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GRAND TRANSITION, DIGITAL REVOLUTION & NEW ENERGY REALITIES

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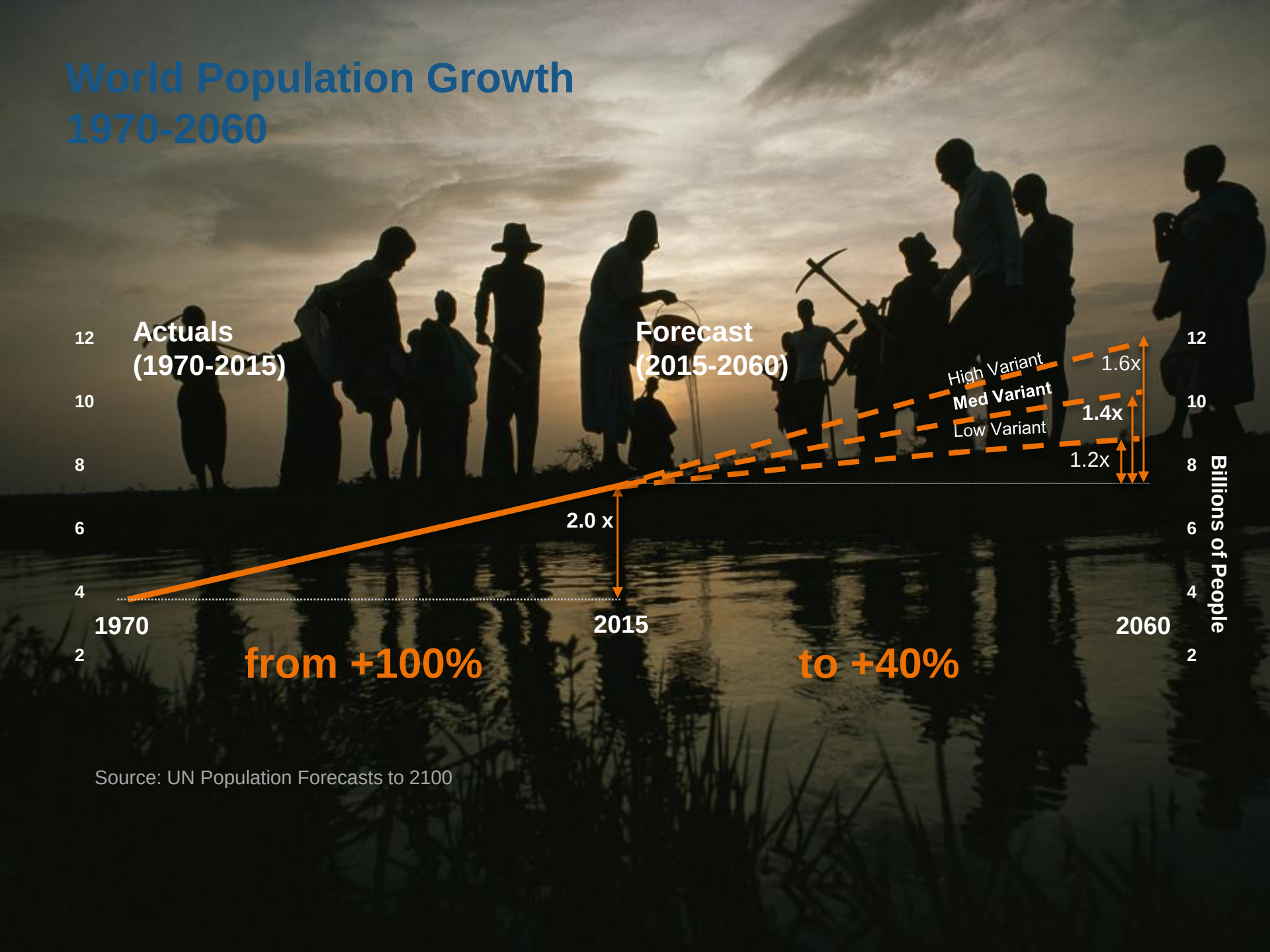
World Population Growth 1970-2060



Source: UN Population Forecasts to 2100

(I) Carbon Intensity Reduction 1970-2015

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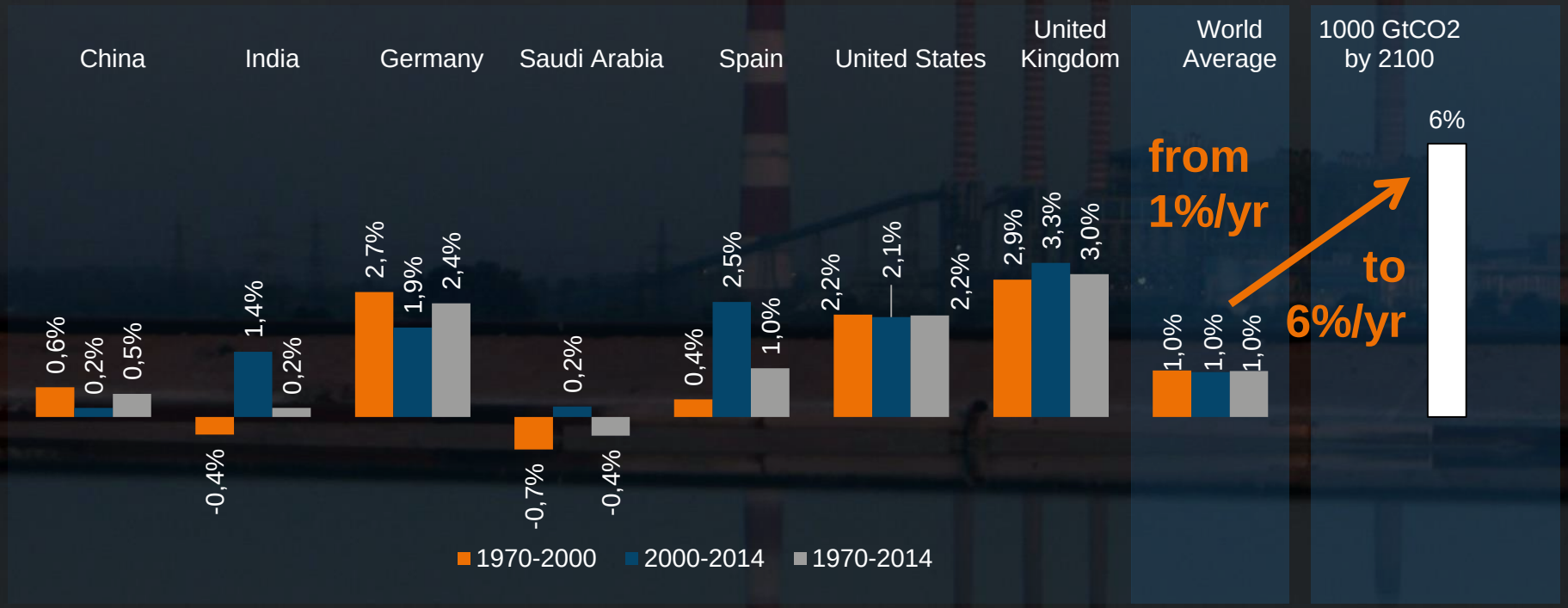
% reduction p.a. 1970-2015 Actuals

2015-2060 de-carbonization required to achieve 1000 $GtCO_2$ by 2100



Source: Total Economy Database, BP (2015) Statistical Review, IPCC (2015) "AR5, Synthesis Report";
Note: Positive % changes denote a reduction in CO_2 emissions [Gt] per GDP [USD]

Note: Assumes global GDP growth of 2.6%

(II) Digitalization & decentralization: Rural household solutions

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(III) New Risks / Resilience
Extreme Weather Events

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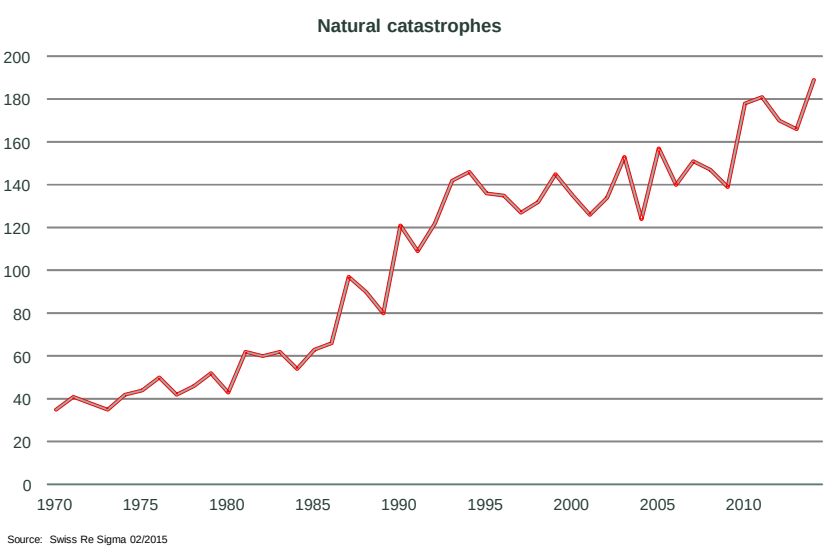
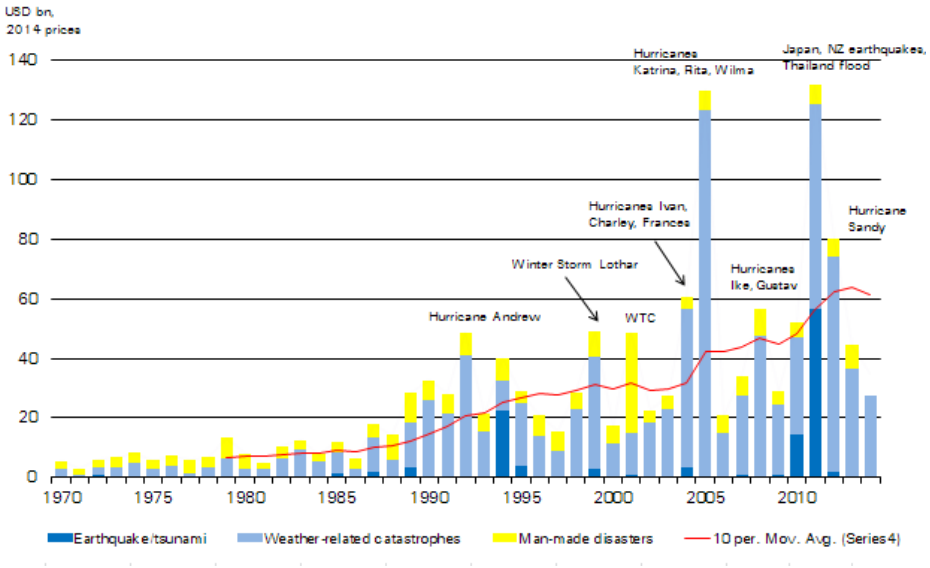
Number of natural catastrophes, 1970-2014: factor 4



Source: Swiss Re Sigma 02/2015

Insured catastrophe losses, 1970-2014



- **Comparing the last 5 years to the last 20 years: The occurrence of extreme events has roughly quadrupled; according to IPCC this is largely related to the 40% increase of carbon dioxide in the atmosphere.**
- **From impact-resistant "hard"/'safe-fail' components to "soft"/'fail-safe' systems.**
- **The solution appears to be 'smarter not stronger'.**

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

(III) New Risks / Resilience
Impacts of El Niño in the LAC Region

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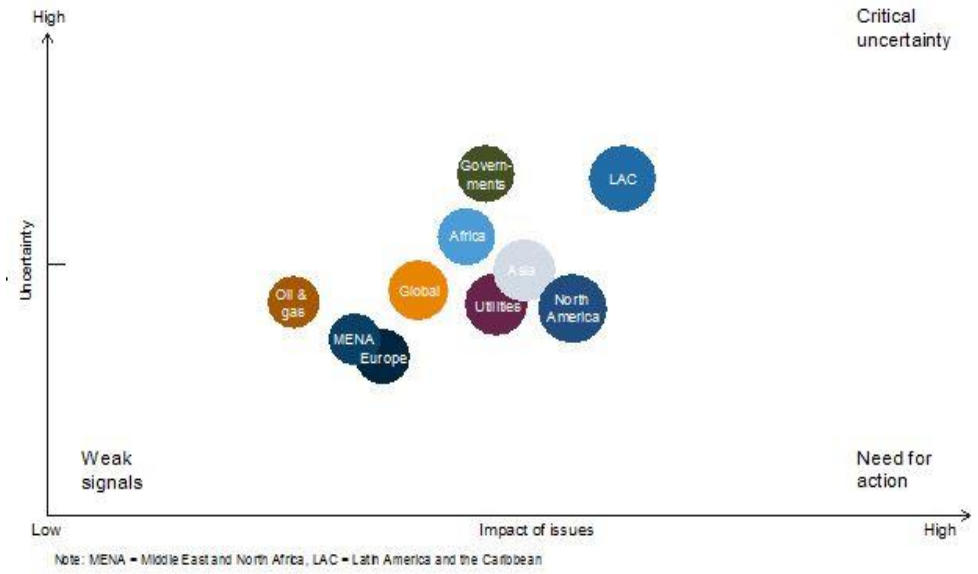
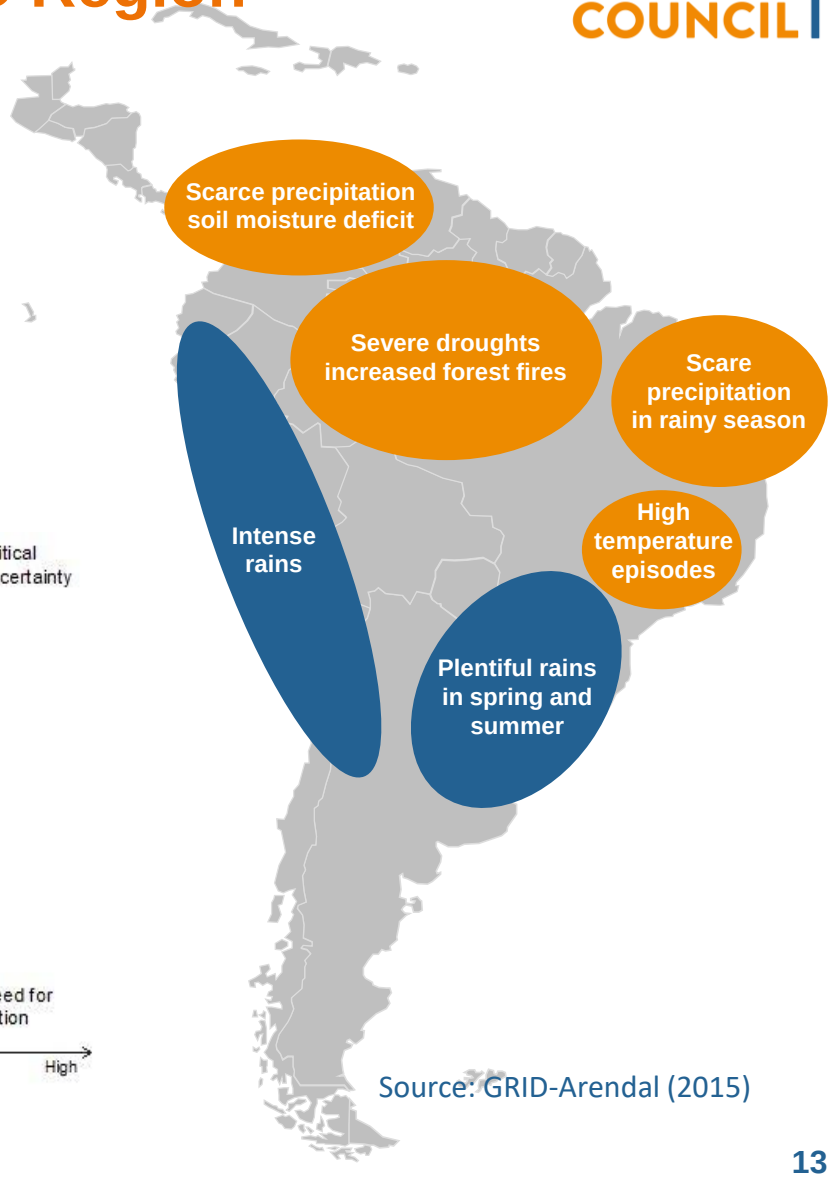
The increased frequency and severity of extreme weather events is a key issue for energy leaders around the world and particularly in the LAC region, as noted by *World Energy Issues Monitor*



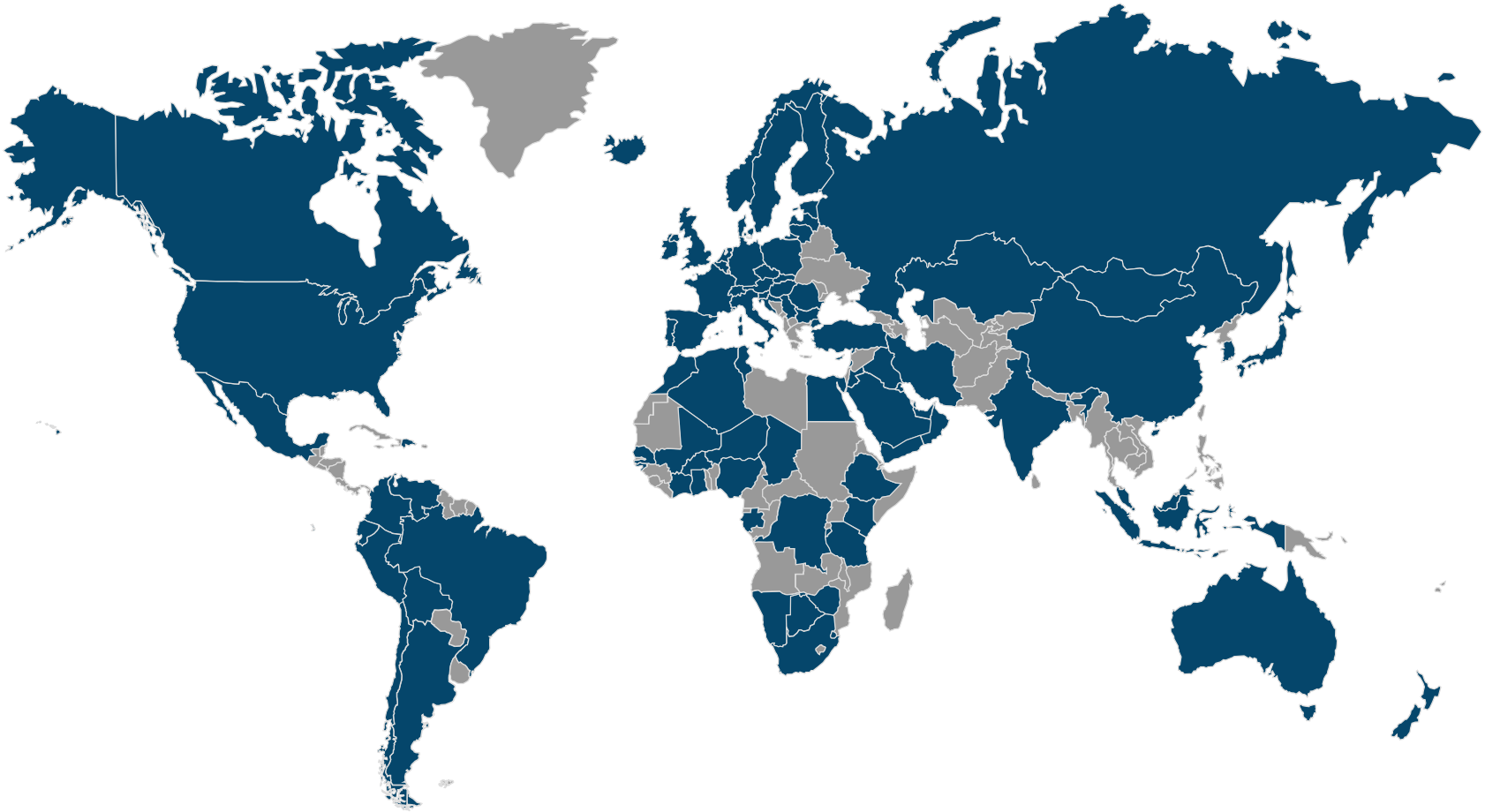


Source: GRID-Arendal (2015)

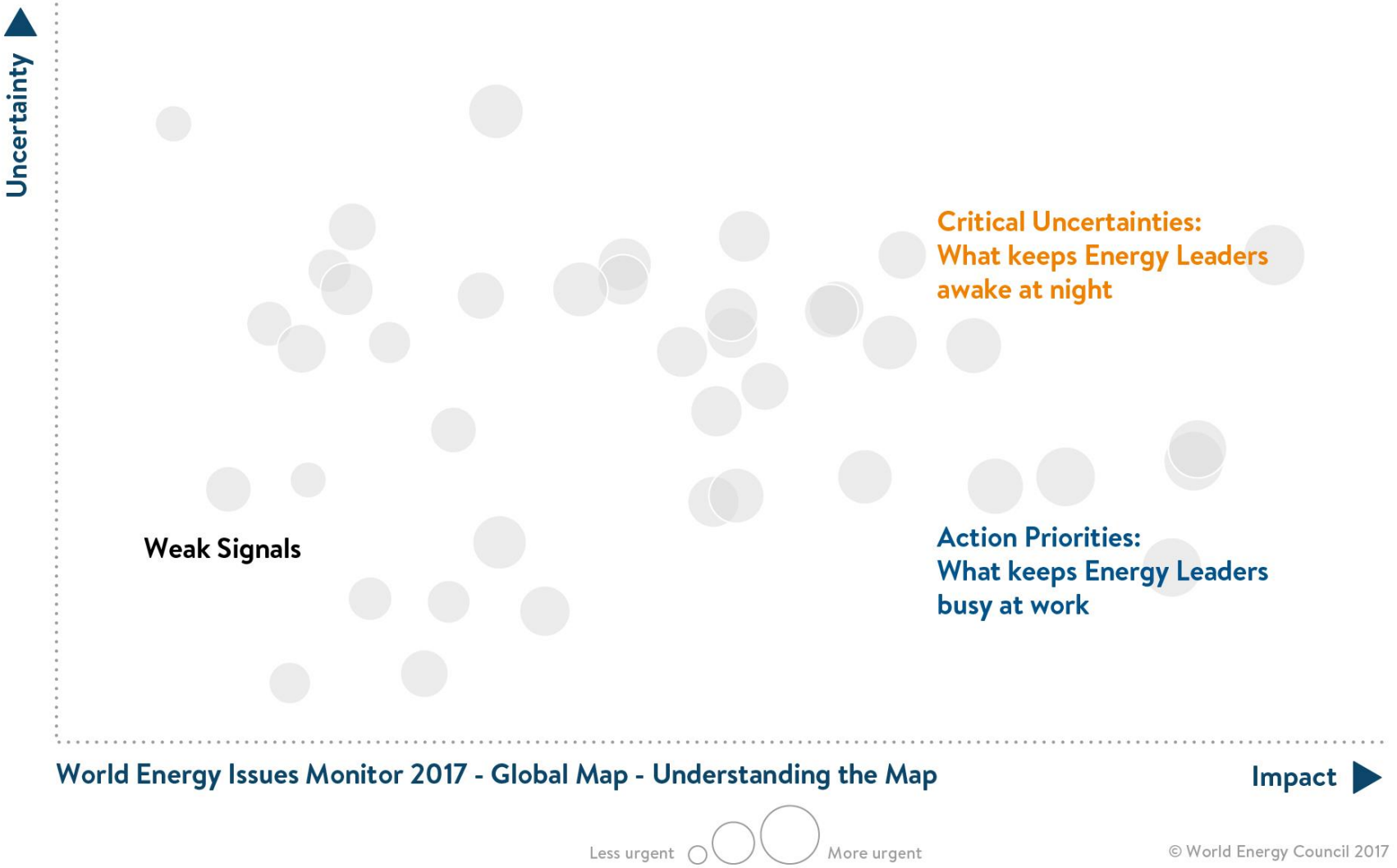
(III) New Risks / Resilience

(III) New Risks / Resilience

Issues Monitor 2017
Responses in 95 countries



Understanding the Monitor



Economic Growth - Reduced Uncertainty

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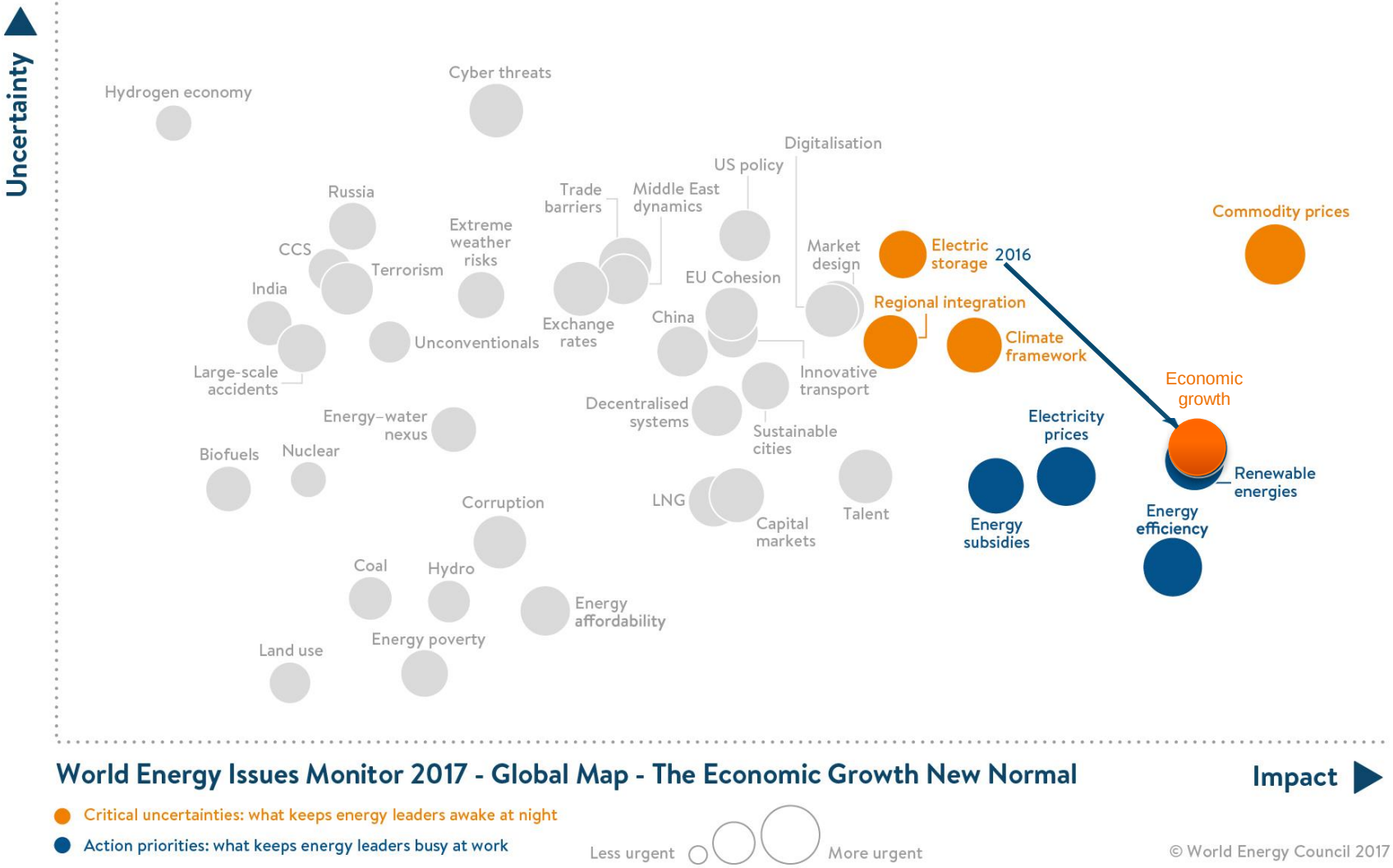

The Innovation Cluster Continues to Move Up on the Agenda

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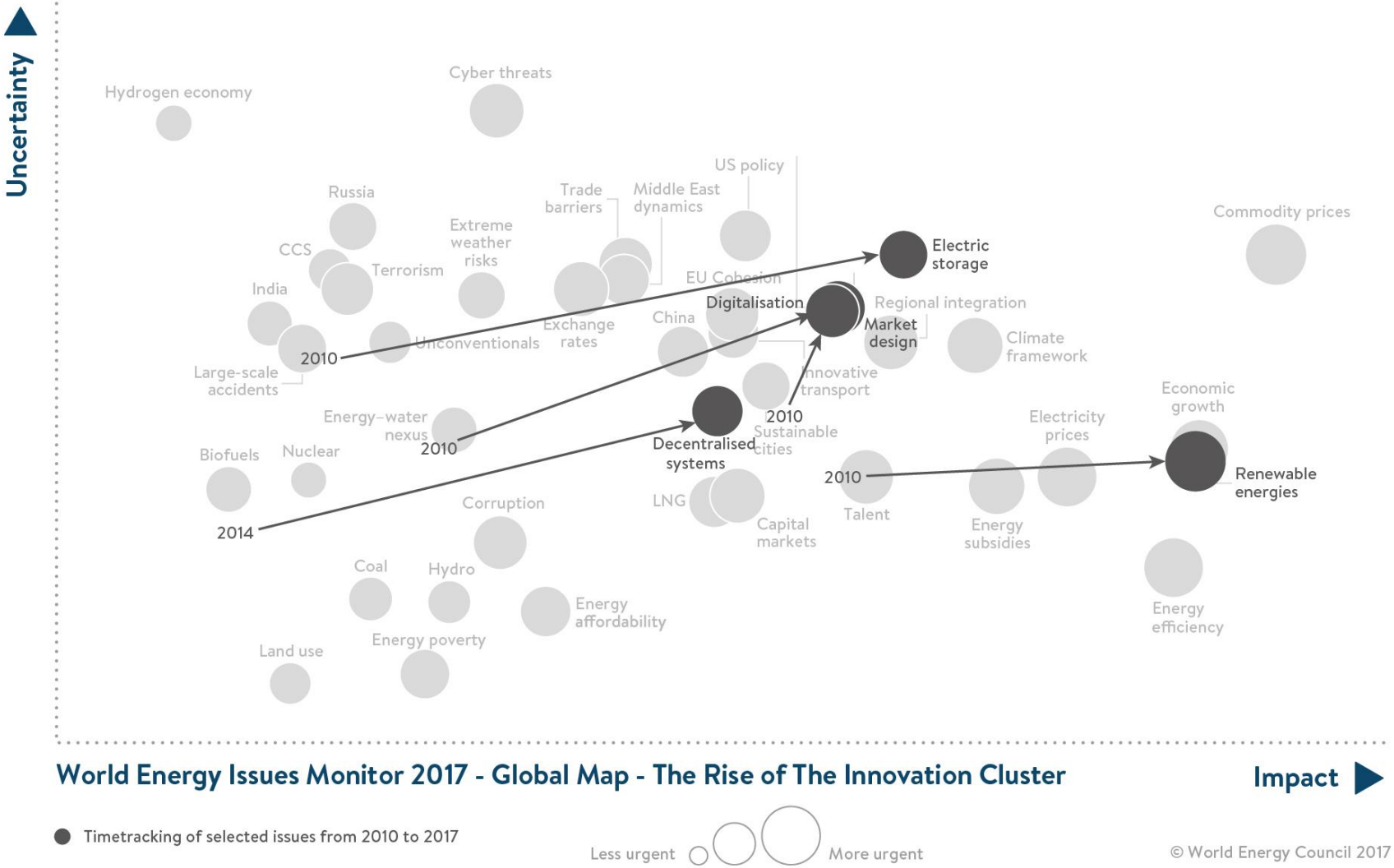

Key Issues Cooling Down

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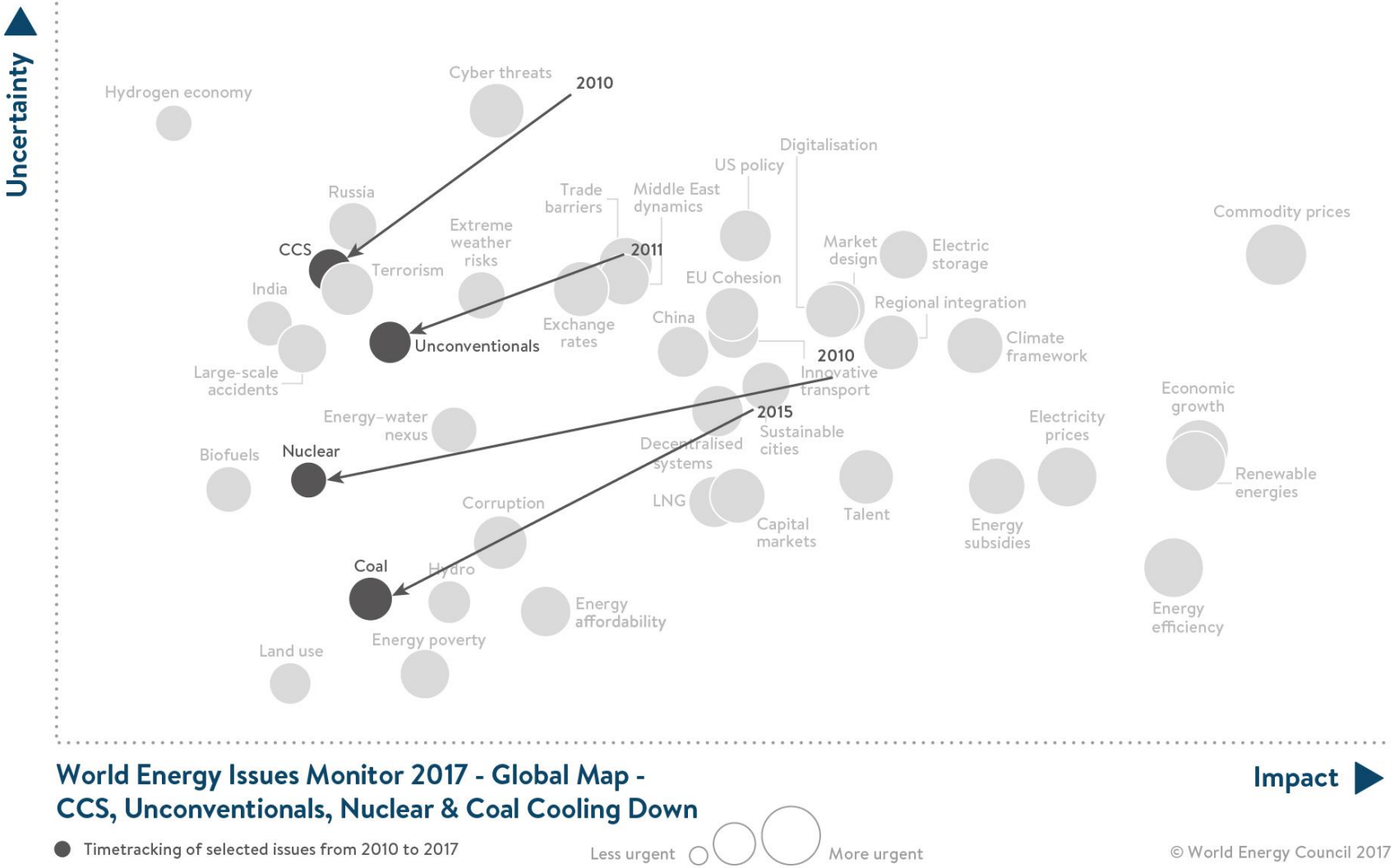

World Energy Issues Monitor 2017 - Global Map - CCS, Unconventionals, Nuclear & Coal Cooling Down

● Timetracking of selected issues from 2010 to 2017

Less urgent — More urgent

LAC Issues Monitor 2017

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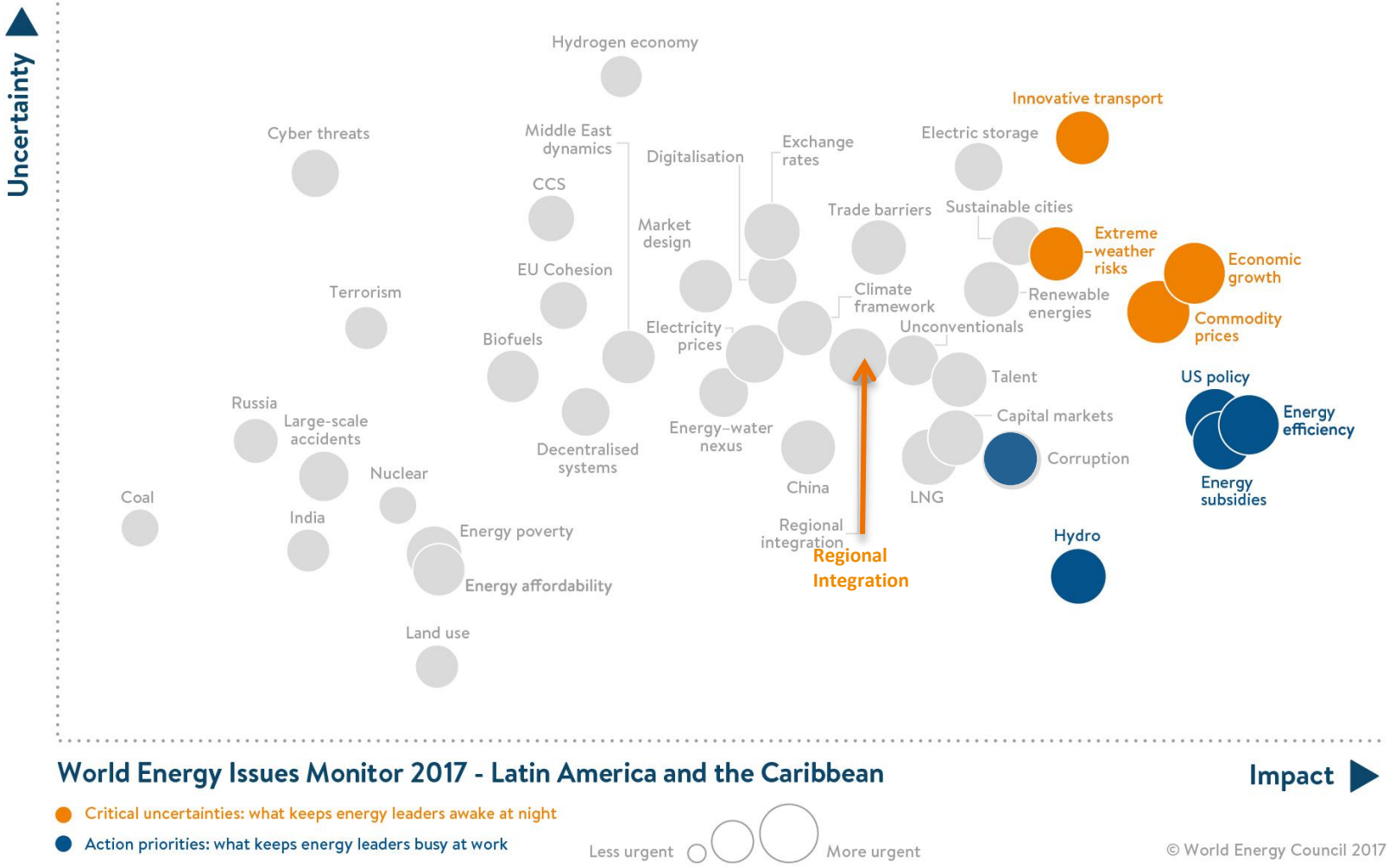

Energy Subsidies in LAC – a key priority

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The energy subsidy (pre-tax) projected for the year 2015 in the LAC region

US$ 35 billion*

0.7% of GDP

2.3% of Tax Revenue

World: US$ 333 billion (0.4% of GDP)

Country	% GDP	% Tax Revenue
Venezuela	10.5	46.2
T&T	2.6	9.0
El Salvador	2.0	11.4
Nicaragua	1.9	9.4
Bolivia	1.9	5.8
Argentina	1.6	4.2
Ecuador	1.5	4.4
Panama	0.3	1.7
Guatemala	0.2	2.4
Colombia	0.2	0.8
Paraguay	0.1	0.5
Brazil	0.1	0.2
Chile	0.0	0.0
Peru	0.0	0.0
Uruguay	0.0	0.0

* Mexico is included

Source: IDDRI (2015), IMF (2015)

Three Scenarios

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Modern Jazz

Market-driven approach to achieving individual access and affordability of energy through economic growth

- Market mechanisms
- Technology innovation
- Energy access for all

Unfinished Symphony

Government-driven approach to achieving sustainability through internationally coordinated politics and practices

- Strong policy
- Long-term planning
- Unified climate action

Hard Rock

Fragmented approach driven by desire for energy security in a world with low global cooperation

- Fragmented policies
- Local content
- Best-fit local solutions

World and LAC energy scenarios

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World Energy Scenarios 2016

- Grand Transition
- Three Scenarios

Modern Jazz

Unfinished Symphony

Hard Rock

"Launched at the Istanbul Congress"

LAC Energy Scenarios 2017

Samba

Tango

Rock

"Launched in Lima"

Three possible futures for energy in LAC

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Samba

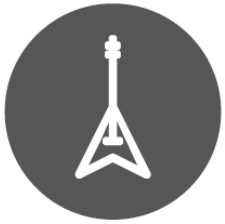
LAC shaped by successful reform and strong innovation and high productivity with market forces

- **Economic diversification beyond commodity exports**
- **Energy affordability for all**

Tango

LAC shaped by governments to achieve sustainable growth and resilient energy system

- **Strong regional integration**
- **Enforcement of tough rules and regulations**
- **High investment: adaptation and mitigation projects**



Rock

LAC shaped by weak economic growth and waning support for global and regional institutions

- **Policies inwardly focused and reform process delayed**
- **Weak infrastructure invest**

1 The world's primary energy demand growth will slow and peak

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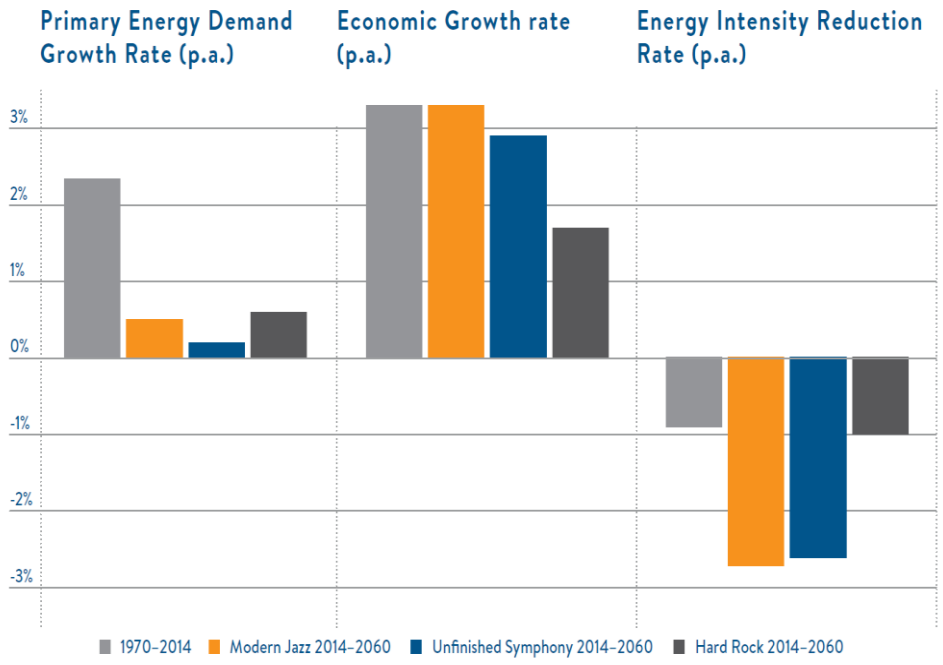
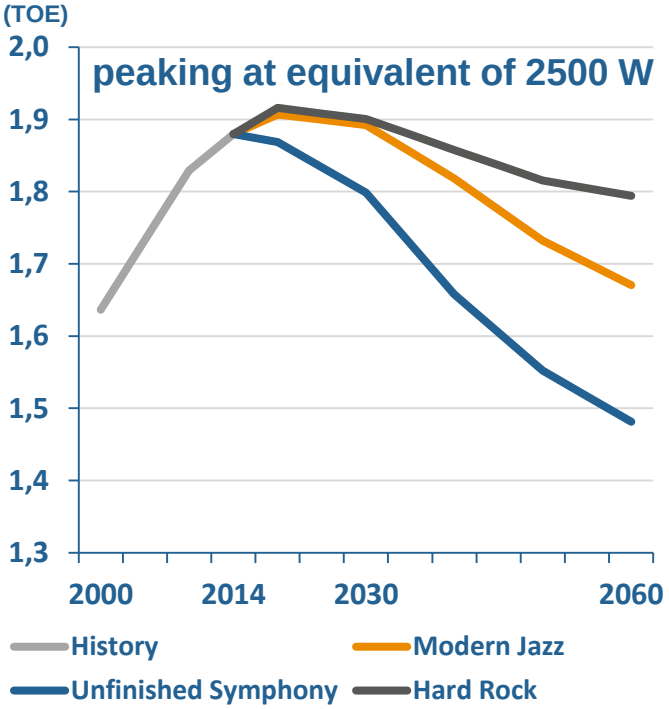
… per capita energy demand will peak before 2030 due to unprecedented efficiencies created by new technologies and more stringent energy policies.

Slower Primary Energy Demand Growth



Per Capita Primary Energy Demand



2 Global demand for electricity will double, in LAC rise by factor 2.3-2.7

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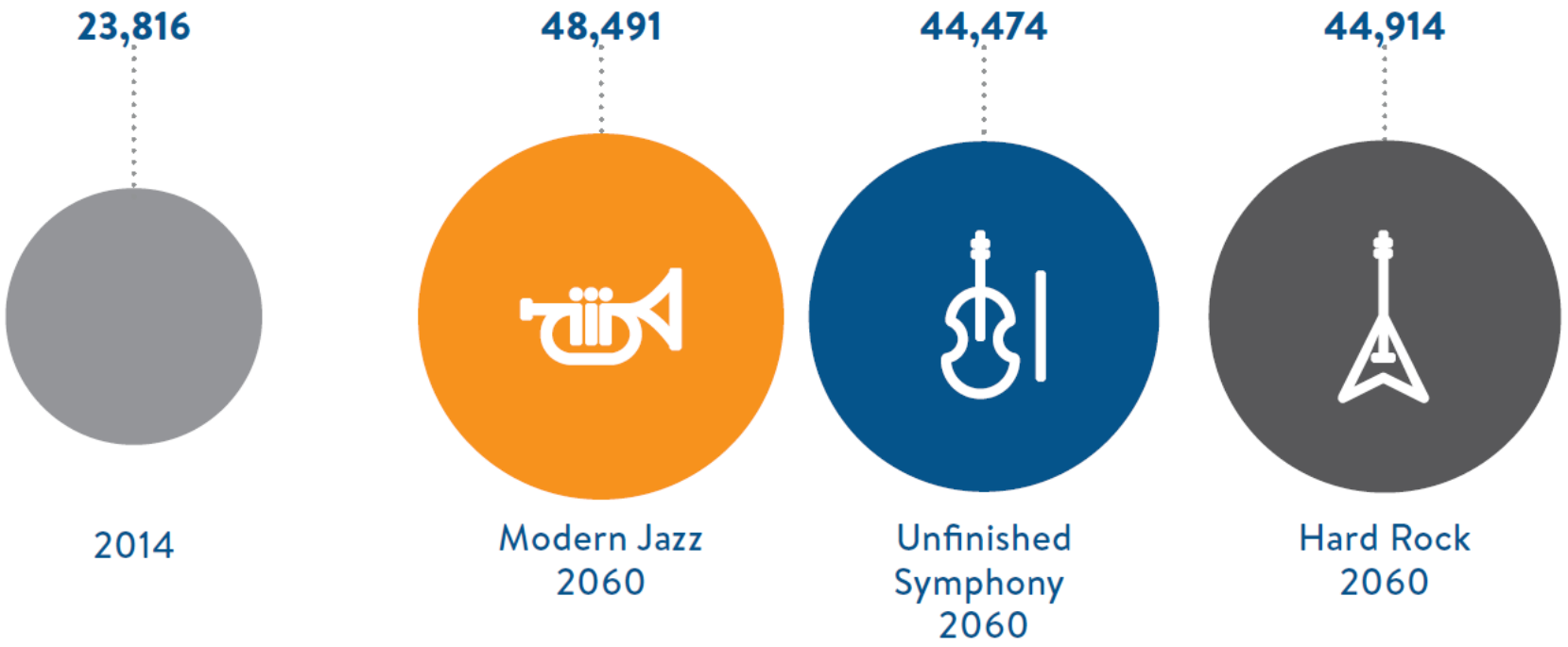
… by 2060. Meeting this demand with cleaner energy sources will require substantial infrastructure investments and systems integration to deliver benefits to all consumers.

Electricity Generation

(TWh)



3 The phenomenal rise of solar and wind energy will continue

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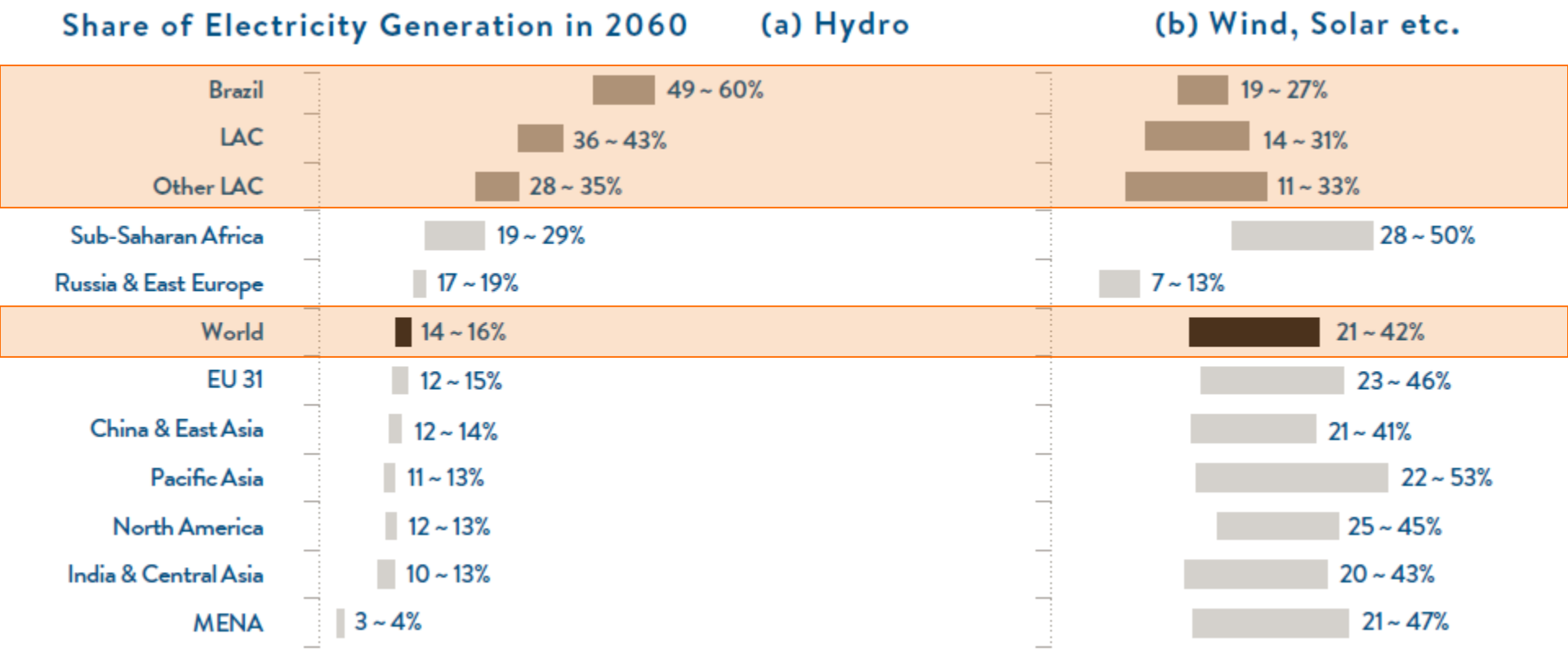
RENEWABLES SHARES IN ELECTRICTY GENERATION BY 2060



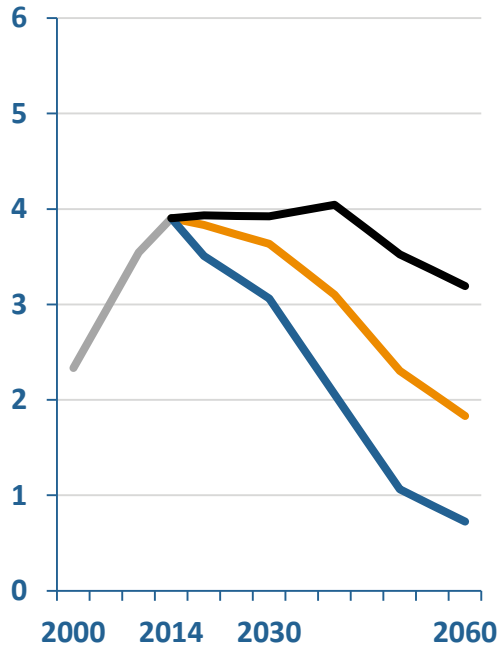
Solar and wind energy account for only 4% of power generation in 2014, but by 2060 it will account for 21% to 42% of power generation

4 Demand peaks for coal and oil

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

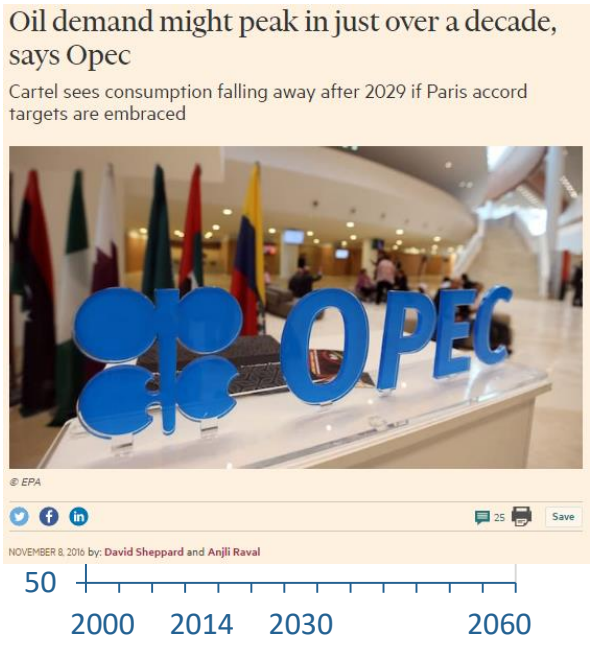
Coal Demand

(‘000 MTOE)



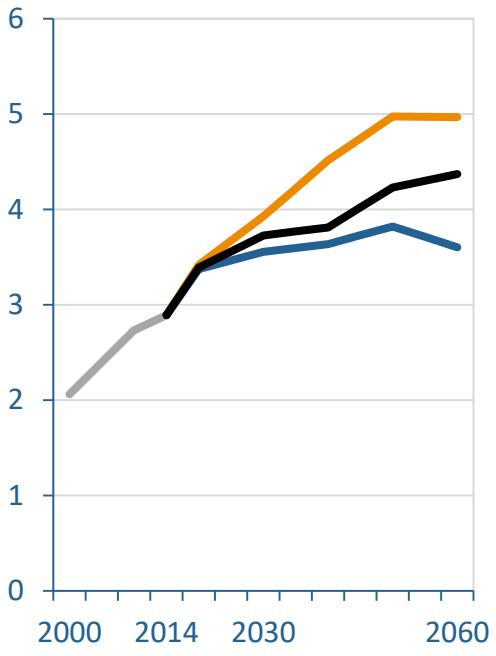
Oil Demand

(mb/d)



Natural Gas Demand

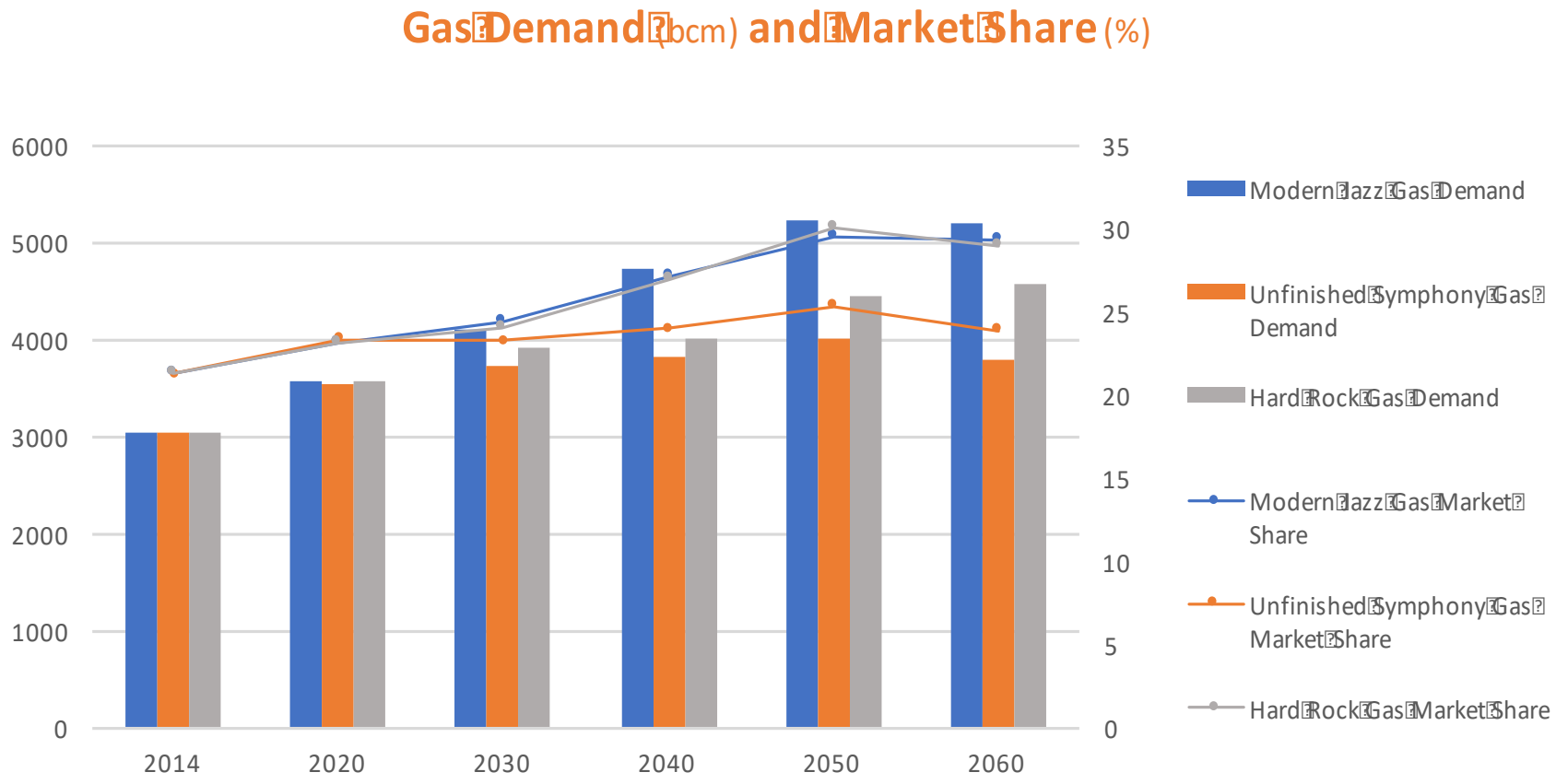
(‘000 MTOE)



History | Modern Jazz | Unfinished Symphony | Hard Rock

4 Natural gas: holds essential place in the global energy mix

- A market share between 25% and 30% of global demand
- Benefiting from an increasing global energy demand in all scenarios
- The only fossil energy retaining a significant place



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

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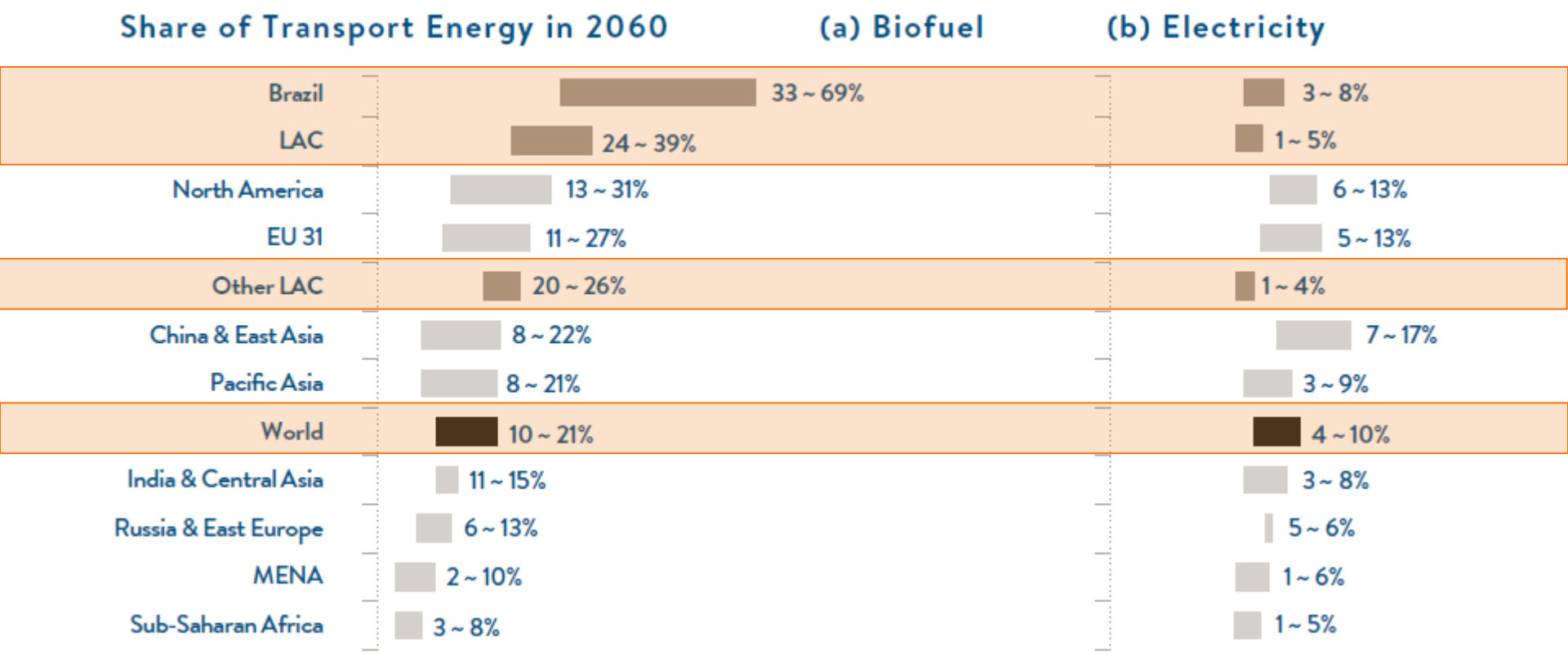
- Gas **market share in power generation is main driver of gas demand growth but with great uncertainty** across the scenarios: By 2060, this could decrease from **22%** (2014) to **17%** in Unfinished Symphony or increase to **26%** in Hard Rock and **32%** In Modern Jazz and corresponds to additional gas demand for power generation between **300 bcm** in Unfinished Symphony to close to **1,500 bcm** in Modern Jazz.

- 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**: **3** in Modern Jazz (2,164 bcm), **2.2** in Unfinished Symphony (1,540 bcm), **1.9** in Hard Rock (1,384 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).

5 Transport – biofuels & electricity shares in transport energy by 2060



6 Limiting global warming

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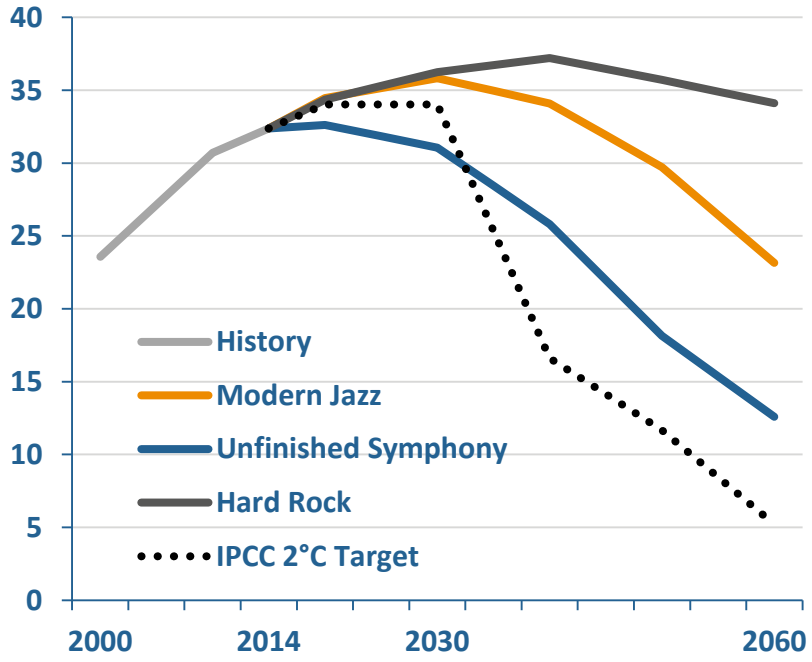
… to no more than a 2°C increase will require an exceptional and enduring effort, far beyond already pledged commitments and with very high carbon prices.

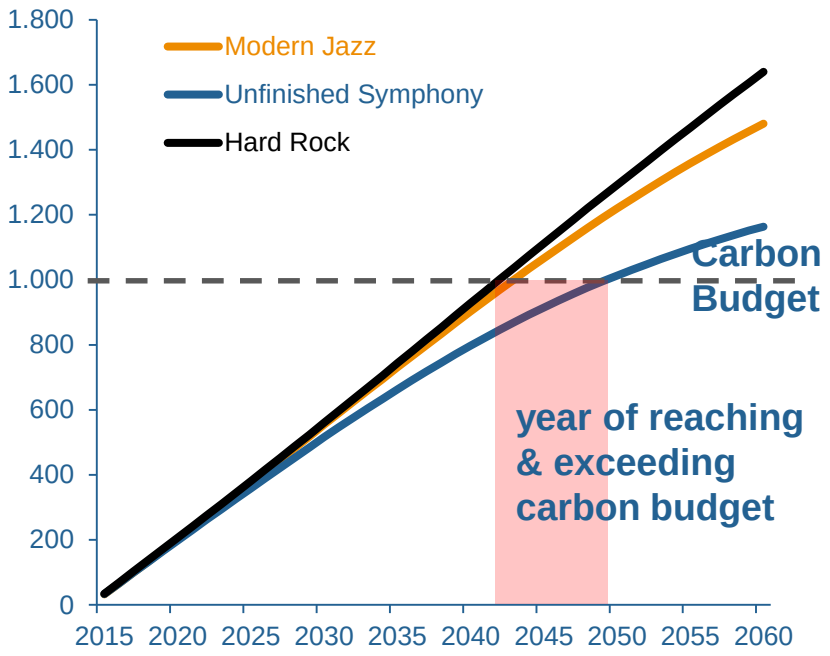
Annual Carbon Emissions

(Gt CO_2)



Cumulative Carbon Emissions 2015-2060

(Gt CO_2)



Balancing the ‘Energy Trilemma’

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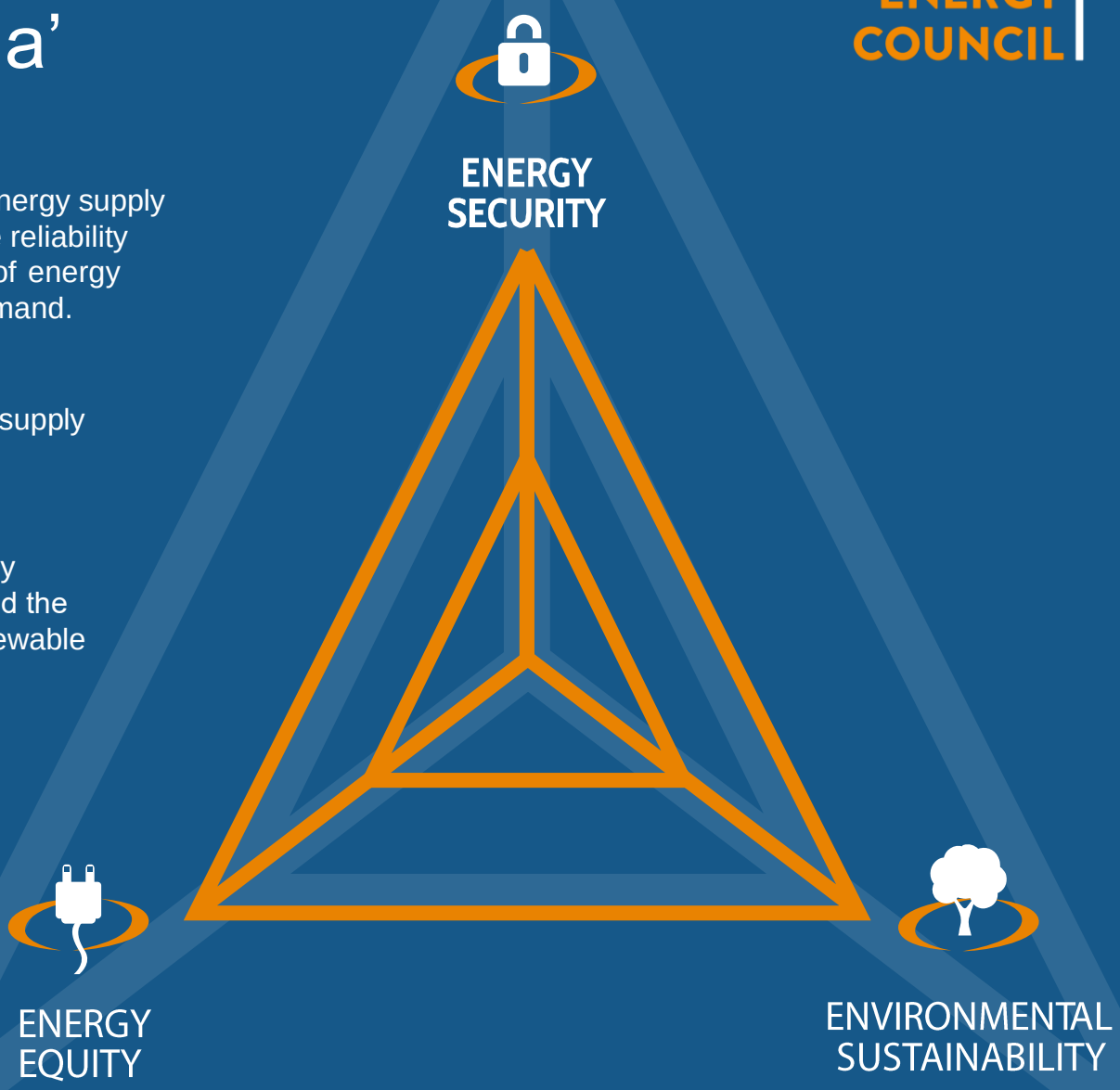
Energy Security
The effective management of primary energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of energy providers to meet current and future demand.

Energy Equity
Accessibility and affordability of energy supply across the population.

Environmental Sustainability
Encompasses the achievement of supply and demand side energy efficiencies and the development of energy supply from renewable and other low-carbon sources.



7 ENERGY TRILEMMA IN 2060

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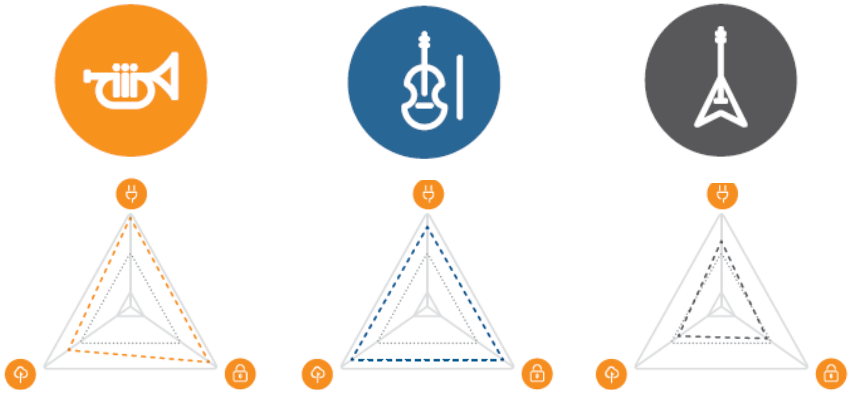
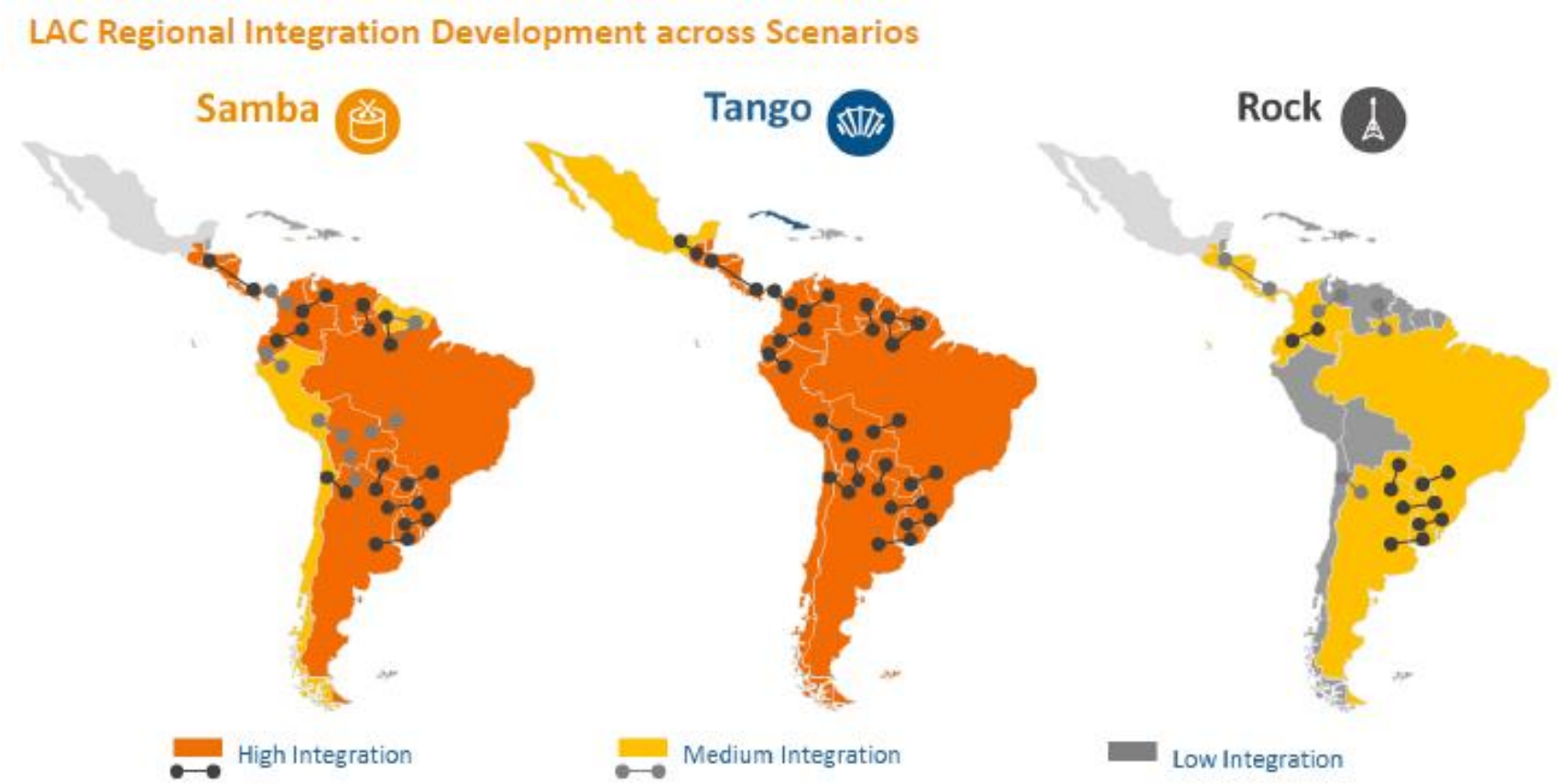


	Modern Jazz	Unfinished Symphony	Hard Rock
Energy Security	• Higher energy production • Greater trading and diversity of international fossil energy suppliers	• Wider diversity of energy resource types • Government-promoted investment in Infrastructure	• More domestic production • Lower capacity for funding infrastructure • Lower trade
Energy Equity	• Energy Access for all by 2060	• 0 – 0.5 bn people still lack access to energy	• 0.5 – 1 bn people still lack access to energy
Environmental Sustainability	• Surpass Carbon budget in early 2040s • Emissions fall 28% below 2014 volumes in 2060	• Surpass carbon budget in before 2060 • Emissions fall 61% below 2014 volumes in 2060	• Surpass carbon budget in early 2040s • Emissions are 5% above 2014 volumes in 2060

Regional integration across the scenarios

Regional integration in LAC can be shaped by the presence of strong regional governance structures



Call to action for LAC energy leaders

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GOVERNMENT POLICY DIRECTIONS

- Need for large-scale investments in energy infrastructure
- Substantial scope for regional integration
- Importance of government leadership

FOCUS OF ENERGY OPPORTUNITIES

- Critical role of cities
- New opportunities for wind, solar and geothermal

CLIMATE-RELATED POLICIES

- Climate change is a key regional concern
- The region as an important proponent of international climate action accords

MACRO-RISK MANAGEMENT

- Beware of “stranded resources” in the region
- Avoid the heavy costs of a Rock scenario

World Energy Trilemma 2016

China

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TRILEMMA INDEX RANKINGS AND BALANCE SCORE

RANK

87

SCORE

BBD

	2014	2015	2016	Trend	Score
Overall rank and balance score	**87**	**87**	**87**	▶	**BBD**
Energy performance					
Energy security	83	70	62	▶	B
Energy equity	77	77	77	▶	B
Environmental sustainability	119	116	117	▶	D
Contextual performance	62	63	62	▶	

World Energy Trilemma 2016

Germany

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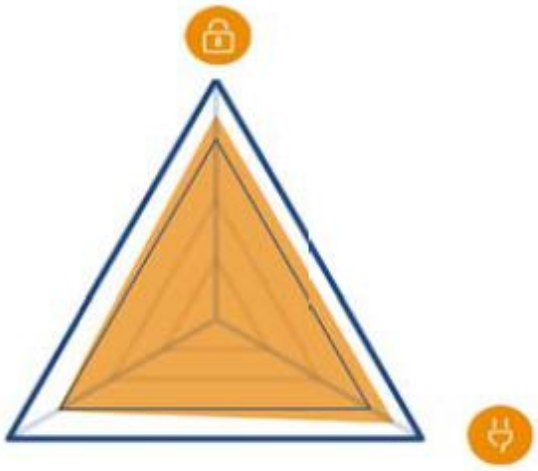
TRILEMMA INDEX RANKINGS AND BALANCE SCORE

RANK

5

SCORE

AAA



	2014	2015	2016	Trend	Score
Overall rank and balance score	4	5	5	▶	AAA
Energy performance					
Energy security	6	6	7	▶	A
Energy equity	20	22	15	▶	A
Environmental sustainability	24	29	31	▶	A
Contextual performance	14	16	15	▶	

World Energy Trilemma 2016

Bolivia

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TRILEMMA INDEX RANKINGS AND BALANCE SCORE

RANK

100

SCORE

CCD

	2014	2015	2016	Trend	Score
Overall rank and balance score	**100**	**98**	**100**	▶	**CCD**
Energy performance					
Energy security	69	65	73	▶	C
Energy equity	97	97	97	▶	C
Environmental sustainability	108	106	107	▶	D
Contextual performance	96	102	110	▼	

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Energy realities are shifting.
Faster than ever.

Innovate or die.

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