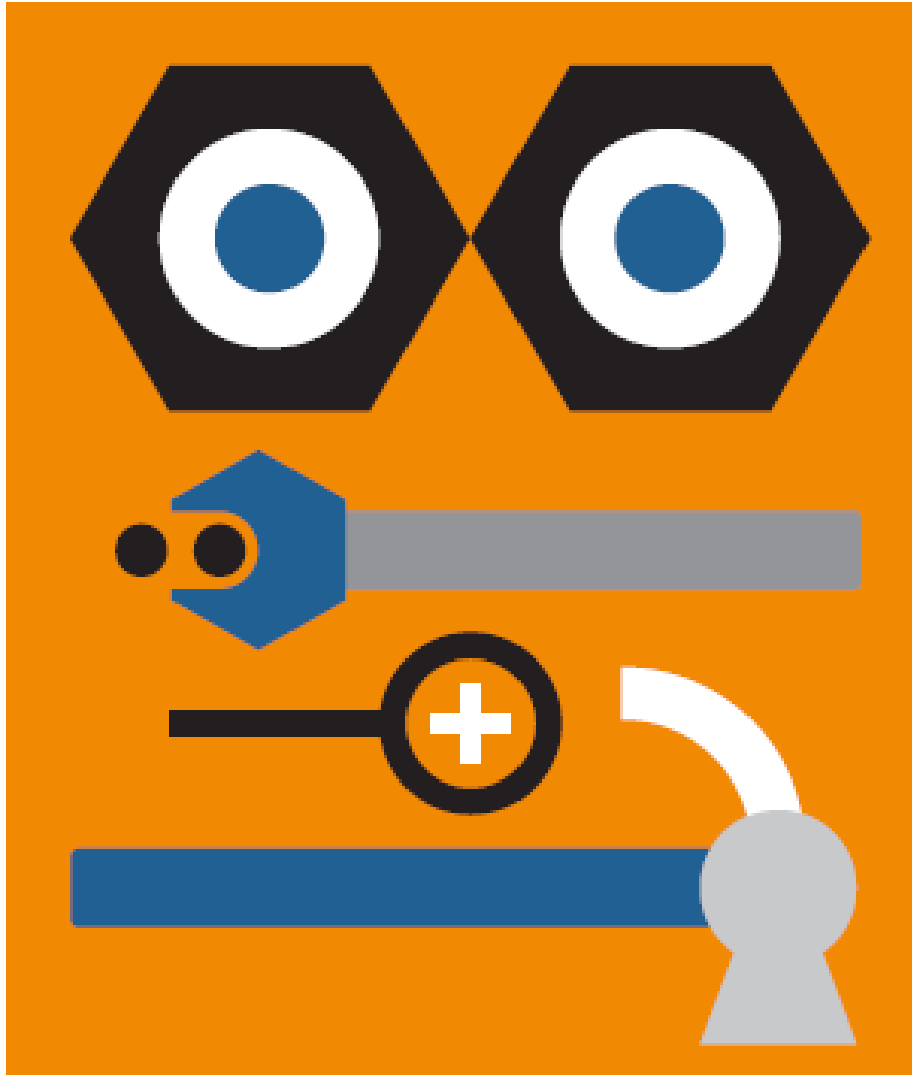




**GRAND TRANSITION, DIGITAL REVOLUTION
& NEW ENERGY REALITIES**

Enable Successful Transition Using Our Tools

Developed with and for use by our members



World Energy Issues Monitor: reality check - global, regional, national energy perspective on energy transition challenges



World Energy Scenarios: engage uncertainty as opportunity - global-, regional- and thematic-focused energy futures frames



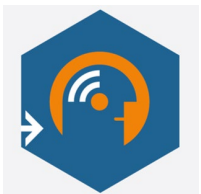
Energy Policy Trilemma: policy pathfinding to balance security, equity & sustainability performance



Innovation Insights: moving innovation from margins to mainstream & digging deeper into wide and fast shifting landscape

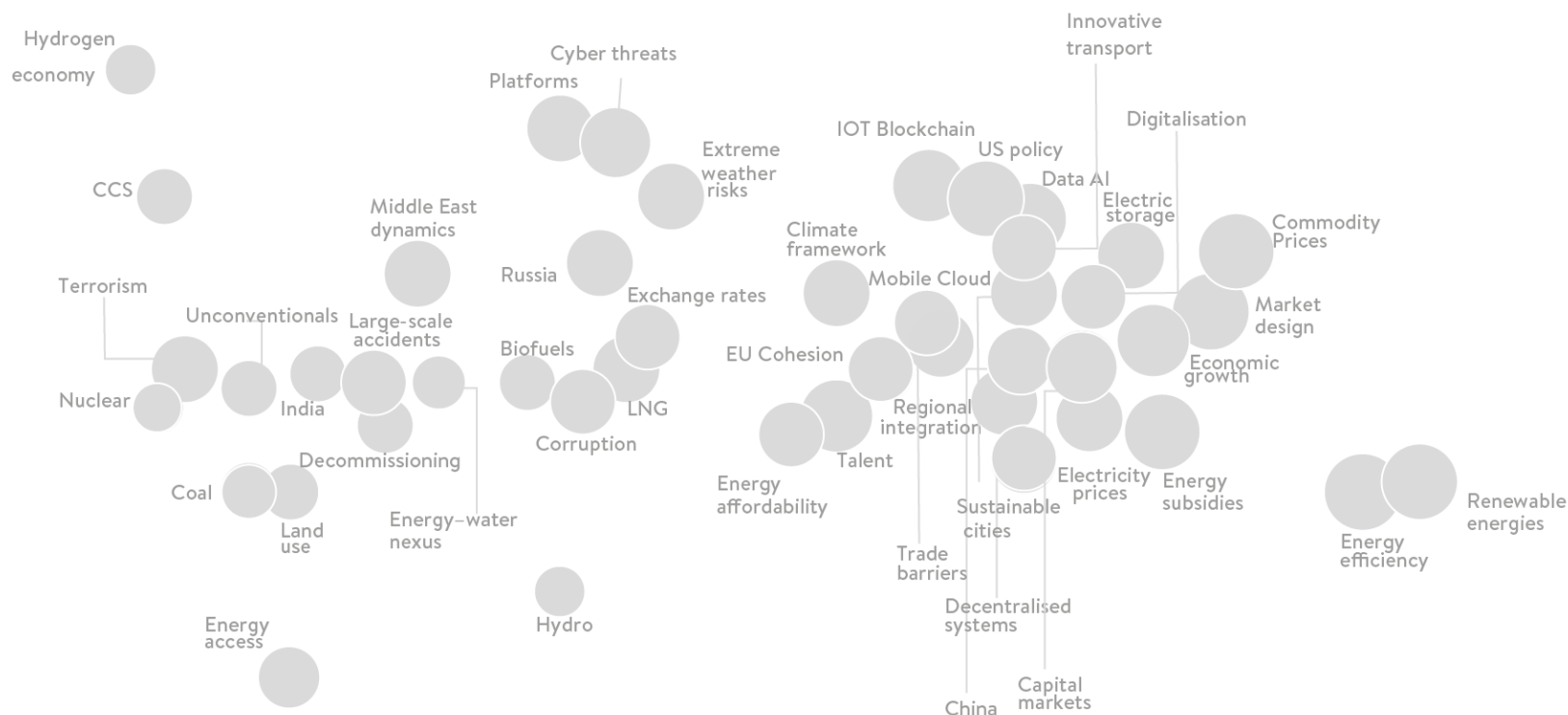


Dynamic Resilience: better prepared for emerging and systemic risks



What is the Issues Monitor

Uncertainty ▲



World Energy Issues Monitor 2019 - Global - 42 Issues

Impact ►

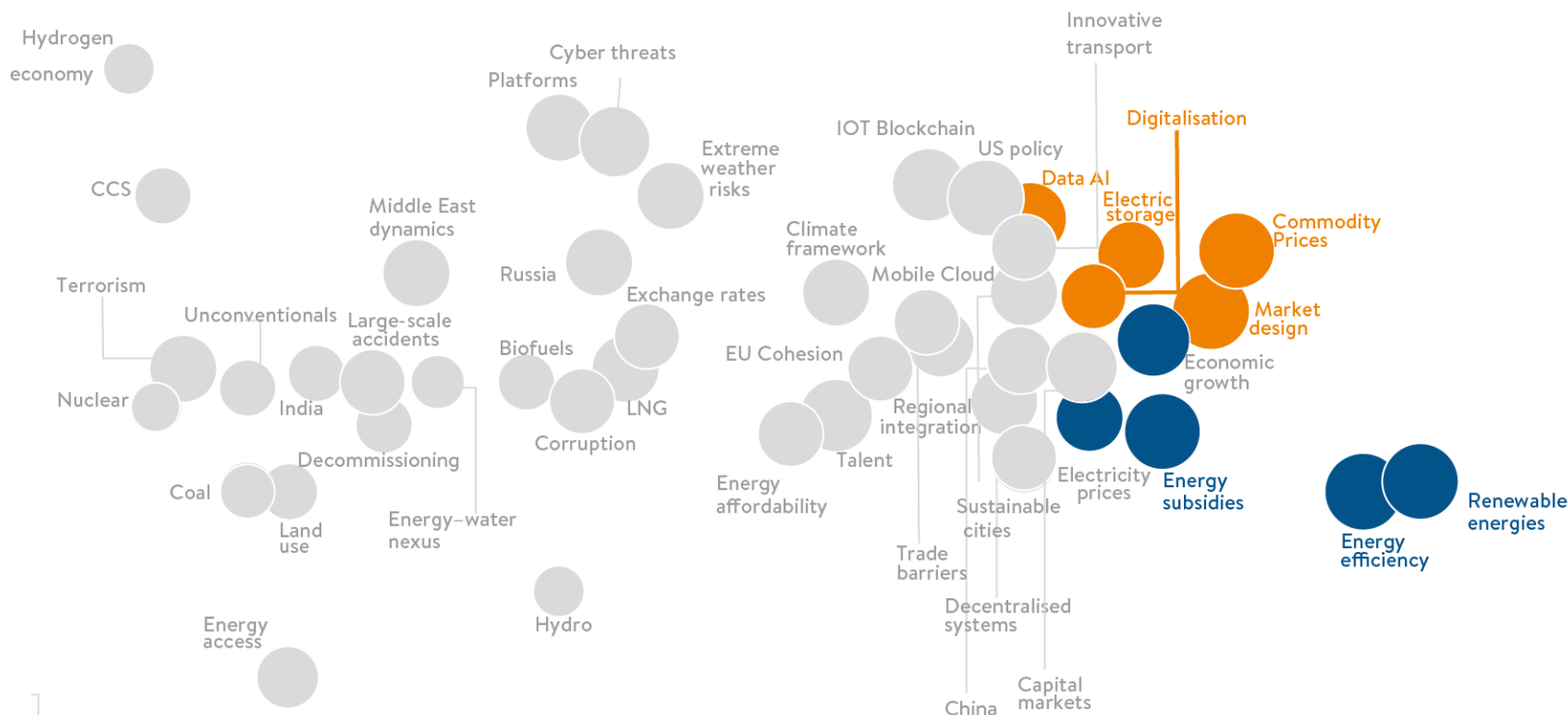
Less urgent ○ ○ ○ More urgent

- The Issues Monitor **assesses 42 issues** in a high-level overview, covering four categories:
 1. Macroeconomic Risks
 2. Geopolitics
 3. Business Environment
 4. Energy Vision & Tech
- The responses are translated into three assessed dimensions:
 1. Impact (x axis)
 2. Uncertainty (y axis)
 3. Urgency (size of bubble)



Issues Monitor - Global Trends

Uncertainty ▲



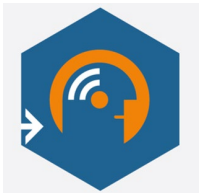
- Similar picture to last year: **Consolidation of energy transition trends** with high emphasis on renewables and energy efficiency

World Energy Issues Monitor 2019 - Global

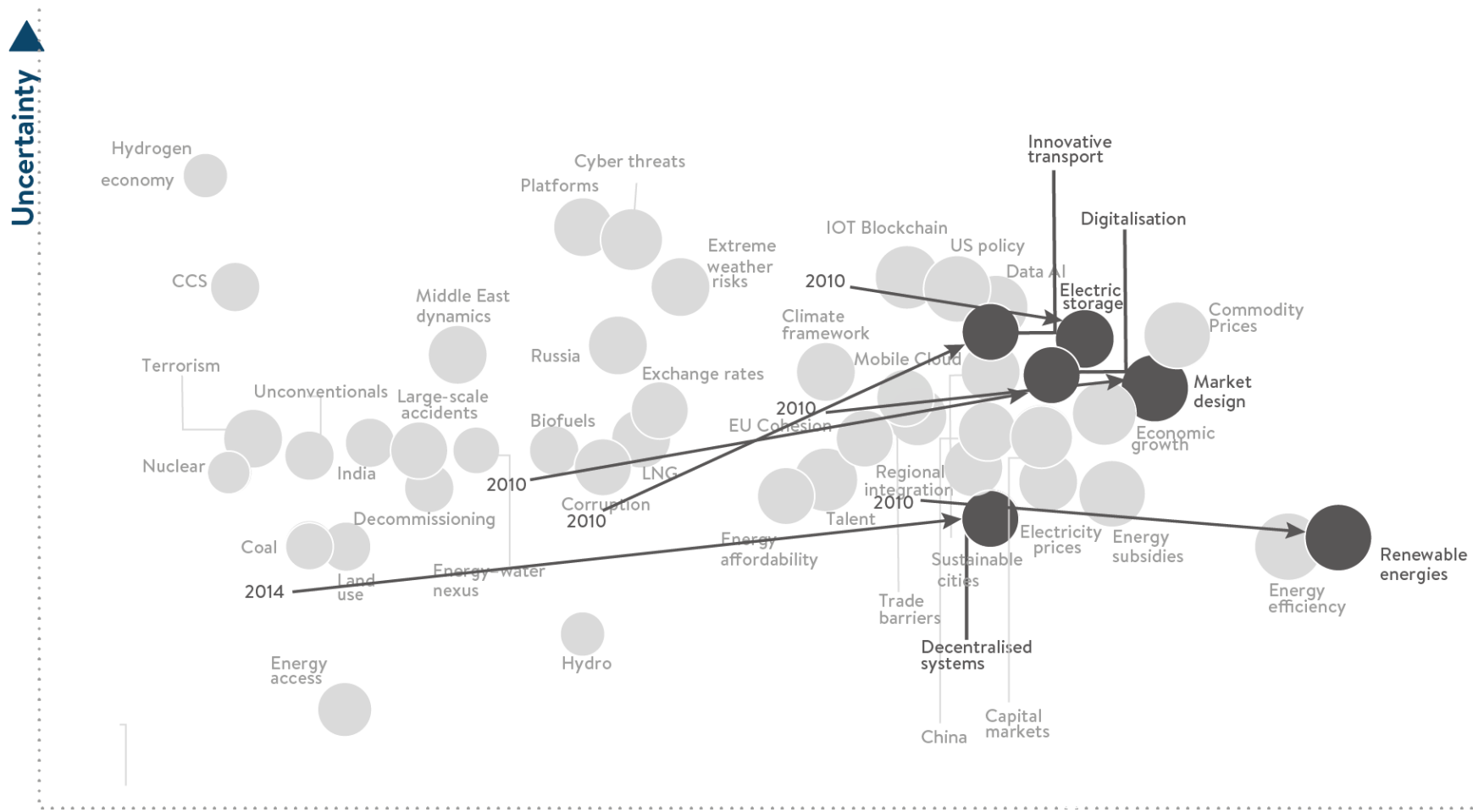
Impact ►

- Critical uncertainties: what keeps energy leaders awake at night
- Action priorities: what keeps energy leaders busy at work

Less urgent ○ ○ ○ More urgent



Tracking Innovation since 2010



- Technology innovation clusters of **renewable energies, electric storage, & innovative transport** are moving up.
- This technology push is going hand in hand with **innovation in new market designs and decentralised systems.**

World Energy Issues Monitor 2019 - Global - Innovation

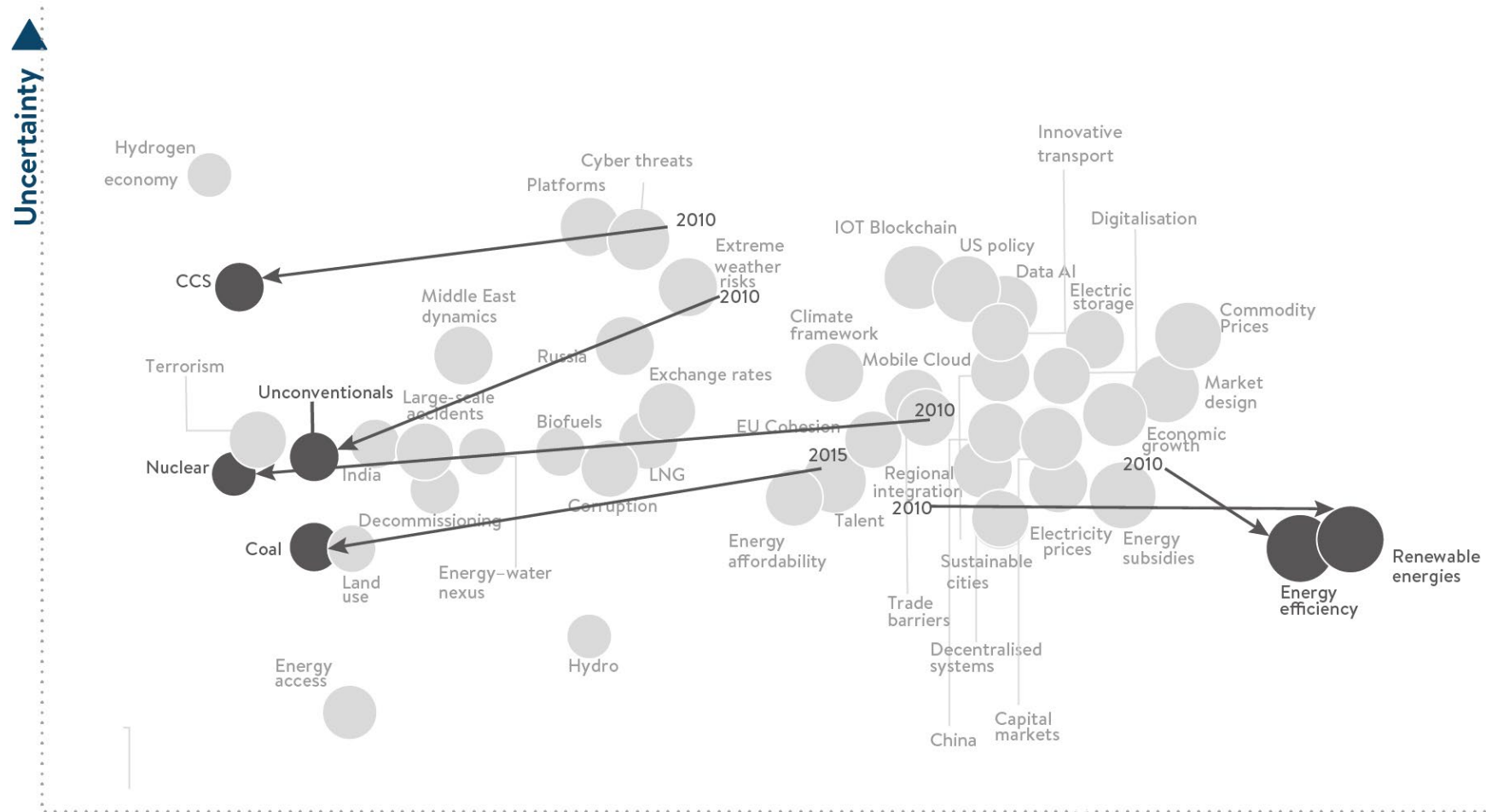
Impact ►

● Timetracking of select issues from 2010 to 2018

Less urgent ○ ○ ○ More urgent



Tracking Decentralisation since 2010



- Traditional baseload generation (i.e. coal, nuclear, etc.) are all very present in the global fuel mix now and in future projections, but **decentralisation** continues its push.
- **Renewable energy and energy efficiency** goals are keeping most countries busy.

World Energy Issues Monitor 2019 - Global - Decentralisation

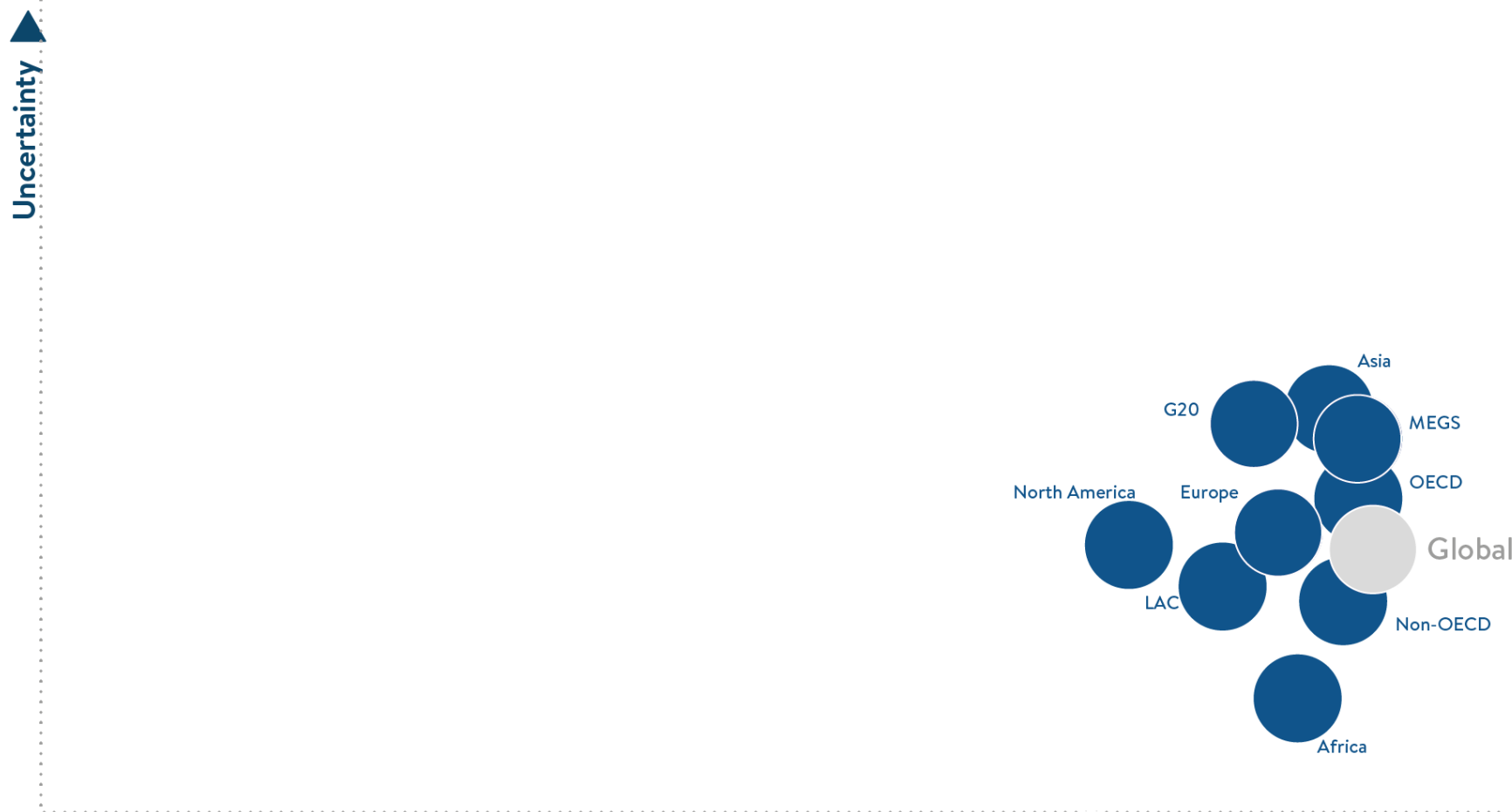
Impact ►

● Timetracking of select issues from 2010 to 2018

Less urgent ○ ○ ○ More urgent



Geographical Tracking of Renewable Energies



- There is great consensus across all regions on the renewables priority.

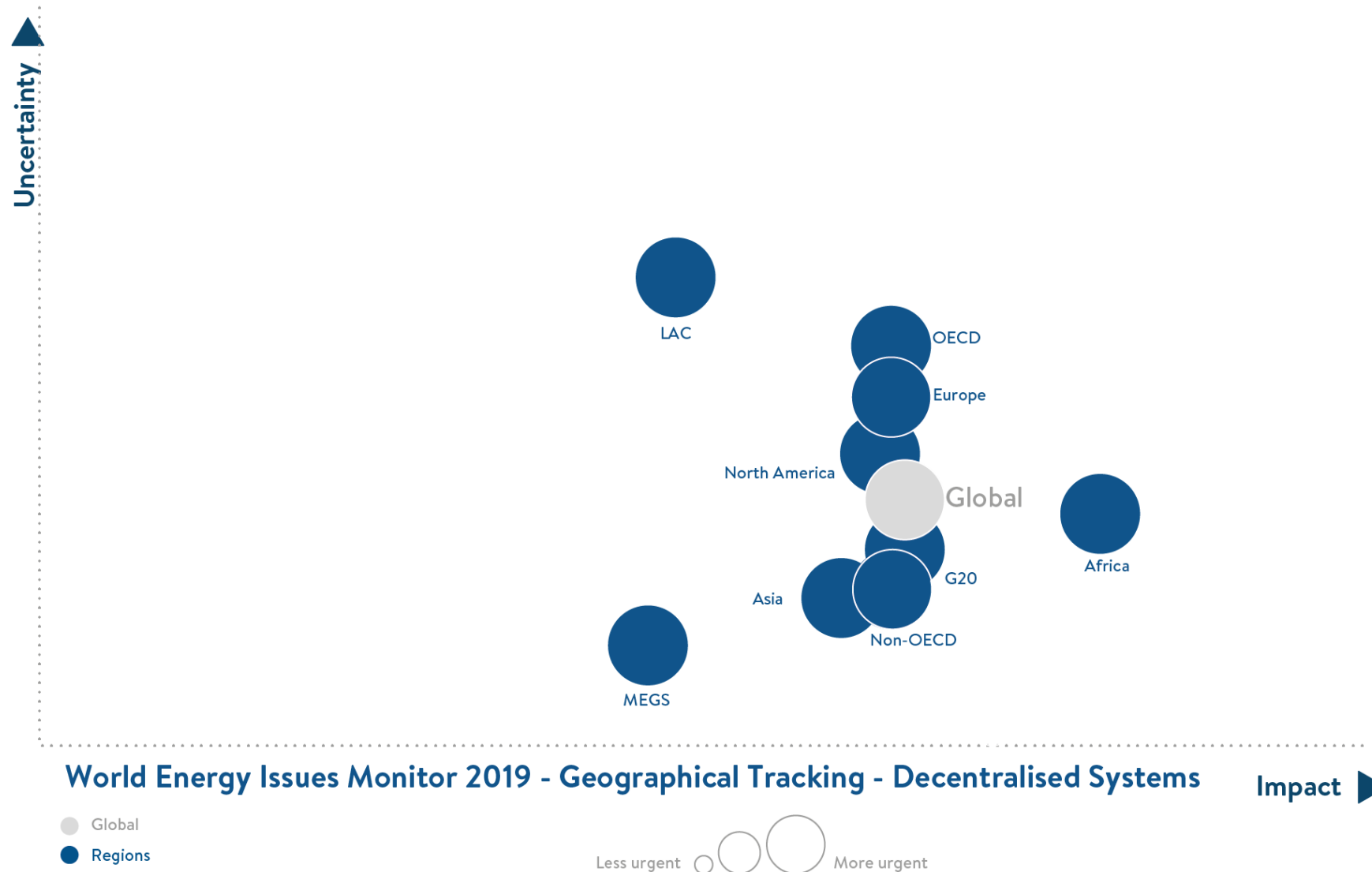
World Energy Issues Monitor 2019 - Geographical Tracking - Renewable Energies

● Global
● Regions

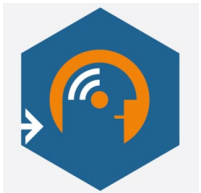
Less urgent ○ ○ ○ More urgent



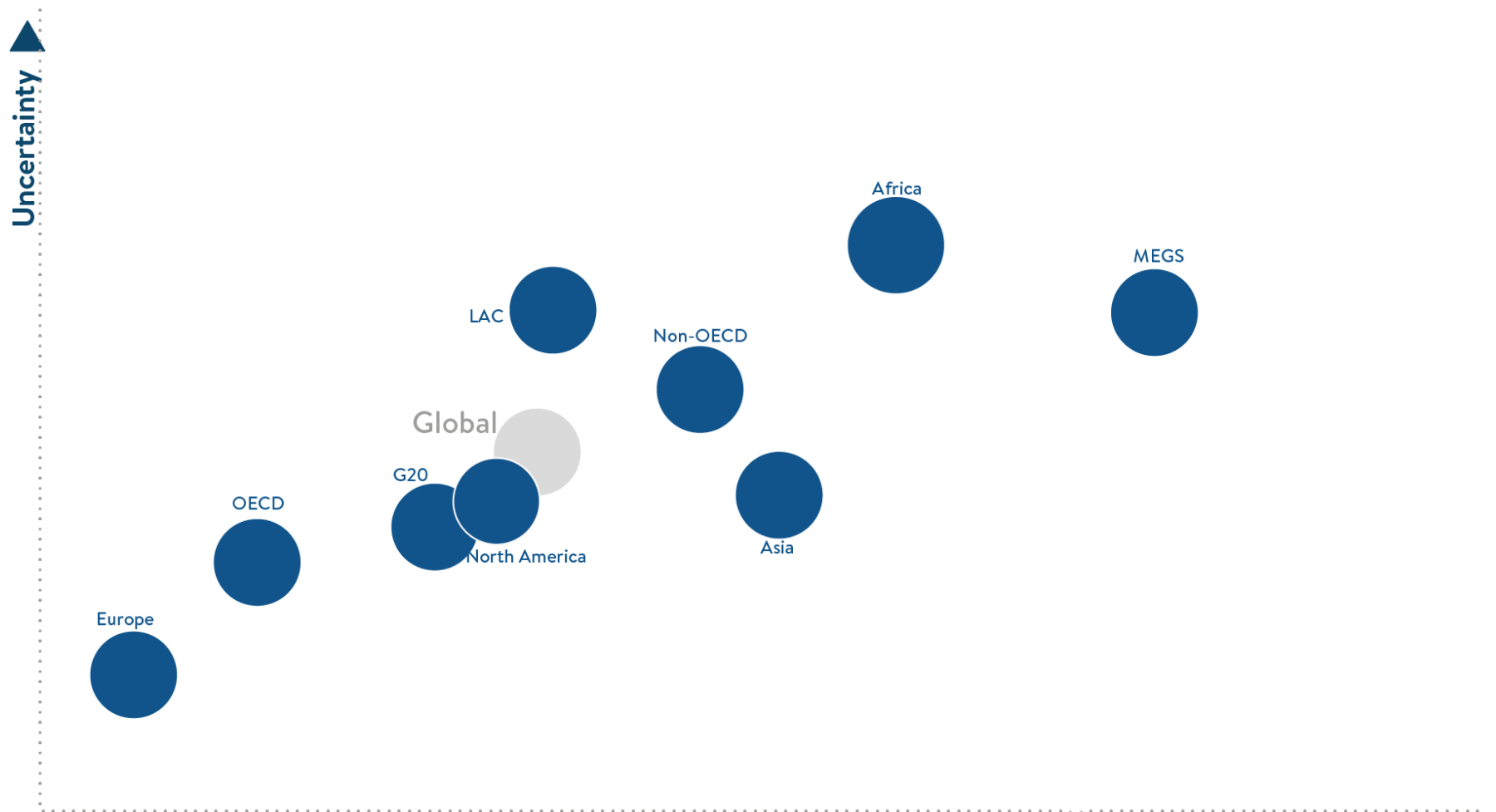
Geographical Tracking of Decentralised Systems



- *decentralised systems* has slight differences across regions.
- Africa is working to reduce the number of people who don't have **access to electricity** by relying on decentralised systems such as **micro-grids**.



Geographical Tracking of Energy Water Nexus



- The water nexus has great differences across regions.
- Water scarcity is increasing in Africa and Middle East due to increasing demand.

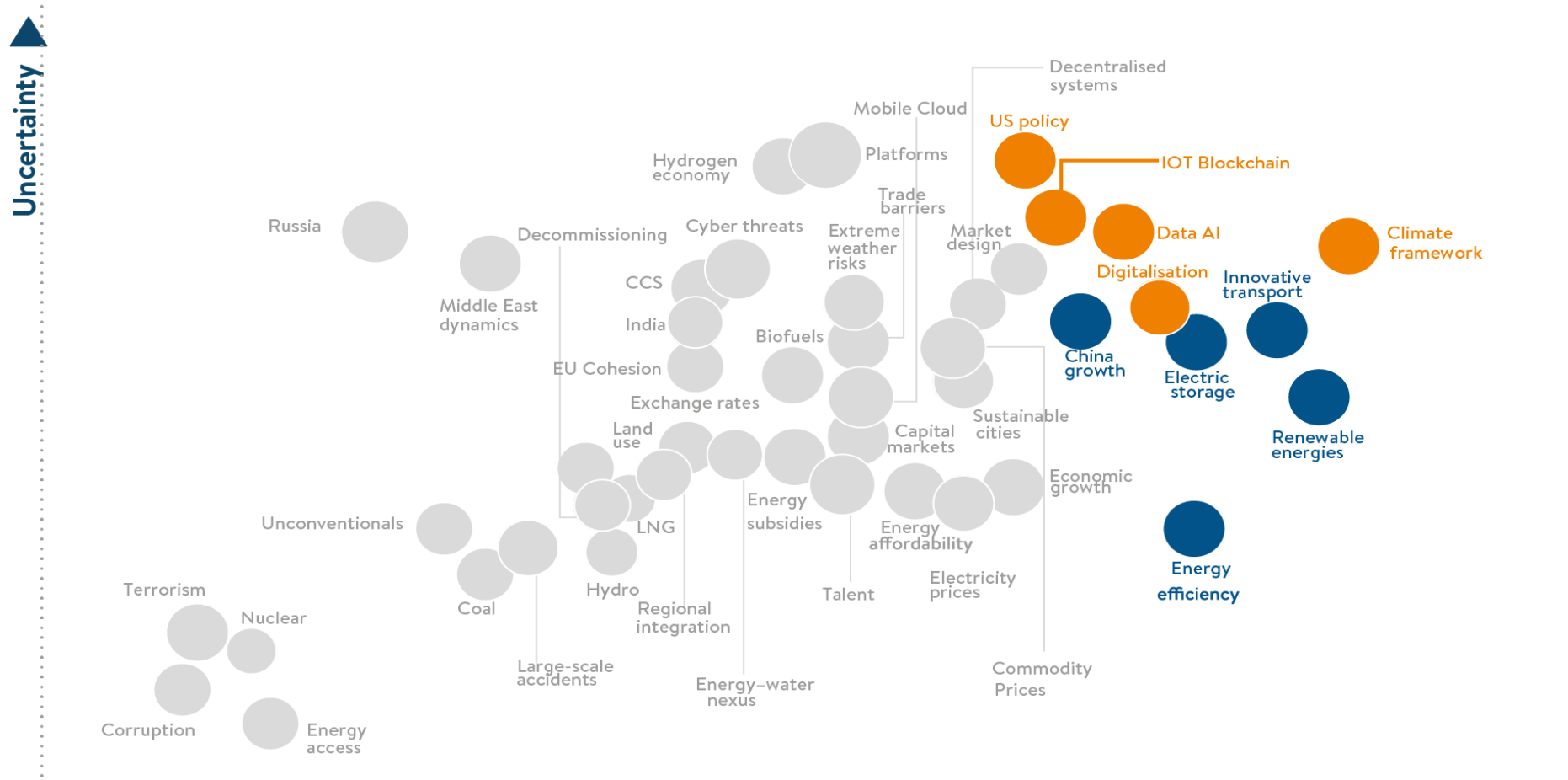
World Energy Issues Monitor 2019 - Geographical Tracking - Energy Water Nexus

Impact ►

● Global
● Regions

Less urgent ○ ○ ○ More urgent

New Zealand 2019 Issues Monitor Map



World Energy Issues Monitor 2019 - New Zealand

Impact ►

● Critical uncertainties: what keeps energy leaders awake at night

● Action priorities: what keeps energy leaders busy at work

Less urgent More urgent

17/11 Mexico's Energy Auction

\$19.18/MWh average price

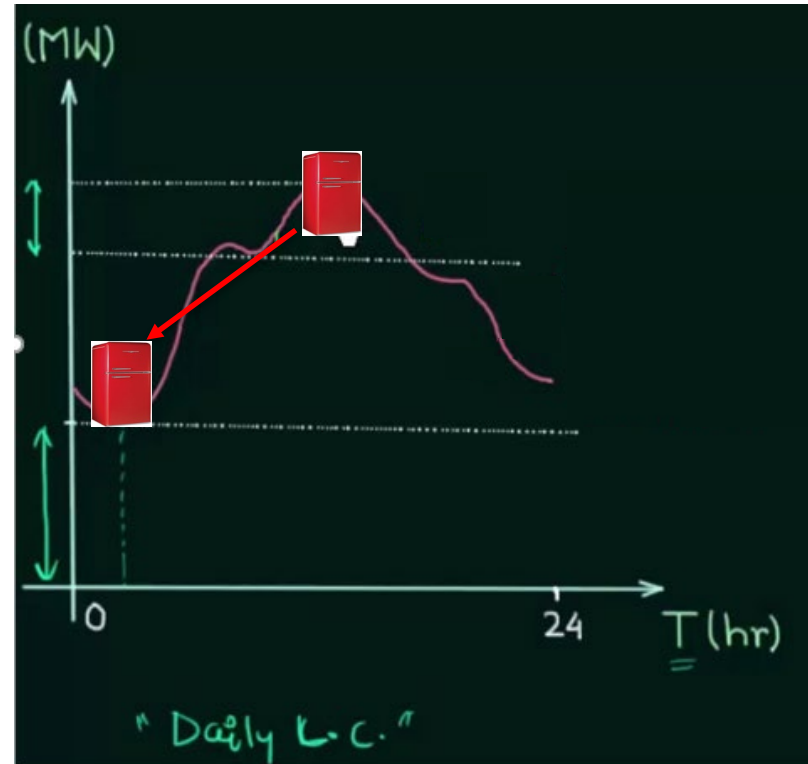
**WORLD
ENERGY
COUNCIL**

17/10 300MW in Saudi Arabia

\$17.86/MWh average price



“uberisation in energy”



Internet of things (IoT) in energy

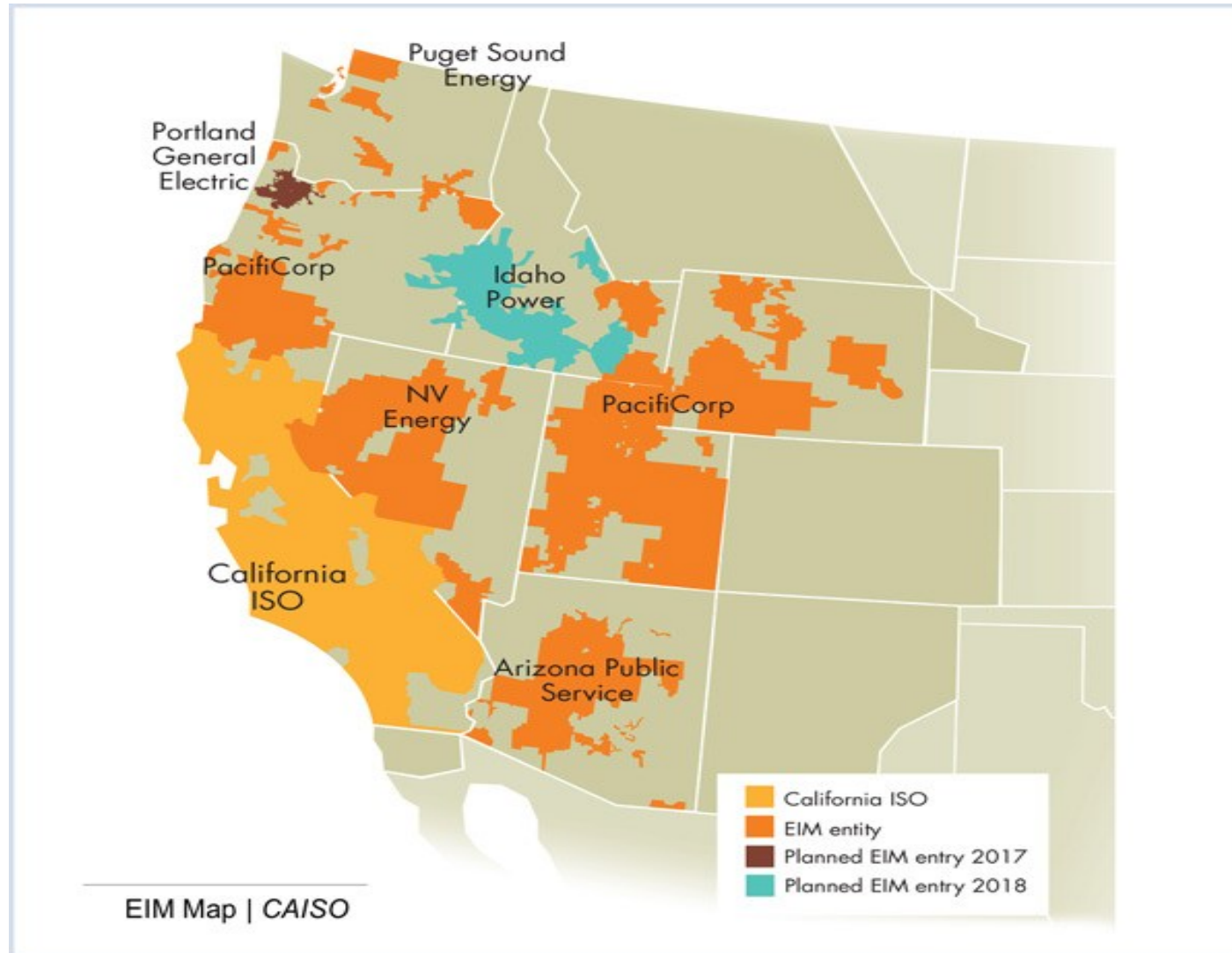
automating transactions between large numbers of small devices

enabled by distributed ledgers / blockchain

has potential to deliver system services at scale

and thereby reduce physical infrastructure needs

California's DERPs



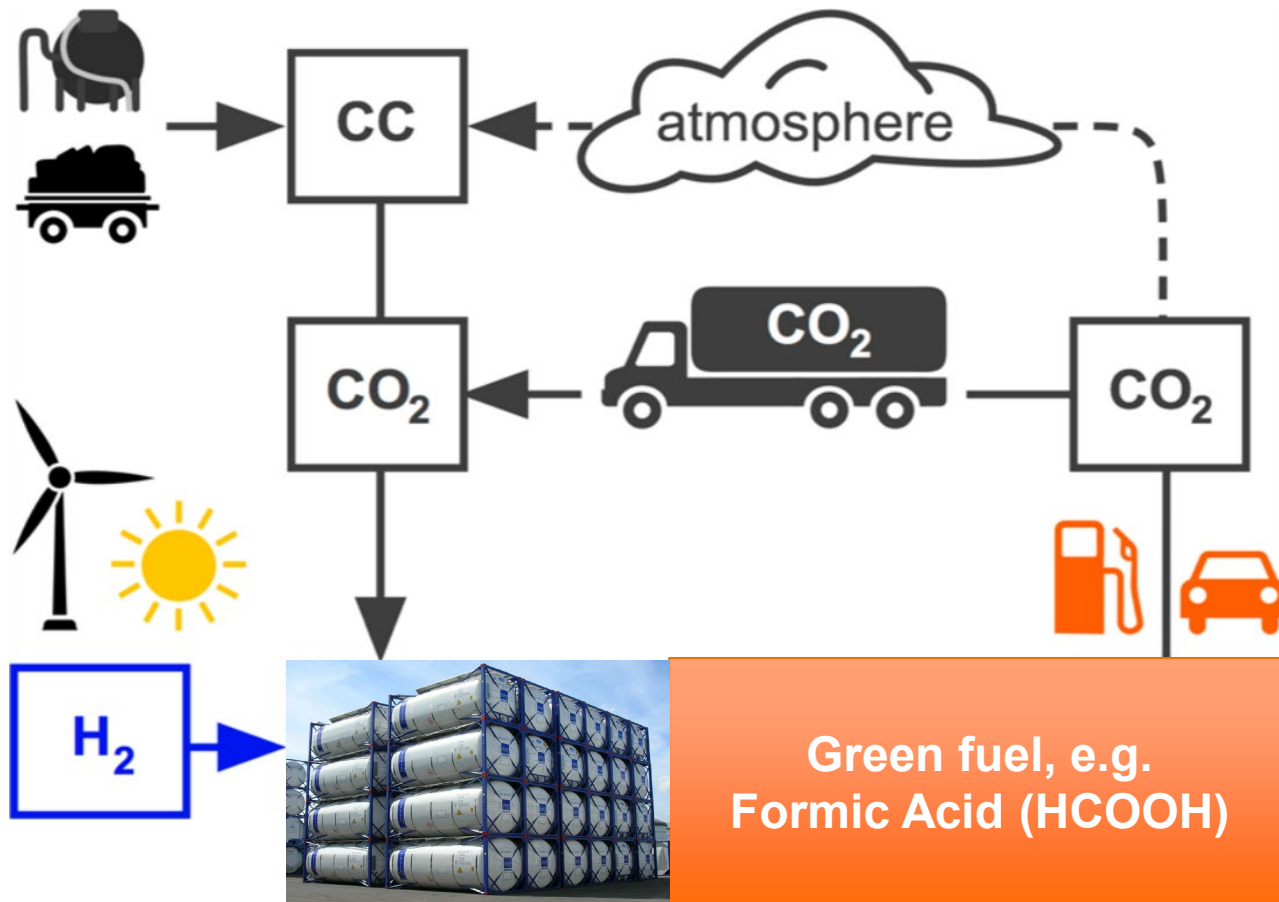
Enabling aggregators

Distributed energy resource providers for aggregators as grid resources (solar, storage, EVs and demand response)



Do it yourself: DHL-style

No 'all electric' vision: Green molecules, building on existing supply chains



“green” fuels from renewable electricity (power-to-X) include hydrogen, ammonia, methane, methanol, formic acid, diesel, gasoline, or kerosene

“PtX is a necessary element of the global energy transition” for storability, cost, availability and acceptability considerations due to reusing existing infrastructure [WEC Germany, frontier economics, 181018]

global trade is key for cost and resources availability considerations.

potential scale: today’s oil production is about equivalent to 2-3 times the electricity production in terms of energy

Digitalization & decentralization: Rural household solutions

**WORLD
ENERGY
COUNCIL**



**Energy realities are shifting.
Faster than ever.**

- The D3 driven transition offers a unique opportunity to achieve more secure, affordable and clean energy for all.
- Electricity is the new oil. The digit is the new battery.
- The way to Trilemma heaven needs green liquids.
- 100% energy access can be achieved by 2030.

Act now.



INSIGHTS: World Energy Scenarios

WORLD
ENERGY
COUNCIL

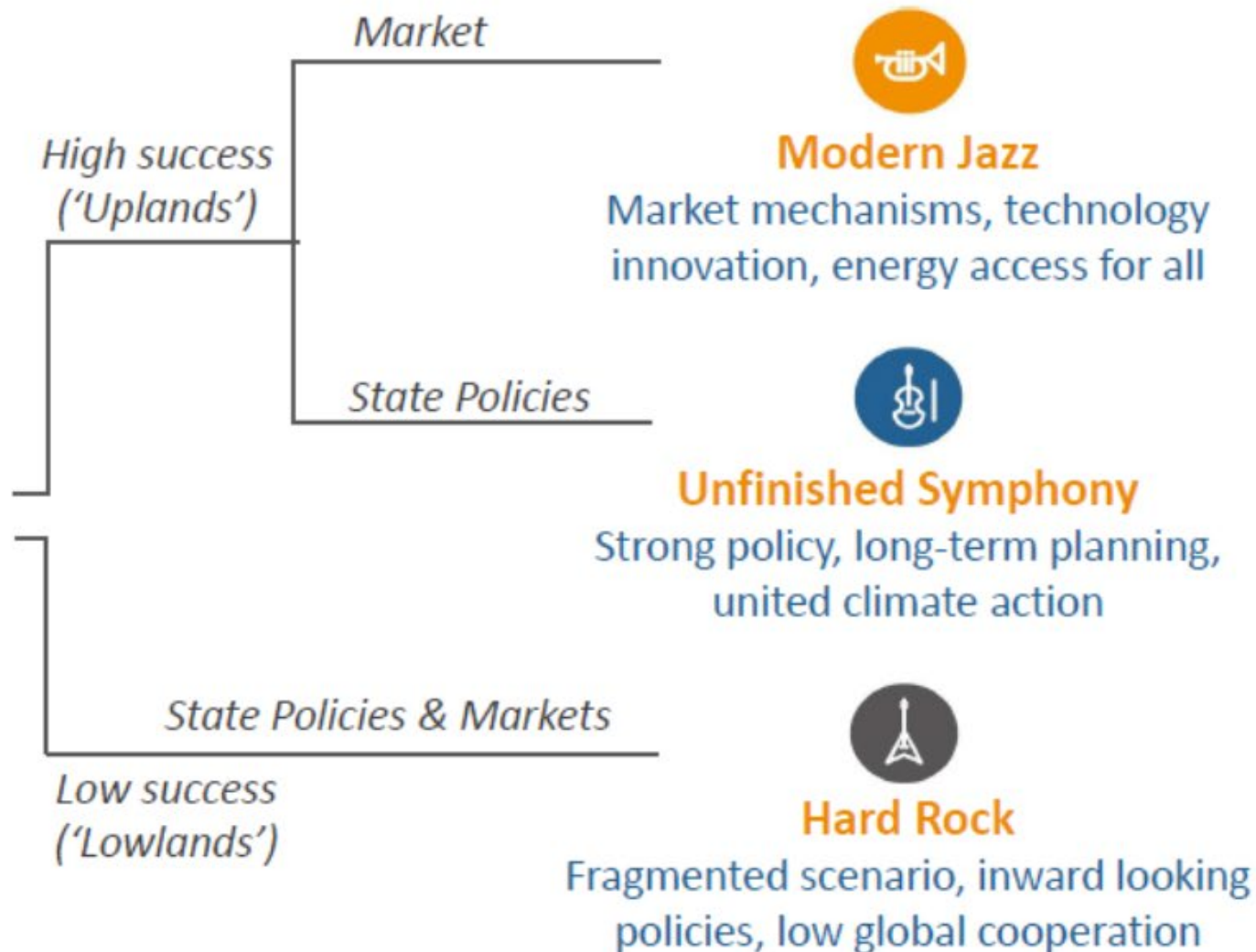
The Grand Transition & Three alternative pathways to 2060

PRE-DETERMINED FACTORS – The Grand Transition

- Slowing population growth
- Range of new technologies
- Appreciation of new planetary boundaries
- Shift in power to Asia

CRITICAL UNCERTAINTIES

- Pace of innovation and productivity
- Int'l governance & geo-political change
- Priority given to climate change
- 'Tools for action' - markets vs state

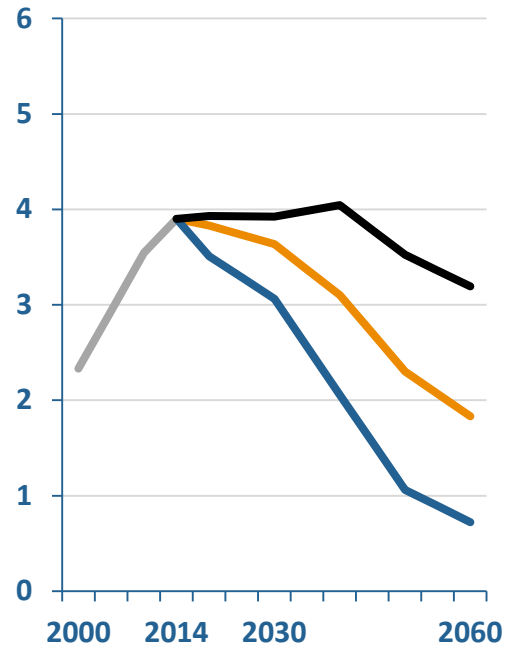


Demand peaks for coal and oil

... have the potential to take the world from “Stranded Assets” to “Stranded Resources”.

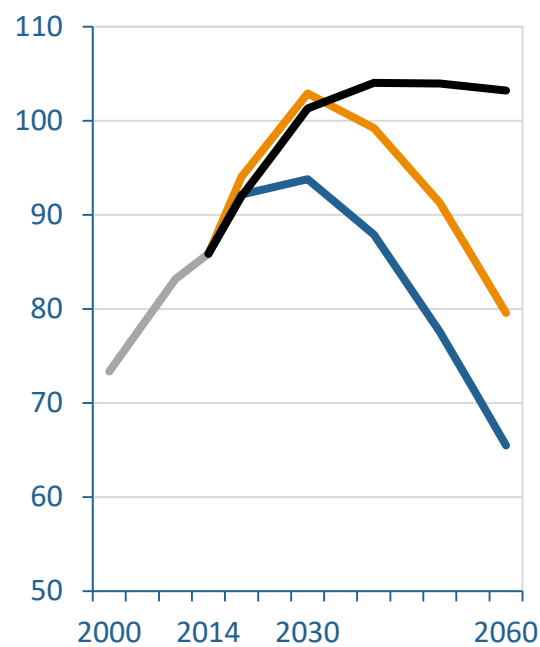
Coal Demand

('000 MTOE)



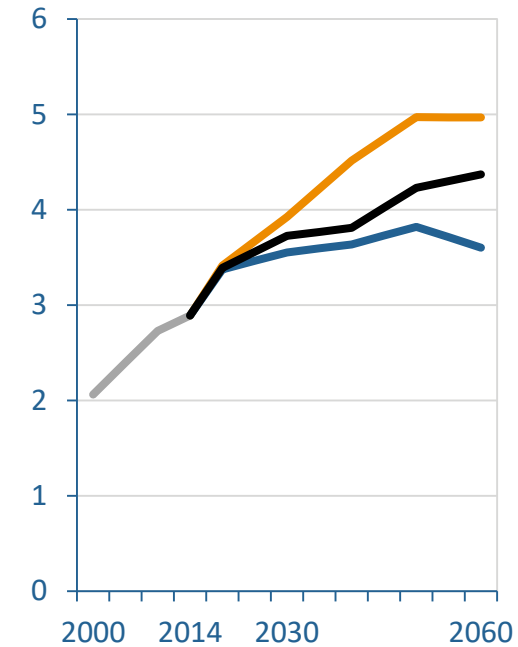
Oil Demand

(mb/d)



Natural Gas Demand

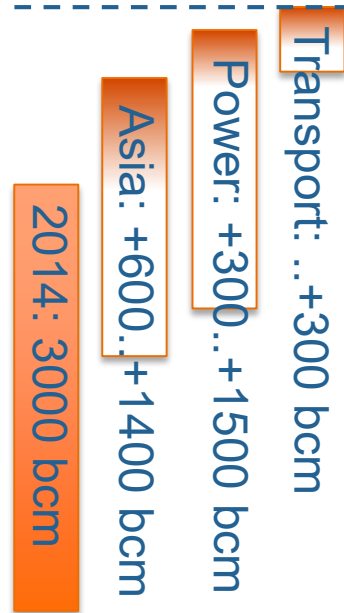
('000 MTOE or kbcm)



— History — Modern Jazz — Unfinished Symphony — Hard Rock

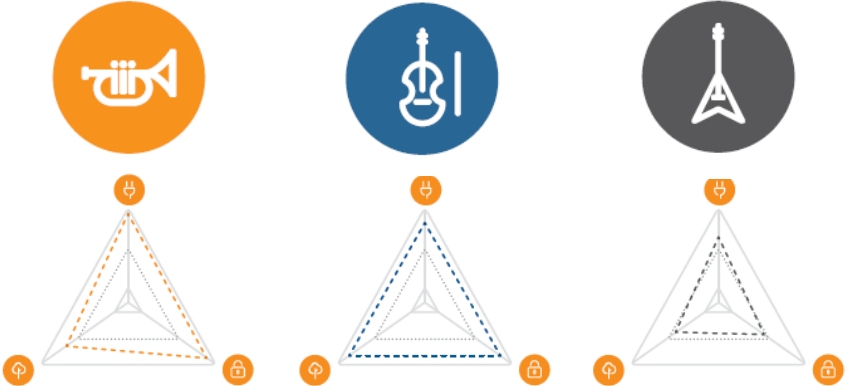
Natural gas: uncertainty in power, shift to Asia, opportunity in transport

By 2060:
+10..70%



- Gas market share in growing power generation is main driver of gas demand growth but with great uncertainty across the scenarios: additional gas demand for power generation between 300 bcm to close to 1,500 bcm
- In 2014, the Asian gas market (710 bcm) accounted for 23% of global gas market. By 2060 we see that volume increase by a factor 2..3, an additional 600 .. 1400 bcm:
- Decarbonisation of the transport sector is one of the most challenging issues of energy transition. Gas contribution is limited and mostly for heavy-duty freight and marine transport, with a potential market share of around 7%-8% of transport fuels by 2060 (up to 300 bcm).

ENERGY TRILEMMA IN 2060



	Modern Jazz	Unfinished Symphony	Hard Rock
Energy Security	<ul style="list-style-type: none"> Higher energy production Greater trading and diversity of international fossil energy suppliers 	<ul style="list-style-type: none"> Wider diversity of energy resource types Government-promoted investment in Infrastructure 	<ul style="list-style-type: none"> More domestic production Lower capacity for funding infrastructure Lower trade
Energy Equity	<ul style="list-style-type: none"> Energy Access for all by 2060 	<ul style="list-style-type: none"> 0-0.5 bn people still lack access to energy 	<ul style="list-style-type: none"> 0.5-1 bn people still lack access to energy
Environmental Sustainability	<ul style="list-style-type: none"> Surpass Carbon budget in early 2040s Emissions fall 28% below 2014 volumes in 2060 	<ul style="list-style-type: none"> Surpass carbon budget in before 2060 Emissions fall 61% below 2014 volumes in 2060 	<ul style="list-style-type: none"> Surpass carbon budget in early 2040s Emissions are 5% above 2014 volumes in 2060