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Energy Resilience: Policies, Regulation and Laws

Workshop on Improving Energy Resiliency in Off-grid Areas
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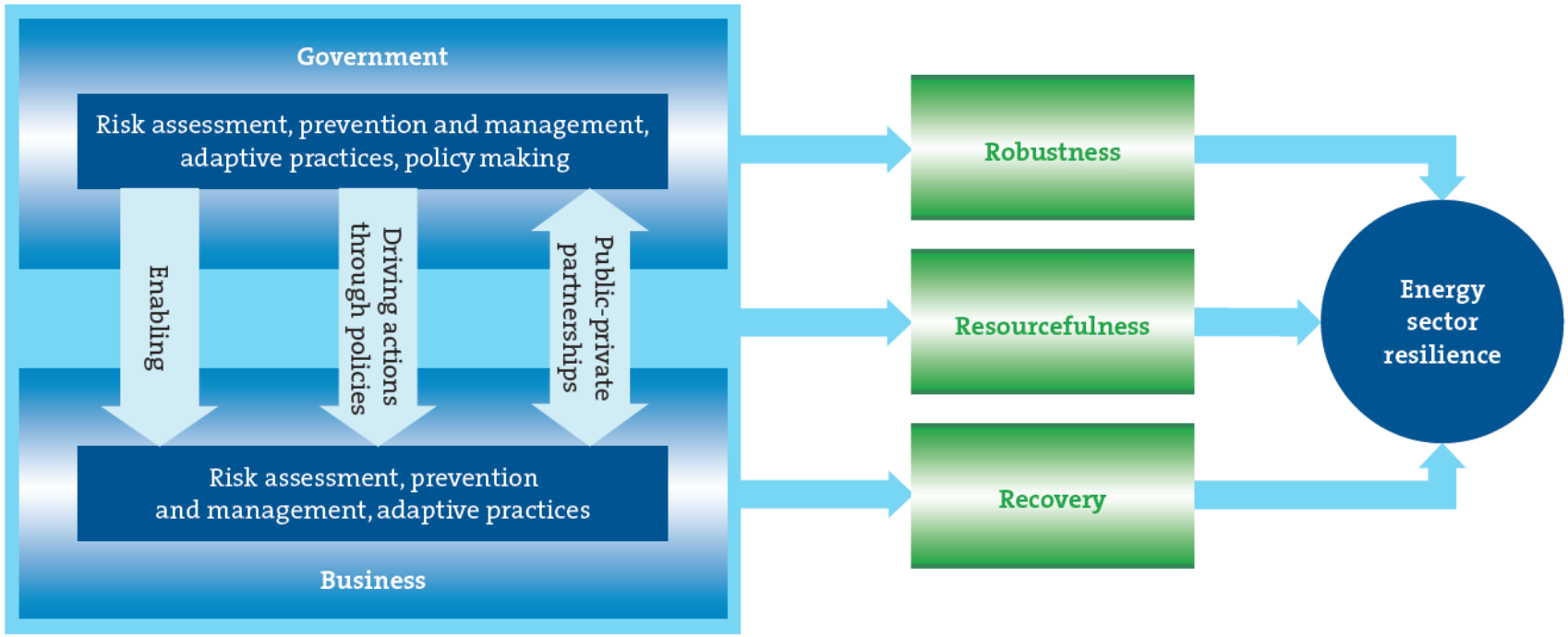
Resilience of the energy sector

- **Resilience** refers to the capacity of the energy system to cope with a hazardous event or trend, responding in ways that maintain its essential functions, identity and structure

The resilience "value chain":

- **Robustness**: the ability of an energy system to **withstand** extreme weather events as well as gradual changes (e.g. sea level rise) and continue operating.
- **Resourcefulness**: the ability to effectively manage operations **during** extreme weather events.
- **Recovery**: the ability to restore operations to desired performance levels **following** a disruption.

Government's role in enhancing energy sector resilience



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Lead the way…
Climate-proofing of energy assets

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Energy sub-sector	Technology and structural measures	Siting and management measures
Thermal and nuclear power	Adopt alternative cooling technologies (closed loop and dry cooling)	Site plants based on access to cooling water and away from high-risk areas Reuse or recycle grey water
Hydropower	Enhance reservoir capacity Improve design of spillways to manage changing water levels	Modify management procedures for water storage Site plants based on projections of hydrological conditions Enhance debris removal
Solar power	Modify surface material for PV panels for improved light diffusion Micro-inverters for each panel to improve stability and increase power output Improve material durability	Site solar panels based on projected changes (in cloud cover, air temperature)
Wind power	Improve turbine design for high wind speeds Improving material durability	Site turbines based on projected changes in wind speed and direction and exposure to extreme events
Transportation, transmission, distribution	Increase T&D line capacity and ability to withstand higher snow and ice load Modify pipeline materials for water proof-ability and ability to withstand freeze-thaw cycles	Place T&D lines underground Improve vegetation management around T&D wires Site pipelines away from areas of high flood risk and extreme freeze-thaw cycles Strengthen emergency response measures (e.g. pipeline spills or electricity outages)

Source: Adapted from IPCC (2014) and IHA (2015)

Renewable Hybrid Mini-grid Systems for increasing resilience

- **Diversifying power source of Mini-grid creates more reliable and resilient systems**

- Decreased cost of renewable energy technologies is making Renewable Hybrid Mini-grid system economically viable option compared to traditional Diesel based system in remote areas and islands.

- Renewable Energy combined with storage has the ability to provide resilient power throughout disasters and calamities

Providing services and information

Knowledge-building and information dissemination

- **Improved collection and dissemination of climate projections and weather data to better understand projected climate change impacts.**

Integrated risk assessments

- **Comprehensive risk assessments provide a fundamental basis for decision-making, by helping determine the resilience risk exposure of proposed projects and investments, and identifying priority areas for action.**
- **Environmental Impact Assessments:** For example in Australia and Canada

Providing services and information

Improving institutional coordination

- Building energy sector resilience transcends the boundaries of traditional government departments.
- The formation of interdepartmental committee and working groups can bring together often disparate government players to share information and reduce duplication.
- Authority and competences often at the sub-national level

Capacity Building of local engineers

- Often in off-grid areas, capacity to fix problems and cope with disasters and calamities are lacking.
- Troubleshooting guidelines for local engineers, and information dissemination can enhance resiliency of off-grid systems in remote areas and islands.

Renewable Hybrid Mini-grid Systems for increasing resilience

Emergency response measures

- Emergency preparedness and response measures enable organised and co-ordinated reactions to disasters.
- Ensure the functioning of strategic assets and a quick recovery from the emergency.

Supporting the right regulatory and policy environment

Governments can support a regulatory environment by:

- Helping to develop guidelines and set standards for infrastructure design and siting
- Updating building codes to consider future climatic change
- Facilitating reporting by energy companies of risks posed by climate change
- Developing standards for energy operators for reliability of supply

Supporting the right regulatory and policy environment

Type	Examples
Asset hardening	▫ Apply more sturdy and fire-resistant materials of power transmission poles and increasing weight load of transmission lines, ▫ Adjust thermal rating and apply dynamic thermal rating systems to transmission and distribution lines ▫ Apply certain specific power grid technologies (such as flexible AC transmission or static VAR compensation systems) to balance voltage due to intermittent renewable power generation
Water and energy efficiency	▫ Water cooling standards for thermal power plants ▫ Energy efficiency standards ▫ Smart grid utilization requirements
Site design and infrastructure location	▫ Elevate or move electrical substations in high-risk flood areas ▫ Locate new infrastructure away from high-risk areas ▫ Incorporate sea level rise for new facilities along coastline

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- *Energy Security*
- *Environmental Protection*
- *Economic Growth*
- *Engagement Worldwide*

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Enhancing project bankability and creating the business case

- **The benefits of investing in resilience can be difficult to quantify, as they include avoided losses or impacts that do not take place. However, clarifying the business case can better identify and allow costs to be shared amongst those that will benefit, such as utilities that avoid damage costs, electricity customers who gain from avoided outages, and society that benefits from affordable, reliable and resilient energy supplies.**

Direct Benefits	Indirect Benefits
• Avoided cost of infrastructure loss and damage	• Avoided loss of mobile communication and alert systems
• Avoided lost revenues for energy suppliers, including costs of restarting operations	• Avoided loss of critical health and public safety services, including water treatment and emergency response
• Avoided business interruptions due to loss of electricity and fuel supply	• Poverty reduction and enhanced social inclusion
• Enhancement of property value	• Enhanced national security

Driving energy resilient investments

Public finance sources

- Direct funding towards resilience-building and avoid maladaptive practices
- Infrastructure bonds to generate long-term infrastructure financing streams

Private sector finance

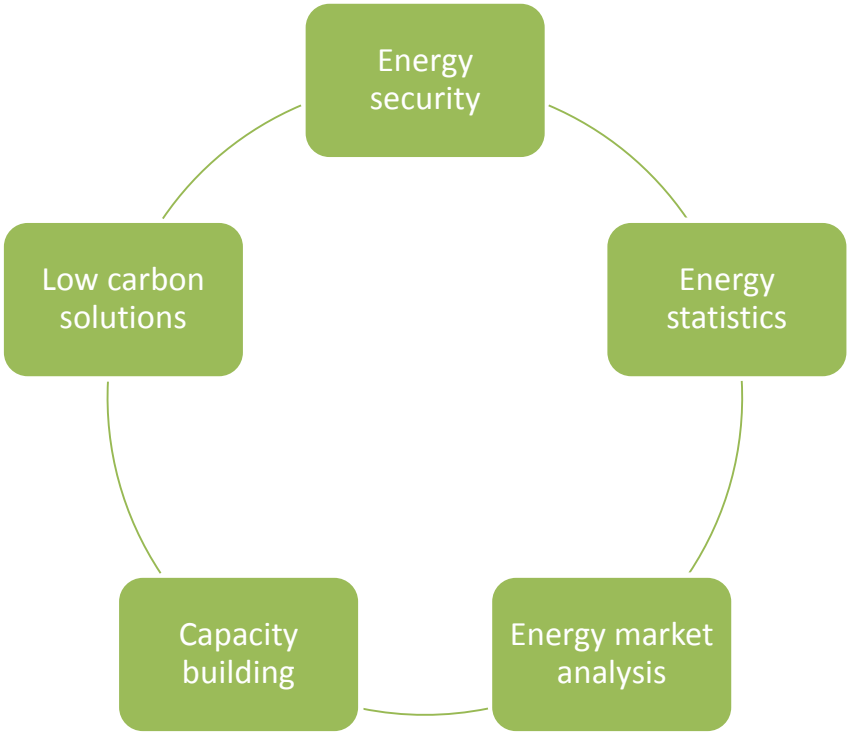
- Enhance mechanisms for private investment
- Issuance of green bonds
- Institutional investors such as pension funds and insurance companies can serve as an important source of private capital

Development and investment banks

- Multilateral financial institutions increasingly aware of the climate impacts
- Develop investment guidelines in order to direct flows towards climate-resilient projects

The International Energy Agency (IEA)

- **Founded in 1974**
  - Formed in wake of 1973 oil embargo with mission to promote energy security -- autonomous agency of the Organisation for Economic Cooperation and Development (OECD)
- **Headquarters: Paris**
- **Secretariat**
  - Staff of around 240, mainly energy experts and statisticians from its member countries
- **Decision-making body: Governing Board**
  - Consists of member country representatives
  - Under the Governing Board, several committees are focusing on each area



Impacts of climate change on energy

Primary energy production

- Increased risk of wildfires, affecting oil production (e.g. 2015 and 2016 Fort McMurray wildfires in Alberta, Canada)
- Water constraints on shale gas or tight gas developments, secondary and tertiary (enhanced) oil recovery approaches, and biofuel production
- Heavy rains increasing moisture content (and decreasing quality) of stock-piled coal surface mines
- Drought, heavy precipitation, and reduced snowpack and other seasonal hydrologic changes affecting hydroelectric production
- Wind speed and direction affecting wind power
- Changes in cloud cover and water vapour affecting solar energy (photovoltaic (PV), concentrated solar power (CSP), solar heating)

Impacts of climate change on energy

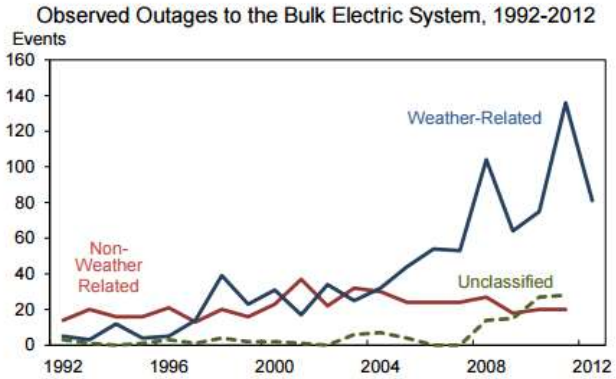
Energy transformation

- **Flood risk** for off-shore and coastal infrastructure (e.g. refineries, gas processing plants, nuclear power plants)
- **Extreme weather** (wind, hail and extreme precipitation) increasing damage to solar PV, flat plate collectors in solar thermal systems, on and off-shore wind turbines, hydropower dams
- **Extreme heat** reducing efficiency of thermal conversion processes and cooling efficiency in thermal power plants, along with reduced efficiency of solar PV cells
- **Lower reservoir** levels may reduce water-to-energy conversion in **hydropower** production, while rising water temperatures can constrain thermal power generation by reducing plant cooling efficiency and increasing cooling water demand
- **Water constraints** on concentrated solar power and carbon capture and storage (CCS) technologies

Impacts of climate change energy

Transportation, transmission, storage, and distribution

- **Higher temperatures** increase transmission losses, reducing overall transmission efficiency
- **Higher temperatures** reducing viscosity of transported fuels



Energy demand

- Increased **cooling** demand (mostly electricity) in summer months and decreased heating demand (heating fuels, electricity) in summer months
- Net changes in energy demand, depending on access to geographic location and access to energy technologies such as air conditioning
- Warmer temperatures increasing recreational transportation demand for tourism in certain regions

The IEA and energy resilience

1. Dialogue facilitation
2. Data and modelling
3. Research stocktaking on impact, vulnerability and resilence policy
4. Policy analysis

IEA activities

1. Dialogue facilitation:

Five Nexus Forum meetings since 2012:

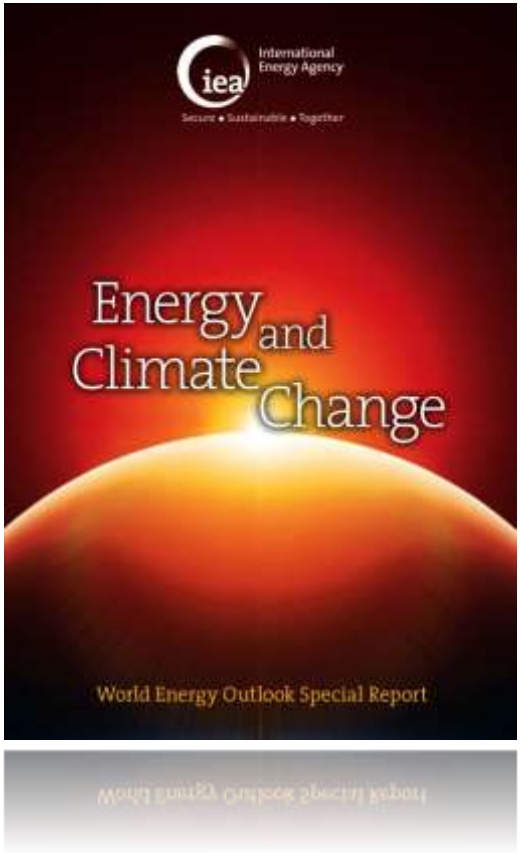
- Implications for Business (Nov. 2012)
- Cities and Insurance (June 2013)
- Electricity Sector Resilience (Oct. 2013)
- Water and Energy (June 2014)
- Policies and Practices (Nov. 2014)
- North America (June 2016)

IEA activities

2. Data and modelling

World Energy Outlook (WEO) has been looking at energy and climate resilience over the past few years:

- 2012: freshwater required for energy production and the outlook for global water use in energy production
- 2013: energy infrastructure and climate resiliency
- 2015: impact of water scarcity on coal-fired power plants in India and China
- 2016: chapter on water/energy nexus: water for energy, energy for water, and future regional/policy stress points and synergies

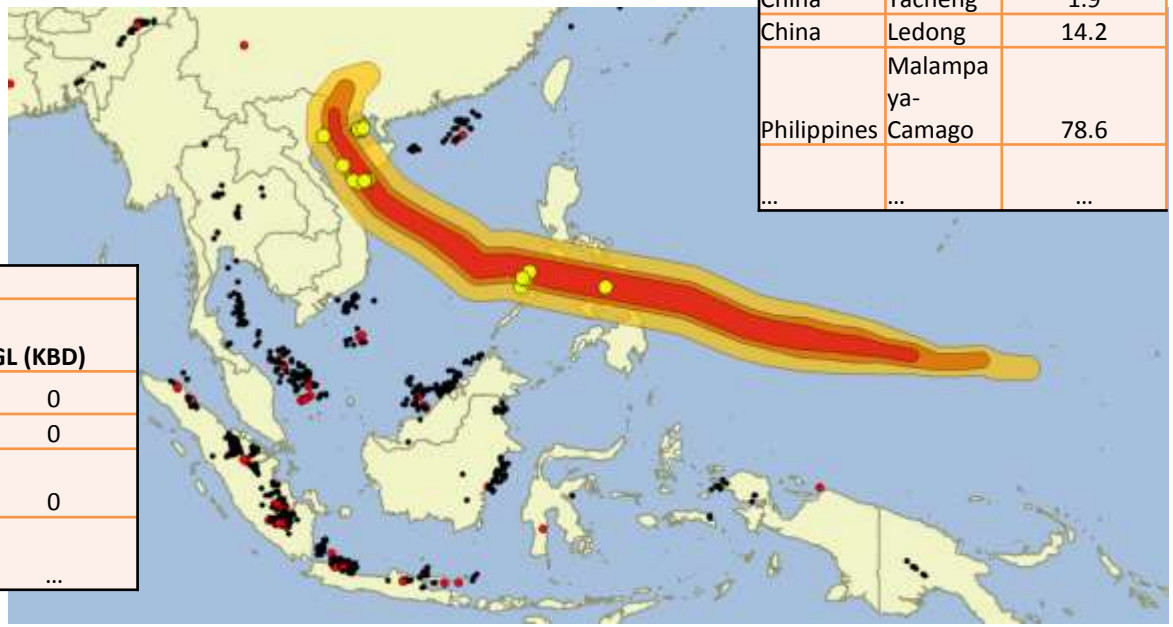


IEA activities

2. Data and modeling (cont.)

Emergency : Developing an analytical tool that makes real-time assessments of the potential impact of natural hazards on energy infrastructure.

AFFECTED GAS PRODUCTION		
COUNTRY	ASSET	CRUDE (KBDOE)
China	Yacheng	1.9
China	Ledong	14.2
Philippines	Malampaya-Camago	78.6
…	…	…

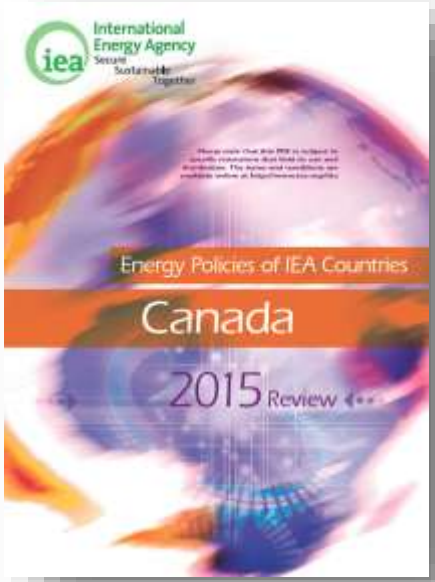


AFFECTED OIL PRODUCTION				
COUNTRY	ASSET	CRUDE (KB/D)	CONDENSATE (KBD)	NGL (KBD)
China	Weizhou	2.5	0	0
China	Ledong	0	1.2	0
Philippines	Malampaya-Camago	0	7.0	0
…	…	…	…	…

IEA activities

3. Research stocktaking on impacts, vulnerability, resilience policies

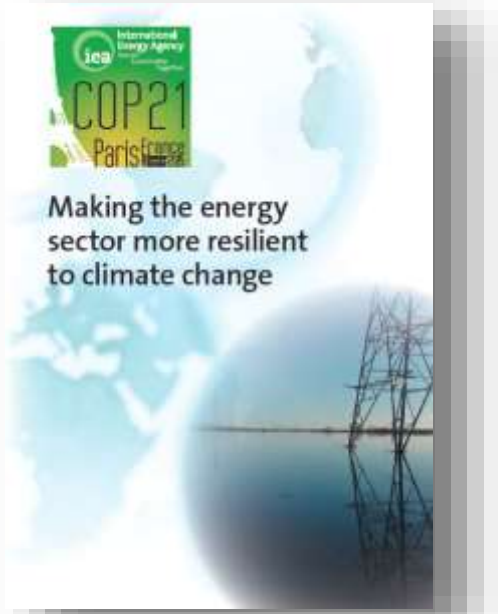
- In-depth country reviews, e.g. US 2014, Canada 2015, Mexico 2016
- Policy and Measures (PAMs) database

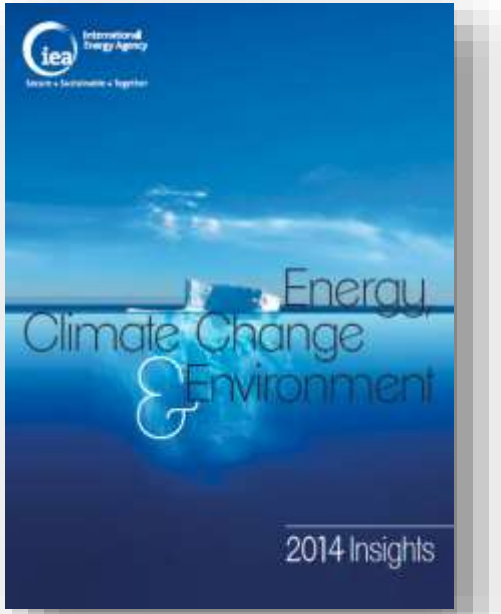


IEA activities

4. Policy analysis

- Resilience brochure for COP 21
- Chapter in the upcoming *Energy, Climate Change and Environment 2016*





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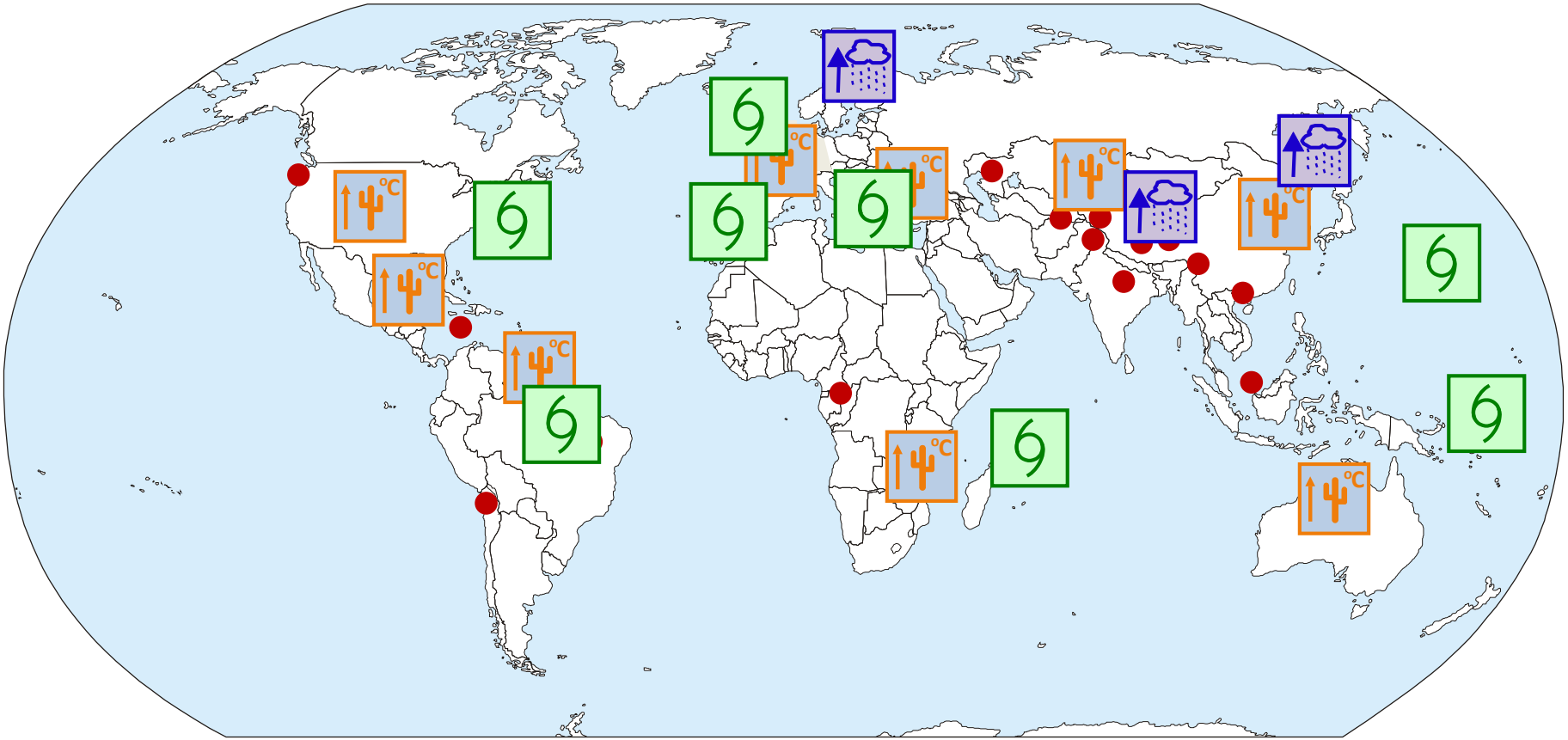
Climate change requires adaptation in the energy sector

Change in tropical cyclones and storms

Increase in heavy rain

Increase of droughts and/or heatwaves

15 largest cities exposed

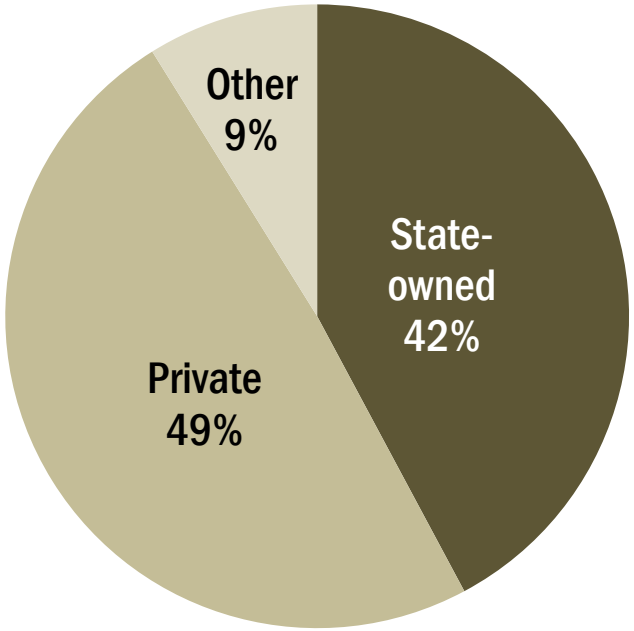


© Natural hazards adapted from Munich RE (2011)

State-owned enterprises

Ownership of fossil fuel generation capacity

3 702 GW



Ownership of 'zero-carbon' generation capacity

1 980 GW (hydropower, other utility-scale renewables and nuclear)