The road to resilience

Financing Resilient Energy Infrastructure

Gas & Energy International Congress

Santa Cruz - August 17th and 18th, 2016

Didier Sire | World Energy Council | April 27th 2016

New risks for energy transition

- Energy sector is undergoing a radical transformation and is exposed to **emerging risks** due to **dramatic changes**.
- Main origins:
  - Increasing **energy demand** (demography, economic growth, urbanisation…).
  - **Technological** revolution.
  - **Climate change**.
- Impacting existing assets and investment projects.
- Issue identified by energy leaders as **critical for energy transition**.
- The Council launched specific study:

Financing Resilient Energy Infrastructure

Financing Resilient Energy Infrastructure

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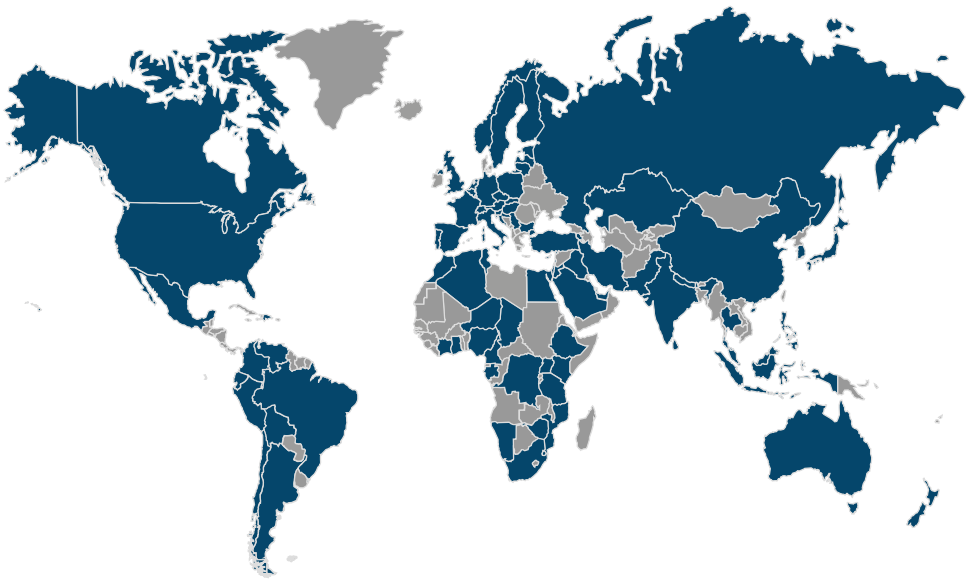
- **Resilience for energy infrastructure:**
  - Refers to its **robustness** and **ability to recover operations** to minimise interruptions to service.
  - Implies the ability to withstand extraordinary events, secure the safety of equipment and people, and ensure continued and reliable energy production.
  - Concerns **individual assets** and reliability of the **energy system** as a whole.
- **Aims:**
  - Identify and characterise the nature, frequency and severity of emerging risks.
  - Share and promote the incorporation of these risks into energy infrastructure design and investment decisions.

Issues Monitor

Issues Monitor



- **90 contributing countries.**
- **Over 1200 energy leaders.**
- **Main concerns of energy leaders.**

Survey responses confirm the **importance** of **three concerns:**

- **Cyber**.
- **Extreme Weather Events**.
- **Energy Water Food nexus**.

Issues Monitor

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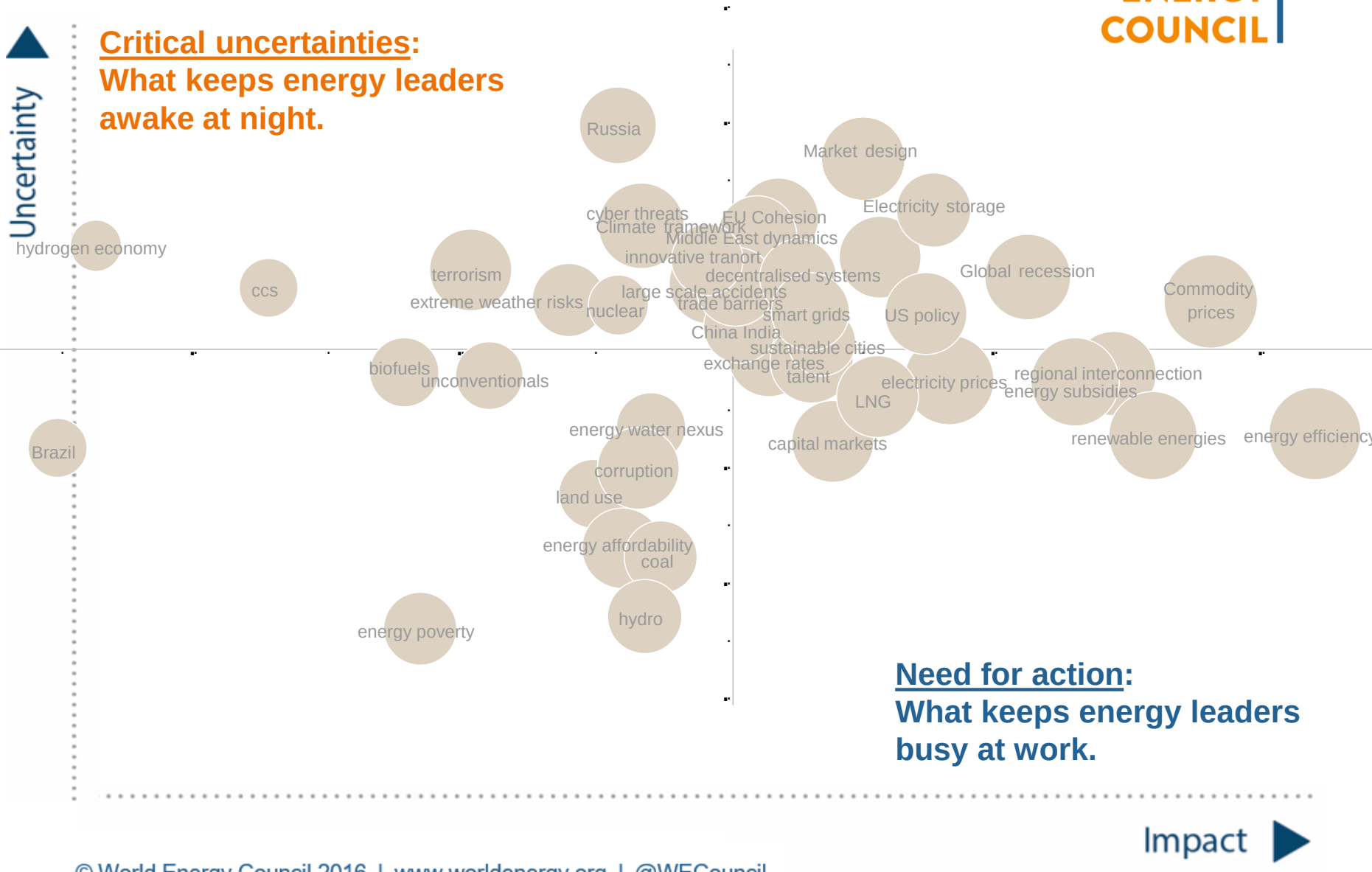
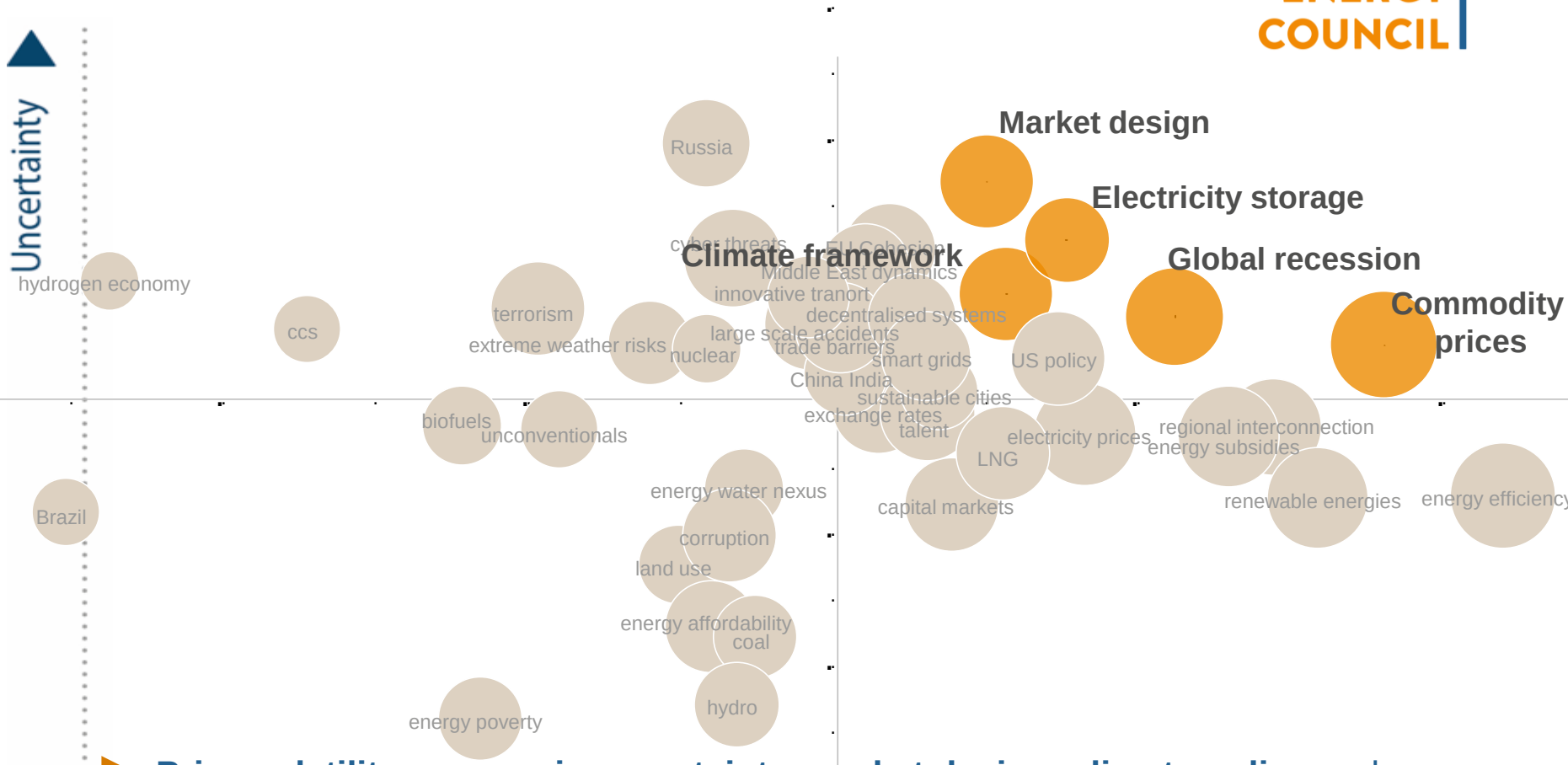
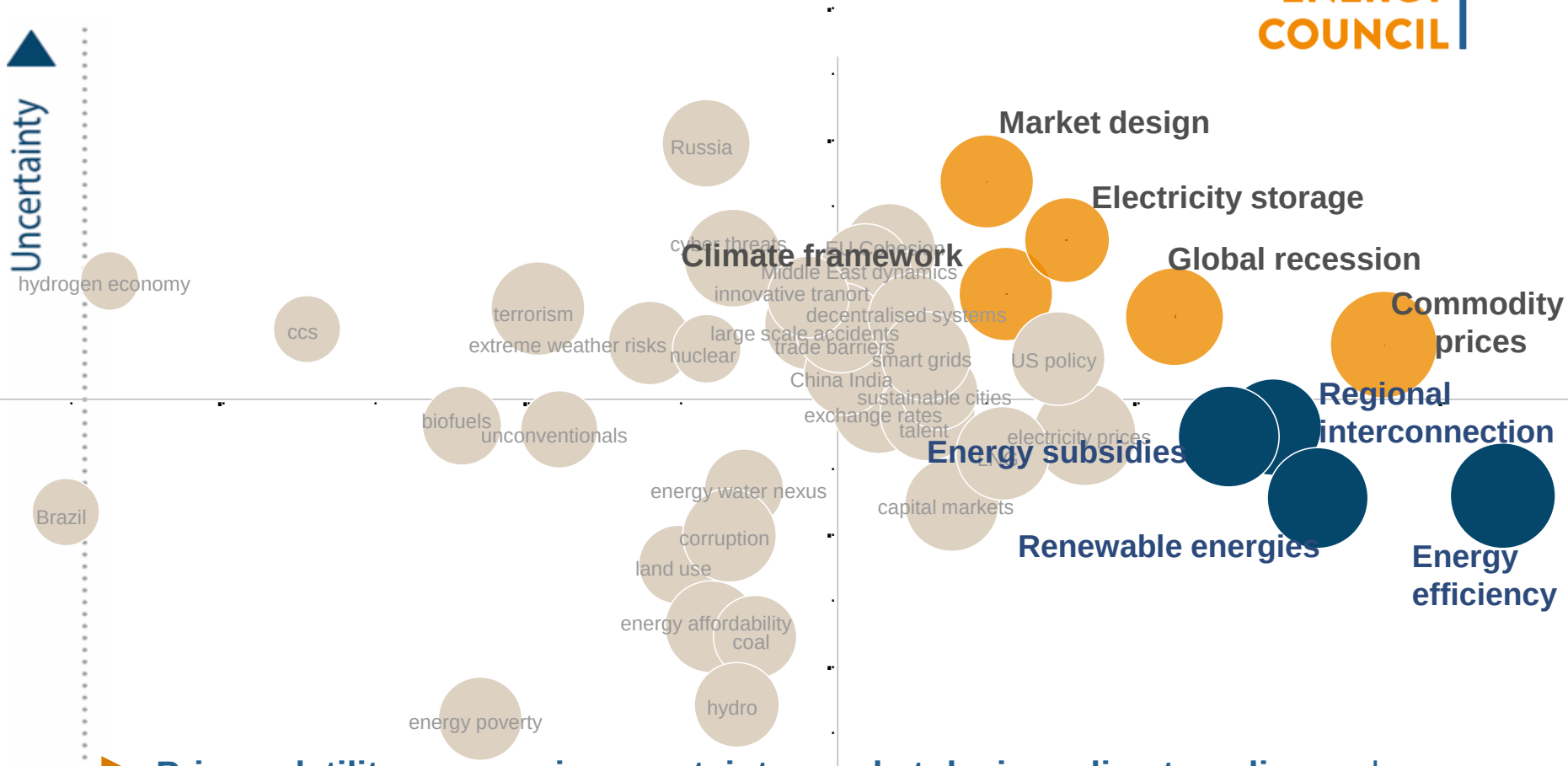


Issues Monitor



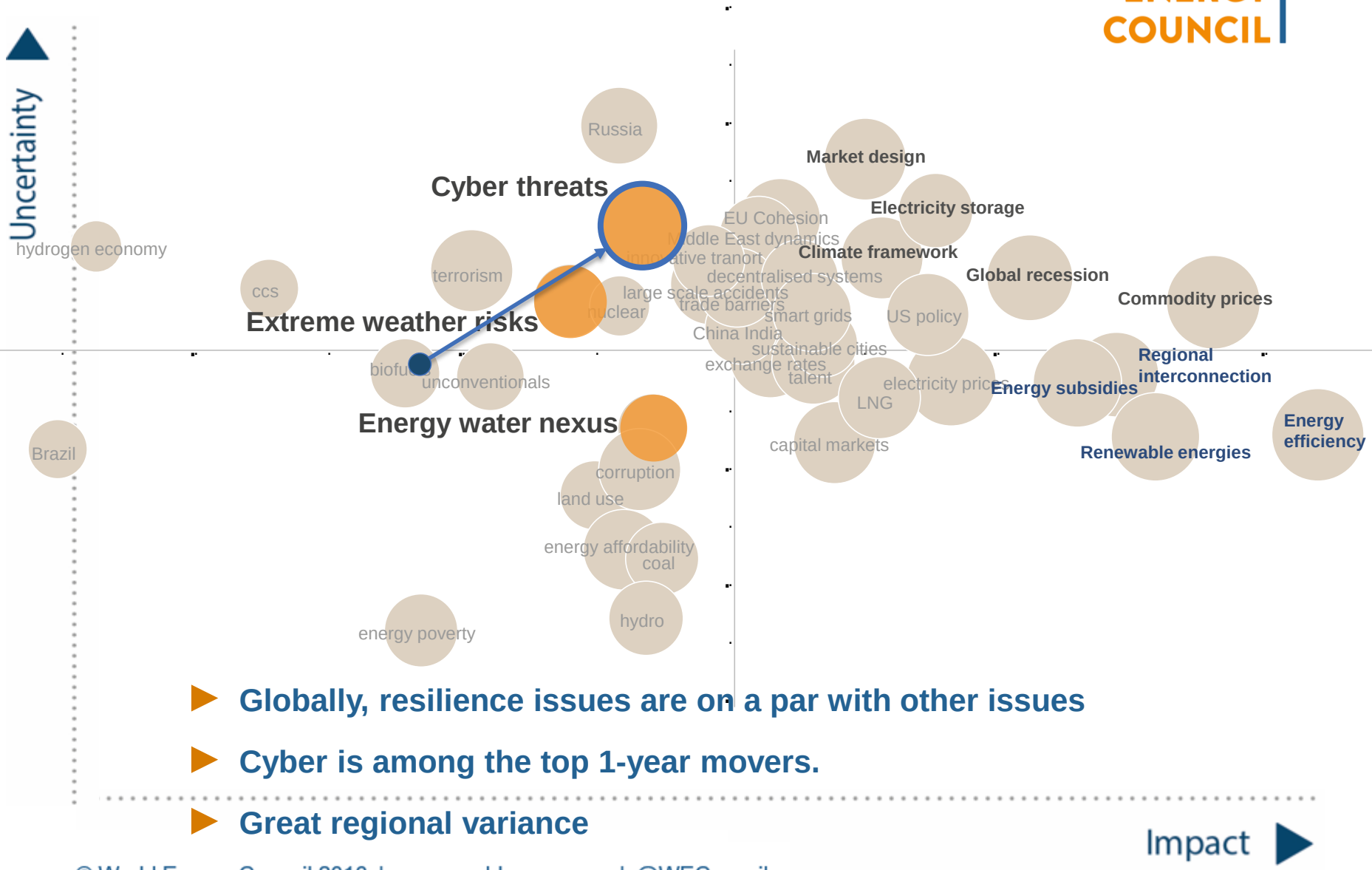
Price volatility, economic uncertainty, market design, climate policy and **electricity storage** are the **top insomnia issues** for energy leaders globally.

Issues Monitor



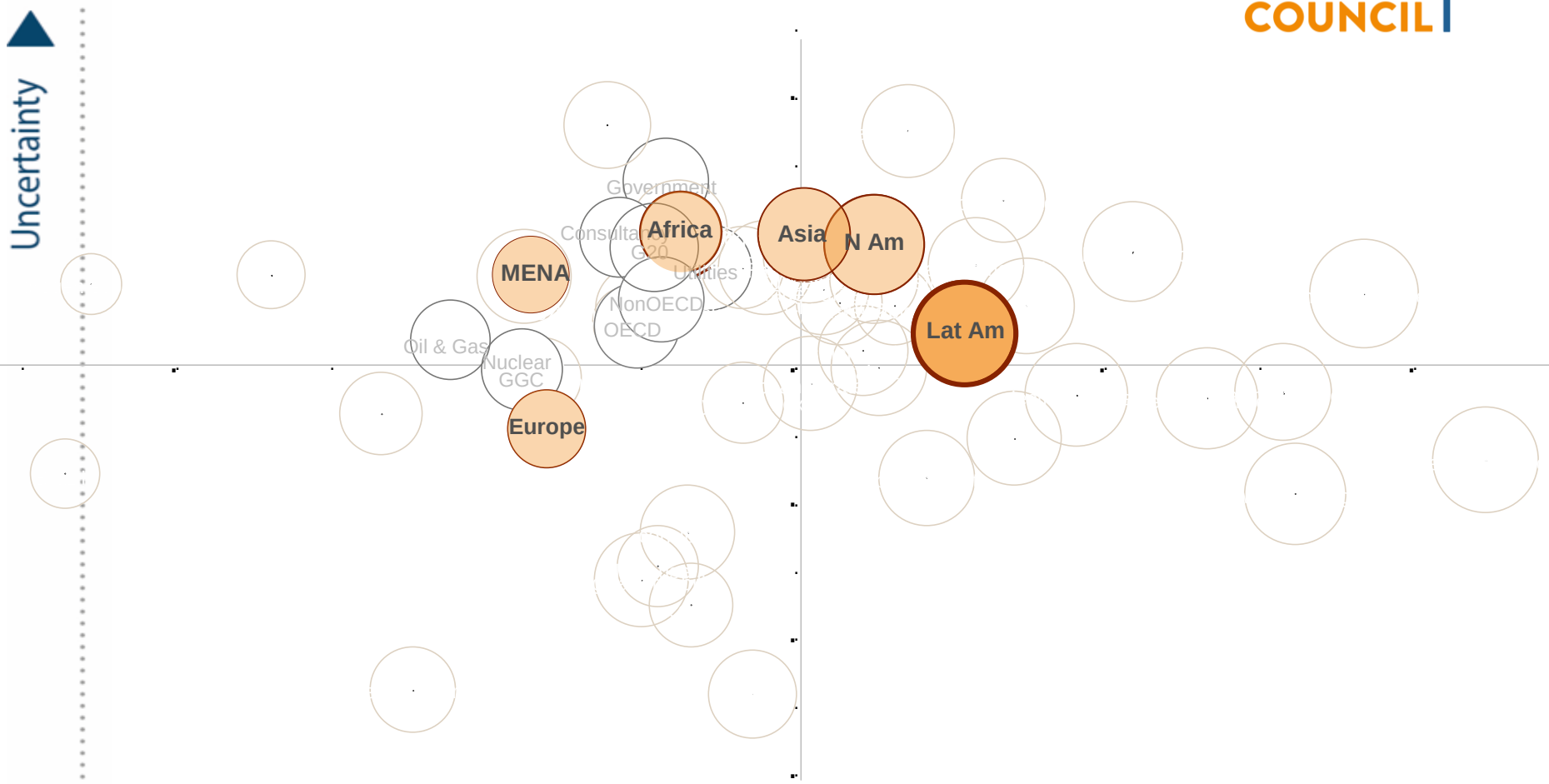
- **Price volatility, economic uncertainty, market design, climate policy** and **electricity storage** are the **top insomnia issues** for energy leaders globally.
- **Regional interconnection, renewables, energy efficiency** and **transitioning subsidy regimes** are **issues keeping energy leaders most busy** globally.

Issues Monitor



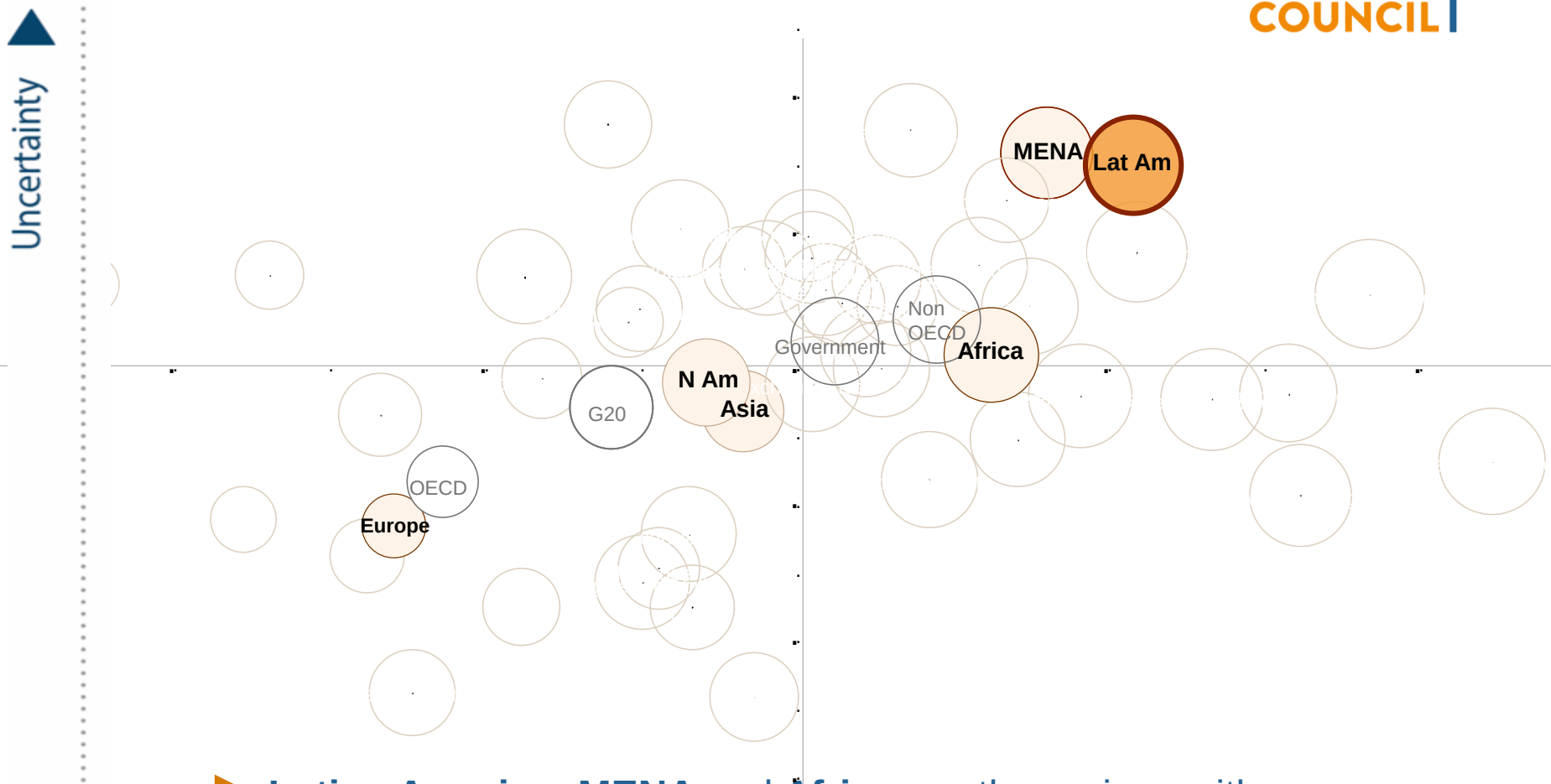
- Globally, resilience issues are on a par with other issues
- Cyber is among the top 1-year movers.
- Great regional variance

Extreme Weather Events risks



- **Americas** and **Asia** are the regions with greatest focus on the issue (Europe lowest).

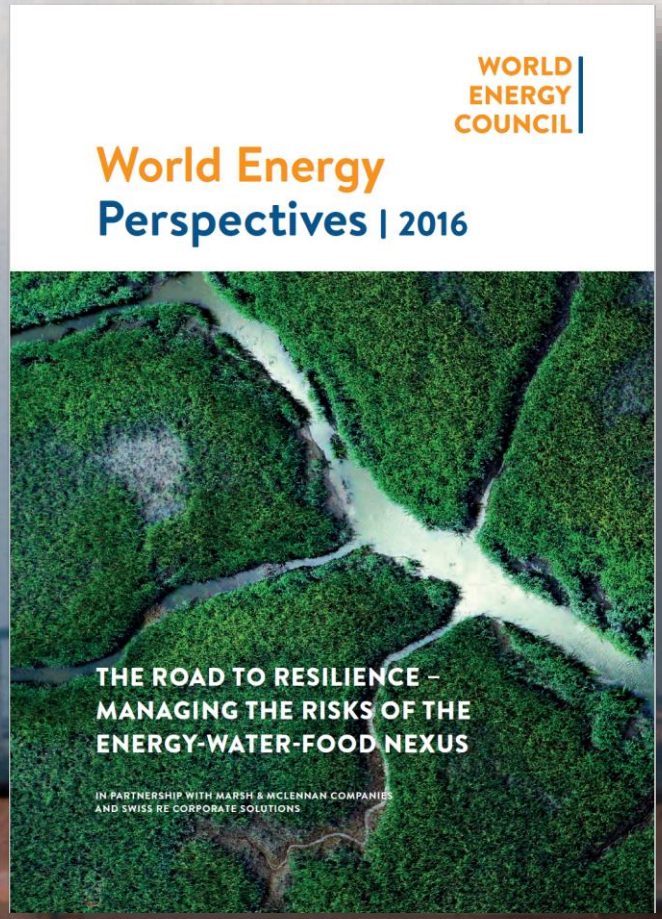
Energy Water Food nexus



- **Latina America, MENA** and **Africa** are the regions with greatest focus on the issue.

Extreme Weather Events
Energy Water Food nexus

Reports



- **Case studies**
- **Contributions from experts from 92 countries**

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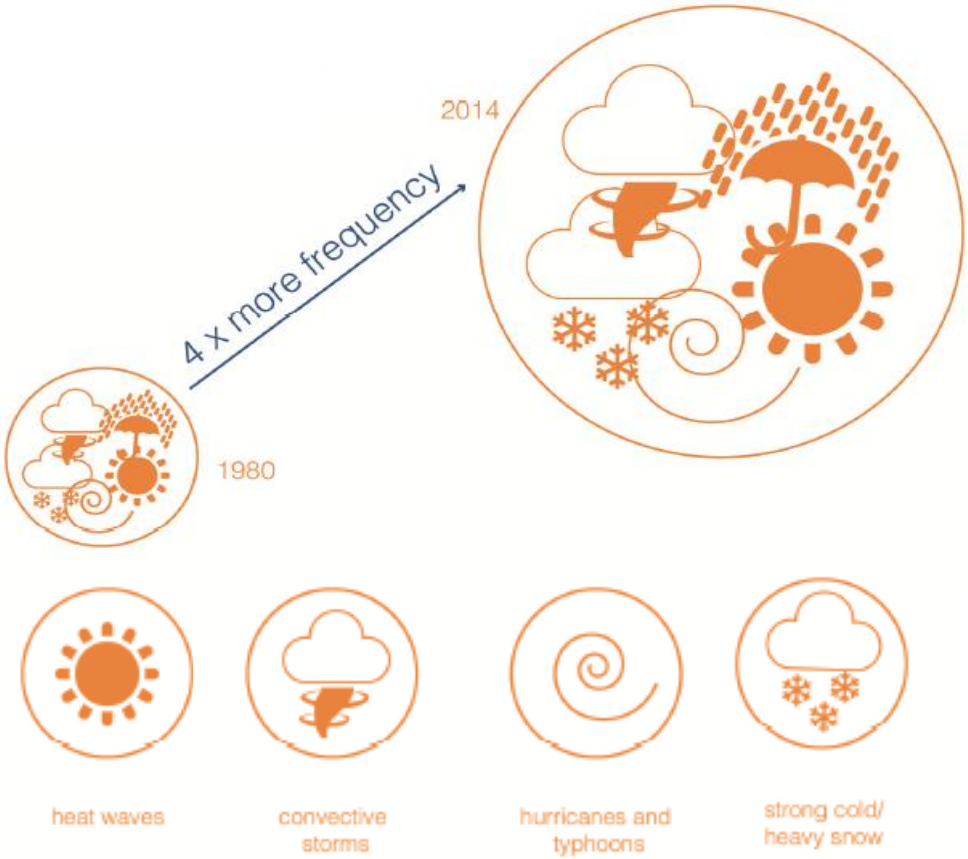
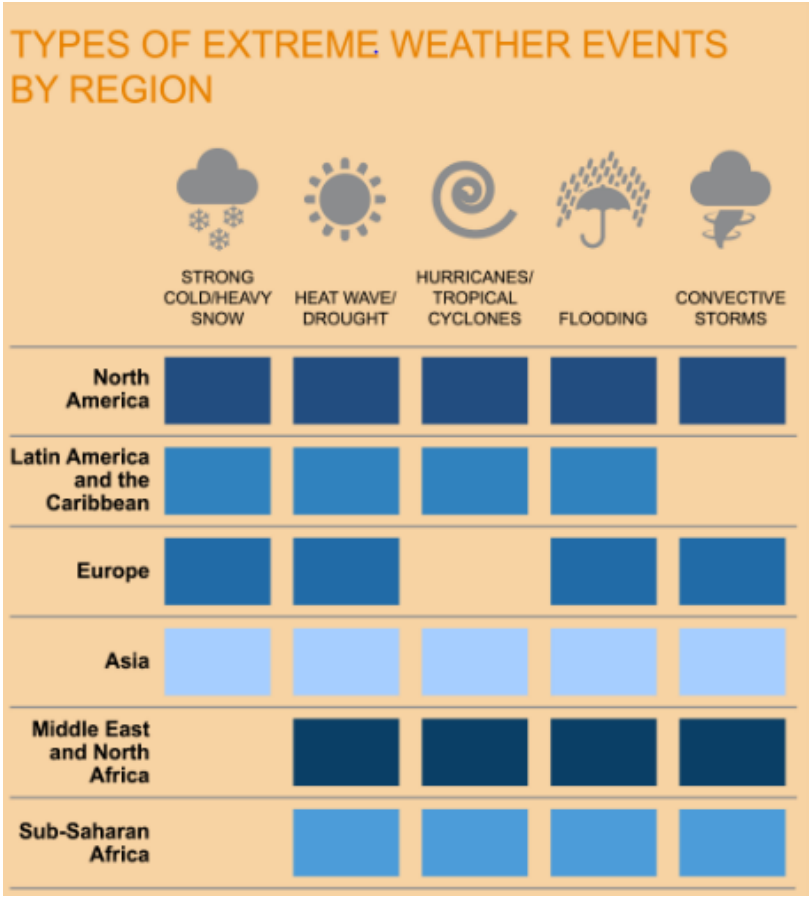
Key Findings

Problem is now!

Key findings: **Problem is now!**

- The number of extreme weather events increased **more than 4 times from 1980 to 2014**; according to IPCC this is largely related to the 40% increase of CO_2 in the atmosphere.





Key findings: **Problem is now!**

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Oil & gas assets

Oil & gas pipelines

Renewables

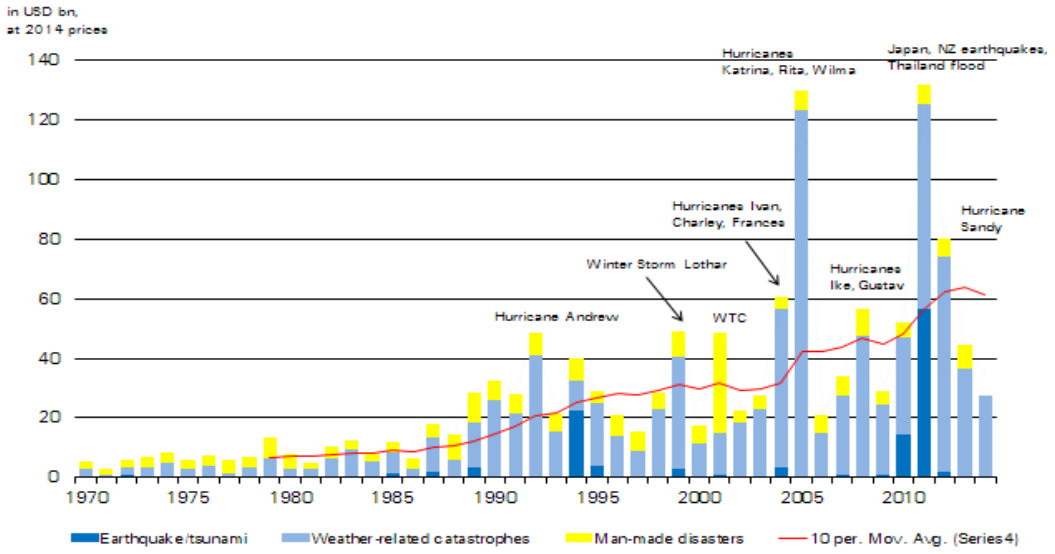
Transmission and distribution

Hydropower

Nuclear

Thermal electricity generation

- **Extreme weather events impact all energy infrastructures:**
  - Decreased performance efficiency.
  - Equipment damages.
  - Production interruption.
  - Output reduction.
  - Lost revenues.
- **Insured catastrophe losses, 1970-2014.**



Source: WEC Financing Resilience Report, 2015 (October 1); also Swiss Re, 2015: Sigma report No 2/2015

Key findings: **Problem is now!**

- **Energy sector** is the **second largest freshwater user** after agriculture.
- **Water** is used **throughout the energy value chain.**
- **98% of the power** currently produced **needs water.**
- **Water scarcity** and **competition for access to water resources** are becoming more and more of a concern:
  - **Lake Turkana region**: Kenya's dependence on the Omo River for irrigation and fishing conflicts with Ethiopia's use of upstream water for **electricity generation and irrigation**.
  - The 2014 droughts in **California** cost USD 2.2 billion in lost agricultural revenues and more than 17,000 jobs along with diminished hydro generation.
  - **Sao Paulo state** in Brazil suffered a severe drought which caused the region's largest agricultural losses in 50 years; huge hydro repercussions.
  - In 2003 in **Switzerland**, increased water temperatures meant that the performance of nuclear power plants had to be curbed by 25% for two months, thus reducing electricity production for the year by 4%.

Key findings: **Risks are likely to intensify**

- **Growing demand for energy, water and food:** Some of the regions that are currently water stressed are also likely to see significant population growth.
- **Increasing uncertainty about water availability and quality** driven by climate change impacts:
  - Declining fresh water availability.
  - Increasing temperatures of ocean waters.
  - More extreme weather patterns.
- **Over the next 50 years** reductions in usable water capacity could **impact >60% of hydropower plants** (24,515 analysed) and **>80% of thermal electric power plants** (1,427 analysed) - *Nature Climate Change.*

Key Findings

Risk assessment is complex!

Key findings: **Risk assessment is complex!**

- **Exposure** of energy systems to new risks is **dramatically changing.**
- **Lack of historical data** to assess emerging risks.
- **Large economic stakes**: in 2015, hydropower facilities in Brazil sustained economic losses of more than USD 4.3 billion due to drought-related energy and water rationing measures.

Key findings: **Risk assessment is complex!**

- **Lack of expertise** in many areas, making **long term** investment decisions **more and more complex:**
  - **Lack of expertise and technological knowledge** to design resilient infrastructures
  - **Lack of knowledge on water issues** and **lack of modelling tools** to adequately **reflect risks** posed by the nexus in energy infrastructure **investment decisions**
  - **Increasing uncertainty** concerning future availability of water for energy and **risks of stranded assets**

Key findings: **Risk assessment is complex!**

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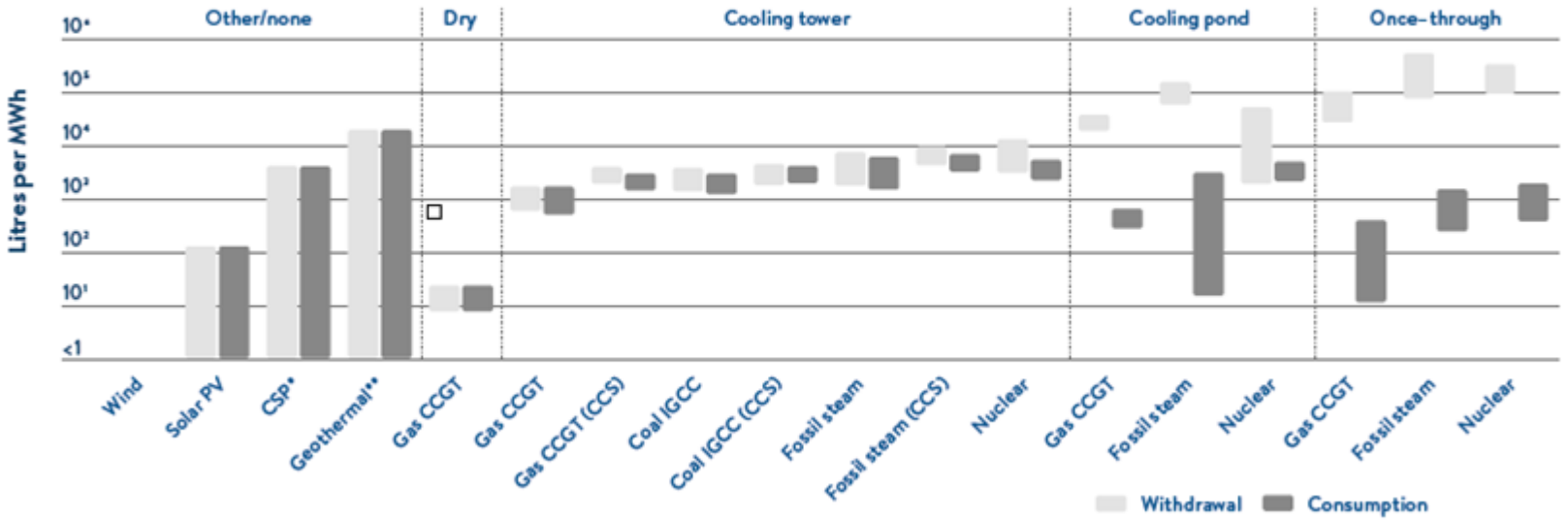
All technologies are not equivalent.

WATER USE BY ELECTRICITY GENERATION TECHNOLOGY



- **Coal** has the highest water consumption while **wind, gas** and **photovoltaic** have the lowest consumption.
- **Higher efficiency in thermal plants** (CCGT) means less heat waste per unit of electricity and therefore require less cooling.
- Technologies to make energy infrastructure more resilient often increase the cost of development.

Challenges

Challenges: **Share understanding of risks**

- Improve **risks assessment tools**.
- Develop **information** and **share** best practices between peers at national, regional and international levels.
- Promote **cooperation** and **collaboration** between all stakeholders: government, industry, financial institution, academic world, communities…
- Understand **regional issues** when necessary.

Challenges: **Take into account international dimension**

- **Energy systems are massively interconnected:**
  - Impact of an accident in one country can dramatically affect neighbouring countries.
  - Regional integration can play an important role in facilitating system restart, thus limiting this impact.
- **A major concern for Energy Water Food nexus**: 261 international trans-boundary basins cover 45% of the earth's land surface, serve 40% of the world's population and provide 60% of the earth's entire freshwater volume.
- Need to **improve cross-border cooperation** to optimise **infrastructure design** and implement **water management frameworks**.

Recommendations

Recommendations: **An evolving approach**

- To date, the energy industry has typically relied on **"hard" resilience** focused on resistance:
  - Single-asset approaches geared towards ensuring that individual infrastructures can withstand a sudden event or impact and return to full performance.
  - Marginal improvement is increasingly costly.
- **"Soft" resilience** is more focused on absorption:
  - Allows for partial system failure in a way that tries to control impact.
  - Aims to be better prepared to absorb a hazardous event and limit its impact.
  - May reduce the cost of adaptation by shifting from expensive protection solutions to more flexible systems.
- To improve overall resilience, industry and policymakers should take **an integrated approach** and use a **combination of hard and soft measures.**

Recommendations: **A reliable regulatory and legal framework**

- **Governments** should:
  - Have **long term energy policy** (Infrastructure lifetime is decades long) to reduce the risk of unforeseen policy or regulatory changes.
  - Clearly **define roles and responsibilities** of the different stakeholders and the **criteria** and **level of resilience** targeted.
  - Develop **systemic analysis** integrating energy, water resources and social considerations to have coherent policies.

- **Regulation** and **legal frameworks** must be **transparent and predictable** to **promote efficient solutions** and to **balance the interests** between stakeholders.

- **International cooperation** must be encouraged:
  - Regional integration can improve resilience.
  - Water resources need to be managed over entire river basins and with all stakeholders to address water rights across sectors and jurisdictions.

Recommendations: **Integrate emerging risks in conception and design of infrastructure projects**

- **Project developers** must adapt and improve capacity:
  - To **identify** the **possible options** to mitigate emerging risks.
  - To **better assess** their resilience capacity regarding **local consideration** such as social equity issues, specific climate risks and water footprint to mitigate the risks of potential stranded assets.

- **Risk assessments** should incorporate **extreme events** and different **climate and hydrological scenarios** to reflect a comprehensive understanding of long-term risks in financial analyses.

- To reflect potential water scarcity, **water value** (shadow water price or water market price if any) must be integrated in price scenarios to test robustness of economic analysis.

Recommendations: Develop appropriate financial and insurance instruments

- An extreme weather event:
  - Can cause some **physical damage** to the energy asset which stops it from working for a period.
  - Can also affect the **operational capability**: a dam without water due to changing hydrological patterns and cycles, a thermal power station with inadequate cooling water, a wind farm with too little or too much wind.
- The **challenge arises** if a **very unlikely** event becomes **more frequent** as a **result of climate change effects**:
  - Insurers evaluate the **chance of a negative event occurring** and **how much damage it will cause**: based on extrapolations of past events.
  - They can **recalibrate their underwriting criteria** frequently if an increase in global average temperatures redefines what was considered as 'normal'.
  - The project risks, and therefore insurance costs, may **significantly increase** during its planned lifespan.

Recommendations: Develop appropriate financial and insurance instruments

- Over the project lifetime, **financial instruments & insurance** need to address:
  - Adverse weather impacts.
  - Weather-related volume exposures.
  - Electricity price volatility.
  - Combined with unplanned power outages.
- These products are still **in the early stages** but could be used to hedge such risks as water scarcity.
- They can help stabilise income volatility and reduce risks for investors.
- **e.g. Derivative-like parametric cover may be available** to mitigate the risk.

Case-study: **Climate insurance to protect government budget in times of drought**

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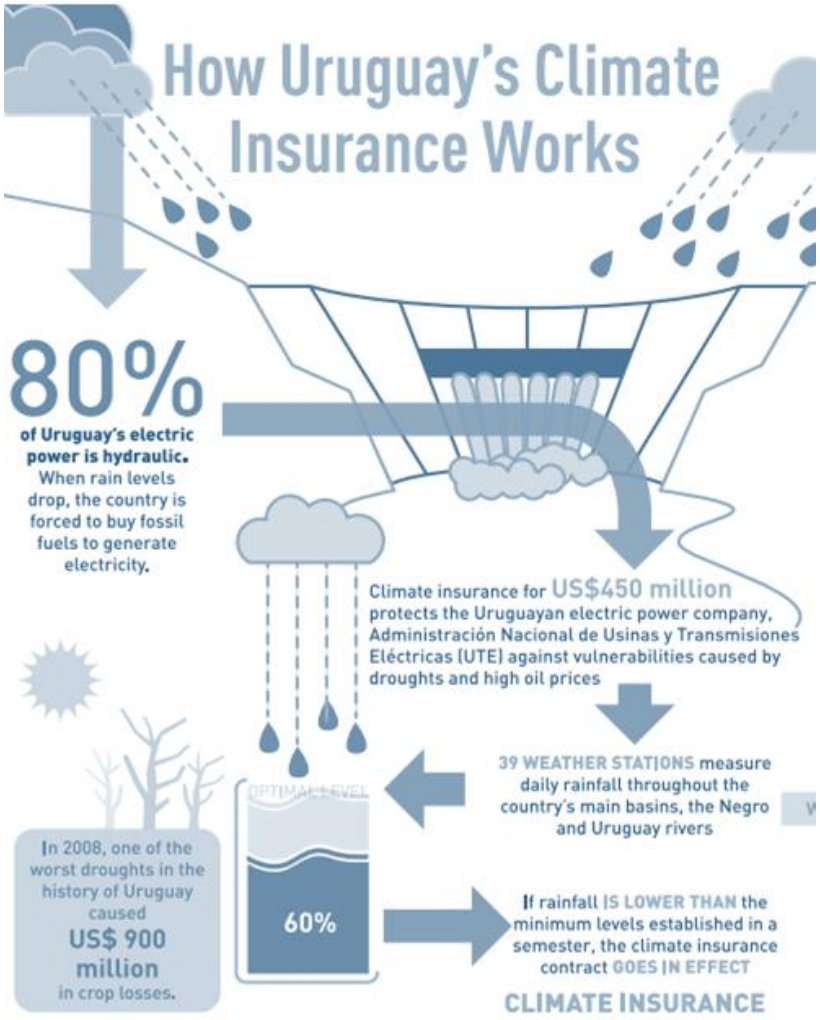
- **Uruguay** relies largely on rainfall for its **hydroelectric** plants to produce electricity.
- 2012 drought resulted in **budget deficit** for buying electricity on international spot market.
- Ministry of Finance entered a USD **450 million weather insurance** with World Bank.
- Transaction uses **rainfall data and oil prices** for settlement, compensating government for combined risk of drought conditions and oil price increase, and thereby **reduces major source of budget uncertainty**.



Case-study: **Dealing with EWF nexus in India**

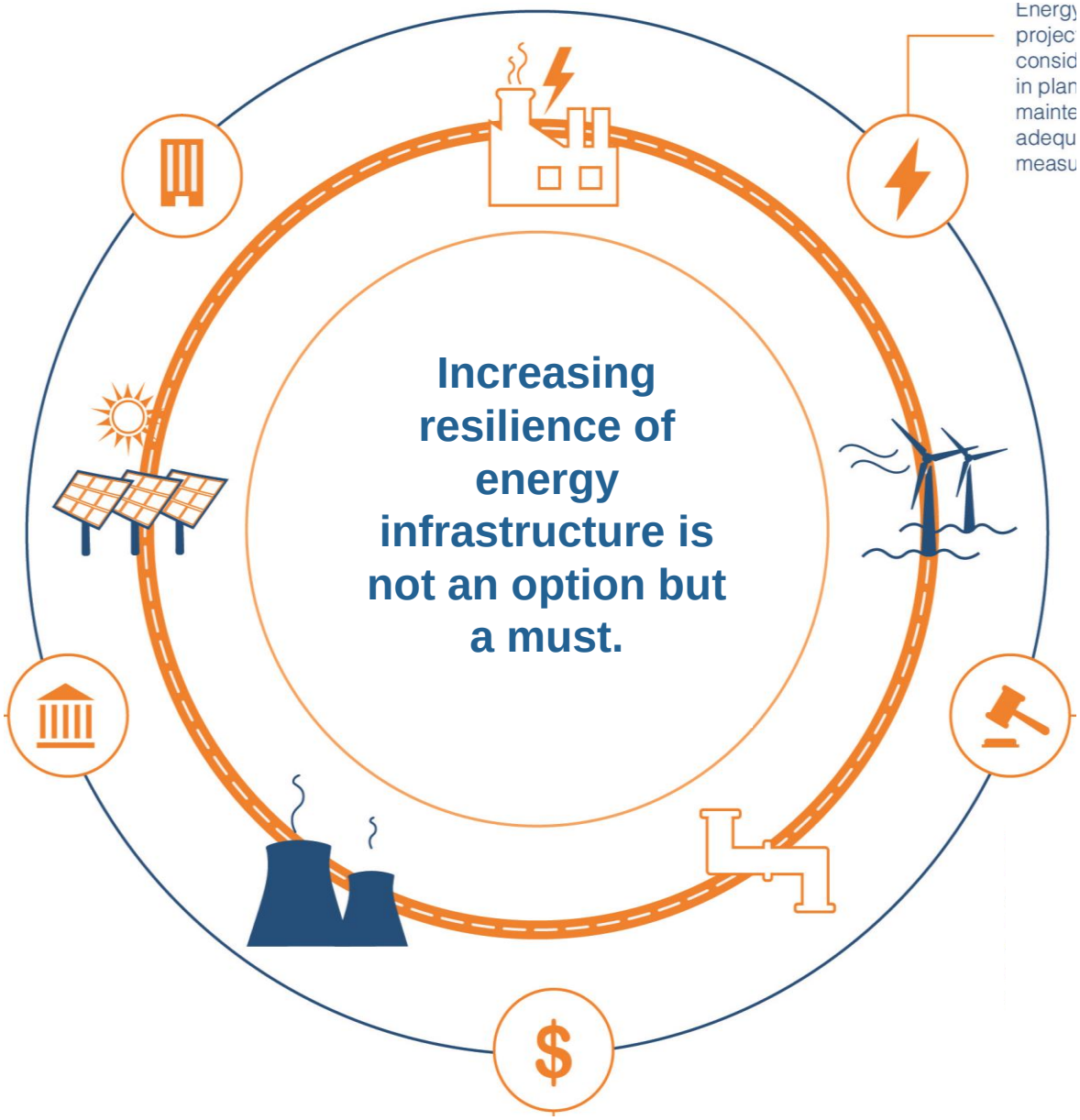
Covered 750m of a canal with solar panels → Generate 1MW

Benefits

- Provide **clean energy** for locals
- Save **land** for food production
- Panels produce at **15% premium** due to water cooling effect
- **Avoid water evaporation**

If **10% of canals** in Gujarat were covered:

- **2,200 MW** generation capability
- Save **11,000 acres**
- Save **2000 crore litres p.a.**



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Thank you

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