projections indicate that climate risks will intensify over the coming decades. Europe is expected to experience more frequent and severe heatwaves, increased droughts in southern regions, more intense and frequent storms and heavier precipitation events in northern Europe (IPCC 2023; European Environment Agency 2024; WMO & C3S 2025). These trends – alongside an increased share of renewables generation – will place further stress on energy networks. If security of energy supply is to be maintained, strengthening the resilience of these networks is key.

3. Current Regulatory Frameworks

Electricity and gas networks in Europe are governed by a multi-level regulatory framework. Each country has its own laws and regulations on energy, as well as a national regulatory authority. However, EU member states – and to a certain extent non-EU member states of the European Economic Area (EEA) – are subject to EU-level directives and regulation. Cross-border coordination is facilitated through the European Network of Transmission System Operators for Electricity (ENTSO-E) and the European Network of Transmission System Operators for Gas (ENTSOG), while the integrity and performance of the cross-border aspects of energy markets are monitored and, to some extent, enforced by the Agency for the Cooperation of Energy Regulators (ACER).

Historically, regulation at both national and EU level has been largely concerned with the three pillars of market efficiency, security of supply, and decarbonisation. Resilience to climate-related extreme events has, however, emerged as a regulatory concern in the last few years. The growing frequency and severity of extreme weather events have highlighted that transmission and distribution system operators (TSOs and DSOs) manage crucial infrastructure that is vulnerable to climate hazards, yet adaptation to this "new normal" is not yet consistently embedded in regulatory frameworks (Baldursson et al. 2023a; Eurelectric 2025).[3]

Electricity and gas TSOs and DSOs are regulated monopolies operating under incentive-based frameworks that combine tariff regulation with performance-based incentives. In particular, the assessment of investments in transmission and distribution networks relies heavily on cost-benefit analysis (CBA), balancing the costs of a project against its benefits. For cross-border projects, the ENTSO-E/ENTSOG guidelines on CBA play a key role in decisions on whether to undertake such projects or not. Specifically, these guidelines are central to the allocation of EU funding to Projects of Common Interest (PCIs) under the Trans-European Networks for Energy (TEN-E) framework (European Commission 2022).

In the past, the evaluation of cross-border projects in electricity and gas has concentrated almost exclusively on outcomes in the electricity and gas sectors, respectively. This is changing with increased system integration. Electricity supply has rising flexibility needs due to larger renewables shares in electricity generation, and electricity is a necessary input in gas compression, liquefaction and safety systems (Jung et al. 2022). Methodological developments under the TEN-E regulation have begun to encourage cross-sector analysis, and ENTSO-E and ENTSOG have developed a model ("Interlinked") used in dual assessment of electricity and natural gas/hydrogen projects (ENTSO-E 2024c, ENTSO-E & ENTSOG 2024).

That climate resilience has been emerging as an EU regulatory and policy objective in recent years is demonstrated by the fact that The Clean Energy for All Europeans Package (2019) and the European Green Deal (2020) not only emphasise decarbonisation and system integration, but also impose a requirement to assess resilience of the electricity system in relation to the Ten-Year Network Development plan (European Commission 2019, Article 48). Moreover, the TEN-E Regulation (European Commission 2022a), while emphasising sustainability and security of supply criteria for Projects of Common Interest, also introduces resilience in the context of climate adaptation. The

[3] Baldursson et al. (2023a) contains a comprehensive overview of resilience of energy networks in EU energy law and regulations, with particular emphasis on regulation of grid operators.

regulation mandates inclusion of climate adaptation in PCI reports and defines climate adaptation as "*a process that ensures that resilience to the potential adverse impacts of climate change of energy infrastructure is achieved through a climate vulnerability and risk assessment, including through relevant adaptation measures*" (European Commission 2022, Section 19). Thus, in principle, resilience is a feature, albeit indirect, of the TEN-E Regulation.

Complementing these sector-specific frameworks, the Critical Entities Resilience (CER) Directive (2022) establishes a framework to strengthen the resilience of entities providing essential services – including electricity and gas – against natural and human-made risks. It requires Member States to identify critical entities in eleven sectors, ensure that they conduct regular risk assessments covering climate-related hazards, and adopt resilience measures proportionate to their exposure. The directive also obliges Member States to develop national strategies for critical-entity resilience and to report on implementation to the European Commission. While the CER Directive is horizontal in scope and does not prescribe sector-specific regulatory instruments, it provides a legal basis for integrating climate-resilience obligations into energy regulation at the national level. Its practical implementation will likely influence how energy regulators and operators embed resilience planning into their existing frameworks.[4]

The EU Adaptation Strategy (2021) acknowledges climate risks to critical infrastructure and, recently, adaptation and resilience to climate change have been highlighted as an essential policy objective (European Commission 2025a). The Commission is launching work on a new "*integrated framework for European climate resilience and risk management to help Member States prevent and prepare for the growing impacts of climate change*" (European Commission 2025b). Thus, climate resilience is firmly on the European agenda. However, there is much work to be done on concrete regulatory instruments such as CBA guidelines for PCIs, which do not yet allow for a quantification or monetisation of high-impact low-probability (HILP) events related to climate change.

Some national regulators in Europe have started to integrate resilience into their regulatory frameworks. A recent report issued by Eurelectric (2025) provides several examples. Notably, the Italian utility regulator, ARERA, has incorporated climate resilience planning requirements into the review of (electricity) DSOs' investment plans and has introduced incentives rewarding DSOs for resilience-related investments (see also the case study in Baldursson et al. 2023a). France has also introduced indirect incentives for grid operators to become more resilient.[5] More broadly, most EU member states acknowledge climate risks to energy infrastructure, but in most cases, this has yet to be translated into systematic, concrete regulatory measures.

In conclusion, climate resilience as a key component of adaptation to climate change is now on the EU policy agenda. Resilience aspects have not, however, been systematically implemented in regulatory practice, neither at the EU nor national levels. Key regulatory instruments such as CBA guidelines do not yet allow for HILP events to be monetised so they can be included in the "*bottom line*" for infrastructure projects, and performance-based incentives related to climate risk are not yet part of

[4] The CER Directive was to be transposed into national law in Member States by October 17 2024. At present, ten MS have enacted national laws implementing the directive.

[5] In France, a joint letter issued on 10 June 2024 by the Ministers of Economy, Energy Transition, and Industry and Energy requested that energy operators prepare climate change adaptation plans.

binding regulatory obligations (although reliability is in some cases). There is much work to be done in this area if the aims of the European Adaptation Strategy are to be achieved.

4. Embedding Resilience in Regulation

As noted in Chapter 4, climate resilience is not yet a core criterion in EU energy law. Better embedding climate resilience in European regulation would happen at the EU level, on the one hand – i.e., in the TEN-E Regulation and the associated TYNDPs – and, on the other hand, in regulation at the national level. While important, TEN-E only governs a relatively small share of infrastructure projects in the EU, viz., cross-border projects of common interest.[6] Most investment in energy infrastructure occurs within national jurisdictions and is overseen by national regulatory authorities (NRAs). To make climate resilience measures uniform and binding at the national level, there would have to be concrete provisions in the EU electricity and gas market legislation.[7] These would have to specify how climate resilience is to be incorporated into risk assessment, project evaluation, and tariff setting or, more generally, incentives related to performance.

That said, the methodologies developed for the TYNDP – in particular, the CBA guidelines of ENTSO-E and ENTSOG – can serve as a model or point of reference for NRAs, TSOs, and DSOs, when assessing energy infrastructure projects. Although these guidelines are not legally binding except in the PCI context, they have the potential to influence national regulatory practice. Hence, strengthening resilience criteria in the TYNDP guidelines could have an indirect impact on national regulatory decisions, even in cases where EU law imposes no formal obligation.

It should be noted here that CBA plays a central role in European jurisdictions where major network investments require *ex ante* regulatory approval. This is most common under hybrid systems that combine an incentive-based revenue cap with project-level oversight, as seen in Great Britain and Italy.

In other jurisdictions, regulators grant system operators greater autonomy. In Sweden, for example, investments are not pre-approved but are evaluated *ex post* through benchmarking of total expenditure against peers. The German regime is also primarily *ex post*, though it includes elements of *ex ante* review for large-scale, critical projects identified in national grid development plans. In such cases, efficiency benchmarking within the revenue-cap review replaces formal project-level CBA as the main regulatory tool. Accordingly, reform of CBA rules is not directly relevant in these jurisdictions, although due consideration of the benefits of resilience measures remains important.

Below, we first consider how the TYNDP guidelines and CBA rules – or, more generally, the evaluation of energy infrastructure investment projects – might be reformed (4.1). We then go on to briefly consider aspects of CapEx/OpEx flexibility (4.2), the role of performance-based incentives (4.3), the possibility of mandatory risk assessments (4.4), and how insurance and risk transfer impact resilience of energy infrastructure (4.5). Finally, in Section 4.6, we consider the issue of cross-border and EU-level coordination.

[6] Annual investment in EU energy grids is on the order of €70 billion annually (IEA 2025, p. 195), while PCI investment is an order of magnitude smaller, approximately €80 billion across a decade or more of development (ACER 2023a).

[7] Including the Electricity Regulation (2019/943), the Electricity Directive (2019/944), and the forthcoming Hydrogen and Decarbonised Gas Market Package.

4.1 Evaluation of Energy Infrastructure Projects

4.1.1 CBA at the EU level

Current CBA guidelines for PCIs largely focus on market integration, security of supply, and sustainability, but do not systematically integrate climate resilience. The ENTSO-E Guideline (ENTSO-E 2024a) allows for climate resilience as one criterion in a "*combined multi-criteria and CBA assessment*," but does not allow for HILP events to be monetised and (still) maintains the stance that "*multiplying low probabilities and very high consequences [has] little meaning*" and therefore excludes it from being directly counted in the welfare assessment of grid projects. The TYNDP Guideline (ENTSO-E 2025) acknowledges that "e*nhancing the grid resilience to [extreme weather] events is becoming of increasing importance" and asks project promoters to provide information about the* "part of CAPEX used for investment climate adaptation measure".

It should be noted that climate resilience may be considered an input to security of supply indicators in the CBA Guideline. These include "*Adequacy to Meet Demand Benefit*" (B6), which is monetised, and "*System Stability Benefit*" (B8), which is not monetised. It follows that some benefits of climate resilience measures will be monetised, albeit indirectly; however, there is no systematic quantification of the overall benefits of such investments. In fact, resilience to climate change is not listed under benefit indicators in the ENTSO-E guideline, but, rather in a separate section on climate adaptation measures. Hence, there is a clear risk that the benefits of climate resilience investments are not adequately taken into consideration, and even that they become "*invisible*" when projects are evaluated.

As for gas, following the 2022 revision of the TEN-E Regulation, new natural gas infrastructure is no longer eligible for PCI status[8]. Such projects are therefore not subject to the CBA process for PCIs. Hydrogen and decarbonised gas projects are, however, eligible for PCI status. Hence, the current ENTSOG CBA methodology (ENTSOG 2024a) only covers hydrogen projects. Hydrogen still plays a limited role in the EU energy system – even though the goals for its future deployment are ambitious – and infrastructure development remains in the early stages. It follows that there is a unique opportunity to include climate adaptation and resilience aspects in project assessment almost from the very beginning of hydrogen infrastructure development. The CBA guideline for hydrogen and other decarbonised gases, however, only "recommends project promoters to assess climate vulnerability and identify the related climate risks as part of the project assessment" (ENTSOG 2024a, p. 49), which is an even weaker status than climate adaptation and resilience measures have in electricity PCI assessment.

Clearly, there is room for improvement in the inclusion of climate resilience and adaptation measures in current methodologies for evaluating energy infrastructure projects. There is growing recognition of this gap. In particular ACER (2023b) states that "*it is necessary that all CBA methodologies factor in […] the impact of future extreme weather events in existing or new Security of Supply indicators*"; moreover, that the "*Security of Supply indicators […] should not be limited to the historical occurrence*

[8] ENTSOG's TYNDP and system-wide modelling framework continue to include natural gas to reflect its role in the current and transitional energy system.

and impact of past events, but incorporate in the analysis – to the extent possible – also future extreme events, in terms of higher expected probability of occurrence and impact area".

4.1.2 How Should Climate Resilience be Included in Project Assessment?

As noted above, the ENTSO-E Guidelines (ENTSO-E 2024a) state that "*multiplying low probabilities and very high consequences [has] little meaning*". Behind this statement, there is probably the notion that it is difficult to compute the expected cost of HILP events due to the uncertainty of probability estimates and the dominance of extreme values. But even if this were true, it does not mean that there is no way of accounting for those risks. Several different analytical approaches are possible. Below, we give a brief overview of a few such approaches.

Scenario Analysis and Stress Testing

This approach, where projects are evaluated against specific extreme-event scenarios (e.g., a 1-in-100-year flood or a 1-in-50-year heatwave), has traditionally been applied in financial risk management, e.g., by bank regulators[9]. It has been adapted to the setting of climate-related financial disclosure frameworks by bodies such as the Task Force on Climate-related Financial Disclosures (TCFD 2017) and the Network for Greening the Financial System (NGFS 2021; 2025). In particular, NGFS has developed harmonised climate scenarios that central banks – including the ECB[10] – regulators, and private institutions now use for climate stress testing.

In the energy infrastructure context, stress testing and scenario analysis can be used to evaluate how the energy system performs under adverse but plausible conditions, both with and without the infrastructure project being evaluated. This allows for assessment of the extent to which the project mitigates vulnerabilities or improves system resilience. At present, scenario analysis is of course applied in the TYNDPs of both ENTSO-E and ENTSOG, but mainly for comparing long-term energy pathways – e.g., in terms of demand, generation, and decarbonisation. It is not systematically used to test resilience to extreme climate events. There are, however, many practical issues to be resolved for scenario analysis in the climate resilience context, including the potential need to standardise scenarios between operators for the purpose of comparability of impacts. Also, the appropriate level of detail in climate hazard scenarios is likely to vary between transmission and distribution operators, as well as between different types of energy systems. Moreover, stress testing may not only be undertaken in the traditional scenario-led approach, but may also be based on vulnerability (e.g., identifying scenarios that lead to stress with unacceptable impact) or decisions (finding stress scenarios which would impact investment decisions).

Probabilistic Catastrophe Modelling

This approach has been developed by the insurance and reinsurance industry. It does not employ deterministic scenarios but rather applies probabilistic models to simulate a wide range of possible hazard events, the resulting damages to exposed assets, and estimates of financial loss. Rather than

[9] In banking, supervisors such as the Basel Committee on Banking Supervision require institutions to use stress testing as a core part of risk management (BCBS 2009), and both the European Central Bank (ECB) and the European Banking Authority (EBA) regularly conduct EU-wide stress tests to assess financial system resilience under adverse conditions (ECB 2022).
[10] See Alogoskoufis et al. (2021).

giving a single estimate of expected benefits of a project (to be included in the CBA), catastrophe models combine hazard maps, asset exposure, and vulnerability data to simulate thousands of potential events and, ultimately, to generate the estimated probability distribution of losses.

As an example of how this methodology can be applied, Swiss Re offers its proprietary probabilistic catastrophe modelling platform as a service to clients, enabling them to run simulations of hazard scenarios to estimate probability distributions of losses (Swiss Re 2025). And Zurich Insurance Group (2025) uses probabilistic catastrophe modelling to assess the vulnerability of Europe's electricity generation and storage assets to climate hazards.

Probabilistic catastrophe modelling could also be combined with deterministic standards for resilience. For example, substations may be required to withstand a 1-in-200-year flood event, and residual risks beyond this threshold could be estimated probabilistically[11]. This mirrors practices in flood protection and water management, such as Dutch dike safety standards (OECD 2018). Applying such methods to energy infrastructure would allow regulators to set minimum resilience standards while still incorporating tail risks.

4.1.3 Cross-sector Impacts

Project evaluation should extend beyond asset-level risks to include cross-sectoral impacts. HILP events often cause cascading failures across energy vectors, such as electricity outages disabling gas compressor stations or water scarcity affecting thermal plant cooling. Including these interactions in CBAs would better reflect the true value of resilience measures (Jung et al. 2022).

4.1.4 Monetising Consequences

A central component of any quantitative assessment of the climate-resilience benefits of infrastructure investment is the monetisation of consequences, particularly the value of energy not supplied during disruptions. For electricity and gas, methodologies for estimating the economic costs of lost load are relatively well developed, most commonly using value of lost load (VoLL) coefficients. However, VoLL estimates for gas, and even for electricity, are not applied uniformly across Europe, creating challenges for consistent appraisal. More fundamentally, existing approaches are geared toward short-duration, small-scale interruptions, and may significantly underestimate the true cost of large-scale system blackouts such as the 2025 event in Spain (ENTSO-E 2025) and earlier blackouts, such as in Italy in 2003 (New York Times 2003) and the UK in 2019 (National Grid 2020). The societal cost of a household losing power for a few hours is potentially an order of magnitude smaller (in per-hour terms) than for the same household experiencing a nationwide loss of electricity that brings essential services and economic and social activity to a halt. Yet, systematic research on how to capture these wider systemic impacts in valuation methods remains limited[12], leaving policy makers without a clear framework for adequately reflecting blackout risks in resilience investment decisions.

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[11] This is the approach taken to flooding in the USA. The Netherlands follows a full probabilistic standard since the 2017 reform of the Water Act (Jorissen et al. 2016; Netherlands Ministry of Infrastructure and Water Management 2025).

[12] Recent research has explored methods better suited to high-impact, long-duration blackouts. These studies show that system-wide outages can impose non-linear, economy-wide costs far exceeding household-level VoLL estimates, yet no consistent framework has yet emerged (Panteli and Mancarella 2017).

Another shortcoming of current VoLL estimates is that they are a static measure of willingness to pay at a particular point in time. However, several factors will affect VoLL over time, and investment decisions need to consider these longer timeframes. For example, greater electrification under decarbonisation will likely increase the consequences of disruptions for the electricity sector. Combined with an increase in the severity and frequency of extreme events, this is likely to lead to higher VoLL estimates.

4.1.5 Conclusion to Section 5.1

Regulatory practice could evolve to incorporate the approaches outlined above more explicitly into project appraisal. Some national regulators are already moving in this direction. In the United Kingdom, Ofgem requires distribution and transmission operators to include HILP events in their CBAs under the RIIO-3 framework (Ofgem 2024a). In Italy, ARERA has begun to integrate resilience into electricity distribution regulation, requiring operators to assess vulnerability to extreme weather and incentivising targeted adaptation investments (Lo Schiavo et al. 2019). A similar shift at the EU level – embedding stress testing, probabilistic catastrophe modelling, cross-sector impact assessment, and more robust monetisation of systemic blackout risks into CBA methodologies – would make the benefits of resilience investments more visible and comparable across jurisdictions. This would help ensure that climate resilience is not treated as an ancillary criterion but as a core component of infrastructure evaluation.

4.2 CapEx/OpEx Flexibility

An important regulatory issue regarding climate resilience and adaptation is how to treat the costs of adaptation within the revenue-setting process. Regulators typically distinguish between capital expenditure (CapEx), which goes into the regulated asset base, and operating expenditure (OpEx), which covers maintenance and ongoing costs. Climate adaptation measures may fall into either category. For example, raising or floodproofing substations is a capital investment, while vegetation management or seasonal wildfire precautions are recurring operational costs. Operators may be reluctant to implement resilience measures unless regulators provide clear rules that allow recovery of such expenditures.

This issue is likely to affect transmission system operators (TSOs) and distribution system operators (DSOs) in different ways. Both manage long-lived, capital-intensive networks, but their asset profiles and risk exposures differ. Electricity TSOs are responsible for high-voltage lines, cross-border interconnectors, high-voltage substations, and control centres, where adaptation often requires major capital investments with long planning horizons. Electricity DSOs are responsible for geographically dispersed medium- and low-voltage lines and substations that are directly exposed to localised hazards such as flooding, wildfires, or ice storms. Many DSO adaptation measures therefore involve a combination of capital investment (e.g., floodproofing secondary substations, undergrounding lines) and ongoing operational expenditure (e.g., vegetation management, inspections, or seasonal preparedness). A regulatory framework that prioritises only the capitalisation of costs could disadvantage DSOs, while one that neglects CapEx flexibility could discourage TSOs from "*future-proofing*" their infrastructure.

Recent regulatory practice illustrates some possible approaches. In Italy, ARERA has allowed dedicated resilience allowances for electricity distribution, enabling DSOs to recover both CapEx and OpEx related to adaptation, provided they demonstrate that interventions target climate vulnerabilities and improve service quality (Lo Schiavo et al. 2019; ARERA 2023). In the UK, Ofgem's RIIO framework offers flexibility in both CapEx and OpEx recovery but places emphasis on justifying costs through cost–benefit analysis and output metrics (Ofgem 2024b). In the United States, the Federal Energy Regulatory Commission (FERC) and the North American Electric Reliability Corporation (NERC) have increasingly highlighted the need to integrate climate resilience and extreme weather preparedness into both investment planning and operational practices, though U.S. regulation relies more on reliability standards and prudence reviews than on explicit resilience allowances (FERC and NERC 2021).

Similar considerations apply in the gas sector, though the asset base and risk profile differ. Gas TSOs manage long-distance transmission pipelines, compressor stations, and storage facilities, where resilience often requires major capital investments (e.g., reinforcing pipelines, flood protection for compressor stations). Gas DSOs, by contrast, operate local distribution grids, metering, and pressure-reduction stations, where adaptation may rely more heavily on OpEx measures such as inspection, leak detection, or seasonal preparedness, complemented by targeted CapEx investments like relocating vulnerable assets. As with electricity, regulatory approaches that emphasise total expenditure ("totex") flexibility – rather than emphasising CapEx over OpEx – would help ensure that both gas TSOs and DSOs pursue the most cost-effective adaptation strategies.

The challenge here is to design regulatory cost recovery in a way that does not bias operators toward either type of adaptation strategy, CapEx or OpEx. A more integrated approach, in which regulators evaluate total expenditure across categories, may help ensure that the most cost-effective resilience measures are incentivised, whether they are investment- or operations-based. Moreover, investment to increase network resilience should be recognised as forward-looking and anticipatory, with benefits materialising not upon commissioning, but later. Embedding such flexibility in European regulatory frameworks would ensure that adaptation costs are treated not as discretionary extras but as integral to delivering a reliable and secure energy supply under changing climate conditions.

4.3 Performance-Based Incentives

Cost recovery through CapEx and OpEx allowances is just one regulatory tool. Increasingly, regulators use performance-based incentives to reward TSOs and DSOs for measurable improvements in resilience. Performance-based regulation (PBR) shifts the emphasis from inputs to outputs, aligning operator strategies with societal goals such as reducing outages, speeding recovery, and strengthening preparedness for extreme events.

Incentive design should reflect the distinct roles of TSOs and DSOs. For DSOs, resilience is typically measured by service continuity metrics such as outage frequency (SAIFI), outage duration (SAIDI), and restoration times after storms or floods. For TSOs, relevant metrics include system adequacy, stability under stress, black-start and restoration capability, and performance in climate stress tests. Tailoring incentives to these functions encourages both asset hardening and improvements in organisational preparedness and operational efficiency.

Several European regulators already apply performance-based schemes. In the UK, Ofgem's RIIO framework links part of network revenue to outputs, including service quality and restoration after severe weather (Ofgem 2024b). Italy's ARERA rewards DSOs for adaptation investments and improvements in continuity indices during extreme weather (Lo Schiavo et al. 2019; ARERA 2023). Norway's NVE/RME adjusts allowed revenues for both TSOs and DSOs based on continuity-of-supply metrics, including Energy Not Supplied (ENS), Customer Interruptions (CI), and Customer Minutes Lost (CMI). The regulatory framework explicitly accounts for severe weather events, which are monitored but may be treated differently from normal interruptions in revenue adjustments (NVE 2022). In the U.S., regulators in New York and Massachusetts have similarly tied utility revenues to restoration times and emergency preparedness (New York PSC 2025; Massachusetts DPU 2014).

The gas sector has fewer examples of performance-based incentives, but similar approaches are emerging. For gas DSOs, incentives could target supply continuity and safety during extreme weather, such as maintaining pressure during cold snaps or rapid response to flood-related pipeline damage. For gas TSOs, relevant metrics might include compliance with resilience stress tests and timely restoration of flows after disruptions. Expanding PBR to gas networks would ensure resilience is rewarded across both electricity and gas, complementing cost-recovery mechanisms and creating dual incentives for prudent adaptation and measurable outcomes.

Looking ahead, effective resilience incentives will require new metrics and benchmarking frameworks that capture both average service quality and performance during extreme, low-probability events. Regulators could combine traditional indices (SAIFI, SAIDI) with resilience-specific indicators such as restoration speed after blackouts, completion of climate stress tests, or improvements in system redundancy. For gas, similar indicators might include continuity of pressure and rapid incident response. Reforming performance-based incentives in this way would better link investment, operations, and resilience outcomes, ensuring operators are rewarded for both efficiency and for protecting society from climate-related disruptions.

4.4 Mandatory Climate Risk Assessments

A further regulatory lever is the requirement for network operators to systematically assess, disclose, and address climate risks. Currently, such requirements are fragmented. At the EU level, mandatory climate vulnerability assessments apply only to infrastructure projects seeking EU funding or Project of Common Interest (PCI) status, as set out in the European Commission's Guidance on Climate Proofing of Infrastructure 2021–2027 (European Commission 2021). There is no general EU-wide obligation for all TSOs and DSOs to publish climate risk assessments (ACER 2023).

However, the Critical Entities Resilience (CER) Directive is set to change this state of affairs by requiring critical energy operators to conduct regular risk assessments – covering, among other hazards, those related to climate change – and to adopt proportionate resilience measures. Although transposition of the directive is still underway and national approaches differ, the CER Directive introduces, for the first time, a general EU-wide obligation for critical entities to integrate resilience into operational planning – complementing the more project-specific requirements of the TEN-E and CBA frameworks.

National approaches vary. In the UK, Ofgem requires operators to address resilience and climate risks in their business plans under the RIIO framework (Ofgem 2023). Italy's ARERA mandates resilience plans for DSOs, linking them to regulatory incentives (ARERA 2023; Lo Schiavo et al. 2019). In Germany, BNetzA requires climate and environmental scenario analysis as part of network development planning, but these are embedded in broader planning processes rather than as a stand-alone, standardised obligation (BNetzA 2024; Netzentwicklungsplan 2025). As a result, climate risk disclosure across the sector remains inconsistent.

Ideally, climate risk assessments for TSOs would cover large, interconnected assets such as transmission corridors and substations, while DSOs would focus on geographically dispersed networks exposed to local hazards. In the gas sector, TSOs and DSOs would assess the vulnerability of pipelines, compressor stations, and local grids to hazards such as flooding, landslides, and extreme temperatures. Regular, standardised disclosures would ensure that both electricity and gas networks are evaluated against evolving climate scenarios (European Commission 2021).

To be effective, climate assessments should go beyond description to include quantified risk analyses, adaptation strategies, and investment priorities, with clear links to performance incentives and cost recovery. This would embed climate resilience as a core regulatory duty, similar to reliability or cybersecurity standards. Over time, the EU could move toward a bloc-wide obligation for network operators to publish climate risk assessments, mirroring the evolution of climate-related financial disclosure frameworks such as the TCFD (ECB 2024; TCFD 2017). Such assessments would also support cost–benefit analysis, ensuring that resilience benefits and climate risks are systematically reflected in project appraisal (European Commission 2021).

4.5 Insurance and Risk Transfer[13]

In Europe, energy transmission and distribution companies typically insure physical assets such as substations, pipelines, and control centres against direct physical damage, but systemic costs from outages are largely uninsured and managed through regulation. Thus, insurance provides a financial buffer for asset losses but does not replace regulatory mechanisms for broader societal impacts.

Insurance practices vary by operator and sector. TSOs often combine commercial policies, pooled schemes, and captive insurers, especially for risks linked to the energy transition that are hard to place in commercial markets. Coverage typically includes property damage and limited business interruption, but long-duration outages remain difficult to insure. DSOs rely more on commercial property and liability insurance, reflecting their exposure to localised hazards.

In the gas sector, TSOs insure pipelines and storage facilities against physical damage, but business interruption coverage is limited, especially for natural catastrophes or prolonged downtime. Gas DSOs prioritise third-party liability over comprehensive asset recovery, and systemic costs of supply interruptions are managed through regulation rather than insurance.

Insurance arrangements are closely linked with regulatory frameworks for cost recovery. Some jurisdictions allow operators to pass uninsured extreme event costs to consumers, while others require operators to absorb these losses. Regulators increasingly demand that insurance and adaptation measures be cost-effective, creating an interaction between adaptation, insurance, and regulation.

Europe also features sector-specific insurance pools and public risk-sharing mechanisms. France's Assuratome pool provides specialised nuclear liability insurance, while Spain's Consorcio de Compensación de Seguros covers extraordinary risks, including natural disasters, for certain energy-

[13] This section is generally based on Aon (2024), ECB/EIOPA (2024), Marsh (2022), Munich Re (2024), Swiss Re (2024), and The Insurance Universe (2024). Citations to references to support specific claims are provided in the text.

sector damages. Such mechanisms are less common for electricity and gas networks (Assuratome 2024; Consorcio de Compensación de Seguros 2024; ECB/EIOPA 2024).

In the United States, insurance and resilience are shaped by litigation and liability exposure. California utilities can be held liable for wildfire damages under strict liability, leading to higher premiums, insurer withdrawals, and the bankruptcy of Pacific Gas & Electric (PG&E) in 2019. In response, California established a $21 bn Wildfire Fund, accessible to utilities meeting safety requirements, but recent wildfire seasons have raised concerns about its long-term adequacy[14].

These examples highlight a key difference: Europe relies on collective insurance pools and state-backed reinsurance to spread catastrophic risk, with regulation addressing systemic outage costs, while the US often uses post-crisis funds and litigation-driven regimes, creating sharper financial shocks but potentially stronger incentives for risk mitigation. Ideally, regulators would balance these approaches to ensure meaningful coverage and promote climate adaptation.

As with all forms of insurance, that for energy assets can create moral hazard if operators expect that financial losses from extreme climate events will be covered, potentially reducing their incentives to invest in climate resilience. While insurers increasingly tie premiums and coverage to adaptation measures, the reality in Europe is that the costs of major disruptions are often passed on to consumers or absorbed by society at large through regulatory mechanisms, rather than being fully borne by operators themselves (ECB/EIOPA 2024; Marsh 2022). This underscores the importance of climate-resilient investments, which function as a form of "*self-insurance*" by directly reducing the likelihood and severity of losses. Aligning insurance frameworks and regulatory incentives with adaptation efforts can help ensure that both financial protection and physical resilience are strengthened, ultimately benefiting the broader public.

4.6 Cross-Border and EU-Level Coordination

Europe's interconnected electricity and gas networks require a coordinated approach to climate resilience that goes beyond national boundaries. Shared infrastructure and interdependencies mean that disruptions in one country can have cascading effects across the internal energy market. Strengthening EU-level instruments – such as risk preparedness plans, PCI/PMI frameworks, and operational coordination platforms – can enhance both long-term planning and real-time response. By embedding climate resilience into scenario analysis, emergency protocols, and infrastructure investment, and, by harmonising standards across Member States, the EU can ensure that resilience becomes a shared responsibility supported by common tools, funding, and governance.

Because electricity and gas networks are regionally interconnected, resilience cannot be addressed solely at the national level. The EU's internal energy market depends on cross-border flows of electricity and gas, facilitated by shared infrastructure such as interconnectors, compressor stations, and transmission corridors. Disruptions in one country can quickly cascade across borders, affecting supply security and grid stability elsewhere. This interconnectedness makes regional coordination essential – not only for operational reliability but also for long-term climate resilience planning (European Commission 2023; Baldursson et al. 2023a).

[14] See Baldursson et al. (2023a) for a case study of PGE.

Cross-border coordination is particularly important in scenario analysis and emergency response planning. Regulation (EU) 2019/941 on risk preparedness in the electricity sector requires Member States to identify regional crisis scenarios and consult neighbouring countries when drafting national risk preparedness plans (European Commission 2022). These plans are reviewed by the European Commission and the Electricity Coordination Group to ensure consistency and cooperation. However, implementation remains uneven, and many plans lack detailed climate risk assessments or joint response protocols. Strengthening these mechanisms could improve collective preparedness for climate-driven disruptions such as heatwaves, floods, and wildfires (IEA 2022). Beyond crisis management, such cross-border planning should also be reflected in Member States' National Energy and Climate Plans (NECPs) and could be further formalised in the upcoming revision of the Governance Regulation, ensuring that regional resilience and adaptation strategies become an integral part of energy system planning across the EU.

Real-time event response coordination is also critical. Climate-related disruptions often require rapid, cross-border action to contain cascading failures and restore service. Platforms such as the Electricity Coordination Group and Gas Coordination Group provide a basis for cooperation, but their mandates could be expanded to include climate-specific response scenarios and joint exercises. Regulation (EU) 2019/941 encourages Member States to coordinate during crises, but most national plans still focus on technical or market failures rather than climate hazards. Embedding climate event response into these frameworks would enhance readiness and reduce recovery times (ACER 2023c; European Commission 2022).

Operational entities such as ENTSO-E and ENTSOG already facilitate coordination among transmission system operators and could play a larger role in climate resilience. These organisations manage cross-border flows and grid stability in real time, making them well-positioned to lead joint response efforts during extreme events. Integrating climate risk into their operational protocols – through shared early warning systems, mutual aid agreements, and climate stress simulations – would strengthen system-wide resilience (ENTSO-E 2024b; ENTSOG 2024). EU-level funding mechanisms, such as the Connecting Europe Facility (CEF), could support investments in emergency preparedness infrastructure, including mobile substations, backup systems, and regional control centre upgrades.

EU-level instruments such as the Projects of Common Interest (PCI) and Projects of Mutual Interest (PMI)[15] frameworks offer a platform for co-financing and accelerating cross-border infrastructure upgrades. These projects benefit from streamlined permitting, enhanced visibility to investors, and access to EU funding. The revised TEN-E Regulation now includes hydrogen and smart grid projects, reflecting the need for integrated planning across electricity, gas, and emerging energy vectors. Expanding the scope of PCI/PMI to explicitly include climate resilience criteria would help ensure that new infrastructure is not only low-carbon but also robust against future climate impacts (European Commission 2023; European Scientific Advisory Board on Climate Change 2023).

[15] A Project of Mutual Interest (PMI) is a cross-border energy infrastructure project that connects the European Union with one or more non-EU countries. PMIs are recognized under the revised TEN-E Regulation and benefit from streamlined permitting, enhanced investor visibility, and eligibility for EU funding, similar to Projects of Common Interest (PCIs), but specifically support energy integration and resilience between the EU and its external partners. See European Commission (2023).

5. Policy and Regulatory Options for Improving Climate Resilience

In general, regulation is approached through two main traditions: command-and-control regulation and incentive-based regulation. Command-and-control regulation specifies in detail the measures that operators must take, such as mandatory flood defences or wildfire buffer zones. Incentive-based regulation, by contrast, sets performance targets or financial signals, and leaves operators to decide how best to achieve them. Each approach has strengths and weaknesses. Command-and-control offers clarity and uniformity, but can be rigid and costly if local conditions vary. Incentive-based approaches give operators more flexibility, and can stimulate innovation, but they depend on regulators' ability to set the right metrics and incentives.

A second axis of variation is between EU-level regulation and national-level implementation. Some issues, such as cross-border interconnectors, require EU-level rules for consistency, while others may be better handled by national regulators familiar with local risks. Policy on resilience must, however, account for Europe's regional diversity: climate hazards, energy mixes, and infrastructure characteristics vary across Member States. Achieving resilience, therefore, calls for EU-level coordination combined with flexibility to tailor measures to regional and national contexts. The following subsections outline different possibilities for embedding climate resilience in regulation, together with their advantages and drawbacks.

5.1 Increased Emphasis on Climate Resilience in EU-level Energy Legislation

One possible approach is to increase the emphasis placed on climate resilience in EU energy legislation, such as the Electricity Regulation (EU 2019/943) and the Gas Regulation (EU 715/2009, pending revision). This would make resilience a binding criterion across member states, ensuring a uniform minimum standard. For example, regulations could require transmission and distribution operators to carry out climate risk assessments or to include resilience measures in investment planning. The main advantage of this approach is legal clarity and consistency across the EU, which would reduce the risk of fragmented implementation. However, it could be criticised for being overly prescriptive and not allowing for differences in regional exposure to hazards. For gas, this approach may need to reflect the transition away from methane infrastructure towards hydrogen and decarbonised gases. For electricity, it would interact directly with system adequacy and security-of-supply rules already in place. (European Commission 2019; ACER 2022).

5.2 Strengthening EU-level Project Assessment through TYNDP and CBA Guidelines

Another possible approach is to strengthen the role of climate resilience in the TYNDPs and the associated CBA guidelines developed by ENTSO-E and ENTSOG. While these methodologies are binding only for PCIs, they act as benchmarks for national regulators and operators, especially in jurisdictions where *ex ante* regulatory approval is required for investments.[16] Expanding resilience indicators in the CBA methodology could therefore influence national practice indirectly. The advantage of this approach is that it builds on existing EU processes without changing primary legislation. The drawback is that it remains indirect: unless explicitly required by EU law, national regulators are free to ignore these guidelines in their domestic frameworks. (ENTSO-E 2024; ENTSOG 2023).

The two above approaches in subsections 5.1 and 5.2 can be seen as complementary. The former enhances resilience directly through national regulatory practice, while the latter strengthens resilience indirectly through EU-wide guidelines.

5.3 Incorporating Resilience Explicitly in National Regulatory Frameworks

Another option is to integrate resilience explicitly into national regulatory frameworks, particularly in the incentive schemes that govern transmission and distribution operators. NRAs already oversee tariff-setting and investment approval, and they could incorporate resilience criteria such as mandatory climate risk assessments, resilience metrics in performance-based regulation, or explicit allowances for adaptation investments. This would include adjusting how system adequacy is measured to take account of extreme events. The advantage is that NRAs can tailor measures to national and regional conditions, such as flood risk in the Netherlands or wildfire risk in Greece. The drawback is the risk of inconsistency across Europe, with some countries moving faster than others. For electricity, regulators such as Ofgem (UK) and ARERA (Italy) have already piloted resilience-related incentives; for gas, examples are more limited. (Ofgem 2023; ARERA 2022).

5.4 Strengthening EU-level Coordination and Stress Testing

A further option is to enhance EU-level coordination of resilience planning through stress testing and joint scenario exercises. ENTSO-E and ENTSOG already conduct system-wide adequacy and infrastructure modelling. Adding climate resilience stress tests – simulating floods, heatwaves, or storms – would allow operators and regulators to see how projects improve system performance under adverse conditions. The benefit of this approach is that it builds a shared understanding of systemic risks and highlights the cross-border benefits of resilience investments. Its limitation is that stress testing is complex and depends on the quality of underlying climate and infrastructure data, which may not yet be harmonised across Europe (ACER 2022; Eurelectric 2025). One could argue that exactly because coordination is difficult, it is even more important to get started. Indeed, what could be done at the EU level is to develop the framework and tools that allow resilience decisions to be made at the national level (including metrics, common CBA approaches and common stress testing approaches). Harmonised tools could have other benefits, such as facilitating learning as well as enhancing cross-border coordination.

[16] In jurisdictions where ex ante approval is not required CBA rules are not directly relevant, cf. discussion in the introduction to Section 4.

5.5 Enhancing the Role of Insurance and Financial Risk Transfer

Finally, resilience could also be supported through insurance and other financial risk-transfer mechanisms. Insurance is already used to cover physical damage to assets, but coverage for long-duration outages is limited. Regulators could encourage or require operators to use insurance to manage certain risks, thereby reducing reliance on consumer-funded recovery. Although insurance as such does not reduce physical exposure to climate risks, it has the advantage of providing rapid financial liquidity after an event, particularly for smaller operators. The disadvantage is that systemic costs – such as widespread blackouts – are difficult to insure, and premiums may become unaffordable as climate risks increase. For electricity operators, insurance is more developed at the transmission level, e.g., through captive insurers, while distribution operators often rely on commercial policies. For gas, coverage is more limited and tends to focus on physical assets rather than business interruption. (Aon 2024; Munich Re 2024; BCG 2025).

5.6 Conclusion to Section 6

The five options outlined above represent different pathways for strengthening climate resilience in European energy regulation. They are not mutually exclusive but differ in scope, feasibility, and implementation horizon. Some, such as improving cost–benefit methodologies and incorporating resilience metrics into national incentive schemes, can be implemented under existing legislation and therefore offer short-term opportunities for reform. Embedding resilience directly in EU legislation (5.1) provides clarity but may lack flexibility. Moreover, this requires legislative amendment and broader political agreement, making it a medium- to long-term action item. Strengthening project assessment guidelines (5.2) and national regulatory frameworks (5.3) can move in parallel, with the former influencing practice indirectly and the latter allowing tailored national approaches. EU-level coordination and stress testing (5.4) helps to capture cross-border systemic risks, while insurance and risk transfer (5.5) provides a financial buffer but cannot substitute for regulatory measures. For electricity, these options align with ongoing discussions on system adequacy and reliability. For gas, they must also consider the transition from methane to hydrogen and decarbonised gases. Taken together, the options illustrate the range of regulatory tools available, each with its own advantages and limitations, for ensuring that Europe's energy infrastructure is prepared for the challenges of a changing climate. The reforms could be phased in over time—beginning with actions feasible under current law and evolving toward a more comprehensive framework in which resilience becomes a core criterion of European energy regulation.

In conclusion, it should be noted that resilience challenges are not only a matter of regulatory design but also of consistent compliance with existing reliability and operational standards. Failures in practice can stem from shortcomings in system operation, monitoring, or enforcement, even where rules are already in place. This raises the question of whether stronger compliance mechanisms should complement new policy instruments. Possible approaches include enhanced supervisory powers for national regulators, independent audits of operator preparedness, or EU-level oversight through bodies such as ACER and ENTSO-E/ENTSOG. The key issue is how to ensure that compliance frameworks are robust enough to deter neglect while avoiding excessive administrative burdens, and how accountability for resilience is best shared among operators, regulators, and European institutions.

6. Conclusions

Climate change is making resilience an increasingly important consideration for Europe's energy networks, alongside efficiency, decarbonisation, and security of supply. Extreme weather events are no longer outliers but recurring stressors on electricity and gas systems, with impacts that cascade across borders and sectors. Without a stronger integration of resilience into regulatory practice, the costs of climate disruptions are likely to grow, with implications for both public trust and the achievement of Europe's wider decarbonisation goals.

The policy and regulatory options discussed in this Issue Paper suggest that there are multiple possible pathways forward. Some involve EU-level measures, others national regulatory reform, revisions to methodologies such as cost–benefit analysis, or the use of insurance and risk-sharing mechanisms. None of these approaches, on its own, appears sufficient, but, taken together, they provide a menu of instruments that could help embed resilience more firmly into the governance of energy infrastructure. A central challenge will be finding the right balance between consistency at the EU level and flexibility for national regulators to respond to diverse local risks.

Resilience investments may be understood as a form of insurance: costs incurred today that reduce the likelihood of greater damages in the future. Whether through reinforcement of physical assets, operational preparedness, or financial mechanisms for sharing risk, adaptation measures can reduce the chances that climate shocks escalate into systemic crises. Regulation has a central role in ensuring that such measures are properly valued and efficient.

The key issues raised in this Issue Paper concern how resilience should be treated in project appraisal and tariff-setting, how incentives and performance metrics might reward adaptation outcomes, and how cross-border and cross-sector cooperation can be strengthened. Different combinations of these approaches may also be possible. The question for policy makers and regulators is how far and how quickly to advance along these lines, and how to weigh the trade-offs involved, to safeguard Europe's energy systems under changing climate conditions.

7. References

ACER. 2023a. Consolidated report on the progress of electricity and gas Projects of Common Interest. https://www.acer.europa.eu

ACER. 2023b. Agency's Position Paper: Towards Greater Consistency of Cost Benefit Analysis. https://acer.europa.eu/sites/default/files/documents/Position%20Papers/ACER_Consistency%20of%20CBA%20methodologies.pdf

ACER. 2023c. Report on Investment Evaluation, Risk Assessment and Regulatory Incentives for Energy Network Projects. June. https://www.acer.europa.eu/sites/default/files/documents/Publications/ACER_Report_Risks_Incentives.pdf

ARERA. 2023. Annual Report on the State of Services and Activities Carried out in 2023. https://www.arera.it/fileadmin/EN/publications/annual_report/summary_2023.pdf.pdf

Alogoskoufis et al. 2021. ECB Economy-wide Climate Stress Test. European Central Bank. ECB Occasional Paper No. 281 https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op281~05a7735b1c.en.pdf

Aon. 2024. Power Insurance and Risk Management. https://www.aon.com/en/capabilities/risk-transfer/power-insurance-and-risk-management

Assuratome. 2024. Nuclear Risk Insurance in France. https://www.assuratome.fr/en/16-summary

Baldursson Fridrik M., Banet Catherine, and Chyong Kong. 2023a. Building Resilience in Europe's Energy System. Centre on Regulation in Europe. https://cerre.eu/publications/building-resilience-in-europes-energy-system/

Baldursson, Fridrik, Catherine Banet, Kong Chyong. 2023b. Regulation and Standards for Resilient European Energy System. February. https://cerre.eu/wp-content/uploads/2023/02/CERRE_Resilience-in-Energy.pdf

Bates, P. D., Savage, J., Wing, O., Quinn, N., Sampson, C., Neal, J., Smith, A. 2023. A climate-conditioned catastrophe risk model for UK flooding. Nat. Hazards Earth Syst. Sci. 23(2) 891 – 908. https://doi.org/10.5194/nhess-23-891-2023

BBC. 2025a. Spain and Portugal wildfires drive worst EU season on record. 28 August. https://www.bbc.com/news/articles/cd6n8qqlj8go

BBC. 2025b. Greece battles wildfires as heatwave rages across southern Europe, 13 August. https://www.bbc.com/news/articles/cdd3my4e0pqo

BNetzA (Bundesnetzagentur). "Bundesnetzagentur confirms Electricity Network Development Plan 2023-2037/2045 for climate-neutral transmission network." 2024.

https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/EN/2024/20240301_NEP.html

CEER. 2024. Report on Regulatory Frameworks for European Energy Networks 2023. Brussels: CEER. https://www.ceer.eu/publication/report-on-regulatory-frameworks-for-european-energy-networks-2023/

Consorcio de Compensación de Seguros. 2024. Acerca del CCS. https://www.consorseguros.es/la-entidad/acerca-de-ccs

CPUC (California Public Utilities Commission). 2023. Decision Approving Settlement Regarding Wildfire Liability Insurance Coverage. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M501/K134/501134412.PDF

ECB. 2024. Climate-related financial disclosures. European Central Bank. https://www.ecb.europa.eu/ecb/climate/climate-related-financial-disclosures/html/index.en.html

ECB/EIOPA. 2024. EIOPA and ECB Joint Paper: Towards a European System for Natural Catastrophe Risk Management. https://www.eiopa.europa.eu/publications/eiopa-and-ecb-joint-paper-towards-european-system-natural-catastrophe-risk-management_en

Ember. 2025. Heat and power: Impacts of the 2025 heatwave in Europe, July 4. https://ember-energy.org/app/uploads/2025/07/Ember-Report-Heat-and-Power-Impacts-of-the-2025-heatwave-in-Europe.pdf

Financial Times. 2025. Europe's Electricity System Tested by Heatwaves as Air-conditioning Use Soars, Aug 3. https://www.ft.com/content/23b3dc59-b40f-48e2-ad93-e301de7ac5f2

ENTSO-E. 2024a. 4th ENTSO-E Guideline for cost-benefit analysis of grid development projects. https://www.entsoe.eu/news/2024/04/09/entso-e-publishes-the-final-guideline-for-cost-benefit-analysis-of-grid-development-projects/

ENTSO-E. 2024b. System Operations Report 2024. Brussels: European Network of Transmission System Operators for Electricity. https://www.entsoe.eu/publications/system-operations-reports/

ENTSO-E. 2024c. ENTSOG and ENTSO-E publish their joint electricity and hydrogen Interlinked Model 2024 progress report for public consultation. Press release, May 7. https://www.entsoe.eu/news/2024/05/07/entsog-and-entso-e-publish-their-joint-electricity-and-hydrogen-interlinked-model-2024-progress-report-for-public-consultation/

ENTSO-E. 2025. Implementation Guidelines for TYNDP 2024; Based on 4th ENTSO-E Guideline for Cost Benefit Analysis of Grid Development Projects; Version for ACER, European Commission and EU Member States Opinion. https://eepublicdownloads.blob.core.windows.net/public-cdn-container/tyndp-documents/TYNDP2024/foropinion/CBA_Implementation_Guidelines.pdf

ENTSOG. 2024a. Methodology for Cost-Benefit Analyses of Hydrogen Infrastructure Projects. https://www.entsog.eu/sites/default/files/2025-02/entsog_CBA_methodolgy_report_250225.pdf

ENTSOG. 2024b. Ten-Year Network Development Plan 2024. Brussels: European Network of Transmission System Operators for Gas, 2024. https://www.entsog.eu/tyndp

ENTSO-E. 2025. 28 April 2025 Iberian Blackout Investigation. Brussels: ENTSO-E. https://www.entsoe.eu/publications/blackout/28-april-2025-iberian-blackout/

ENTSO-E and ENTSOG. 2024. Progress Report on Interlinked Modelling: The Cross-Sectorial Integration of Energy System Planning. April. https://www.entsog.eu/sites/default/files/2024-05/entsos_ILM_progress_report_240430.pdf

Eurelectric. 2025. Strengthening Climate Resilience: Strategies for Enhancing DSO Resilience against Climate Change. Brussels: Eurelectric. https://www.eurelectric.org/publications/strengthening-climate-resilience-strategies-for-enhancing-dso-resilience-against-climate-change

European Commission. 2019. Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity. Brussels: European Commission. http://data.europa.eu/eli/reg/2019/943/oj

European Commission. 2021. Technical Guidance on the Climate Proofing of Infrastructure in the period 2021–2027. https://ec.europa.eu/newsroom/cipr/items/722278/

European Commission. 2022a. Regulation (EU) 2022/869 on Guidelines for Trans-European Energy Infrastructure (TEN-E). Brussels: European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R0869

European Commission. 2022b. Directive (EU) 2022/2557 of the European Parliament and of the Council of 14 December 2022 on the resilience of critical entities and repealing Council Directive 2008/114/EC. Brussels: European Commission. https://eur-lex.europa.eu/eli/dir/2022/2557/oj/eng

European Commission. 2023. Projects of Common Interest and Projects of Mutual Interest. https://energy.ec.europa.eu/topics/infrastructure/projects-common-interest-and-projects-mutual-interest_en

European Commission. 2025a. Adaptation and resilience to climate change. https://climate.ec.europa.eu/eu-action/adaptation-and-resilience-climate-change_en. Retrieved on September 9, 2025.

European Commission. 2025b. European Climate Resilience and Risk Management – Integrated Framework. https://climate.ec.europa.eu/eu-action/adaptation-and-resilience-climate-change/european-climate-resilience-and-risk-management-integrated-framework_en. Retrieved on September 9, 2025.

European Environment Agency. 2019. Adaptation challenges and opportunities for the European energy system – Building a climate-resilient low-carbon energy system. Publications Office. https://www.eea.europa.eu/en/analysis/publications/adaptation-in-energy-system

European Environment Agency. 2024. European Climate Risk Assessment, EEA Report 01/2024. https://www.eea.europa.eu/en/analysis/publications/european-climate-risk-assessment

European Scientific Advisory Board on Climate Change. 2023. Towards a Decarbonised and Climate-Resilient EU Energy Infrastructure: Recommendations on an Energy System-Wide Cost-Benefit Analysis. Brussels: European Scientific Advisory Board on Climate Change, March. https://climate-advisory-board.europa.eu/reports-and-publications/towards-a-decarbonised-and-climate-resilient-eu-energy-infrastructure-recommendations-on-an-energy-system-wide-cost-benefit-analysis

European Commission. 2021. EU Strategy on Adaptation to Climate Change. Brussels: European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:82:FIN

European Commission. 2022. Regulation (EU) 2022/869 on Guidelines for Trans-European Energy Infrastructure (TEN-E). Brussels: European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R0869

Federal Energy Regulatory Commission (FERC) and North American Electric Reliability Corporation (NERC). 2021. The February 2021 Cold Weather Outages in Texas and the South Central United States: Causes and Recommendations. Washington, DC: FERC and NERC. https://ferc.gov/media/february-2021-cold-weather-outages-texas-and-south-central-united-states-ferc-nerc-and

GRDF. 2025. Private communication, October 13.

International Energy Agency. 2022. Climate Resilience for Energy Security. Paris: IEA. https://www.iea.org/reports/climate-resilience-for-energy-security

International Energy Agency (IEA). 2025. World Energy Investment 2025 10th Edition. https://www.iea.org/reports/world-energy-investment-2025

Intergovernmental Panel on Climate Change (IPCC). 2023. Climate Change 2023, Synthesis Report https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_LongerReport.pdf

Jorissen, Richard, Erik Kraaij, and Ellen Tromp. 2016. Dutch Flood Protection Policy and Measures Based on Risk Assessment. E3S Web of Conferences 7: 20016. https://doi.org/10.1051/e3sconf/20160720016.

Jung, D., Fernandez Blanco Carramolino, R., Yusta Loyo, J.M. and Bolado Lavin, R. 2022. Interaction gas-electricity toolbox, EUR 30935 EN, Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/62982

Karagiannis, G., Turksezer, Z., Alfieri, L., Feyen, L. and Krausmann, E. 2019a. Climate Change and Critical Infrastructure - Floods. Publications Office of the European Union. https://doi.org/10.2760/007069

Karagiannis, G., Cardarilli, M., Turksezer, Z., Spinoni, J., Mentaschi, L., Feyen, L. and Krausmann, E. 2019b. Climate Change and Critical Infrastructure – Storms. Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/986436

Koks, E.E., van Ginkel, K.C.H., van Marle, M.J.E., & Lemnitzer, A. 2022. Critical Infrastructure Impacts of the 2021 Mid-July Western European Flood Event. Natural Hazards and Earth System Sciences, 22: 3831–3838. https://nhess.copernicus.org/articles/22/3831/2022/

Liu, Zhongwei, Eden, Jonathan M., Dieppois, Bastien, Drobyshev, Igor, Krikken, Folmer, Blackett, Matthew. 2025. Global assessment of historical changes in extreme fire weather: Insight from CMIP6 ensembles and implications for probabilistic attribution to global warming, Global and Planetary Change, Volume 252, https://doi.org/10.1016/j.gloplacha.2025.104822.

Lo Schiavo, Luca, Carlo Turconi, and Ferruccio Villa. 2019. Regulatory Incentives for Improving the Resilience of Electricity Distribution Grids in Italy. In 25th International Conference on Electricity Distribution (CIRED 2019), 3–6 June, Madrid. https://www.cired-repository.org/server/api/core/bitstreams/11baa975-40da-4508-a96c-d3af9983f994/content

Marsh. 2022. How Insurance Can Accelerate the Energy Transition. https://www.marsh.com/en/industries/energy-and-power/insights/how-insurance-can-accelerate-the-energy-transition.html

Marsh. 2023. Energy & Power | Insurance Broking & Risk Management. https://www.marsh.com/en/industries/energy-and-power.html

Massachusetts Department of Public Utilities. 2014. Order Adopting Final Revised Emergency Response Guidelines for Electric Companies, D.P.U. 14-72-A (December 23, 2014). Boston: Massachusetts Department of Public Utilities. https://www.mass.gov/info-details/emergency-response-plans.

Munich Re. 2024. Power & Utilities: Mastering the Energy Transition. https://www.munichre.com/en/solutions/for-industry-clients/coverage-for-the-power-and-utilities-industry.html

National Gas. 2024. Adapting to change, fit for the Future: Our Climate Change Adaptation Report 2024. December. https://www.nationalgas.com/sites/default/files/documents/National%20Gas%20adaptation%20reporting%202024%20LOW.pdf

National Grid. 2019. Technical Report on the Events of 9 August 2019. Warwick: National Grid Electricity System Operator. https://www.nationalgrideso.com/document/152346/download

Netherlands Ministry of Infrastructure and Water Management. 2025. “Delta Decision on Flood Risk Management.” Delta Programme. https://english.deltaprogramma.nl/three-topics/flood-risk-management/delta-decision

Netzentwicklungsplan. 2025. Network Development Plan 2037/2045 (2025). https://www.netzentwicklungsplan.de/en/nep-aktuell/netzentwicklungsplan-20372045-2025

New York State Public Service Commission. 2025. PSC Approves Electric Utility Emergency Response Plans, March 20. Albany: New York State Department of Public Service. https://dps.ny.gov/news/psc-approves-electric-utility-emergency-response-plans.

New York Times. 2003. Outage hits in night, stranding travelers and causing chaos : Blackout cuts power for hours in Italy. September 29. https://www.nytimes.com/2003/09/29/IHT-outage-hits-in-night-stranding-travelers-and-causing-chaos-blackout-cuts.html

NVE-RME. 2022. National Report 2021 (RME Rapport 8/2022): Electricity and Gas Markets. Oslo. https://publikasjoner.nve.no/rme_rapport/2022/rme_rapport2022_08.pdf

OECD. 2018. Climate-Resilient Infrastructure. Paris: Organisation for Economic Co-operation and Development. https://www.oecd.org/content/dam/oecd/en/publications/reports/2018/12/climate-resilient-infrastructure_4370bc43/4fdf9eaf-en.pdf

Ofgem. 2020. RIIO-2 Final Determinations for Transmission and Gas Distribution network companies and the Electricity System Operator. London: Ofgem. https://www.ofgem.gov.uk/decision/riio-2-final-determinations-transmission-and-gas-distribution-network-companies-and-electricity-system-operator

Ofgem 2023. Future Systems and Network Regulation Core Document. 2023. https://www.ofgem.gov.uk/sites/default/files/2023-10/RIIO-3%20Framework%20Decision%20.pdf

Ofgem. 2024a. RIIO-3 Sector Specific Methodology Decision – Overview Document. London: Office of Gas and Electricity Markets. https://www.ofgem.gov.uk/sites/default/files/2024-07/RIIO_3_SSMD_Overview.pdf

Ofgem. 2024b. RIIO-ED2 Regulatory Instructions & Guidance: Annex B – Costs, Volumes and Revenue. London: Office of Gas and Electricity Markets. https://www.ofgem.gov.uk/sites/default/files/2024-06/RIIO-ED2_Annex_B_Costs_Volumes_and_Revenue_v1.1_%28tracked%29.pdf

Panteli, Mathaios, and Pierluigi Mancarella. 2017. Modeling and Evaluating the Resilience of Critical Electrical Power Infrastructure to Extreme Weather Events. IEEE Systems Journal 11 (3): 1733–42. https://doi.org/10.1109/JSYST.2015.2389272

REE. 2022. Spanish Electricity System 2022 – Renewable Electricity Generation. https://www.sistemaelectrico-ree.es/en/2022/spanish-electricity-system/generation/renewable-electricity-generation

Rockas, O., Isolähteenmäki, P., Laine, M., Lindfors, A. V., Hämäläinen, K., and Laakso, A. 2025. Future Rime Ice Conditions for Energy Infrastructure over Fennoscandia Resolved with a High-Resolution Regional Climate Model, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2025-1745

Swiss Re. 2024. Energy and Natural Resources. https://corporatesolutions.swissre.com/insurance-solutions/energy-natural-resources.html

Swiss Re. 2025. Swiss Re NatCat Modelling Engine. Cutting-edge natural catastrophe models for better risk selection, pricing and accumulation control. https://www.swissre.com/reinsurance/property-and-casualty/solutions/natcat-modelling-engine.html?utm_source=chatgpt.com

TCFD. 2017. Recommendations of the Task Force on Climate-related Financial Disclosures https://assets.bbhub.io/company/sites/60/2021/10/FINAL-2017-TCFD-Report.pdf

The Insurance Universe. 2024. Understanding Energy Insurance: Key Coverage Options Explained. https://theinsuranceuniverse.com/energy-insurance-and-coverage-options/

United Nations Environment Programme (UNEP). 2024. Climate Risks in the Power Generation Sector. https://www.unepfi.org/wordpress/wp-content/uploads/2024/05/Climate-Risks-in-the-Power-Generation-Sector-1.pdf

United Nations Office for Disaster Risk Reduction. 2025. GAR 2025; Global Assessment Report on Disaster Risk Reduction: Resilience Pays: Financing and Investing for our Future. https://www.undrr.org/gar/gar2025#download?utm_source=publication&utm_medium=pdf&utm_campaign=GAR2025

WMO and C3S. 2025. European State of the Climate 2024. https://climate.copernicus.eu/esotc/2024

Zurich Insurance Group. 2025. Safeguarding Our Energy Future: Protecting Europe’s Energy Infrastructure Against Climate Risk. https://mandalapartners.com/uploads/safeguarding-our-energy-future-full-report.pdf

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