Climate risk and impact assessments for energy security

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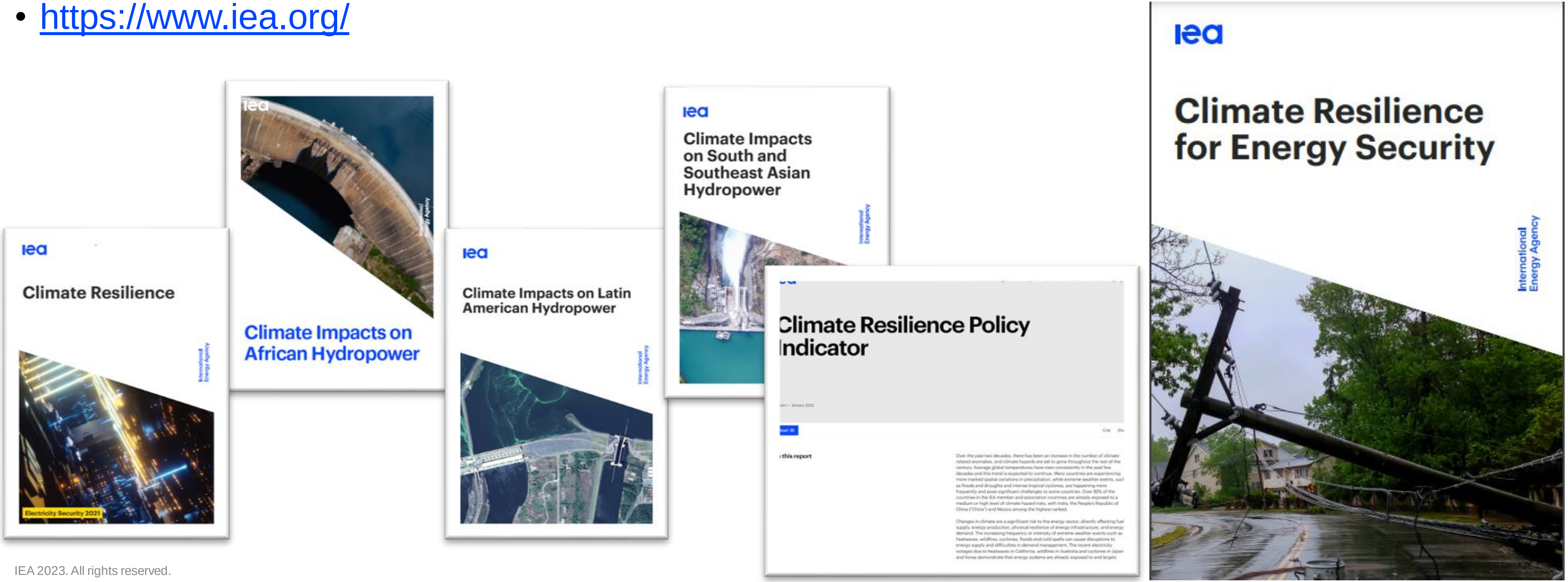
The IEA contributes to climate resilience of energy systems

- IEA is actively working on assessing climate impacts and enhancing climate resilience
- It considers climate change as an emerging threat to energy security
- https://www.iea.org/



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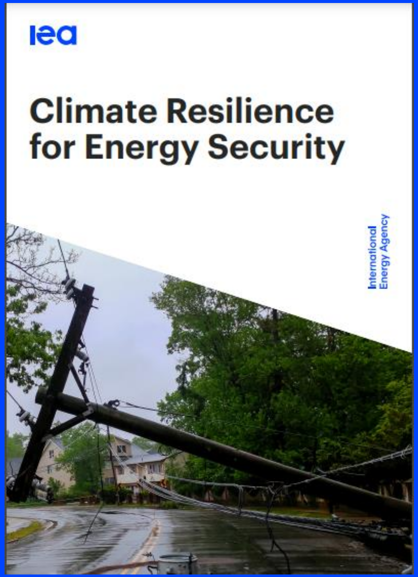


www.iea.org/reports/climate-resilience-for-energy-security

Definition and Methodology

- **Climate risk:**
  - refers to the factors that are associated with the potential consequences of climate change.
  - results from the interaction of **hazard, exposure and vulnerability**.
  - determines the actual consequences of climate change (“climate impacts”).

Hazard

(Temperature, Precipitation, Wind, Sea level)

- Historical records
  (IEA-CMCC Weather for Energy Tracker, EM-DAT, WMO, UNDRR, Copernicus)
- Climate projections by scenario (IPCC)

Exposure

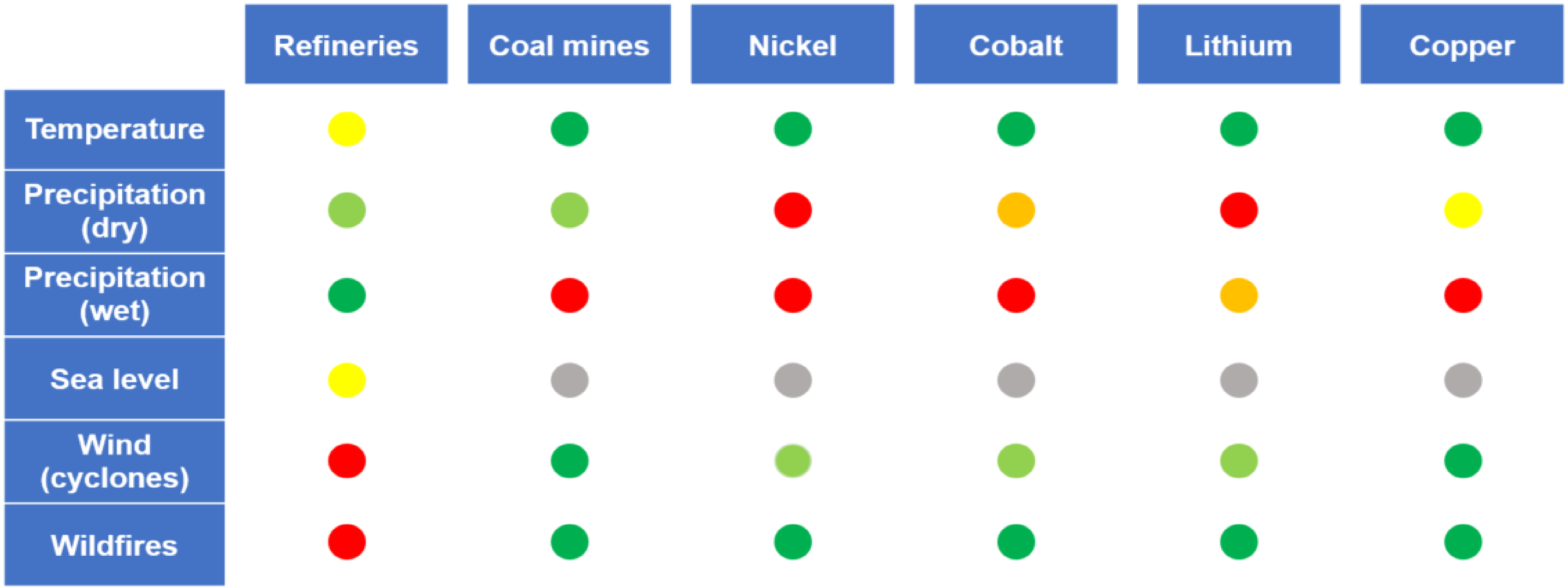
- GIS analysis of energy production sites and climate hazards
  (IEA, S&P Global, Global Energy Monitor, Open Street Map)
- Compilation of geographical information on climate hazards

Vulnerability

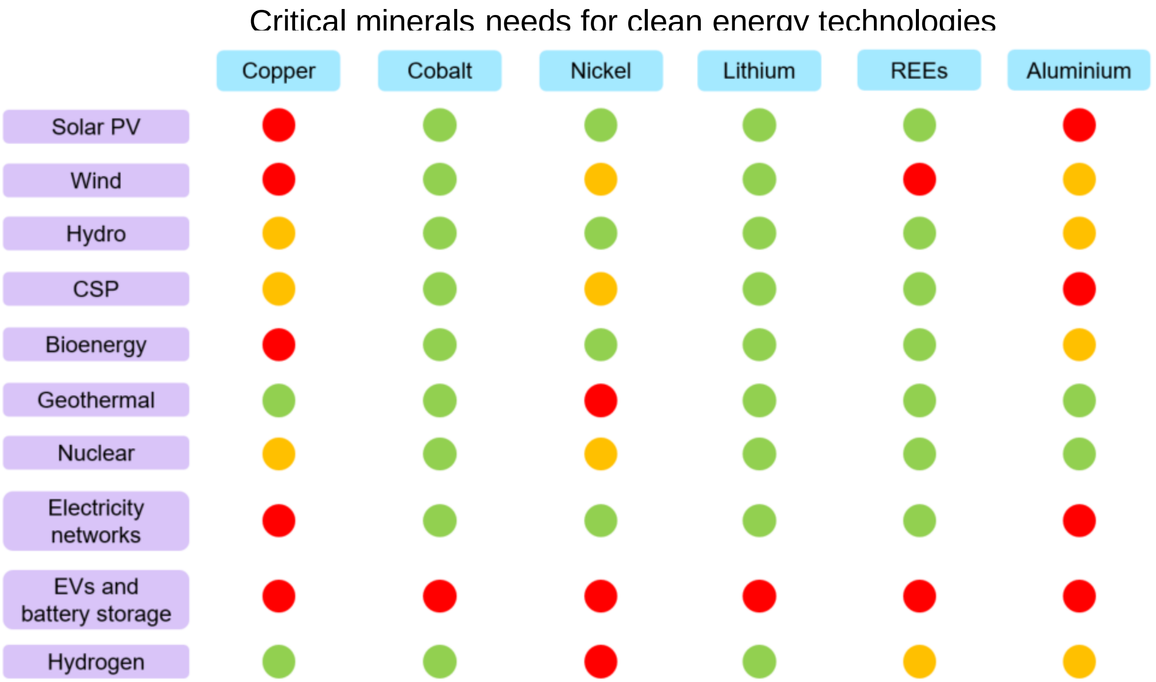
- Literature review
- Expert consultation (IEA Consultation Group on Climate Resilience for Energy Security)

Overview – Fuel and Minerals

High-emissions scenario



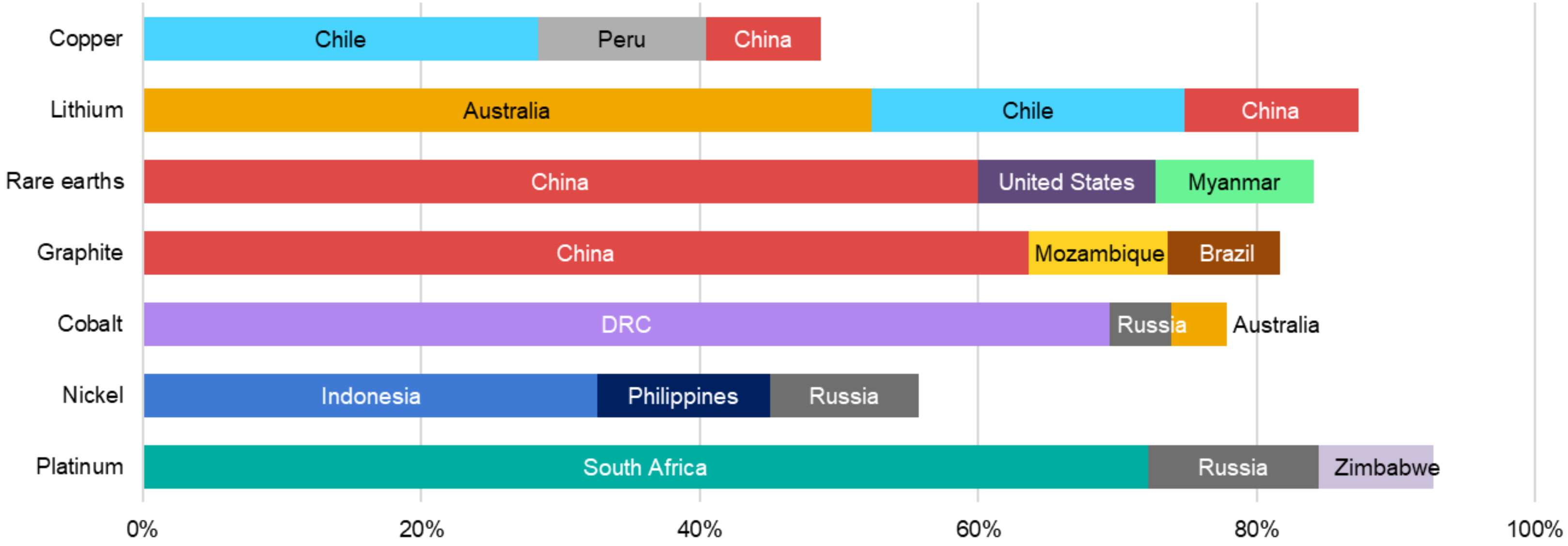
Critical Minerals Needs for Clean Energy Technologies



Note: Colours indicate the relative importance of minerals for a particular clean energy technology (red = high; orange = moderate; green = low). See Annex of *The Role of Critical Minerals in Clean Energy Transitions* report for methodologies and data sources. CSP = concentrating solar power. REEs = rare earth elements.

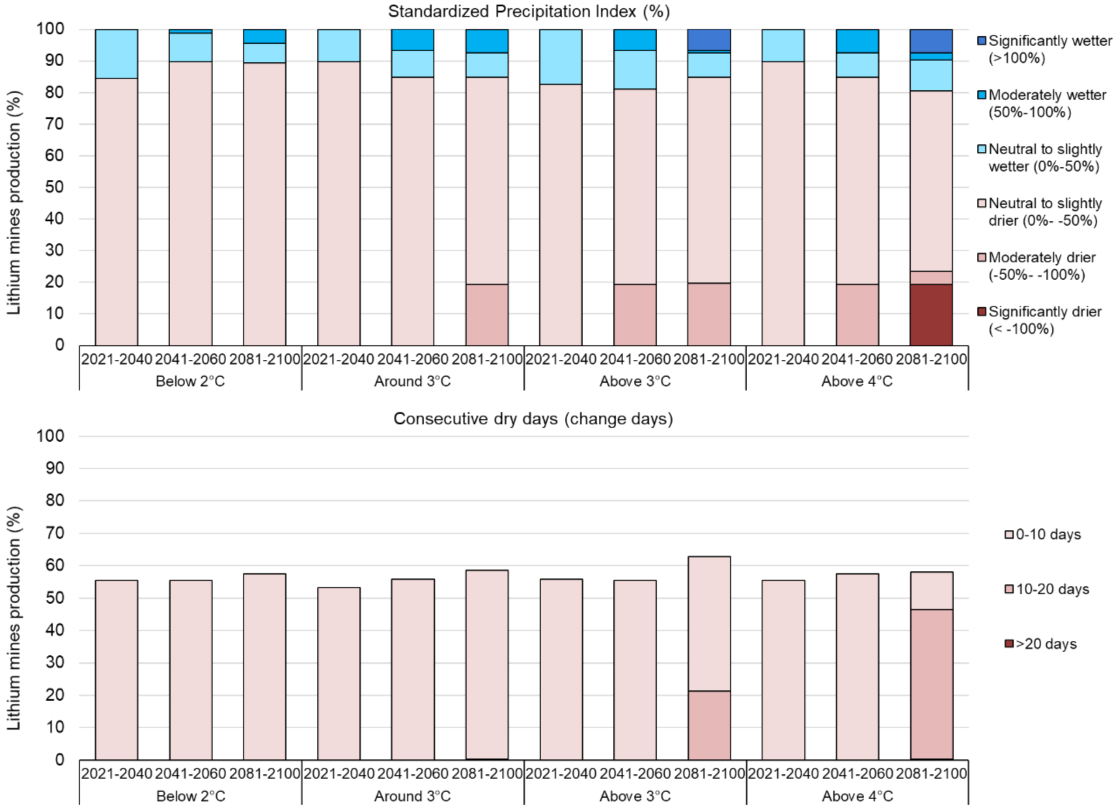
Geographically Concentrated Production of Critical Minerals

Share of top three producing countries in total production of selected minerals, 2019



Changes in precipitation could disrupt the supply of critical minerals

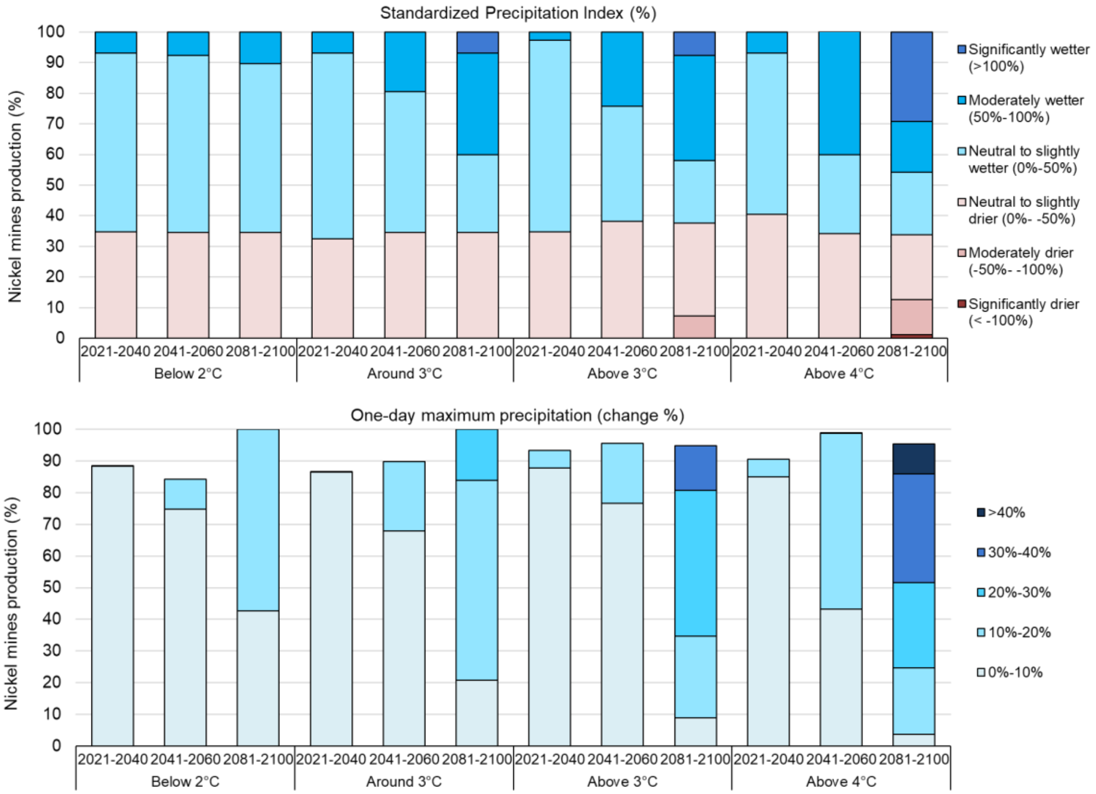
Lithium



Lithium production areas are projected to experience a drier climate possibly with droughts

Changes in precipitation could disrupt the supply of critical minerals

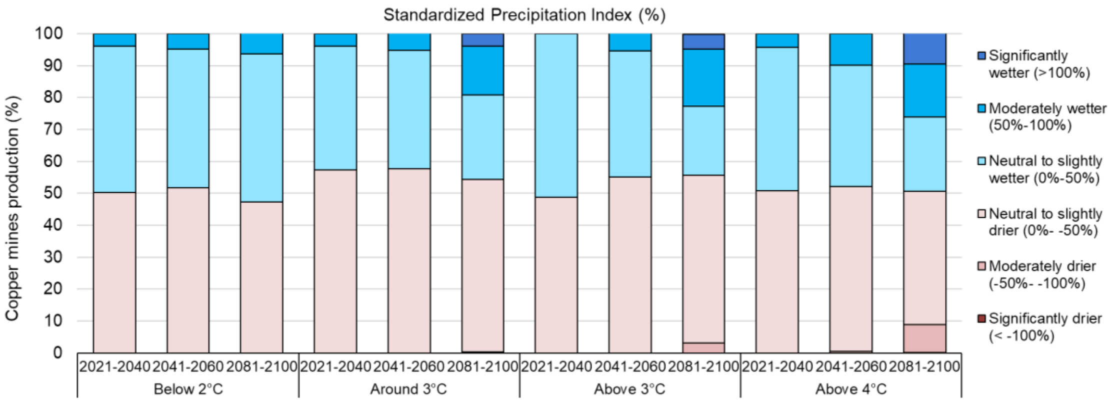
Nickel

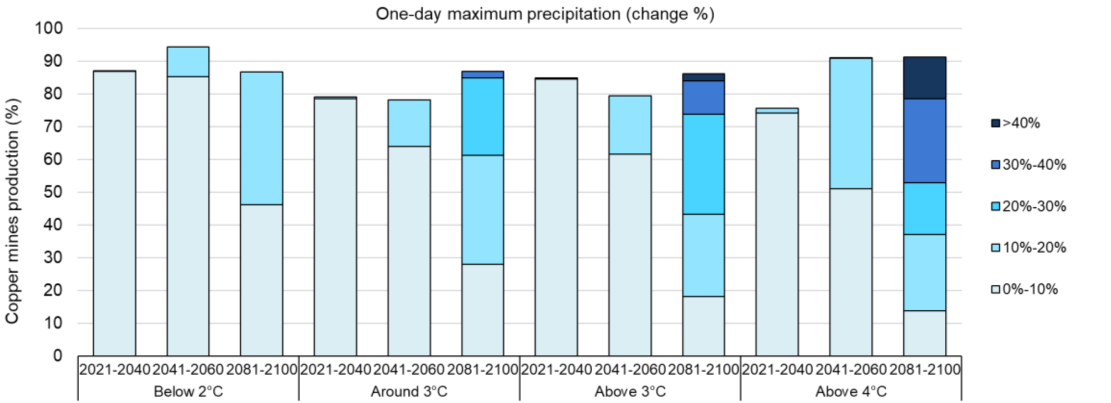


Nickel production areas are projected to experience a wetter climate possibly with heavy rainfall and floods

Changes in precipitation could disrupt the supply of critical minerals

Copper

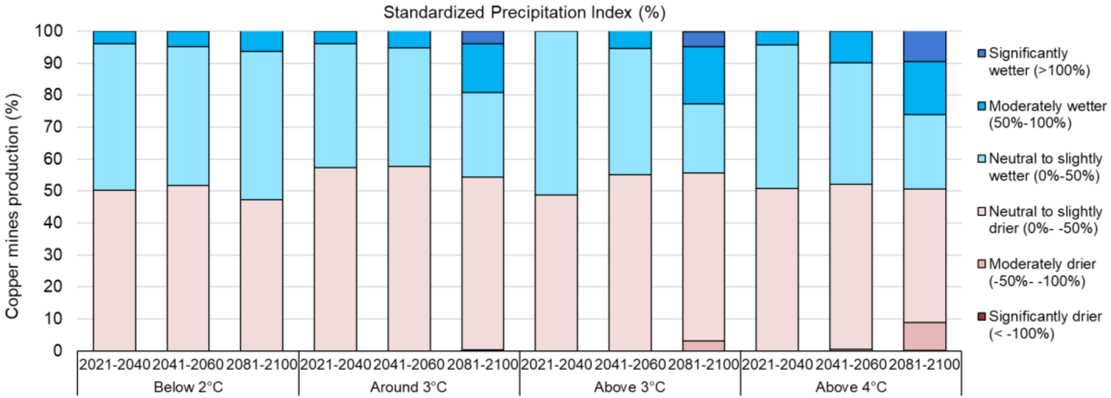


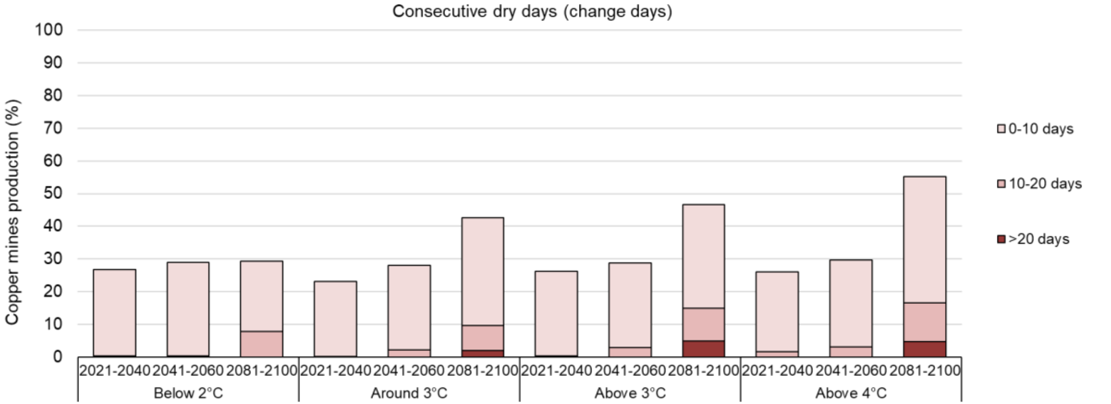


Copper production is projected to see mixed impacts from climate change, depending on production sites

Changes in precipitation could disrupt the supply of critical minerals

Copper

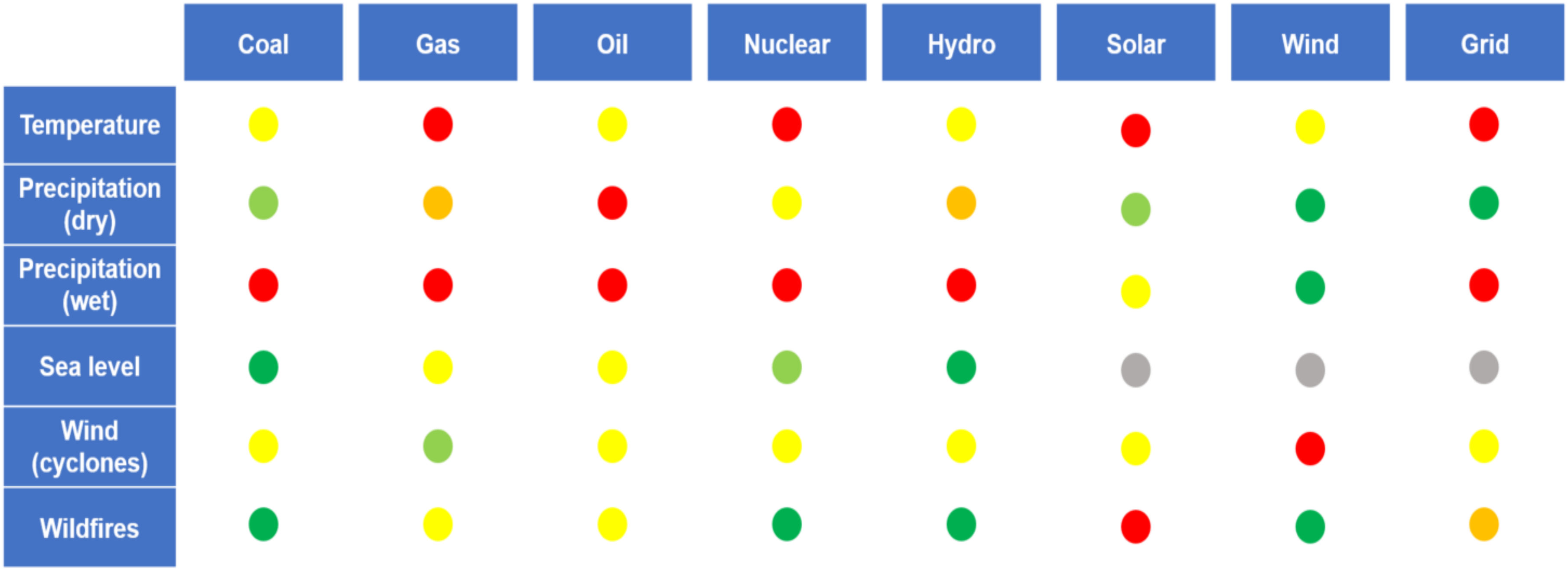




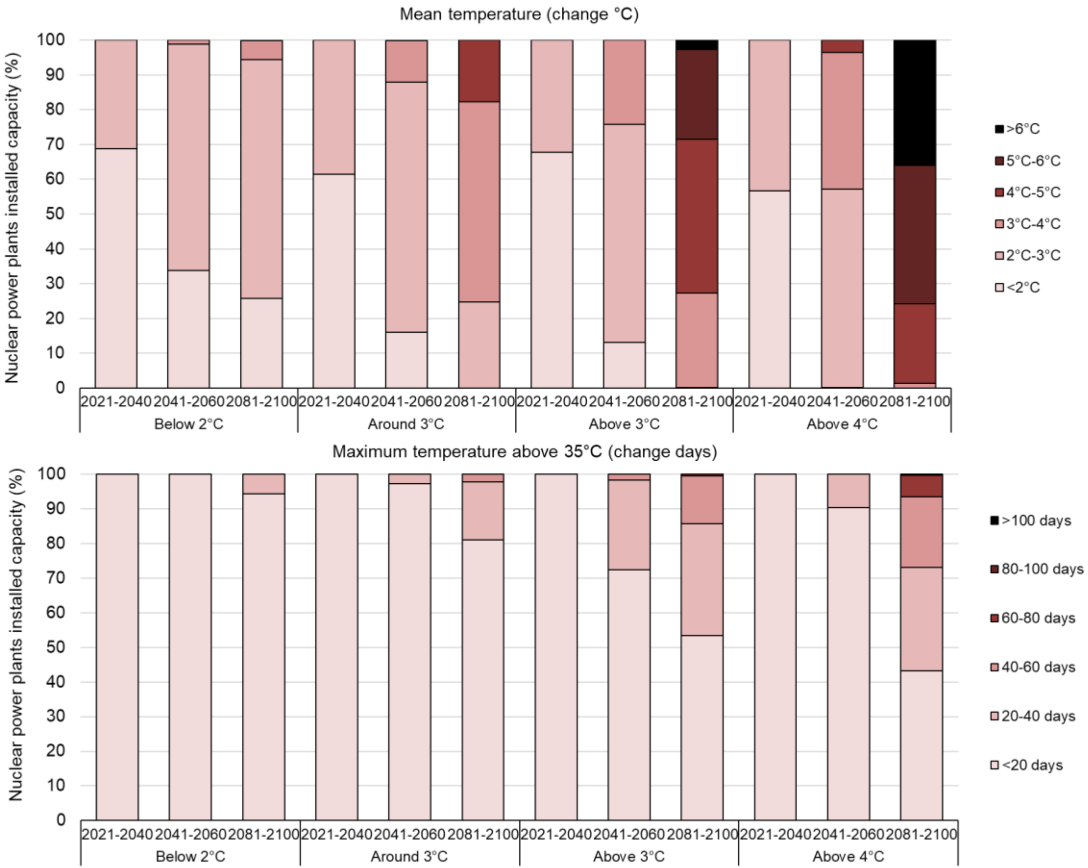
Copper production is projected to see mixed impacts from climate change, depending on production sites

Climate change risks to power plants and electricity grids

High-emissions scenario

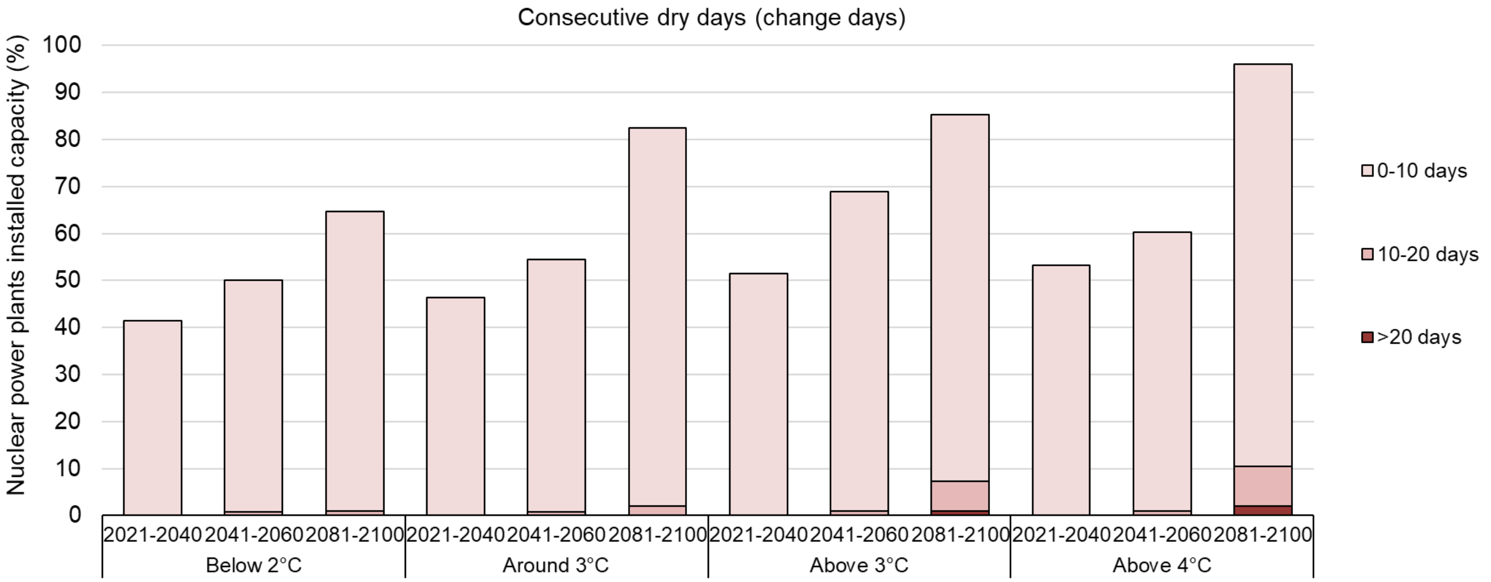


Higher temperatures will add risks to nuclear power generation

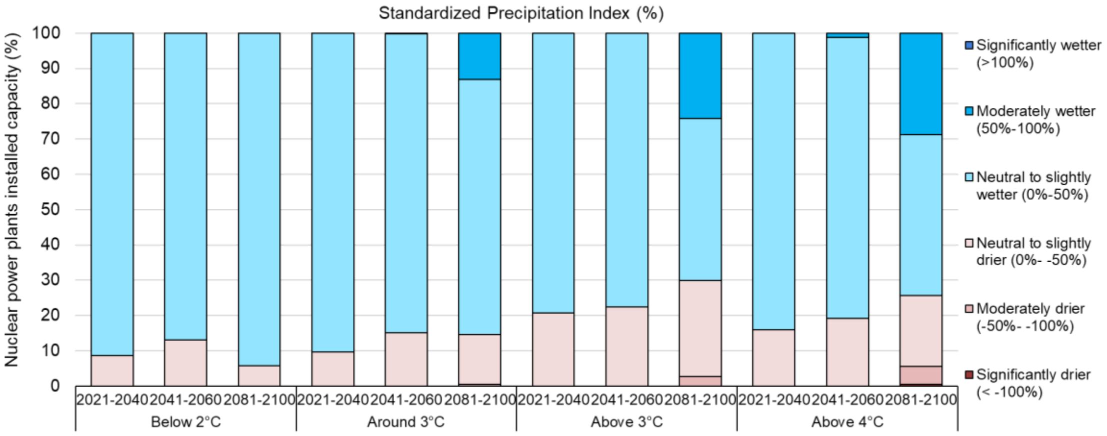


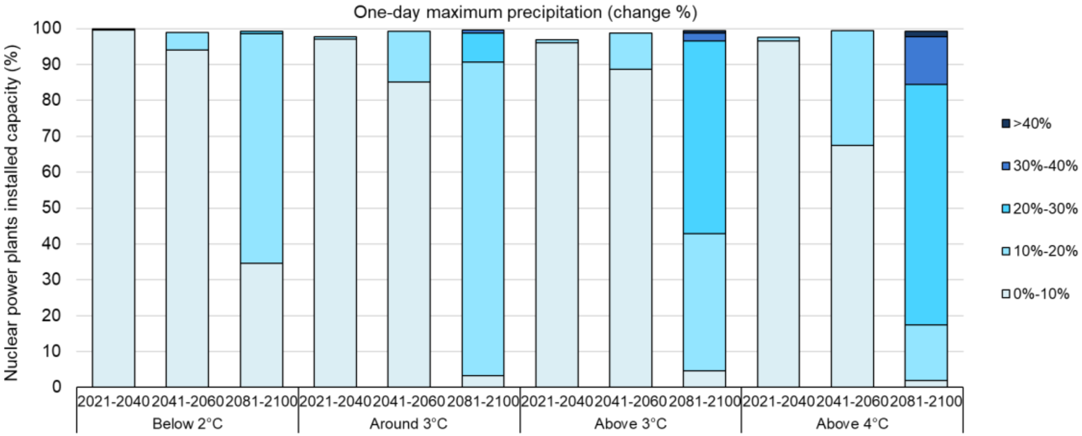
Severe droughts may limit cooling water availability for nuclear power

Nuclear power plants exposed to a drier climate by climate scenario

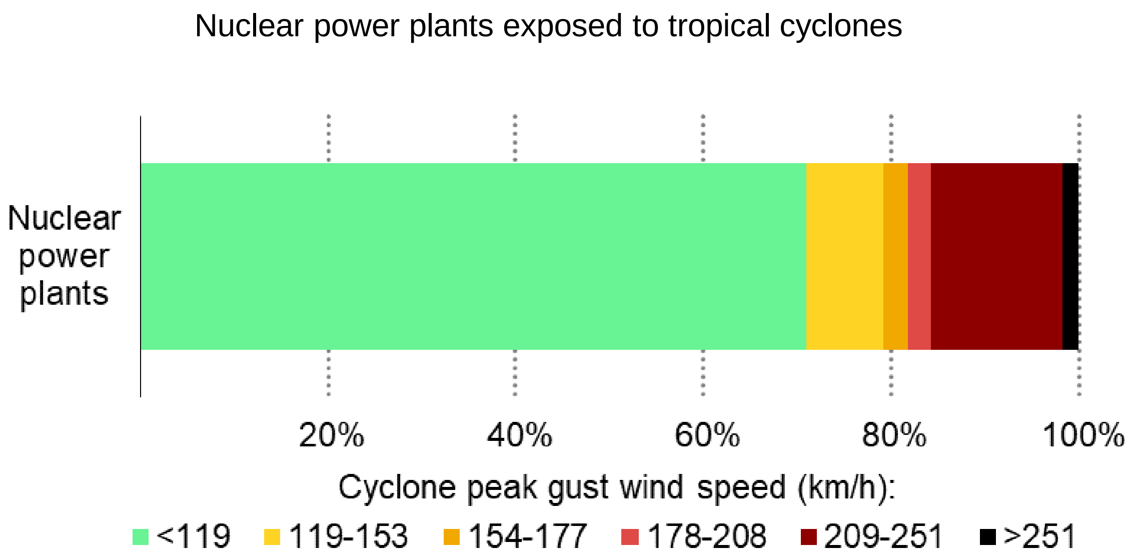


More frequent floods and heavy rainfall could disrupt nuclear power



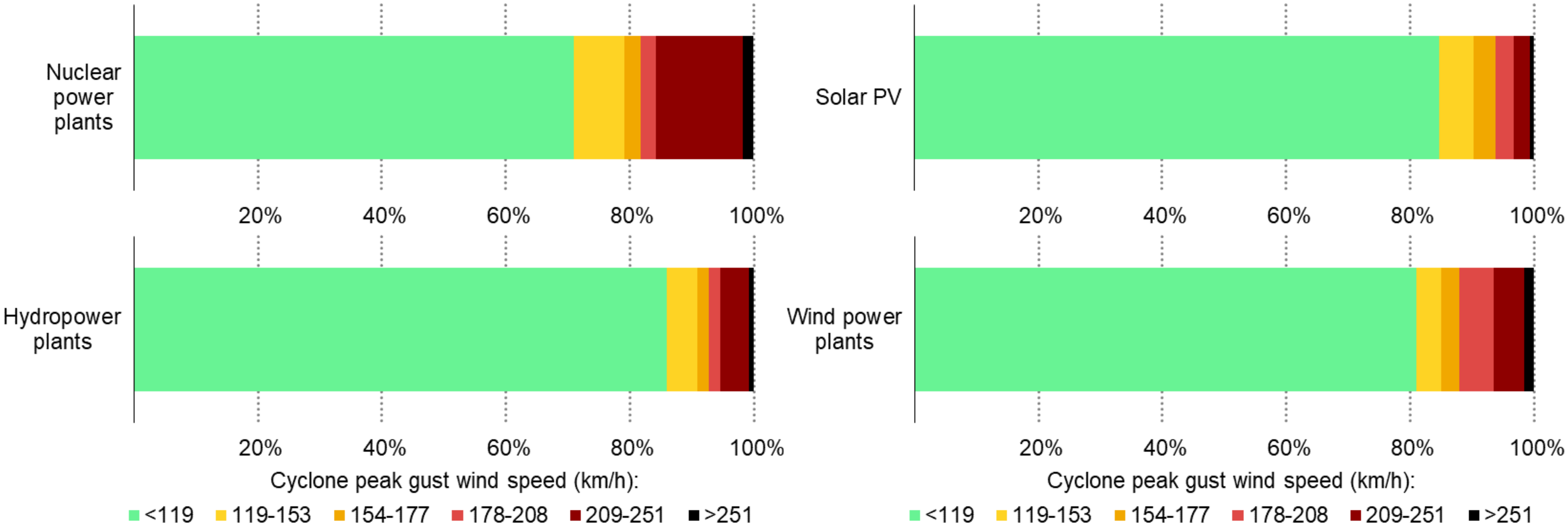


More intensified tropical cyclones could lead to longer disruptions



Note: The wind speed categories are divided according to the Saffir-Simpson Hurricane Wind Scale, a 1 to 5 rating based on a hurricane's maximum sustained wind speed. To be classified as a hurricane, a tropical cyclone must have a wind speed of at least 119 km/h, after which it falls into Category 1. Hurricanes rated Category 3 and higher (> 177 km/h) are known as major hurricanes.

Comparison of the level of exposure to tropical cyclones



Limitations and Future Research

Hazard

- Projection data for tropical cyclones (and broadly storms)
- Projection data for wildfires with land use change
- Embedded uncertainty due to limited observation data for some locations

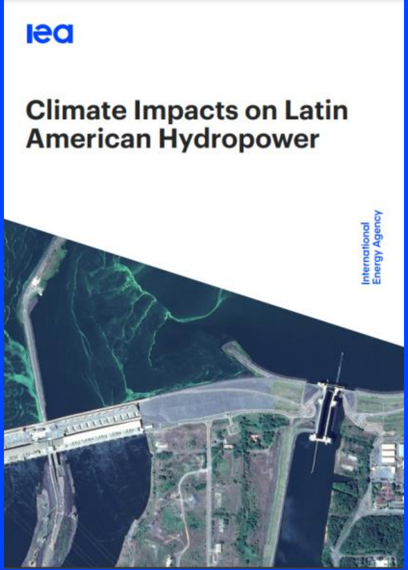
Exposure

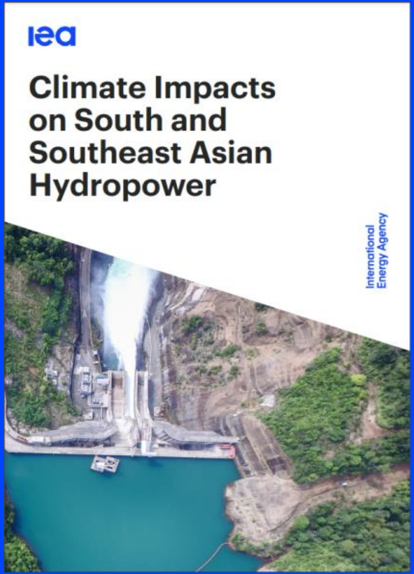
- Accurate data for new and planned production sites

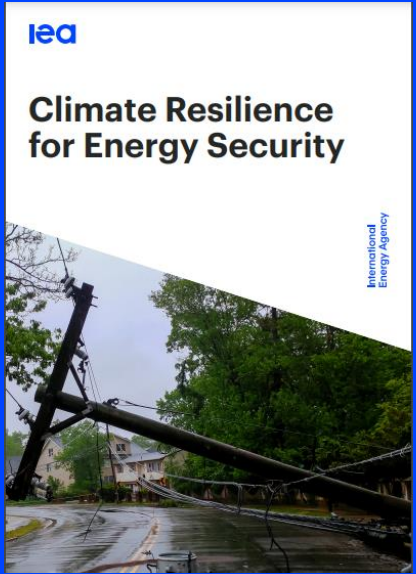
Vulnerability

- Broader participation of experts in the IEA consultation group
- Detailed information on technical features

2. Climate Impact Assessment

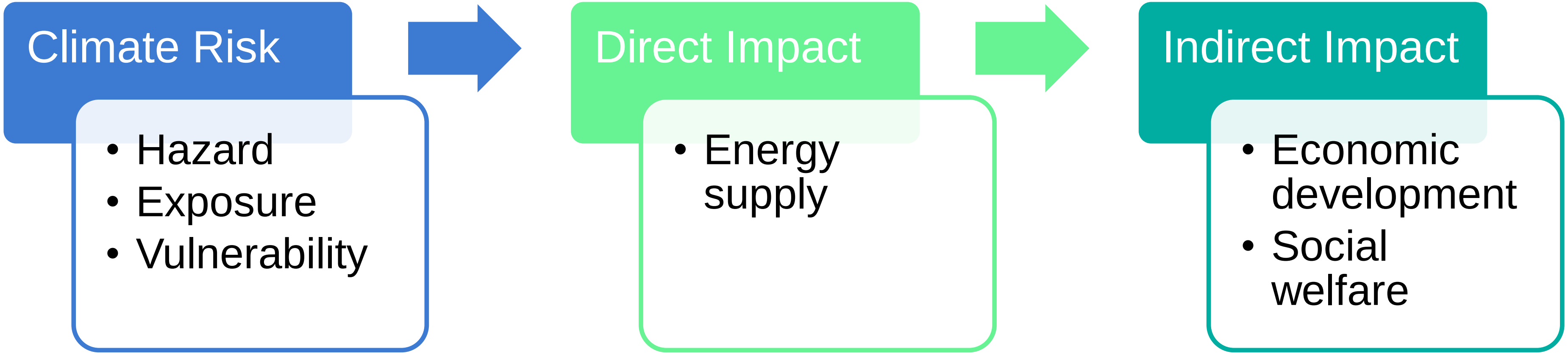






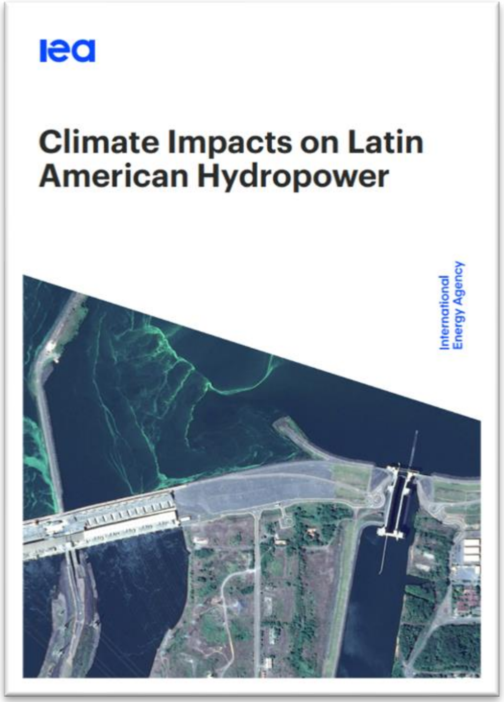
Definition

- **Climate impact:**
  - refers to the actual consequences of climate change
  - requires more detailed modelling.
  - consists of direct impacts (energy supply) and indirect impacts (social welfare, economic development).



Climate impacts on Latin American hydropower

- In Latin America, hydropower is the main source for electricity generation in many countries.
- Hydropower is likely to remain significant or potentially increase, supporting the achievement of development and climate goals in the region.
- However, climate change poses an increasing challenge to Latin American hydropower.

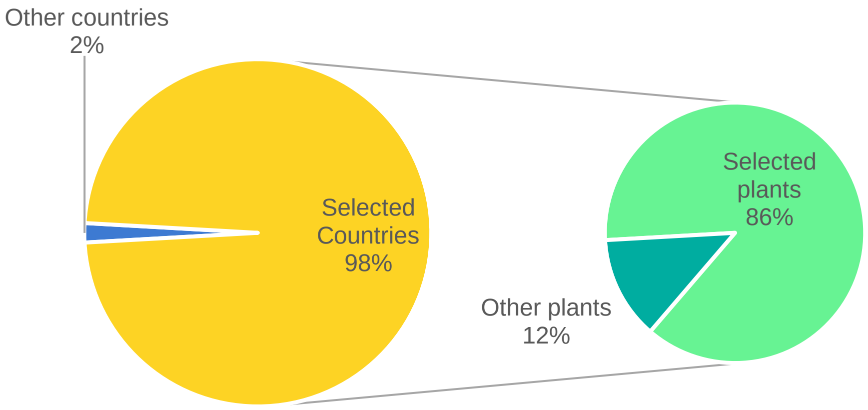


https://www.iea.org/reports/climate-impacts-on-latin-american-hydropower

How to assess climate impacts on Latin American hydropower

Scope

- 13 countries
- 86% of hydropower installed capacity in Latin America
- Time horizon of 2020-2099
- Baseline of 1970-2000



Models and scenarios

- Five General Circulation Models (GCM)
- Four Global Hydrological Models (GHM)
- Three emissions scenarios:

  Below 2°C, Below 3°C and Above 4°C

Overview of models

Overview of the GCMs, GHMs and RCPs considered in the assessment

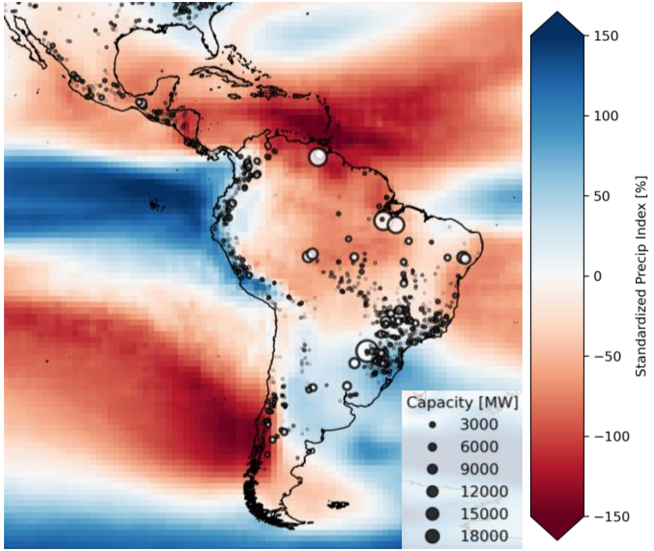
General Circulation Models (GCM)	Global Hydrological Models (GHM)	Representative Concentration Pathways (RCP)
GFDL-ESM2M	H08	RCP 2.6
HadGEM2	LPJmL	RCP 4.5
IPSL-CM5	MPI-HM	RCP 8.5
MIROC-ESM	PCR-GLOBWB	
NorESM1		

Overview of the scenarios

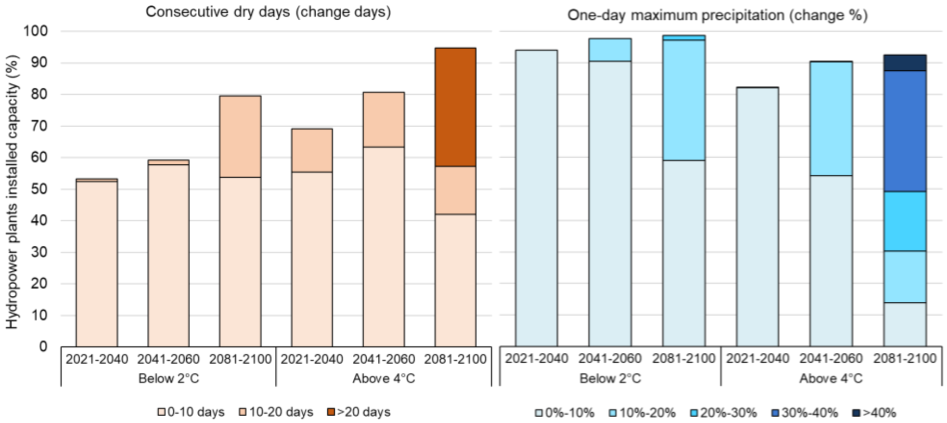
Scenario	Below 2°C	Below 3°C	Above 4°C
Representative Concentration Pathway	RCP 2.6	RCP 4.5	RCP 8.5
Targeted radiative forcing in the year 2100	2.6 W/m^2	4.5 W/m^2	8.5 W/m^2
CO2-equivalent concentrations (ppm)	430-480	580-720	>1000
Global temperature change	1.6(±0.4)°C	2.4(±0.5)°C	4.3(±0.7)°C
Likelihood of staying below a specific temperature level over the 21st century	Likely to stay below 2°C	Likely to stay below 3°C	More unlikely than likely to stay below 4°C

Climate Risk Assessment: Latin American Hydropower

Standardised Precipitation Index (%) for 2081-2100 relative to 1850-1900 for scenarios SSP5- 8.5



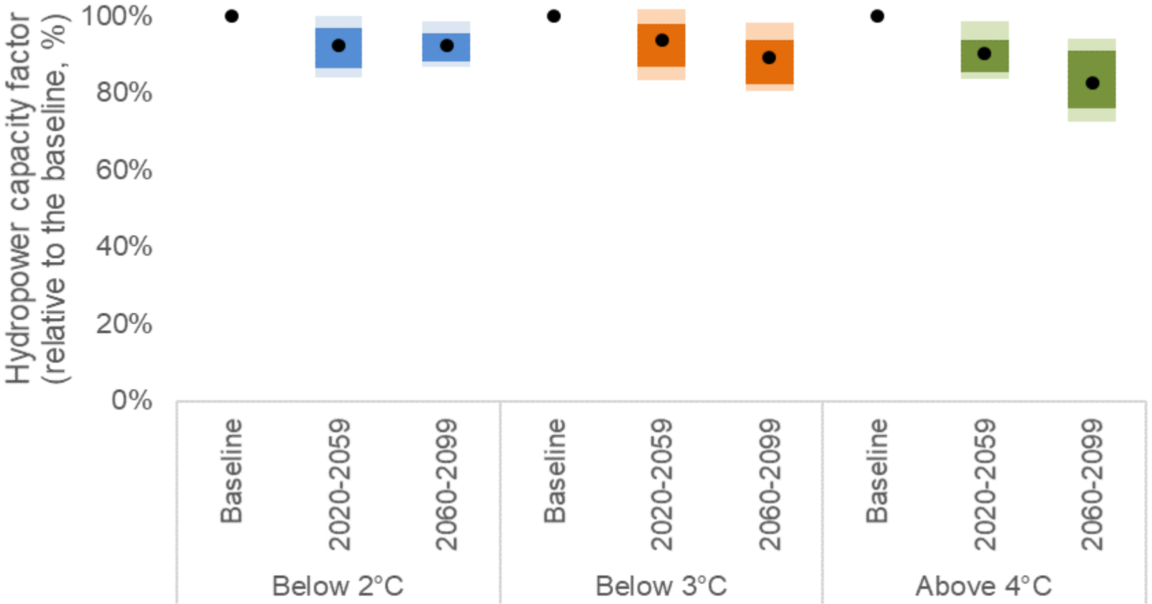
The exposure level of hydropower plants to changes in consecutive dry days and one-day maximum precipitation, compared to 1850-1900



Hydropower plants in Latin America are exposed to climate change.
Some will experience a drier climate, others will see a wetter climate.

Climate impacts on hydropower in Latin America (overall)

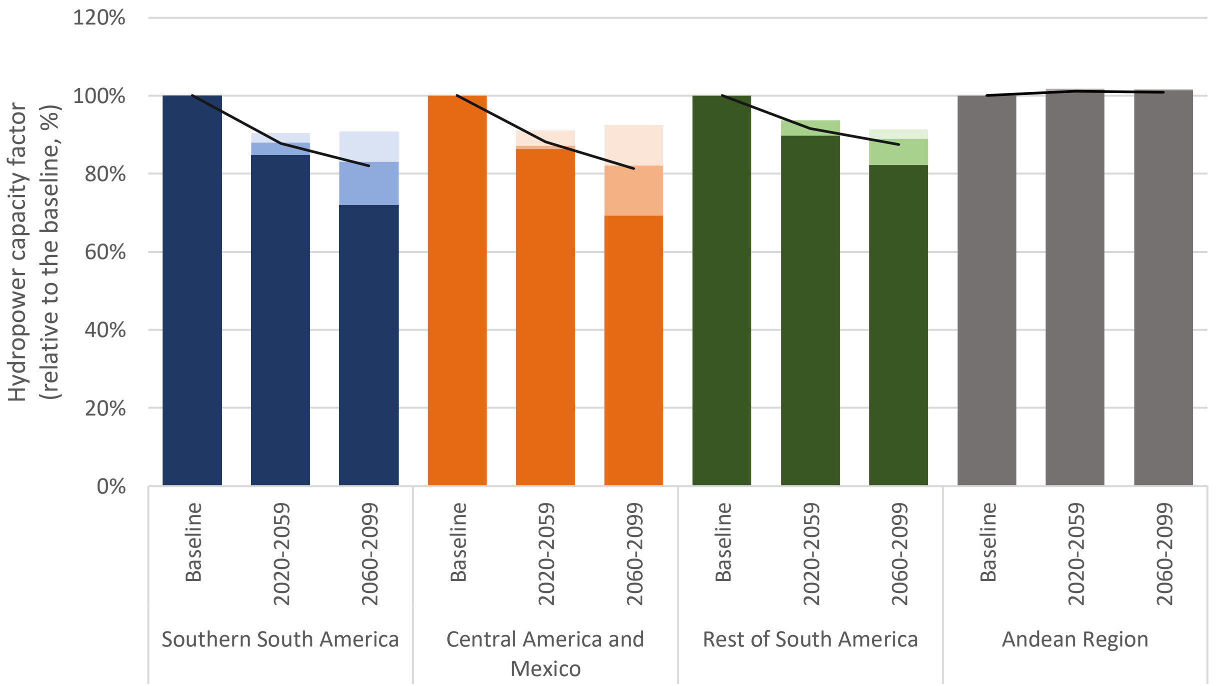
Changes in hydropower capacity factor (relative to the baseline, %), Latin America



Climate change is projected to cause a decrease in the mean hydropower capacity factor in Latin America. Overall, higher GHG emissions will lead to a larger decrease in hydropower capacity factors.

Climate impacts on hydropower in Latin America (by sub-region)

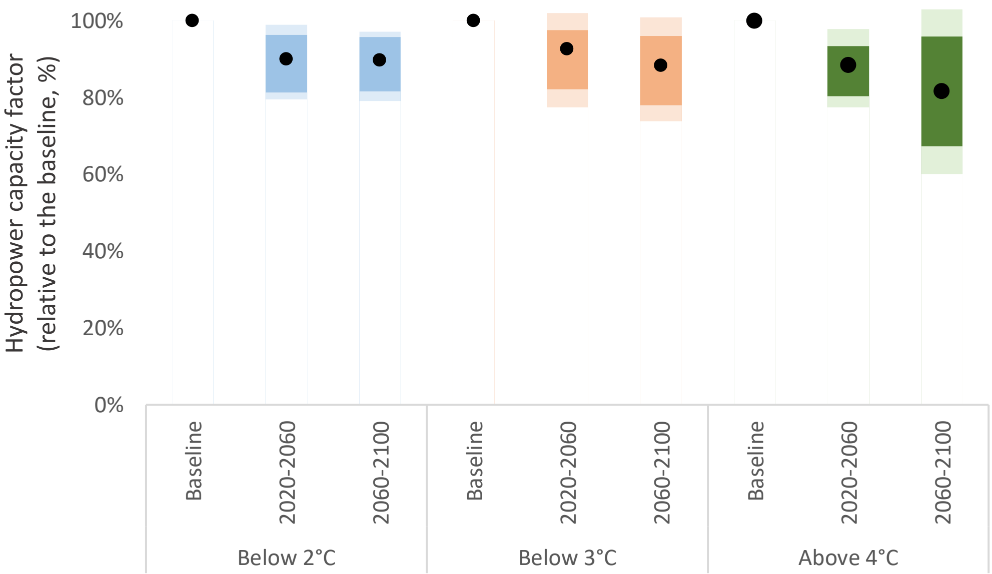
Changes in hydropower capacity factor (relative to the baseline, %) by sub-region



Climate impacts on Latin American hydropower will vary geographically.

Climate impacts on hydropower in Brazil

Brazil hydropower capacity factor (relative to the baseline, %) by scenario



Current climate projections suggest a decrease in hydropower capacity factor in Brazil. However, further studies will be needed to obtain more accurate projections.

Limitations and Future Research

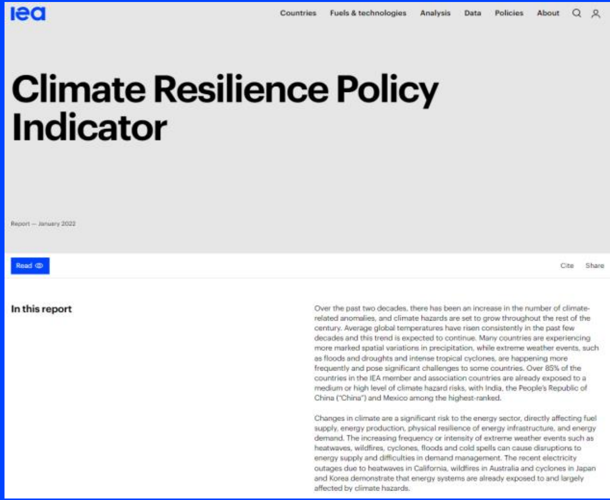
- **Climate Impacts on Hydropower Series**
  - Update with new IPCC scenarios, GCMs and GHMs:
    - **Updated results will be published in Q4/2023 – Q1/2024 for approx. 40 countries**
  - Expand geographical coverage to the world (all countries with over 1000 MW installed capacity)
  - Provide monthly variability analyses and comparisons between different hydropower technologies

- **Climate Impacts on Energy Supply in General**
  - Expand technology coverage to other power generation technologies (e.g., wind, solar PV, thermal)
  - Assess indirect impacts on social welfare and economic development
  - Calculate the costs and benefits of climate impacts on energy supply

3. Climate Resilience Measures

www.iea.org/reports/climate-resilience-for-energy-security

www.iea.org/reports/climate-resilience-policy-indicator



Countries Fuels & technologies Analysis Data Policies About

Climate Resilience Policy Indicator

Report — January 2022

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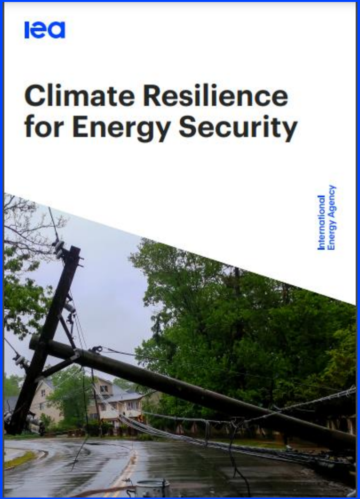
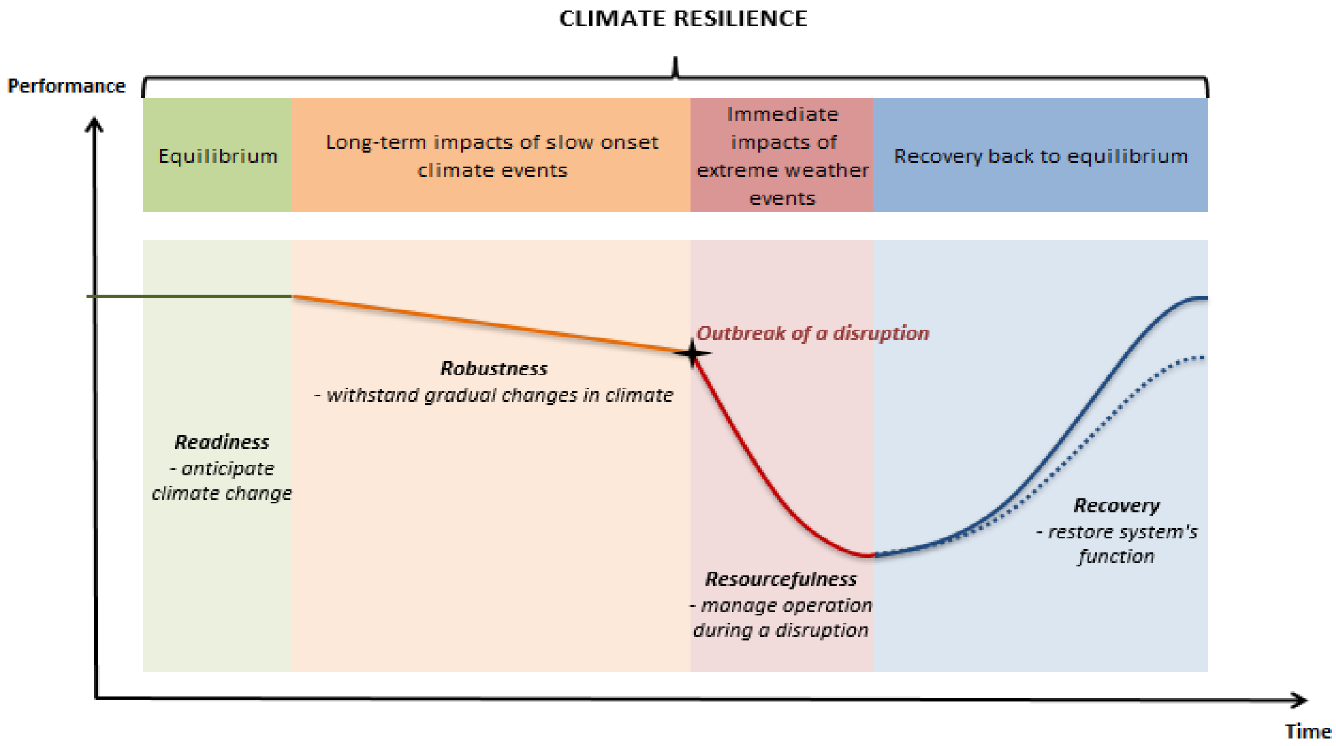
In this report

Over the past two decades, there has been an increase in the number of climate-related anomalies, and climate hazards are set to grow throughout the rest of the century. Average global temperatures have risen consistently in the past few decades and this trend is expected to continue. Many countries are experiencing more marked spatial variations in precipitation, while extreme weather events, such as floods and droughts and intense tropical cyclones, are happening more frequently and pose significant challenges to some countries. Over 85% of the countries in the IEA member and association countries are already exposed to a medium or high level of climate hazard risks, with India, the People's Republic of China ("China") and Mexico among the highest-ranked.

Changes in climate are a significant risk to the energy sector, directly affecting fuel supply, energy production, physical resilience of energy infrastructure, and energy demand. The increasing frequency or intensity of extreme weather events such as heatwaves, wildfires, cyclones, floods and cold spells can cause disruptions to energy supply and difficulties in demand management. The recent electricity outages due to heatwaves in California, wildfires in Australia and cyclones in Japan and Korea demonstrate that energy systems are already exposed to and largely affected by climate hazards.



Definition



Building and strengthening the climate resilience of energy systems is increasingly important, given the hazards faced and the impacts on energy security.

Supply side

Measure	Readiness	Robustness	Resourcefulness	Recovery
Conduct climate risk and impact assessment				
Implement physical system improvement				
Switch to water efficient and heat resilient production process				
Diversify energy supply chain				
Better monitor for early warning and emergency response				

Energy suppliers, including generators and operators of transmission and distribution systems, play a key role in improving resilience across all four dimensions.

Demand side

Measure	Readiness	Robustness	Resourcefulness	Recovery
Ensure climate proofing in design and performance				
Increase awareness and promote behavioural changes				
Improve energy efficiency				
Use smart and advanced technologies for better management				
Adopt nature-based solutions				
Switch to climate-resilient materials				

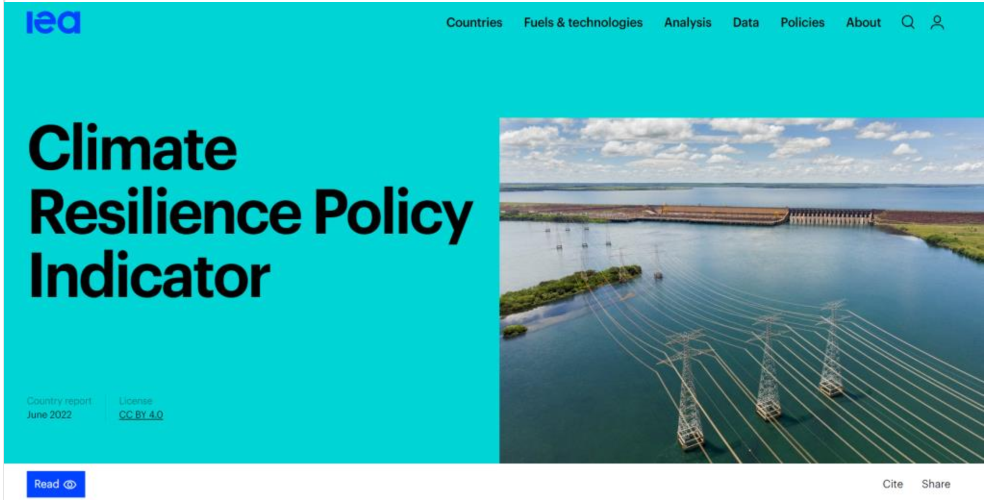
Energy consumers contribute to energy-sector climate resilience by adopting demand-side measures in main end-use sectors, such as buildings, industries and transport.

Authorities and governments

Measure	Readiness	Robustness	Resourcefulness	Recovery
Enhance knowledge about climate risks and impacts				
Establish appropriate policy frameworks				
Mainstream climate resilience into relevant regulations				
Mobilise financing and investment				
Support adequate climate insurance				
Ensure emergency preparedness				

Energy authorities have a critical role in building energy-sector climate resilience by establishing an enabling policy and market environment.

Climate Resilience Policy Indicator

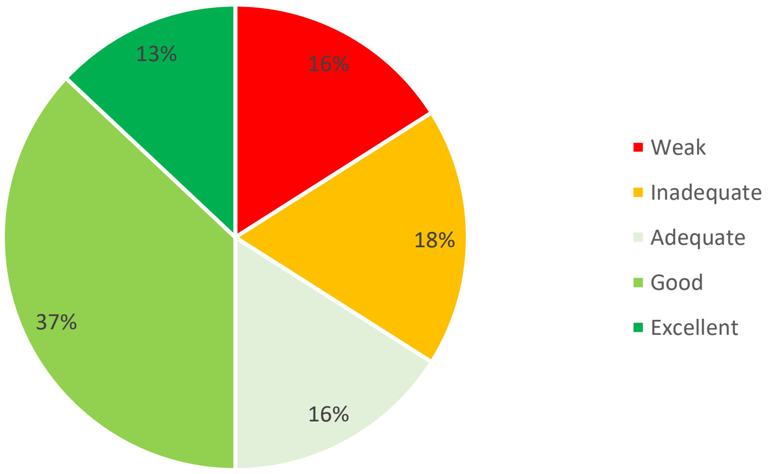


www.iea.org/reports/climate-resilience-policy-indicator

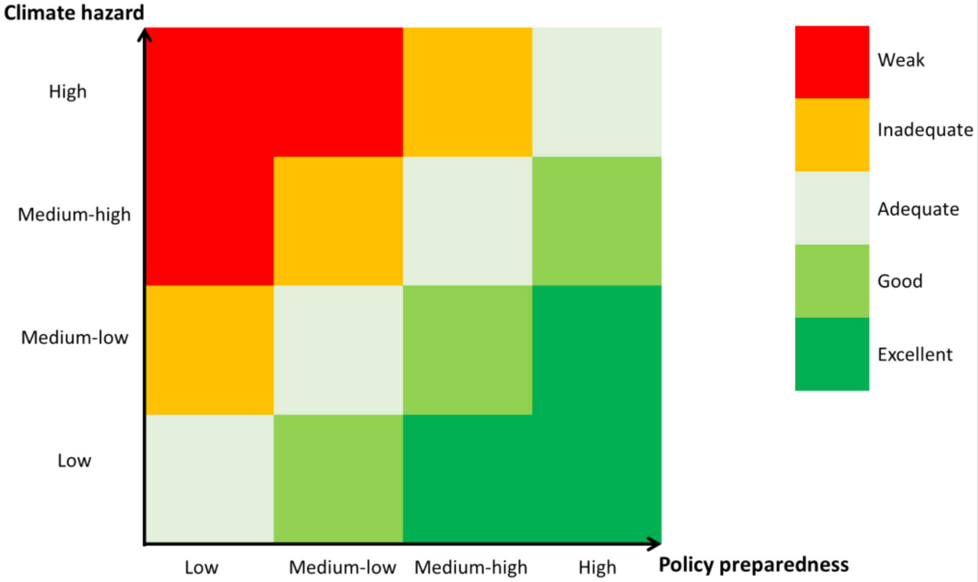
- **Objective**
  - Encourage governments to incorporate energy sector climate resilience into national policies
- **IEA member countries**
  - 27 countries as of June 2023
- **Climate Hazard**
  - Extreme weather events based on historical records
- **Policy Preparedness**
  - Take stock of existing policies relevant to climate resilience

Climate Resilience Policy Indicator

Climate resilience policy indicator
IEA member and association countries



Climate resilience policy indicator rating grid,
IEA member and association countries



The IEA Climate Resilience Policy Indicator assesses the level of climate resilience of each country by comparing the level of climate hazard that the country is facing against its policy preparedness.

Limitations and Future Research

- **Tailored recommendations for resilience measures**

- **Expansion of geographical coverage of Climate Resilience Policy Indicator**

- **Expansion of hazard coverage of Climate Resilience Policy Indicator**

- **Upcoming reports:**
  - Climate Resilience for Energy Transitions in Egypt (3 July)
  - Climate Resilience for Energy Transitions in Oman (3 July)
  - Climate Resilience for Energy Transitions in Morocco (3 July)
  - **Launch event** (4 July, Hybrid, Rabat) **Register here**
    https://www.iea.org/events/climate-resilience-for-energy-transitions-in-the-middle-east-and-north-africa

For questions and suggestions, please contact jinsun.lim@iea.org
Thank you.