SHURA
ENERGY TRANSITION CENTER

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Energy transition in numbers

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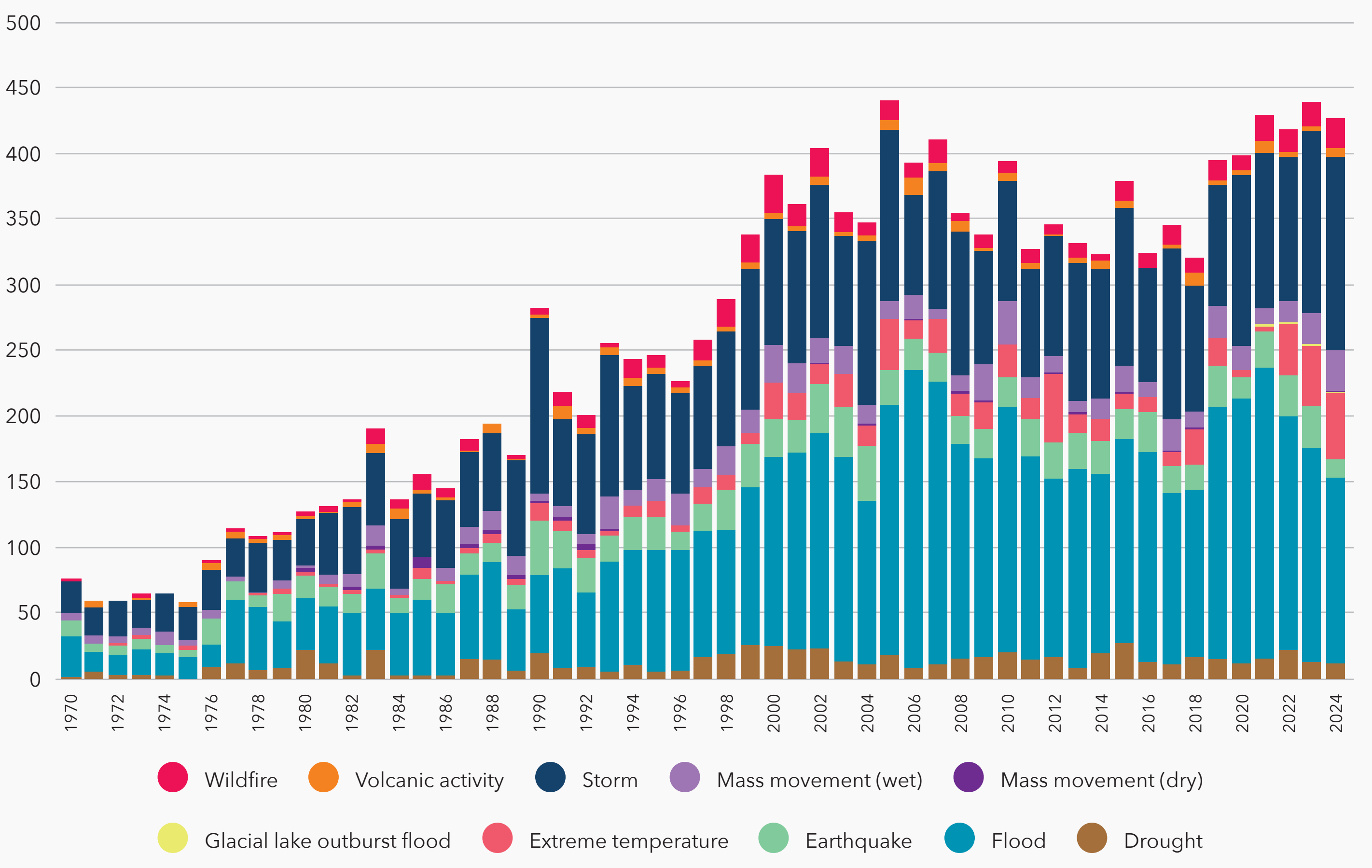
Extreme weather events* and natural disasters, whose frequency and intensity have increased in recent years, pose significant operational and economic risks to power transmission and distribution infrastructure. These events not only result in loss of life but also cause economic losses due to power outages and disruptions in the supply chain.

In regions affected by climate-related events or natural disasters such as earthquakes, disruptions in transmission and distribution networks can prevent end users from accessing energy, even when power generation facilities remain undamaged. Accordingly, strengthening grid infrastructure is regarded as a key priority for implementing climate change adaptation strategies and ensuring energy supply security.

Annual global frequency of natural disasters by type, 1970–2024 (Number of events)



*IRENA (2025) considers storms, extreme temperatures, droughts, wildfires, floods, and mass movements within the scope of extreme weather events.

Source: IRENA (2025)

According to IRENA (2025), infrastructures are exposed to multiple physical hazards, including heatwaves, storms, wildfires, droughts, land subsidence, and sea-level rise. Climate change leads to more frequent and severe climate-related hazards, and these events can set off a chain of interconnected effects. Analyses by Climate Central (2024) indicate that between 2000 and 2023, 80% of large-scale power outages in the United States of America were caused by weather-related events.

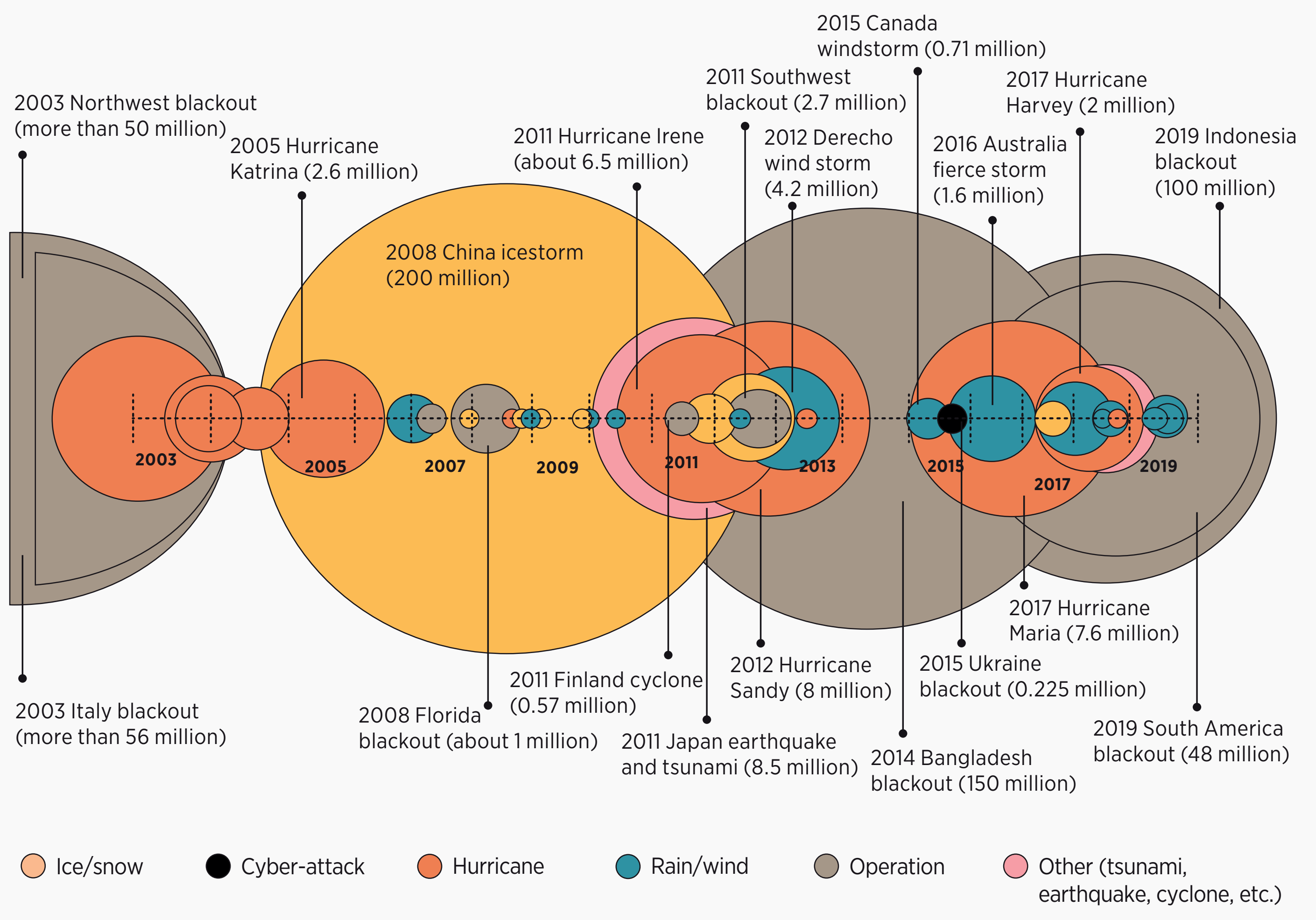
According to EM-DAT (2025) data, a total of 393 natural disaster events were recorded worldwide in 2024, affecting approximately 167 million people. In 2024;

- Although an annual average of 11 uncontrolled wildfires was observed between 2004 and 2023, this number nearly doubled in 2024, by reaching 21.
- Approximately 33 million people were affected by extreme heat conditions in Bangladesh,
- In the USA, Hurricane Helen caused economic losses of US$ 56 billion, while Hurricane Milton resulted in losses of US$ 38 billion.
- Earthquakes in Japan have resulted in total damages amounting to around US$ 15 billion.

According to ABS-CBN (2025), a magnitude 6.9 earthquake in the Philippines in 2025 caused damage to power transmission lines, resulting in several days of electricity outages for approximately 820,000 subscribers.

These data highlight the significant operational and economic risks that extreme weather events and natural disasters, such as earthquakes, impose on infrastructure systems.

Number of people (in millions) experiencing power outages due to natural disasters and cyber-attacks between 2003 and 2019



Source: IRENA (2025)

IRENA's (2025) recommended actions for strengthening and enhancing the resilience of electricity infrastructure against the climate crisis.

Action 1. Identify extreme weather events and system vulnerabilities:	Using weather and climate models to assess the likelihood of extreme weather events and their potential impacts on electric infrastructure. Identifying and mapping the most critical vulnerabilities within power systems.
Action 2. Identify resilience-enhancing measures:	Prioritizing the most significant vulnerabilities across various power systems and evaluating resilience-enhancing measures that can address these identified vulnerabilities
Action 3. Conduct cost-benefit analysis:	Performing comprehensive cost-benefit analyses in which the recurring outage costs, emergency repair activities, and downtime costs associated with weather events are comparatively evaluated, in order to proactively implement resilience investments.
Action 4. Adopt policies for proactive resiliences:	Develop strategic national plans and policies that promote proactive measures and investments to strengthen the resilience of the electricity sector, and that integrate the principle of resilience into system design and operation.
Action 5. Secure investment for resilience:	Conducting cost-benefit analyses that compare the costs of resilience measures with the avoided losses can help inform investment decisions by identifying the most economically effective strategies. Such analyses estimate whether the benefits of an action outweigh its costs and enable ranking of alternatives based on their cost-benefit ratios, which supports prioritization and timing of resilience investments.
Action 6. Harden infrastructure:	Protecting critical assets in a manner appropriate to local climate threats such as flooding and storms, and selecting solutions that are aligned with the specific vulnerabilities that have been assessed.
Action 7. Foster distributed energy resources:	Reducing reliance on the central grid through distributed energy resources enhances the resilience of critical services. Energy storage solutions can be deployed to meet regional needs, and because storage plays a key role in balancing supply and demand, policies should encourage its adoption by facilitating new revenue opportunities for investors and operators.
Action 8. Integrate grid-forming* renewables:	Integrating renewable energy sources, which are increasing their share in electricity generation and provide grid-forming capabilities, can enhance system reliability during power outages and reduce dependence on fossil fuel supply chains.
Action 9. Integrate smart grid solutions:	Predictive analysis, forecasting, and smart monitoring enable proactive interventions against changing weather conditions, thereby minimizing related outages and optimizing existing infrastructure. This approach can also help avoid the need for costly new infrastructure investments.
Action 10. Facilitate knowledge sharing:	Provide regular training for utility personnel to strengthen capacity and facilitate knowledge sharing. Establish open platforms that share resilience strategies, case studies, and policy frameworks to enhance community engagement and stakeholder communication. In addition, research and development (R&D) activities involving the public and private sectors, as well as universities should be encouraged to support innovation and collaborative learning.

*Grid-forming inverters can interface with energy storage systems alongside renewable energy sources such as solar and wind, and operate as voltage-source converters without relying on an external reference.

Source: IRENA (2025)

- International examples clearly demonstrate the impact of weather-related outages on system reliability, while high-cost infrastructure damages make energy supply security vulnerable.
- The widespread deployment of renewable energy sources is strategically important not only for achieving climate targets but also for enhancing the resilience of the energy system. Strengthening transmission and distribution infrastructure, complemented by distributed renewable generation, storage systems, micro-grids, and on-site generation solutions, can contribute to limiting the impacts of earthquakes and climate-related natural disasters on the electricity system.
- Türkiye's location in a siesmic belt, along with increasing flood risks due to climate change, represents a significant systemic risk to energy infrastructure. Effective management of these risks requires conducting city-level disaster risk assessments, strengthening infrastructure resilience, and integrating digital technologies into planning processes.
- In developing disaster-resilient infrastructure, Türkiye can effectively enhance energy supply security and system flexibility by integrating distributed generation facilities with storage systems, leveraging its solar energy potential.
- In Türkiye, establishing an integrated emergency response and coordination mechanism, in which the roles of sector stakeholders are clearly defined under public oversight, can facilitate rapid interventions to minimize energy supply disruptions during disasters.