Maailma Energeetikanõukogu

Uuringud ja tegevus

Mihkel Härm
Peasekretär
Maailma Energeetikanõukogu ERK

Eesti Teaduste Akadeemia
Kohtu 6, Tallinn

18.11.2015

Ettekande sisu

- Maailma Energeetikanõukogu
- World Energy Trilemma
- World Energy Scenarios
- Arutelu

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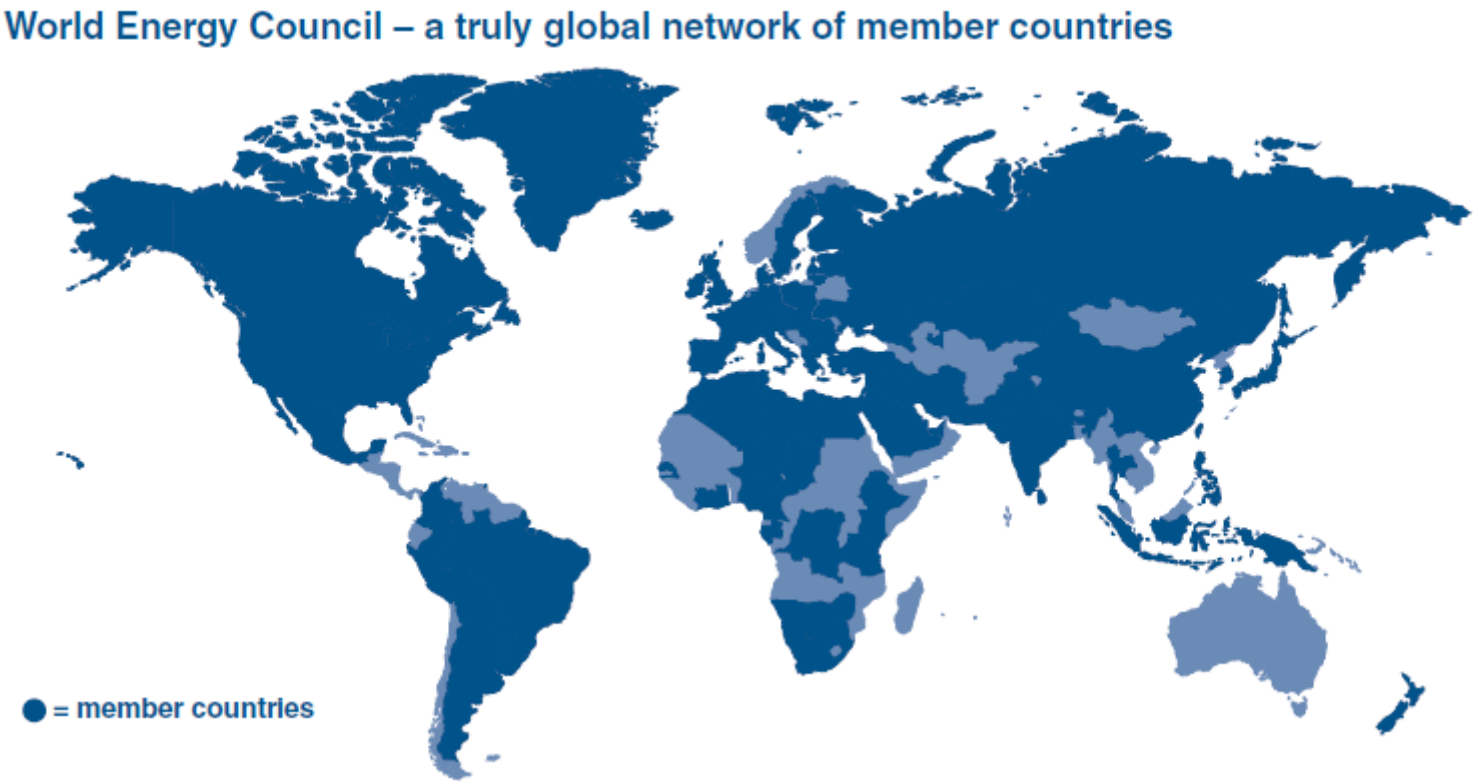
Maailma Energeetikanõukogu



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Eesti liikmelisus taastati 1998. aastal.

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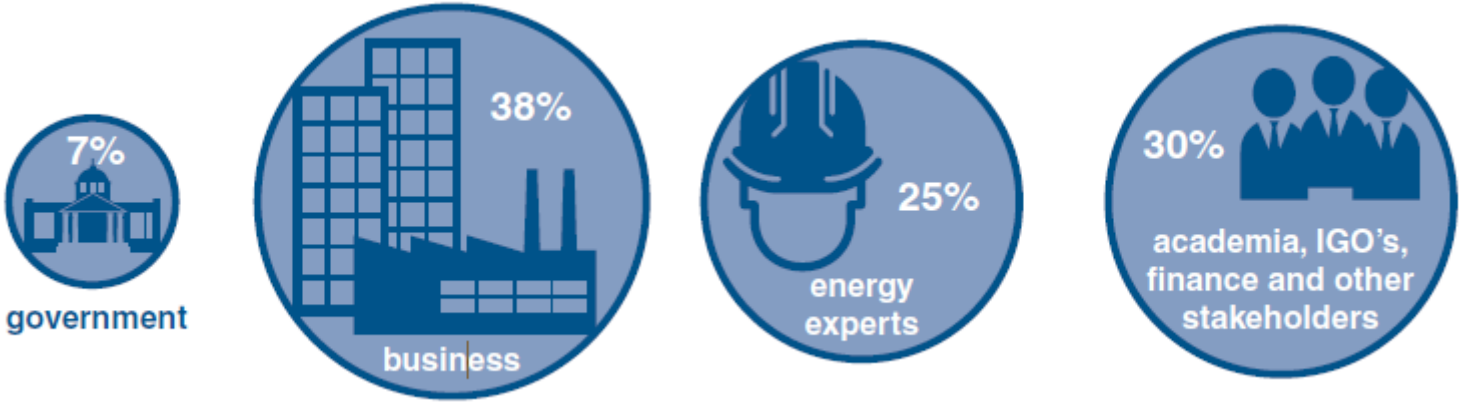
Maailma Energeetikanõukogu



Eesti rahvuskomitee liikmed (seisuga 18.11.2015)

- **Teaduste Akadeemia**
- Tallinna Tehnikaülikool
- MKM
- Keskkonnaministeerium
- Eesti Energia
- Eesti Elektritööstuseliit
- Eesti Gaas
- Eesti Gaasiliit

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Maailma Energeetikanõukogu – inimesed

Peakontor

- President Marie-José Nadeau
- Peasekretär Christoph Frei

Eesti rahvuskomitee

- Juhatuse esimees Margus Vals
- Peasekretär Mihkel Härm

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Maailma Energeetikanõukogu tegevus

- Peamised uuringud
  - World Energy Trilemma *Eesti osaleb.*
  - World Energy Resources *Eesti osaleb.*
  - World Energy Scenarios *Eesti osaleb.*
  - World Energy Issues Monitor *Eesti kohta on eraldi raport.*

- Üritused
  - World Energy Congress
  - Peaassamblee (Eestis toimus aastal 2006)
  - Regionaalsed üritused, sh 2015 Eestis toimunud Baltic Sea Roundtable.
  - Riiklikud üritused, sh erinevad konverentsid ja seminarid Eestis.

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World Energy Congress – a truly global event

WORLD ENERGY COUNCIL
CONSEIL MONDIAL DE L'ÉNERGIE
For sustainable energy.

WORLD ENERGY TRILEMMA

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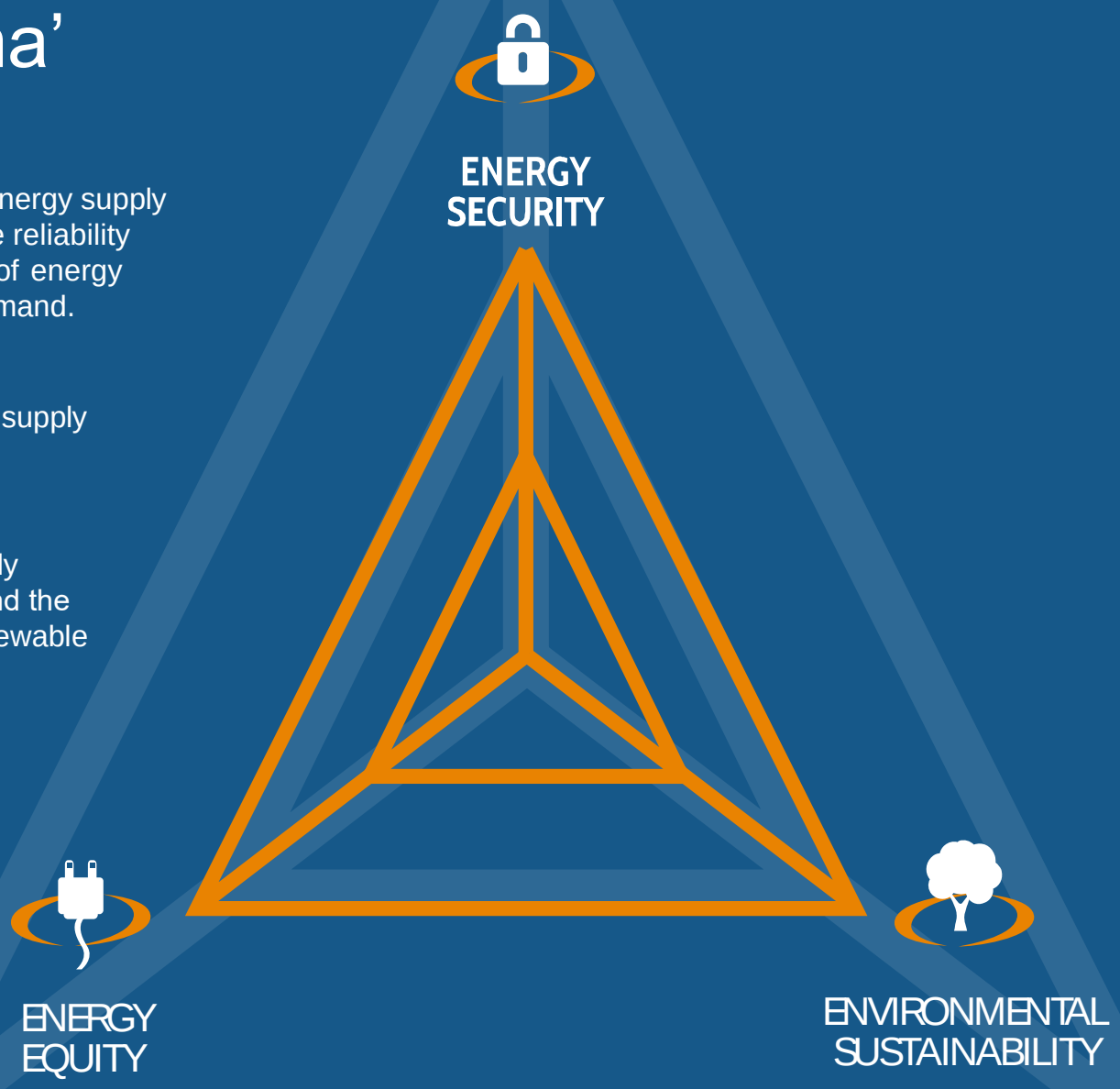
Balancing the ‘Energy Trilemma’

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.



Total score	Indicator type	Dimension	Indicators	
Country performance 100%	1. Energy performance 75%	1.1 Energy Security 25%	1.1.1 Ratio of total energy production to consumption 1.1.2 Diversity of electricity generation 1.1.3 Distribution losses as a percentage of generation 1.1.4 Five year CAGR of the ratio of TPEC to GDP 1.1.5 Days of oil and oil product stocks 1.1.6a For importers – Net fuel imports as a percentage of GDP 1.1.6b For exporters – Fuel exports as a percentage of GDP	1/6 Each
		1.2 Energy equity 25%	1.2.1 Affordability of retail gasoline 1.2.2 Affordability and quality of electricity relative to access	1/2 Each
		1.3 Environmental sustainability 25%	1.3.1 Total primary energy intensity 1.3.2 CO_2 intensity 1.3.3 Effect of air and water pollution 1.3.4 CO_2 grams/kWh from electricity generation	1/4 Each
	2. Contextual performance 25%	2.1 Political strength 8.3%	2.1.1 Political stability 2.1.2 Regulatory quality 2.1.3 Effectiveness of government	1/3 Each
		2.2 Societal strength 8.3%	2.2.1 Control of corruption 2.2.2 Rule of law 2.2.3 Quality of education 2.3.4 Quality of health	1/4 Each
		2.3 Economic strength 8.3%	2.3.1 Cost of living expenditure 2.3.2 Macroeconomic stability 2.3.3 Availability of credit to the private sector	1/3 Each

Enhanced methodology for 2013

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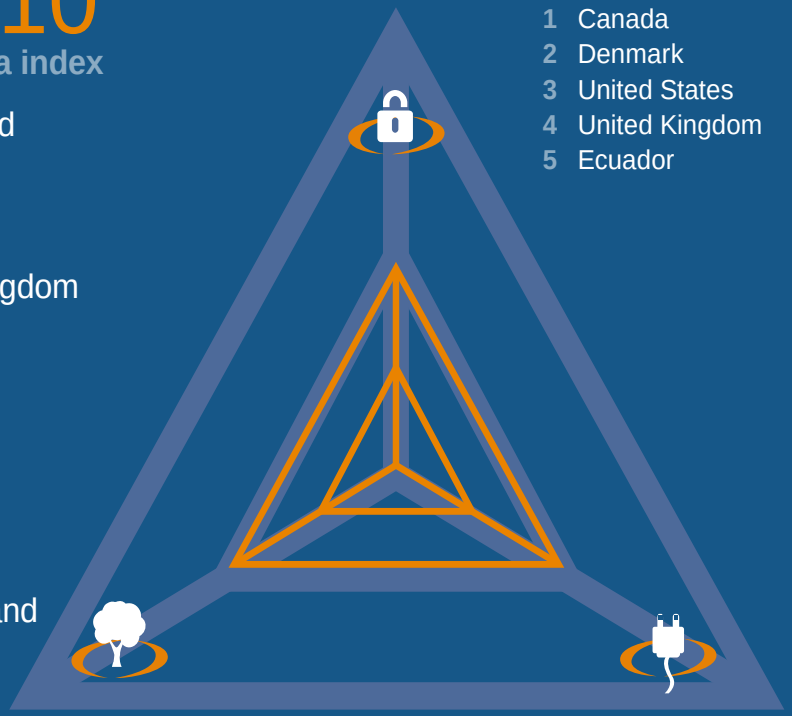
TOP 10

2015 Trilemma index

1. Switzerland
2. Sweden
3. Norway
4. United Kingdom
5. Austria
6. Denmark
7. Canada
8. France
9. Finland
10. New Zealand



Energy Security

1. Canada
2. Denmark
3. United States
4. United Kingdom
5. Ecuador
6. Australia
7. Nigeria
8. Gabon
9. Argentina
10. Switzerland

Environmental Sustainability

1. Switzerland
2. Costa Rica
3. Colombia
4. Uruguay
5. Albania
6. Norway
7. Paraguay
8. Mauritius
9. Sweden
10. Gabon

Energy Equity

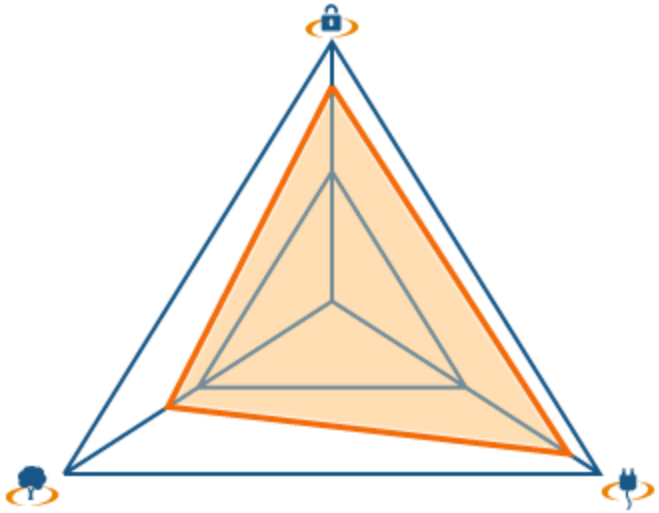
1. United States
2. Canada
3. Luxembourg
4. Qatar
5. Switzerland
6. United Arab Emirates
7. Saudi Arabia
8. Hong Kong, China
9. Austria
10. Oman

Finland

BALANCE SCORE
AAB

INDEX RANK
09

ENERGY TRILEMMA BALANCE



Download graph | Download CSV

ENERGY TRILEMMA INDEX RANKINGS AND BALANCE SCORE

	2013	2014	2015	TREND	SCORE
ENERGY PERFORMANCE	17	10	11	→	
Energy Security	37	26	23	→	A
Energy Equity	21	16	16	→	A
Environmental Sustainability	45	37	51	↓	B
CONTEXTUAL PERFORMANCE	6	7	11	→	
Political Strength	2	2	2	→	
Societal Strength	1	3	3	→	
Economic Strength	34	20	27	→	
OVERALL RANK	13	8	9	→	AAB

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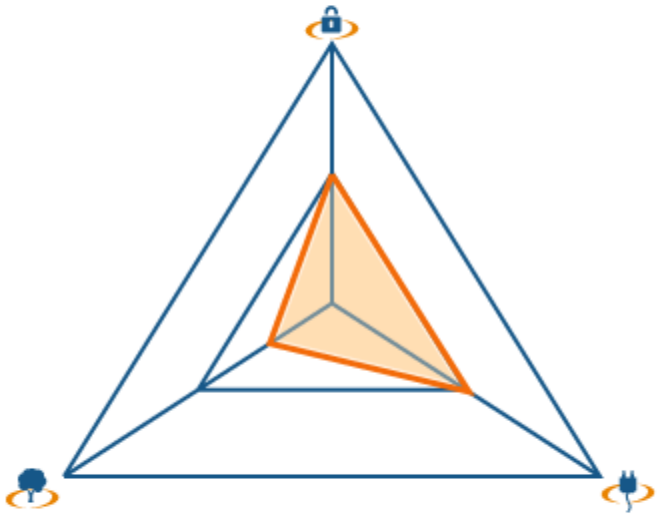
Estonia

BALANCE SCORE
BCD

INDEX RANK
59

ENERGY TRILEMMA BALANCE



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ENERGY TRILEMMA INDEX RANKINGS AND BALANCE SCORE

	2013	2014	2015	TREND	SCORE
ENERGY PERFORMANCE	82	93	85	→	
Energy Security	65	71	66	→	C
Energy Equity	51	68	64	↓	B
Environmental Sustainability	117	115	100	↑	D
CONTEXTUAL PERFORMANCE	25	21	21	→	
Political Strength	26	30	27	→	
Societal Strength	30	30	27	→	
Economic Strength	35	22	25	→	
OVERALL RANK	68	75	59	→	BCD

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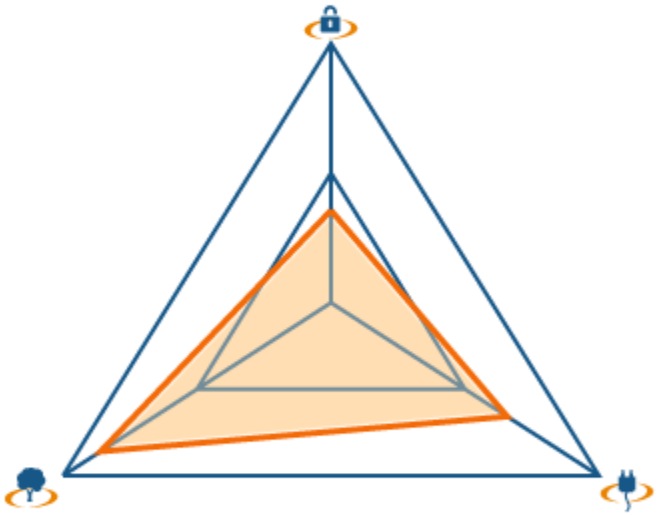
Latvia

BALANCE SCORE
ABC

INDEX RANK
39

ENERGY TRILEMMA BALANCE



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ENERGY TRILEMMA INDEX RANKINGS AND BALANCE SCORE

	2013	2014	2015	TREND	SCORE
ENERGY PERFORMANCE	51	51	34	→	
Energy Security	98	96	84	→	C
Energy Equity	54	59	45	↑	B
Environmental Sustainability	14	14	19	→	A
CONTEXTUAL PERFORMANCE	43	40	39	→	
Political Strength	41	39	36	→	
Societal Strength	42	43	42	→	
Economic Strength	62	52	53	→	
OVERALL RANK	43	43	39	→	ABC

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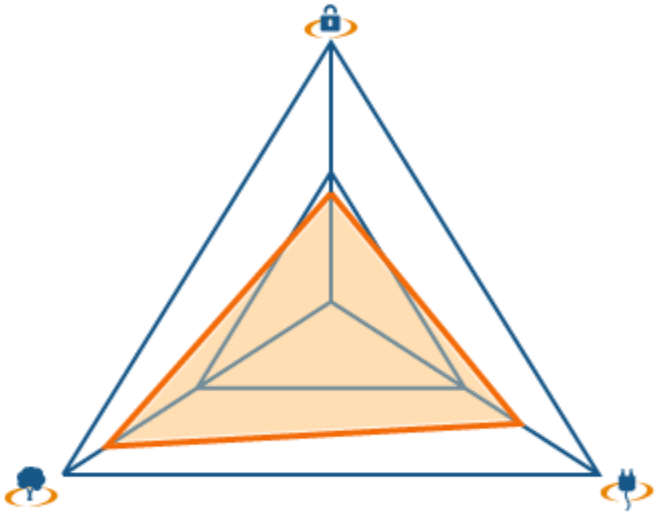
Lithuania

BALANCE SCORE
ABC

INDEX RANK
29

ENERGY TRILEMMA BALANCE



Download graph | Download CSV

ENERGY TRILEMMA INDEX RANKINGS AND BALANCE SCORE

	2013	2014	2015	TREND	SCORE
ENERGY PERFORMANCE	48	46	27	↑	
Energy Security	93	90	76	↑	C
Energy Equity	46	45	39	→	B
Environmental Sustainability	26	20	22	→	A
CONTEXTUAL PERFORMANCE	42	39	32	↑	
Political Strength	36	33	28	↑	
Societal Strength	39	39	40	→	
Economic Strength	69	62	47	→	
OVERALL RANK	42	37	29	↑	ABC

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Trilemma uuringu järeldused

- Edusammud on nähtavad…
  - Energiaefektiivsus ja taastuvenergia osakaal kasvavad.
  - Energia kättesaadavus paraneb.

  … aga progress aeglane.

- Vaja on investeerimiskindlust, selleks on vaja stabiilset poliitilist keskkonda.

- Eesti positsioon on tingitud CO2 emissioonidest.

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WORLD ENERGY ISSUES MONITOR

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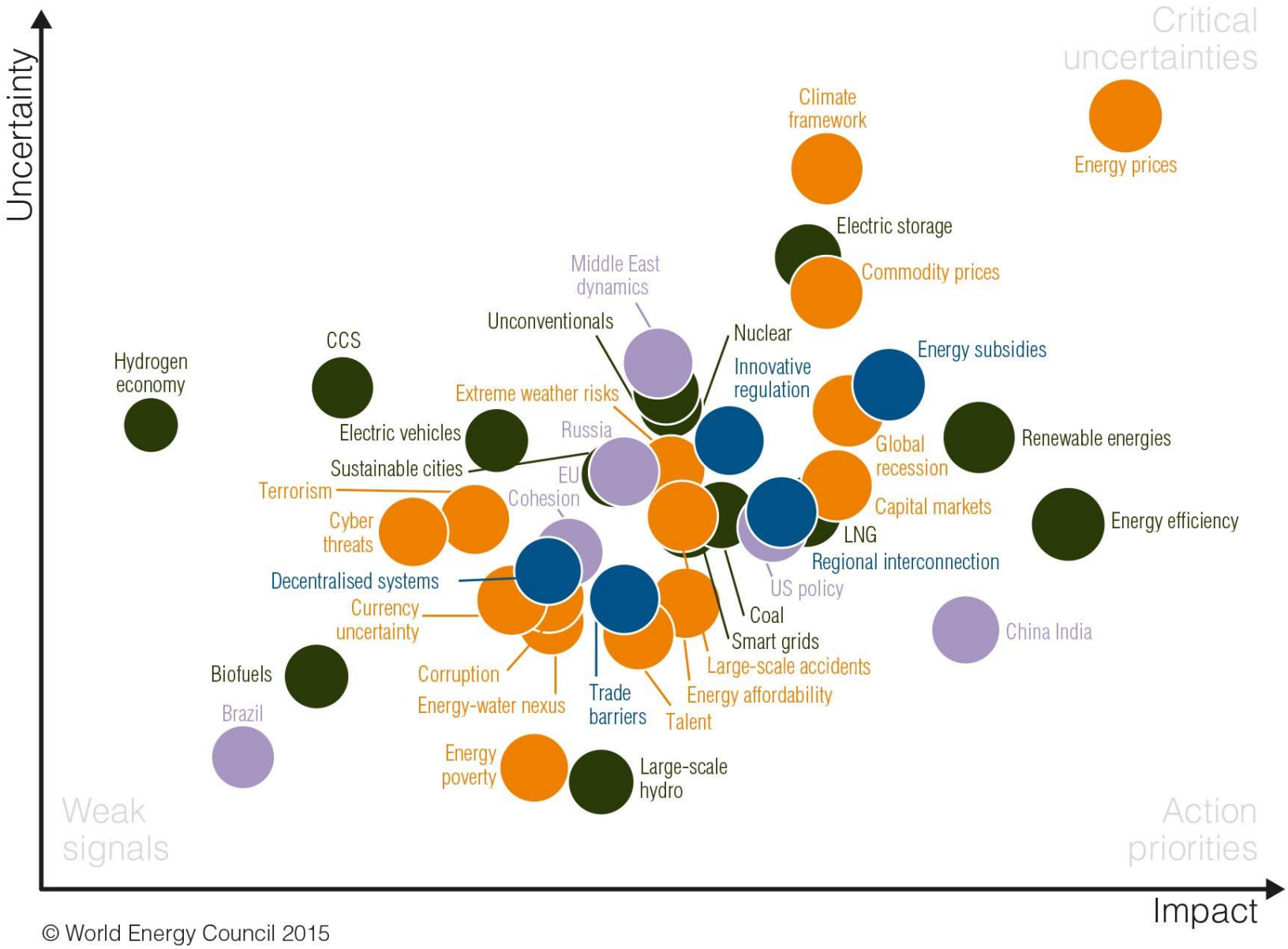

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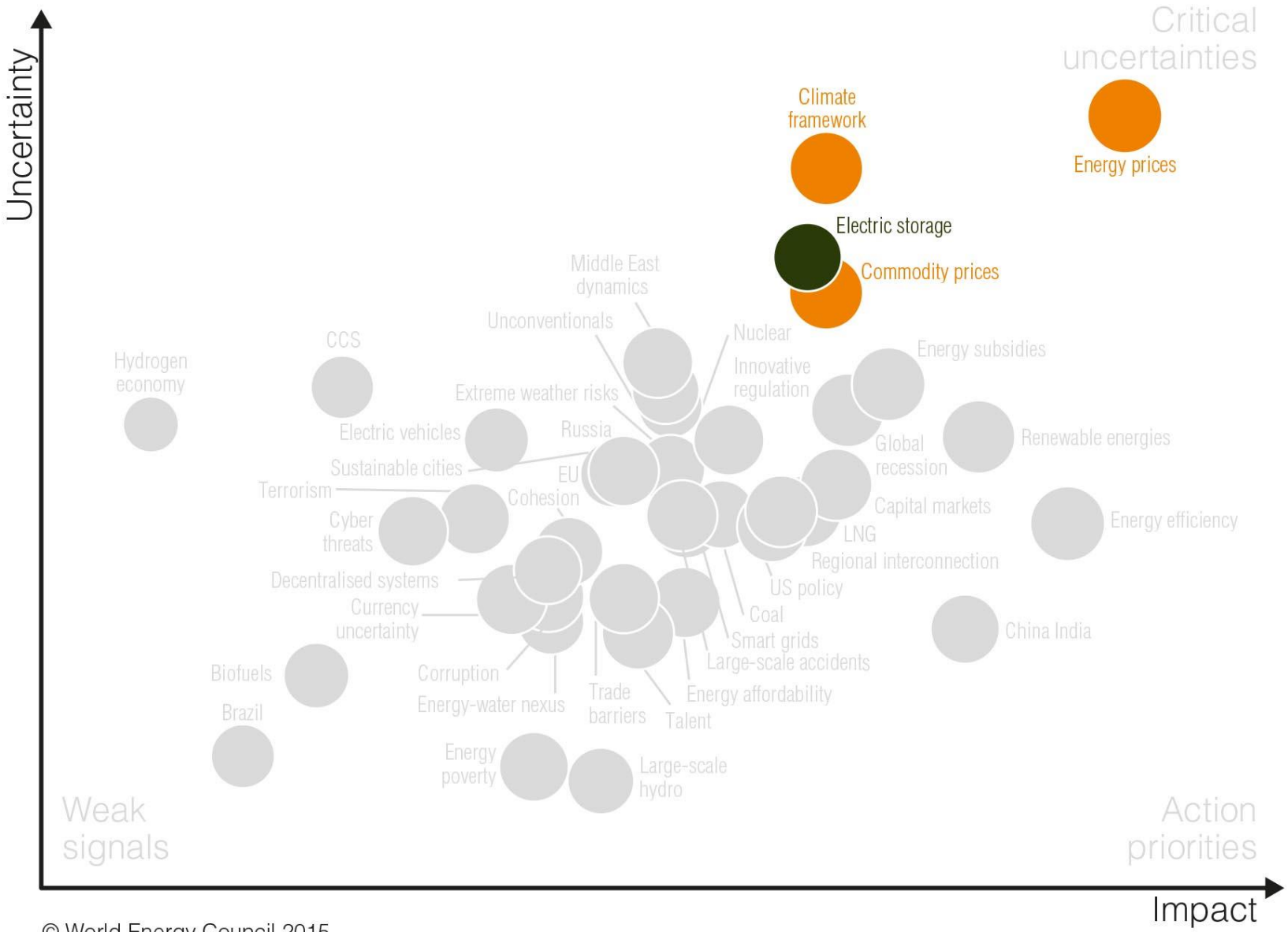

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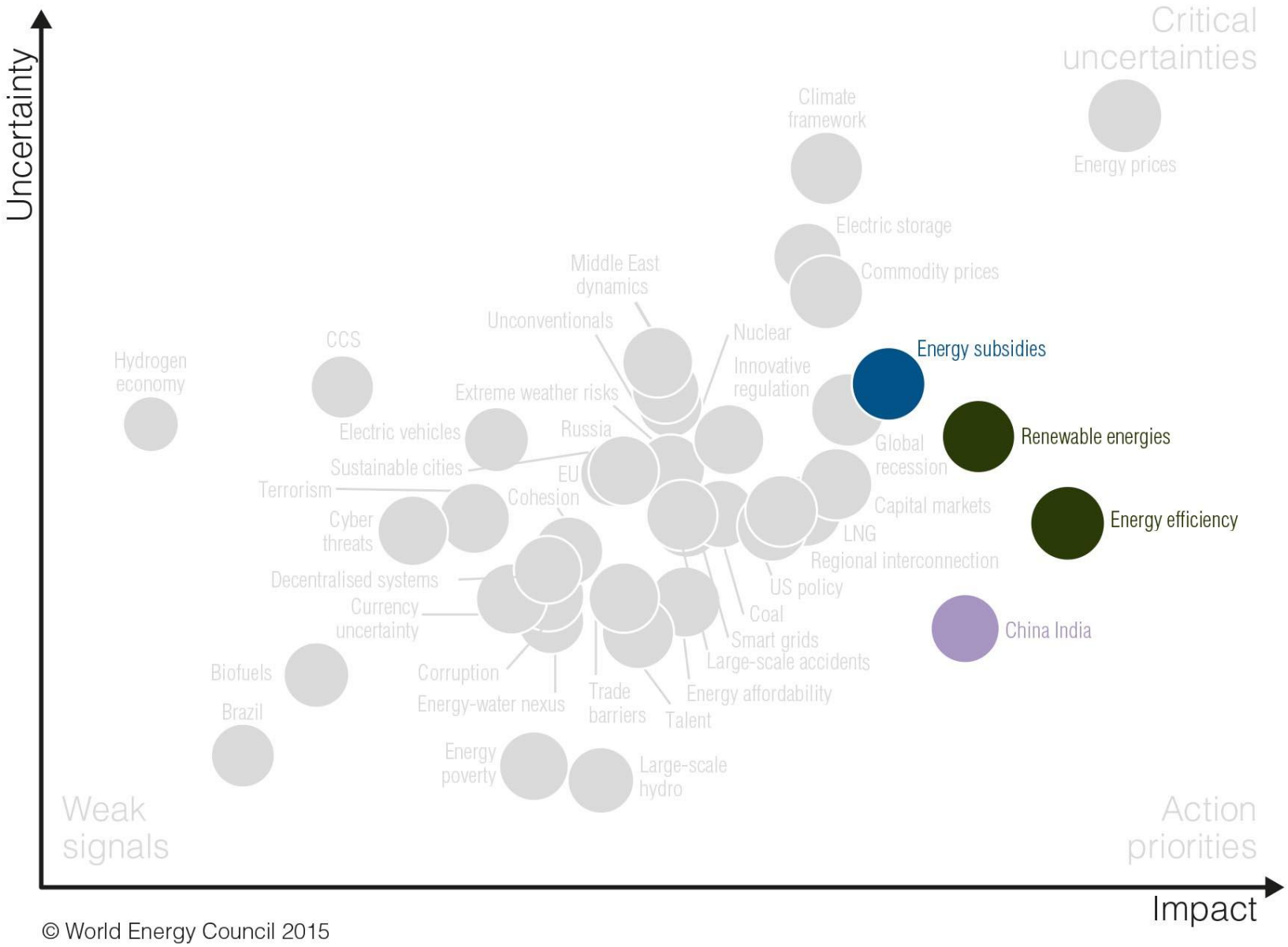

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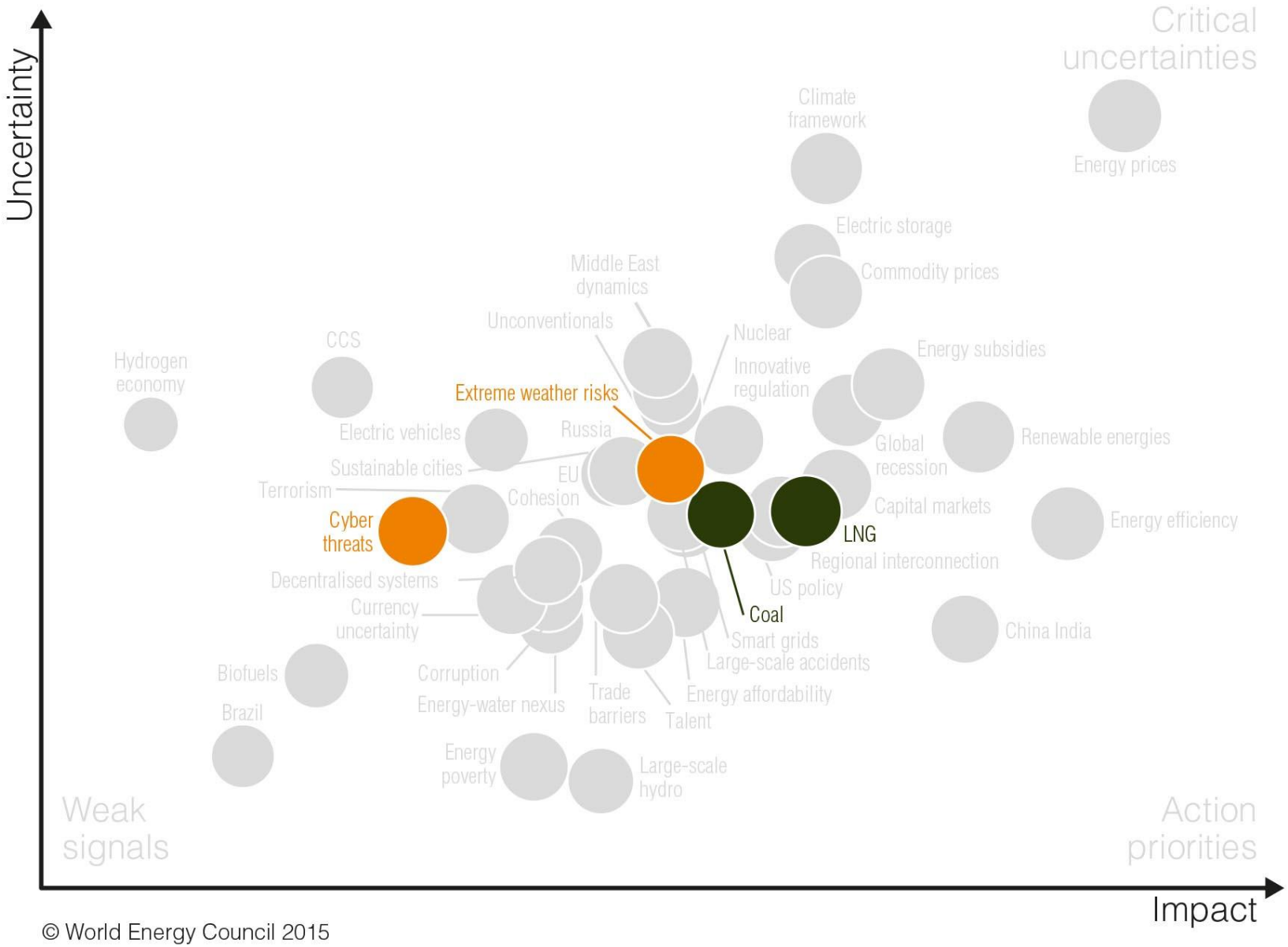

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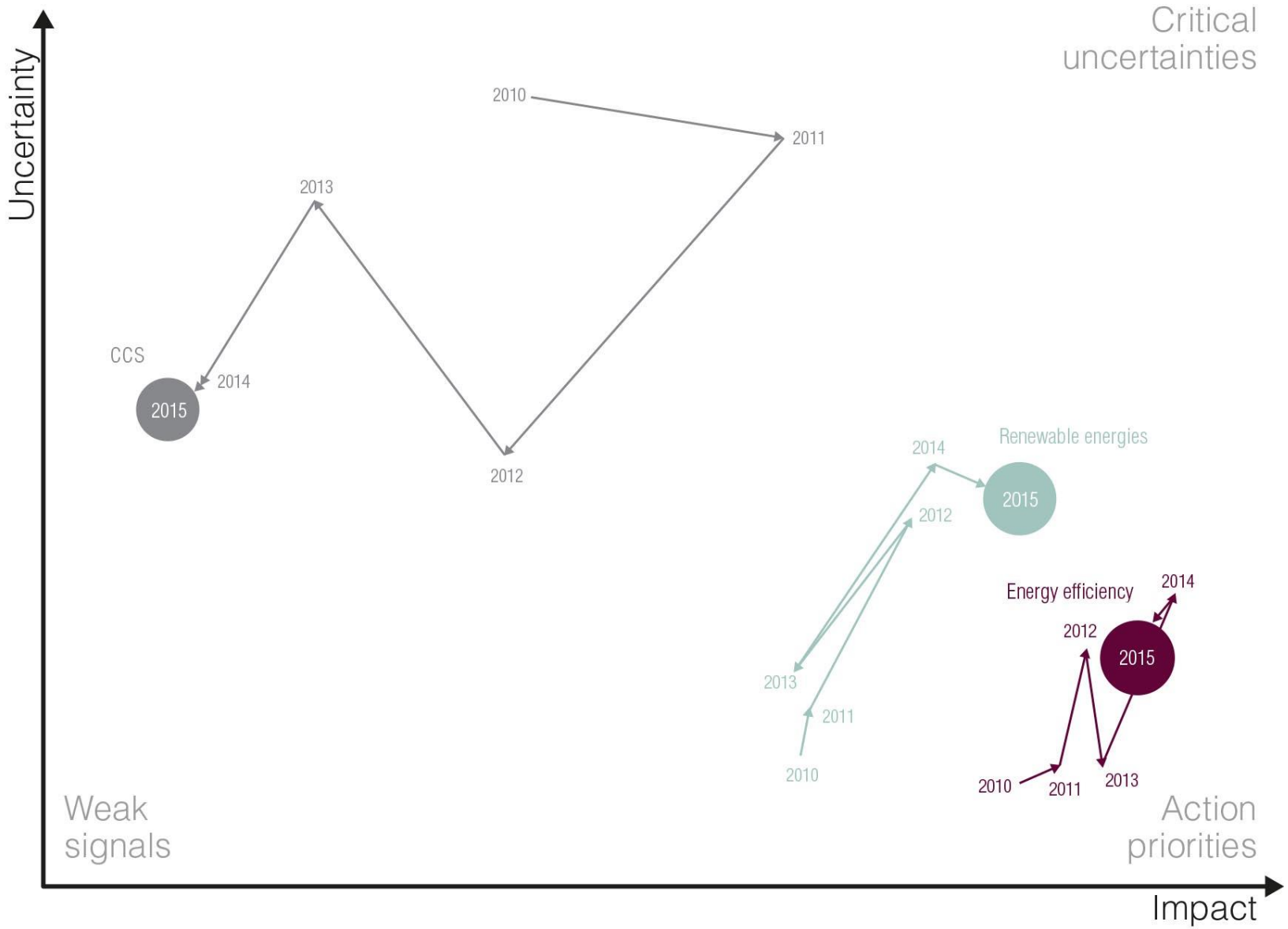

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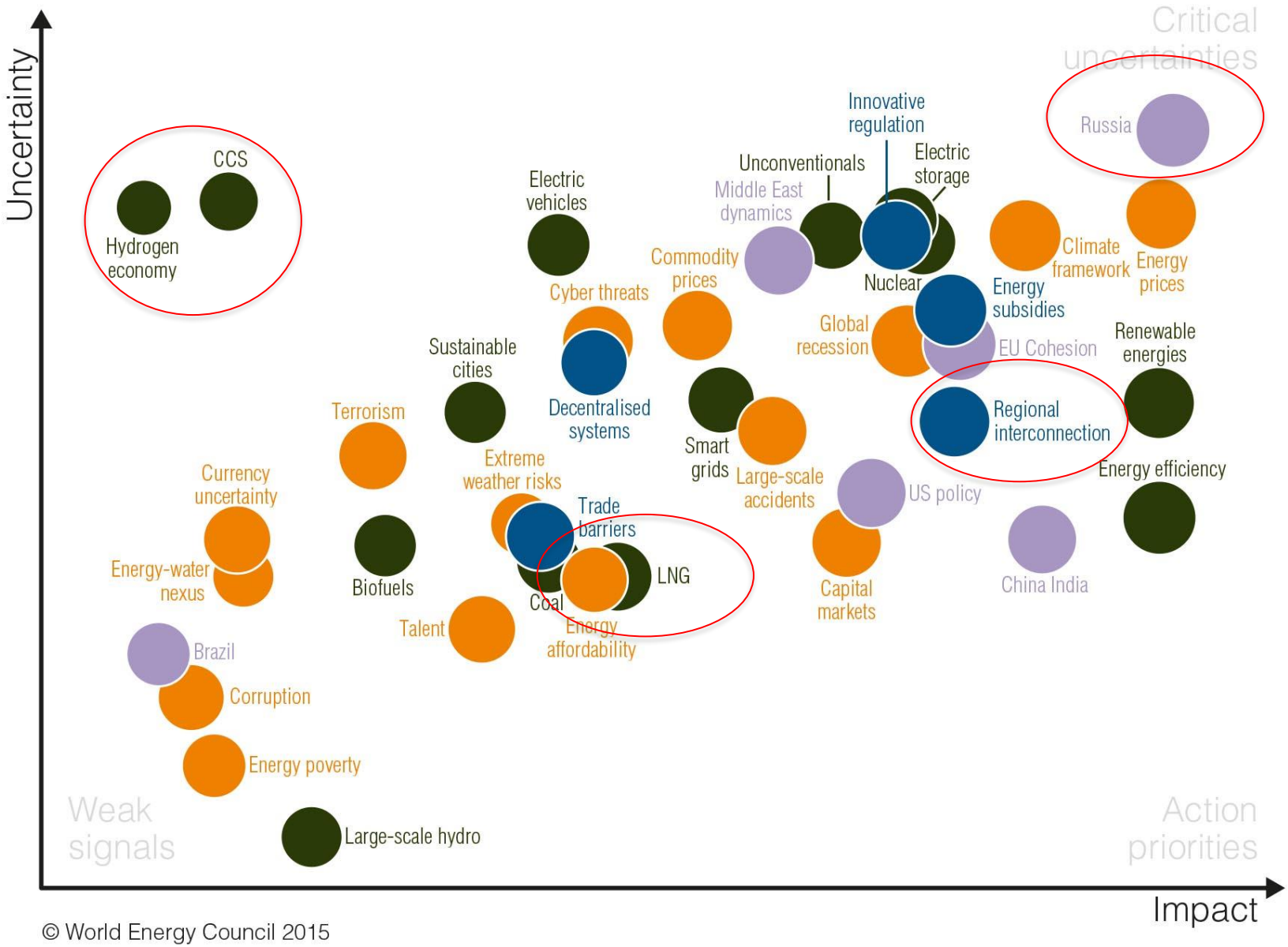

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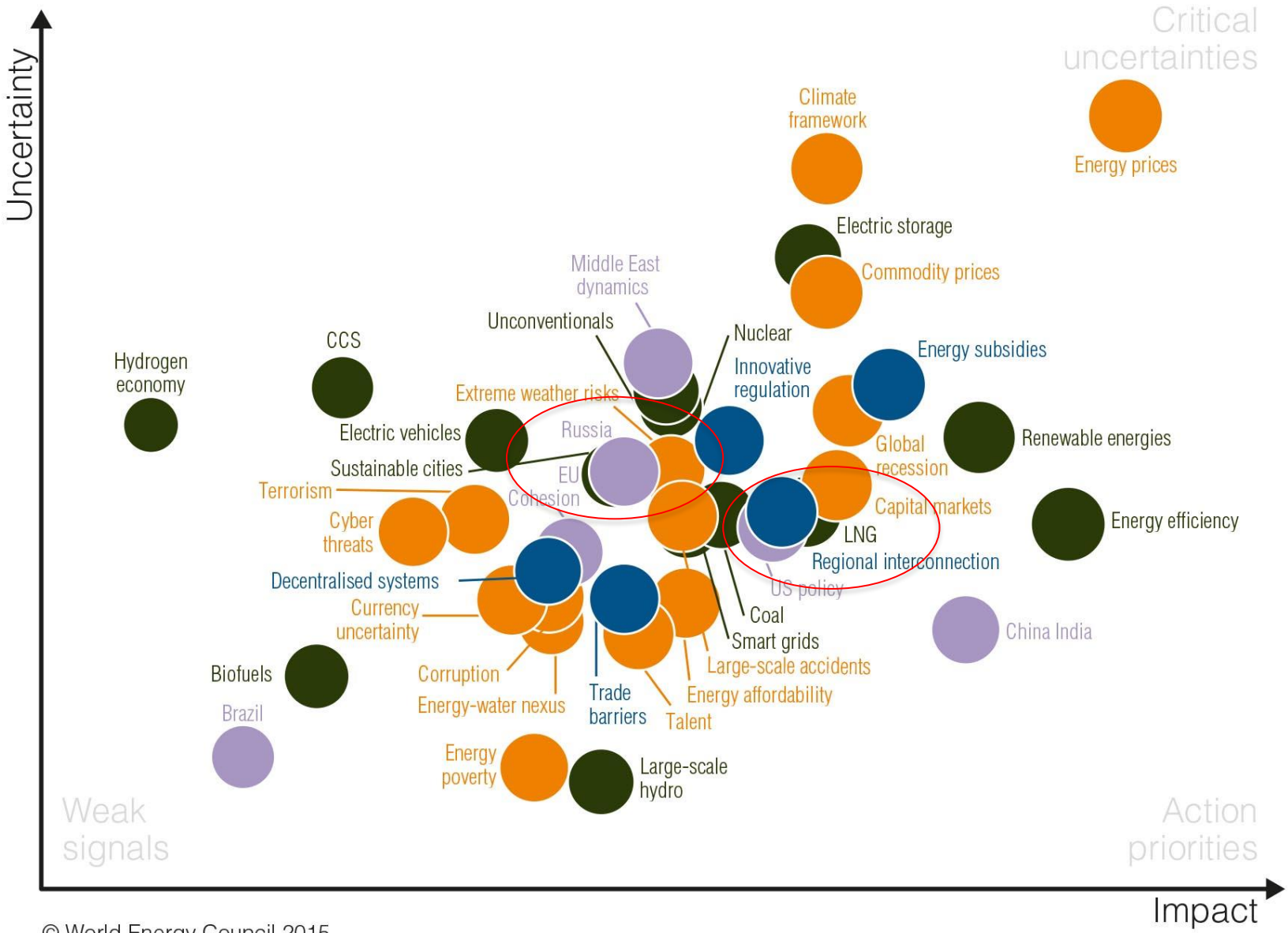

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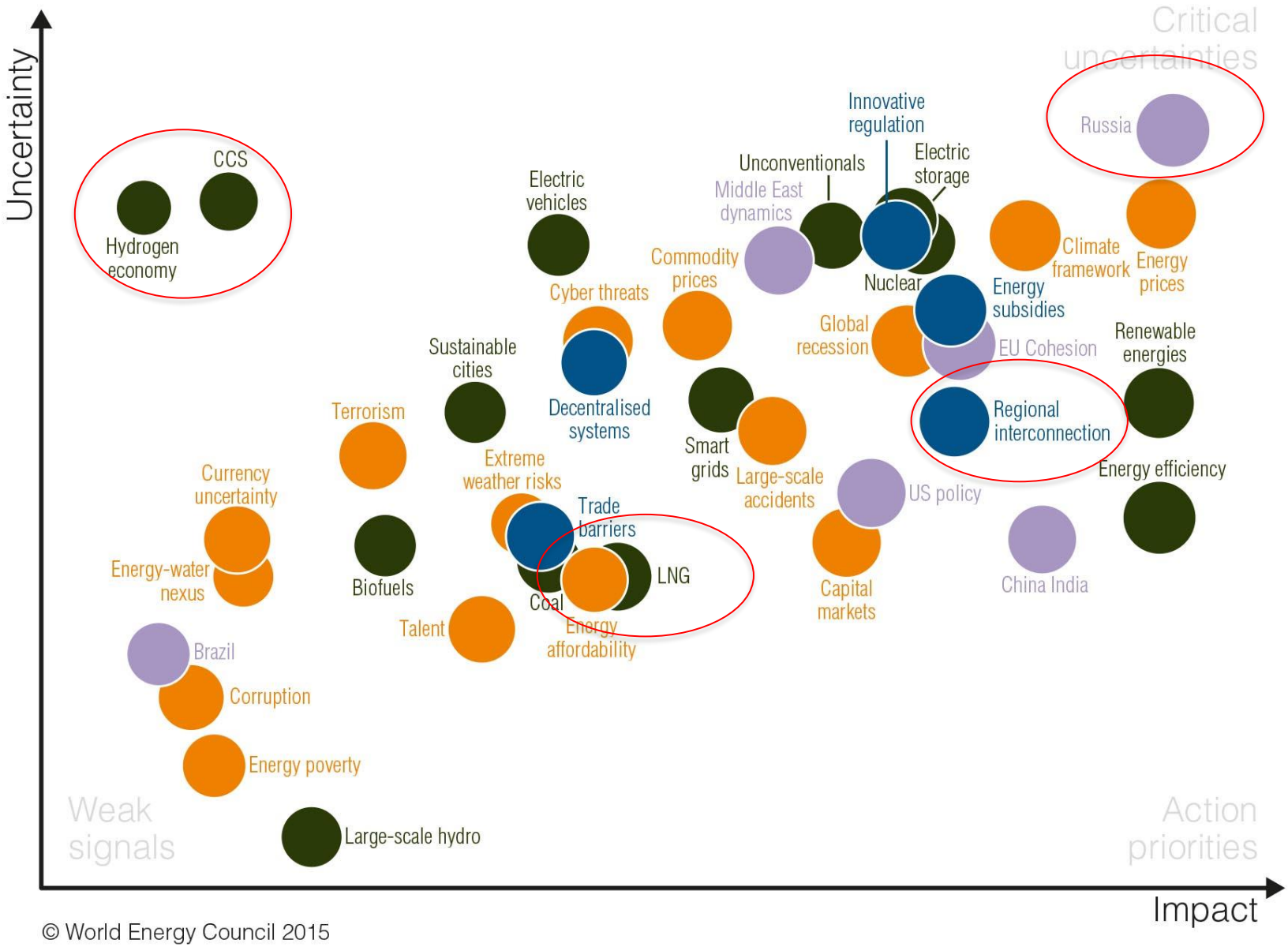

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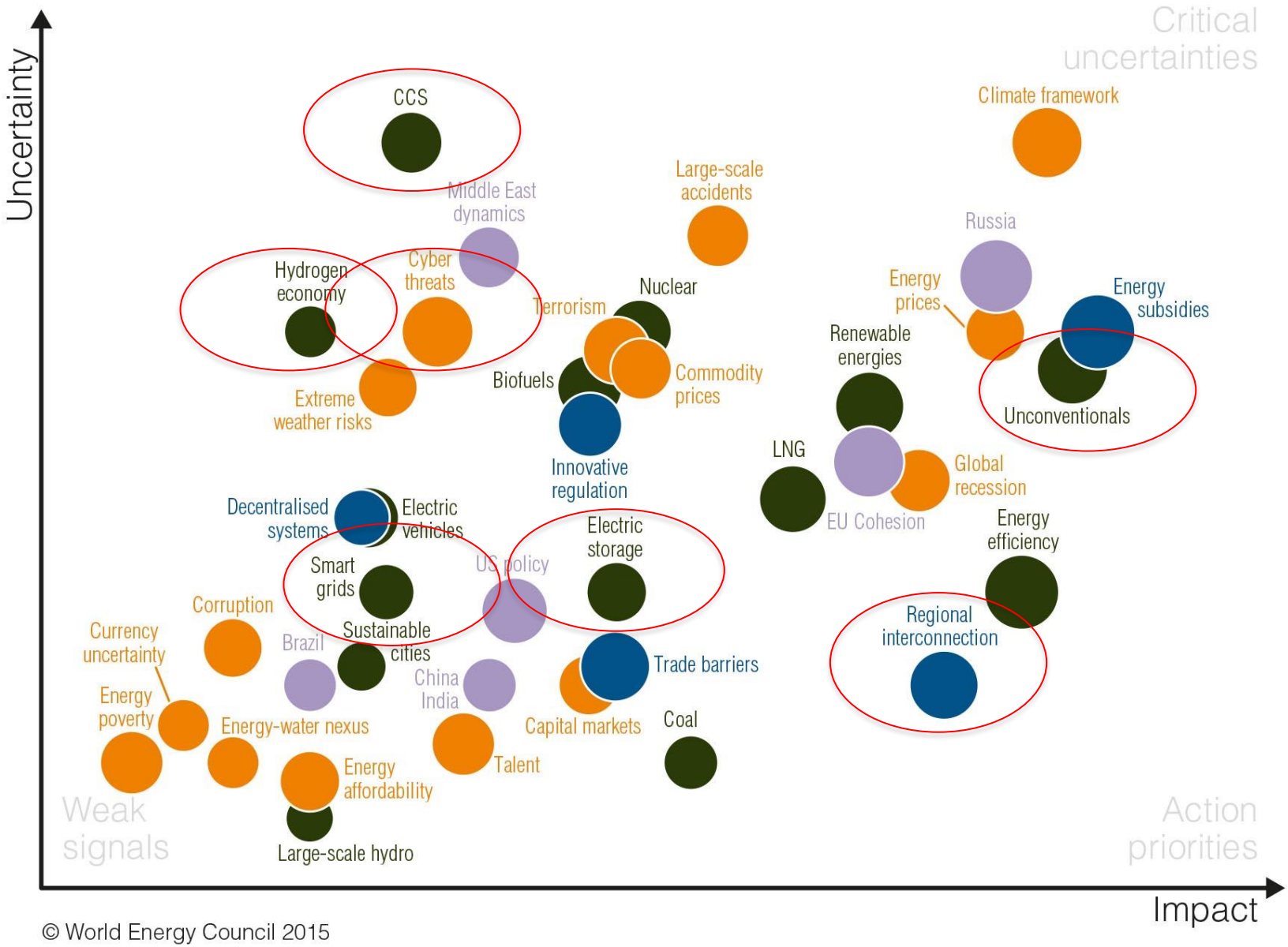

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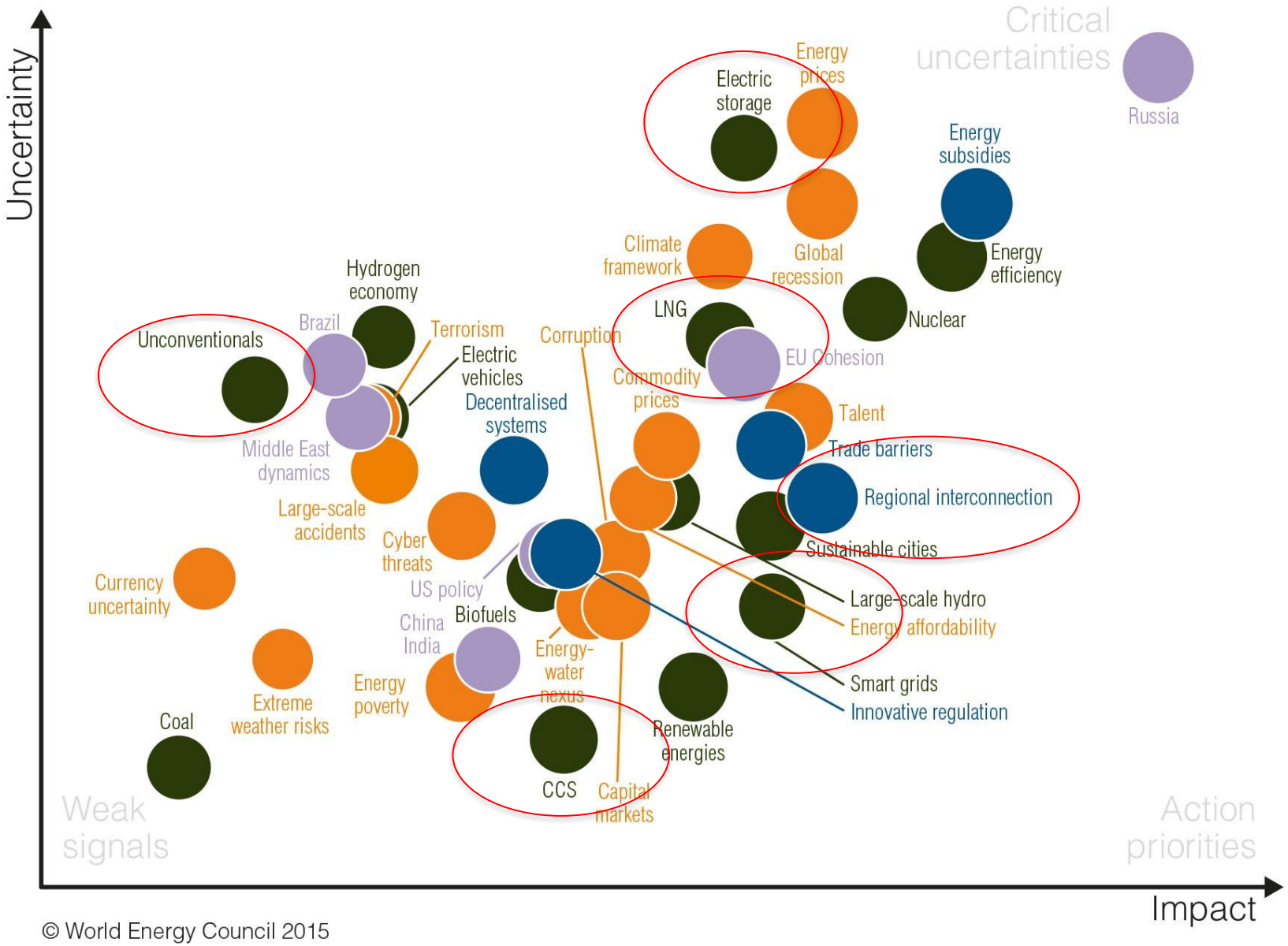

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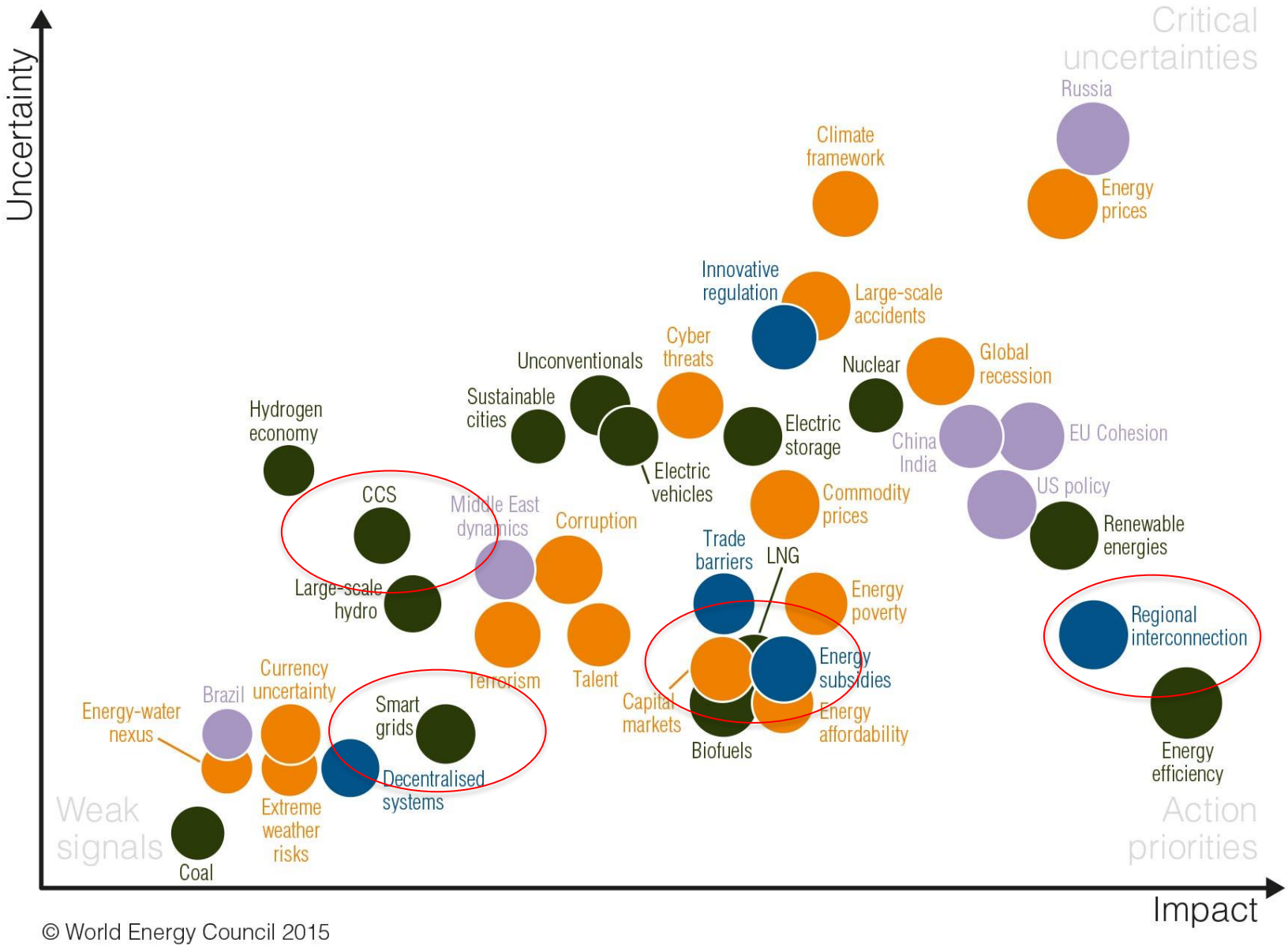

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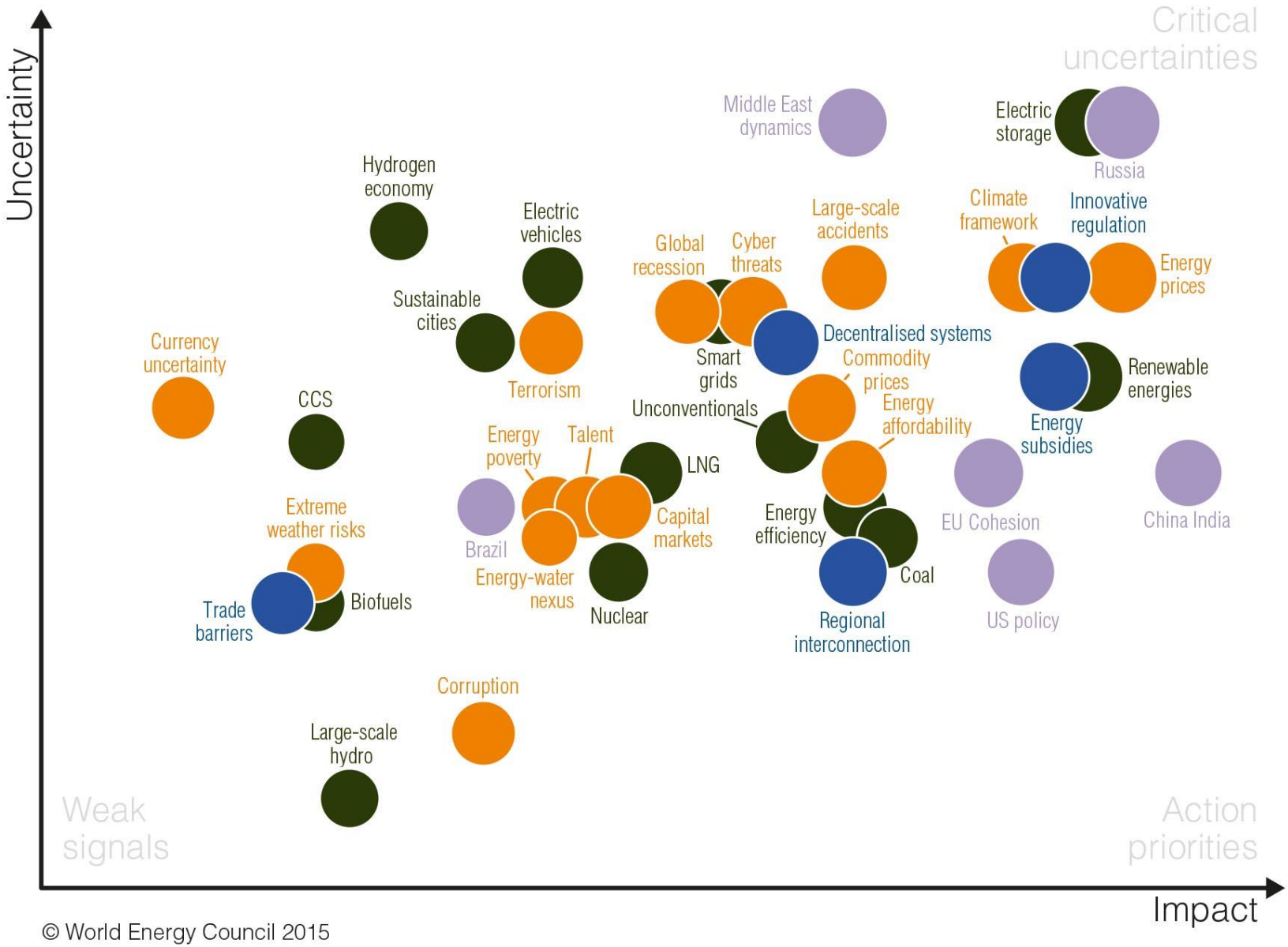

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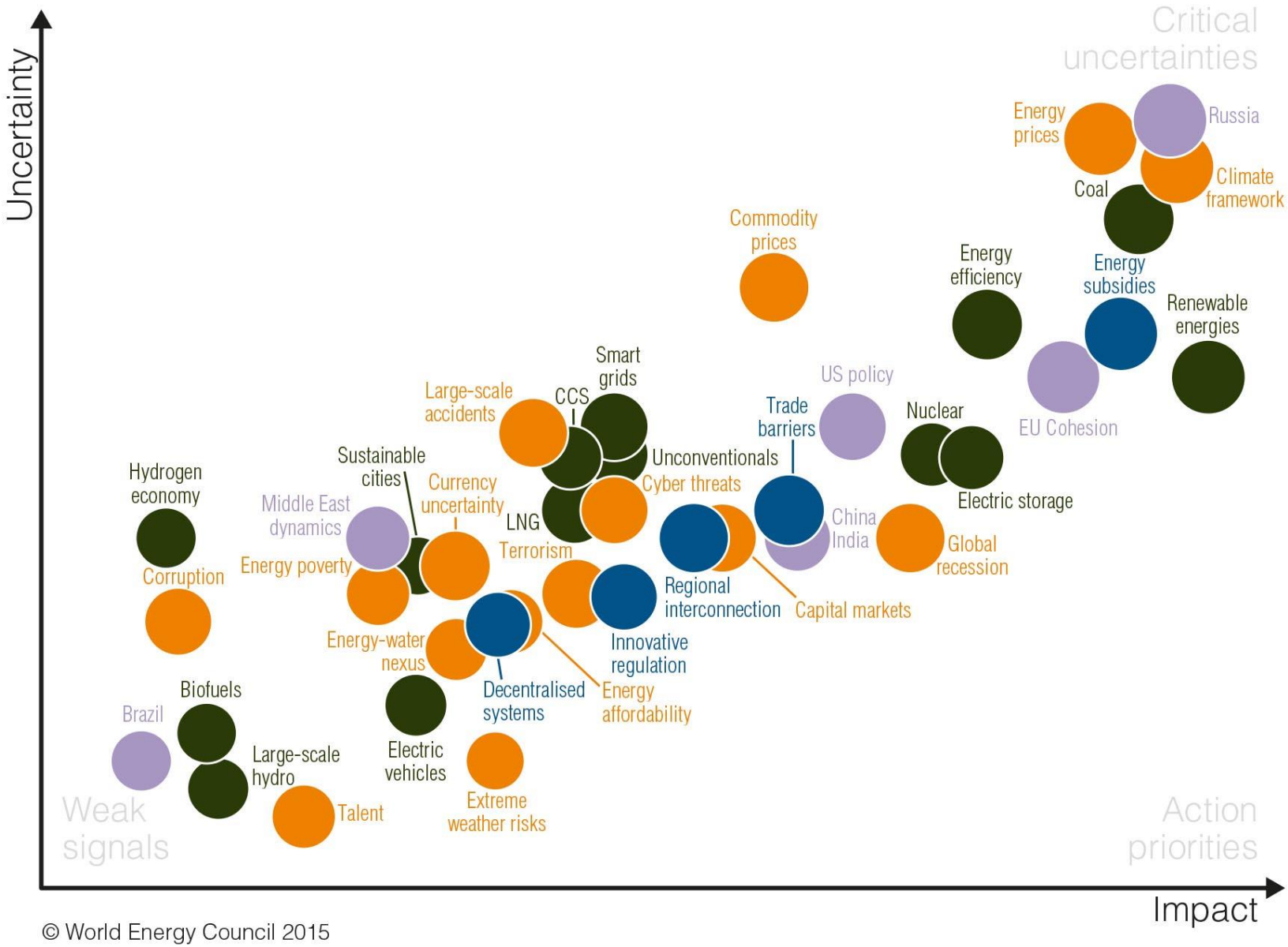

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WORLD ENERGY SCENARIOS

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Mis võib järgmise 100 aastaga juhtuda

- Ameerikas elab 500 miljonit inimest
- Soe ja külm õhk tuleb kraanist
- Rongid sõidavad 250 km/h
- Kõik kõnnivad vähemalt 10 km päevas
- Autod on odavamad kui hobused
- Poest saab osta valmistoitu
- On võimalik näha kõikjale maailmas
- Igal pool on telefonid
- Pilte saab telegraafiga edastada
- Inimesed on pikemad
- Kivisütt ei kasutada
- Õhulaevad on olemas
- Herned on sama suured kui peedid

Ladies' Home Journal
Detsember, 1900

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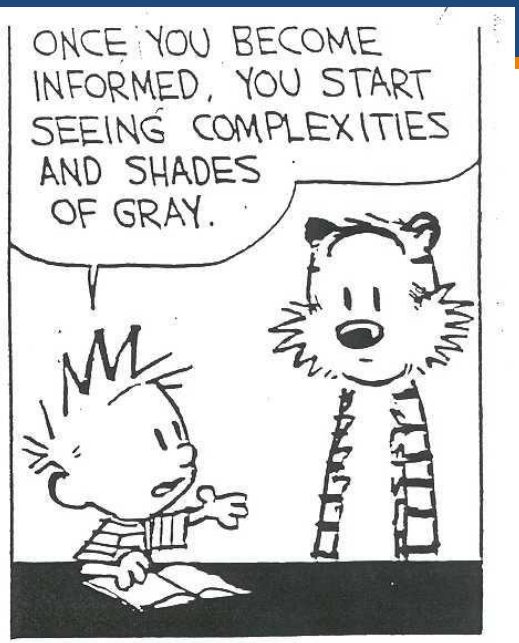

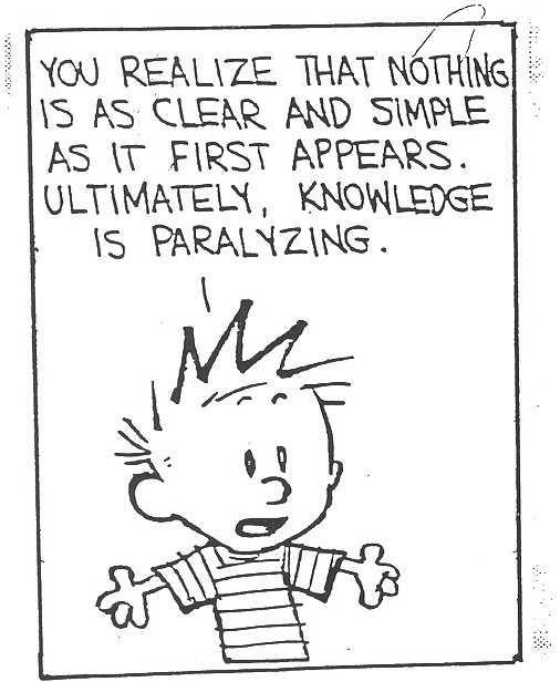

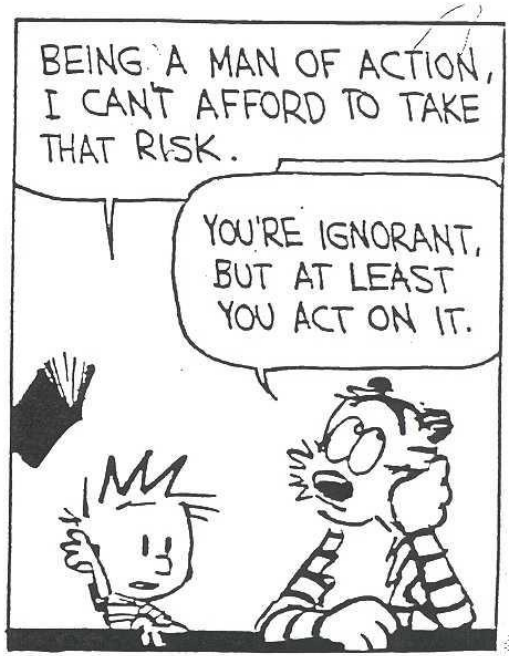

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Stsenaariumid WEC-i käsitluses

- Stsenaariumid EI OLE tuleviku ennustamine
- **Stsenaariumid on alternatiivsed tulevikud**
- **Strateegiad ja plaanid, kuidas käituda**
- **Küsimused, MITTE vastused**
- **Fookus on järgmisel 1-3 aastal**
- **Mida teha täna, et aastal 2060 oleks tõenäosus soovitud tuleviku osas suurem**

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OLULISED TRENDID

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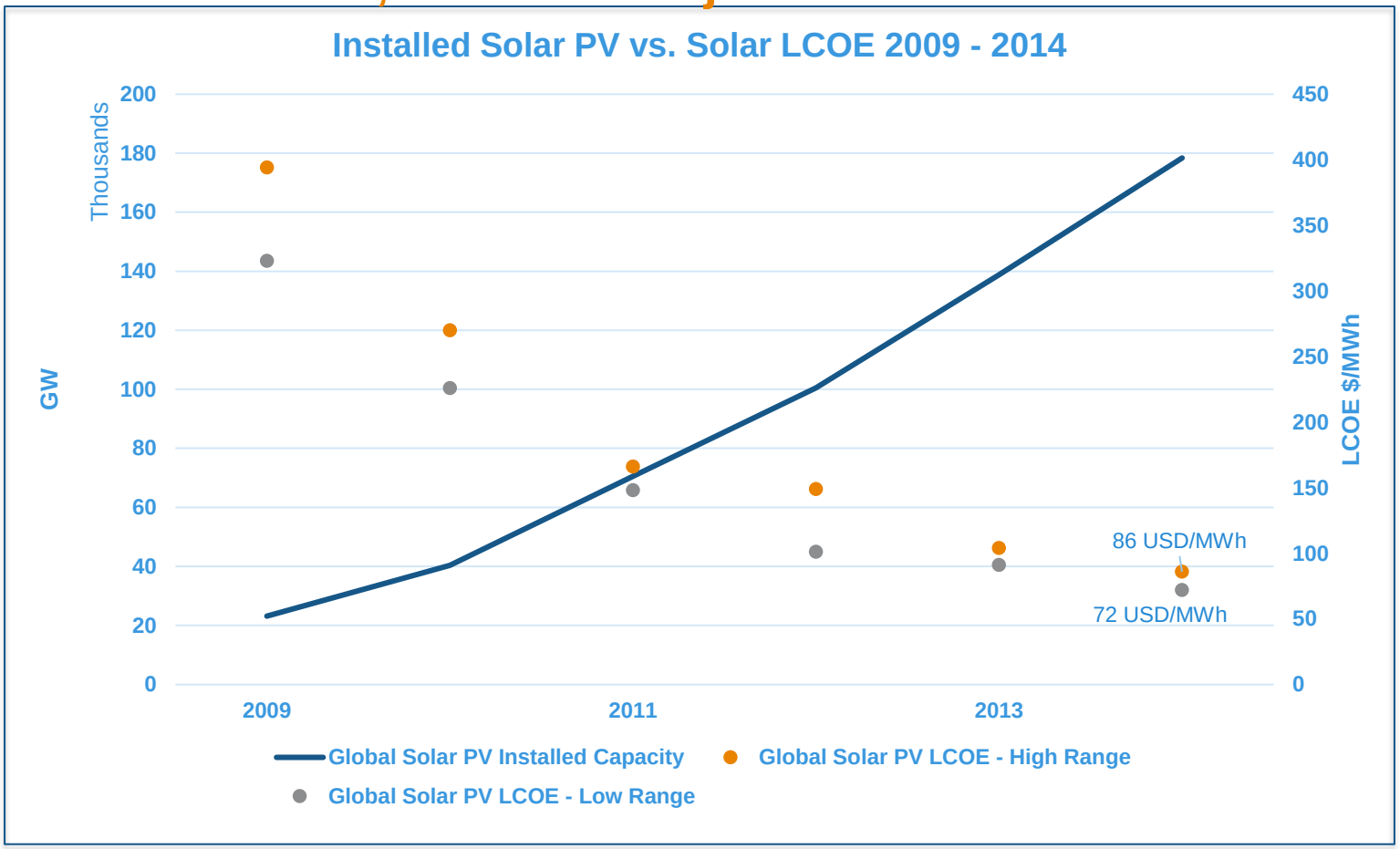
Odavam päikese energia

Päikese energia kasutamine on muutunud viimastel aastatel oluliselt odavamaks, ilmselt trend jätkub.



Source: Lazard LCOE, Clean Energy Business Council Outlook for PV

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Võrguettevõtte ärimudel peab muutuma

Integreeritud hajavõrgud

Nutikas regulatsioon võimaldab kasutada uusi tehnoloogiaid

- Nutivõrk
- Paindlik regulatsioon
- Võrk kui vahendaja ja turuplats

Odav päikese energia, salvestamine, EV, efektiivsus, tarbimise juhtimine

- Hinnakujunduse reform
- Uued ärimudelid
- Uus regulatsioon
- Muutunud tarbijakäitumine

Regulatsioon ja ärimudelid ei jõua tehnoloogiaga sammud pidada

- Hajatootmine ainult enda tarbeks
- Võrgust eraldumine
- Võrgus on ülevõimsused ja asjatud investeeringud
- *Stranded assets* – nii tarbijal, tootjal kui võrgul

Off-grid

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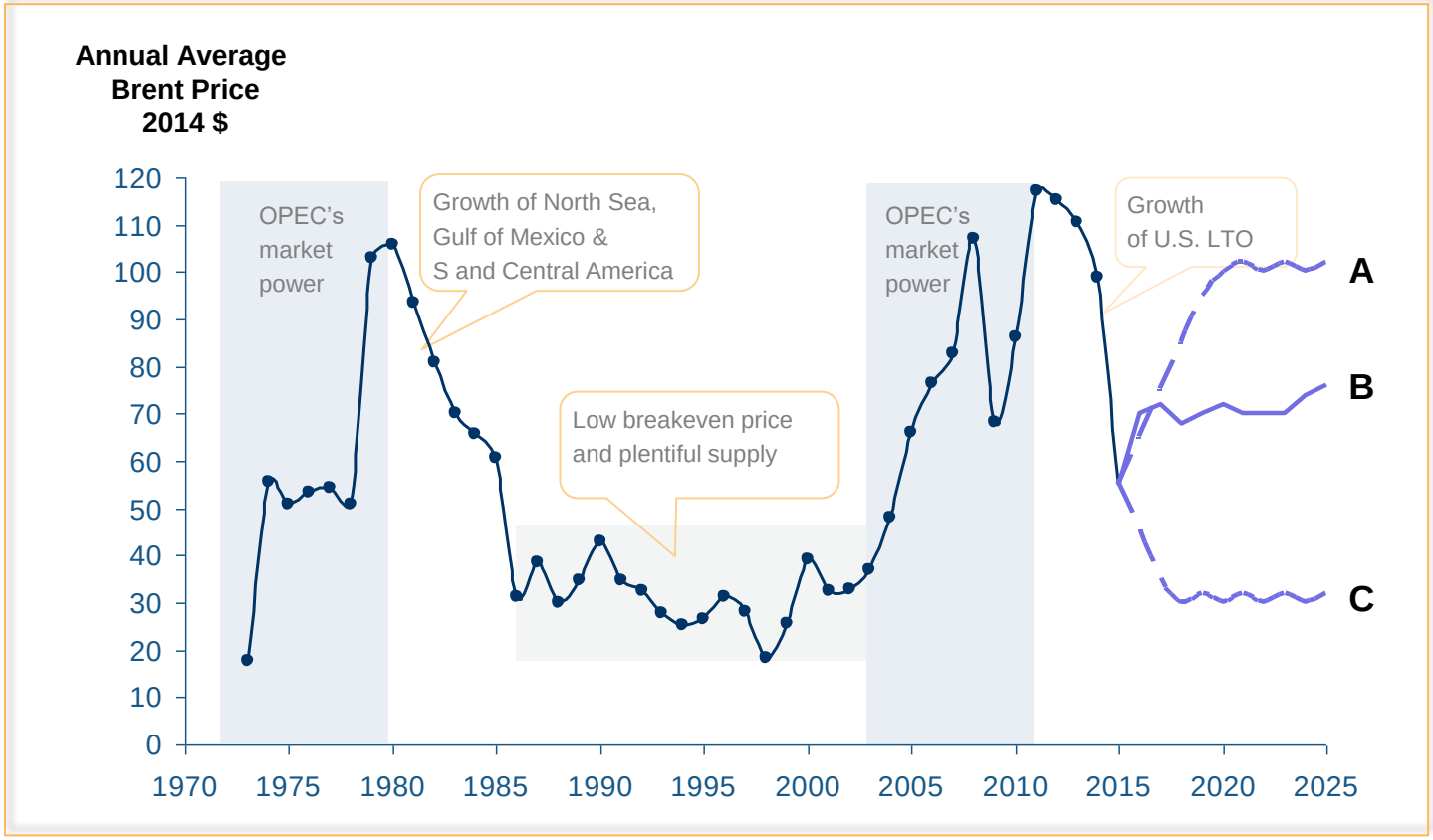
Nafta hinna tulevik?

Price evolution



Source: Schlumberger Business Consulting

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Kildagaas ja kildaõli – nafta hinna piirajad?

BASIN BREAKEVEN OIL PRICE PER BARREL	
Marcellus Shale - SW liquids rich	$24.23
Marcellus Shale - Super Rich	$25.63
Utica - Wet gas	$32.39
Mississippian Horizontal - East	$42.15
Utica - Liquids Rich	$44.04
Eagle Ford - Liquids Rich	$46.05
Niobrara - Wattenberg	$46.10
Wolfcamp - N. Midland (Horizontal)	$53.92
Eagle Ford - Oil Window	$55.29
Wolfcamp - S. Midland (Horizontal)	$61.57
Mississippian Horizontal - West	$64.05
Wolfberry	$64.63
Bakken Shale	$64.74
Wolfcamp - N. Delaware (Horizontal)	$68.54
Uinta - Green River	$68.77
Uinta - Wasatch (H)	$72.15
Granite Wash - Liquids Rich Horizontal	$73.10
Uinta - Wasatch (V)	$74.95
Barnett Shale - Southern Liquids Rich	$84.45

Source: Credit Suisse

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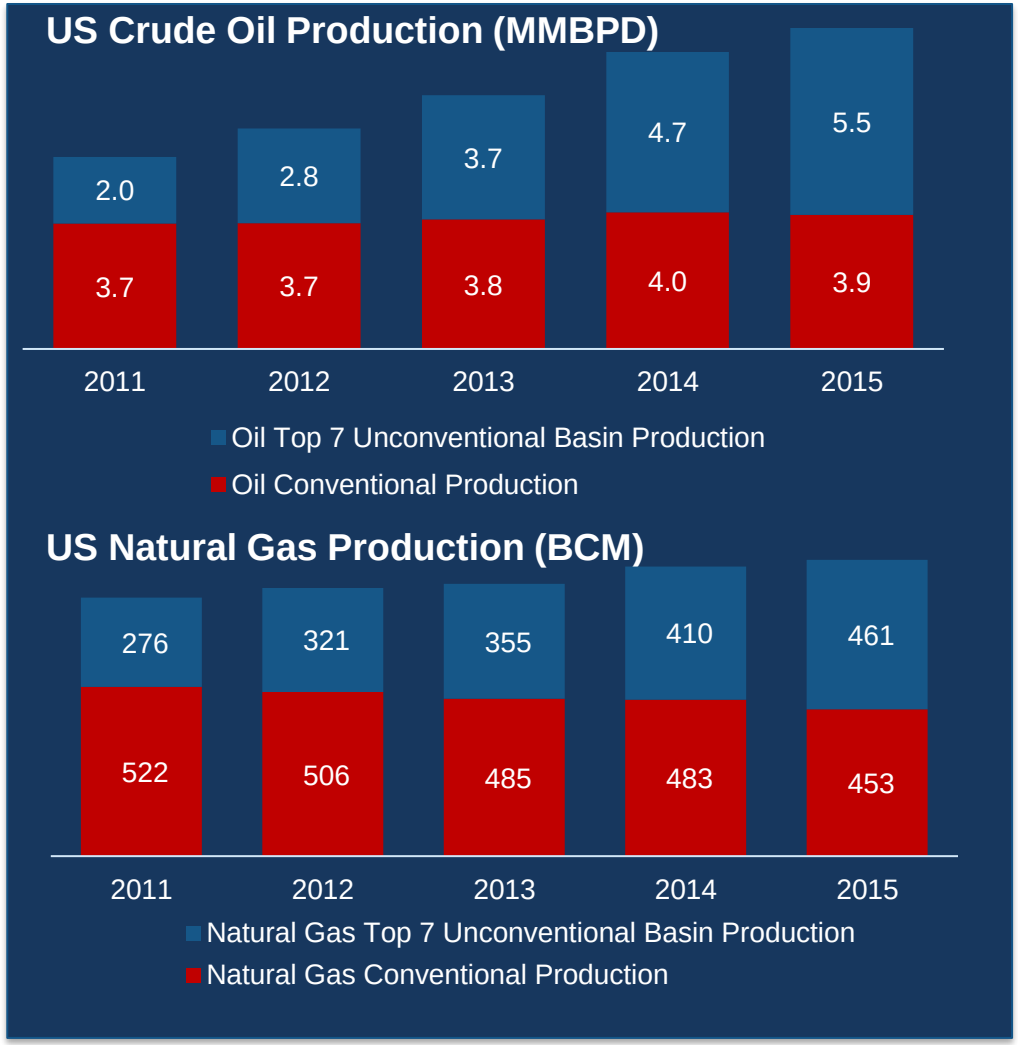
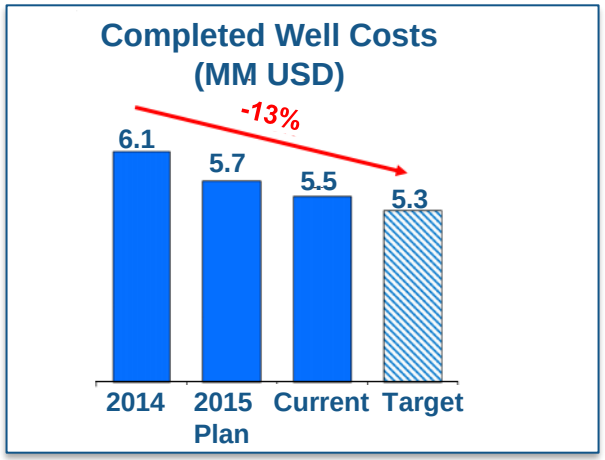
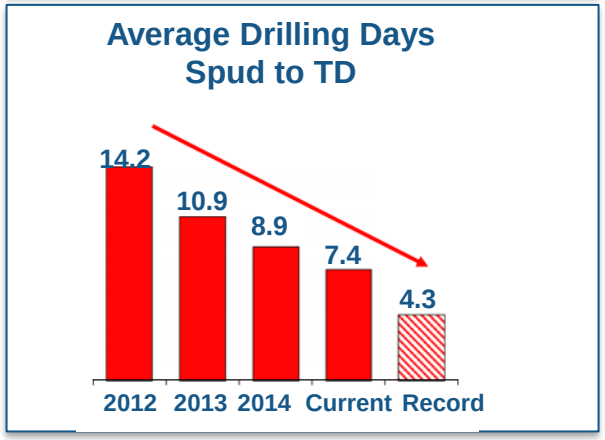


Source: EIA

Kildaõli tootjad muutuvad järjest efektiivsemaks

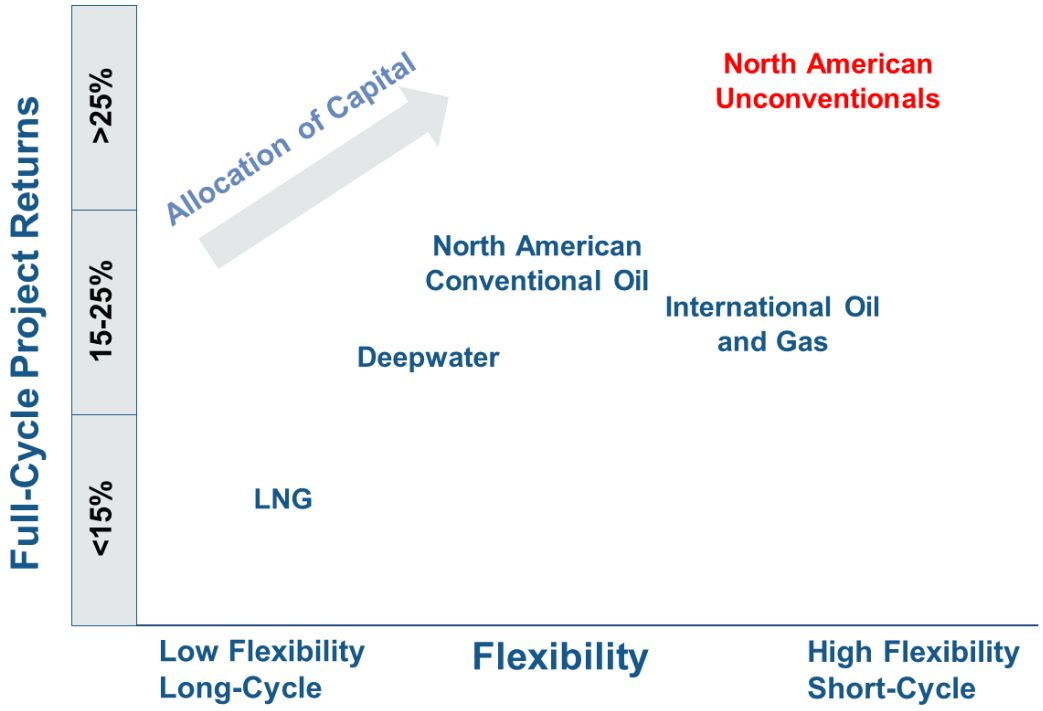
EOG Eagle Ford Operations





Source: EOG Investor Presentation, May 2015

Conoco Phillips: Flexibility vs. Returns by Asset Type



Source: Conoco Phillips Investor Presentation, May 2015

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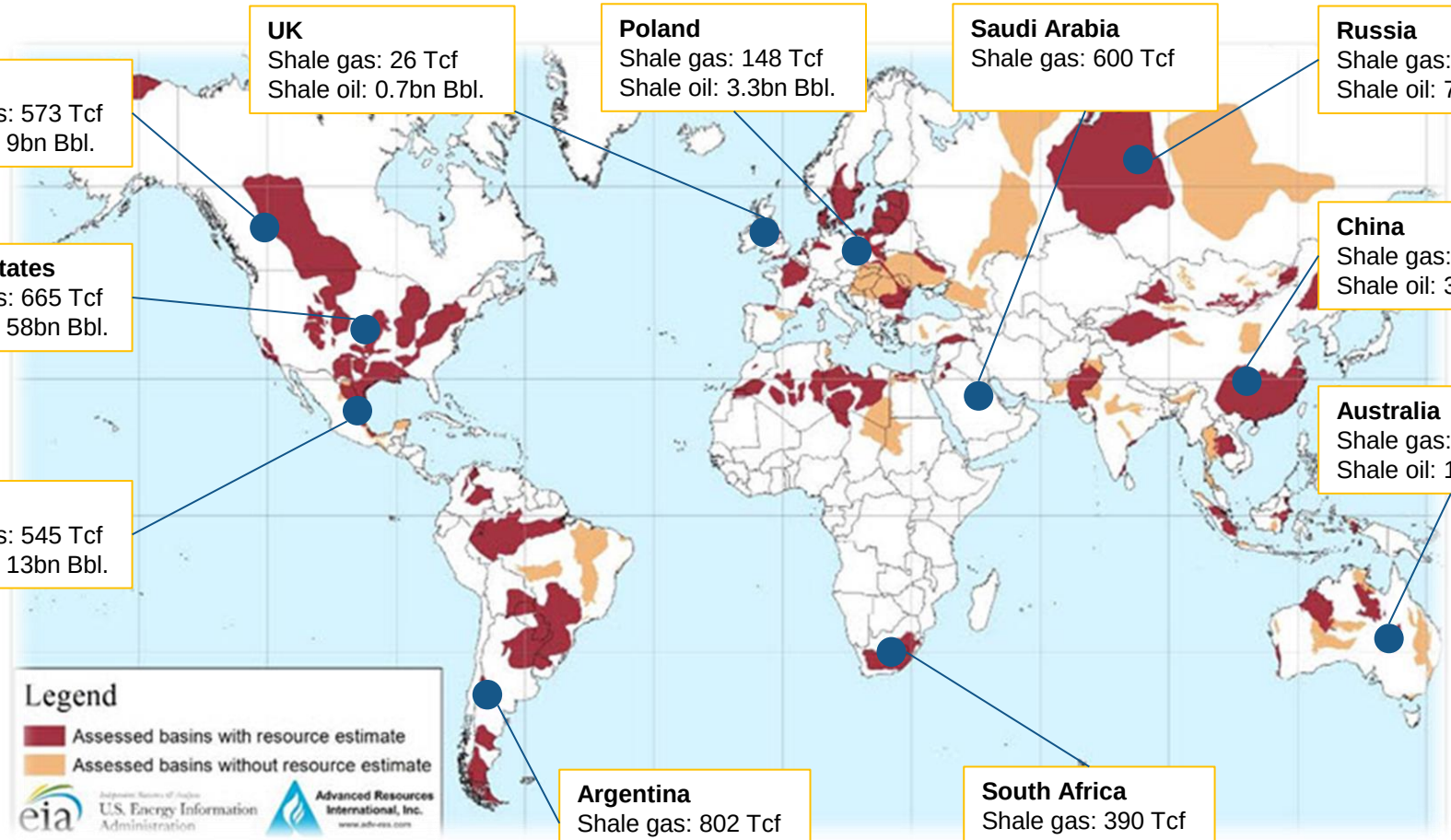
USA edulugu võib korduda paljudes teistes riikides



Canada
Shale gas: 573 Tcf
Shale oil: 9bn Bbl.

UK
Shale gas: 26 Tcf
Shale oil: 0.7bn Bbl.

Poland
Shale gas: 148 Tcf
Shale oil: 3.3bn Bbl.

Saudi Arabia
Shale gas: 600 Tcf

Russia
Shale gas: 287 Tcf
Shale oil: 75bn Bbl.

United States
Shale gas: 665 Tcf
Shale oil: 58bn Bbl.

China
Shale gas:1,115 Tcf
Shale oil: 32bn Bbl.

Australia
Shale gas: 437 Tcf
Shale oil: 18bn Bbl.

Mexico
Shale gas: 545 Tcf
Shale oil: 13bn Bbl.

Argentina
Shale gas: 802 Tcf
Shale oil: 27bn Bbl.

South Africa
Shale gas: 390 Tcf

Tcf: Trillion cubic feet
Bbl: Barrel

© World Energy Council 2015

Source: Technically Reoverable Shale Oil and Shale Gas Resources, EIA 2013

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Kildagaas sõltub aga paljudest faktoritest

Will slow down even more because low oil price

	Argentina (Neuquén Basin) > 200 wells	China (Sichuan Basin) > 200 wells	Australia (Cooper Basin) ~60 wells	Poland (Baltic Basin) > 40 wells	Russia (W. Siberian Basin) <10 wells	UK (Bowland Basin) <10 wells	Mexico (Burgos Basin) <20 wells	South Africa (Karoo Basin) No wells	Saudi Arabia (S. Ghawar Basin) > 80 wells
Size of potential resources in basin	583 tcf 20bn bbl	287 tcf	93 tcf	105 tcf 1.2bn bbl	285 tcf 75bn bbl	26-130 tcf	393 tcf 6.3bn bbl	390 tcf	600 tcf
Enabling fiscal regime									
Geology				▲					
Land access/ operability									
Unconventional services sector	▲								
Oil & gas distribution network									
Conventional and other competition									
Skilled workforce									

Pacer *today* (will change) for speed of market development

▲ Change from June 2014 report

Sources: EIA, UK Geological Survey, Saudi Oil Ministry, Accenture Research

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Energiasektori tippjuhtide intervjuudes kõlanud fraasid

SECURITY OF SUPPLY
CHANGE OF PARADIGM
PUBLIC AND PRIVATE
OIL AND GAS
SOLAR AND WIND
FOOD AND WATER SUPPLY
GLOBAL SUPPLY CHAIN
ROLE OF GOVERNMENT
CHINA AND INDIA
ELECTRIC POWER TRANSMISSION
CHANGES IN LIFESTYLE
ENERGY STORAGE SYSTEM
CLIMATE CHANGE AGENDA
FUTURE OF ENERGY
TERMS OF ENERGY
OUTCOME OF COP
FOOD AND WATER
DEBT UNDER CONTROL
GROWTH RATES OF CHINA
TECHNOLOGY CHANGES
ELECTRICITY AND WATER
CONTROL OF THE ENERGY
IMPACT OF CHEAPER OIL
ACCESS TO ENERGY
SOCIAL UPRISING
DEMAND FOR ENERGY
GLOBAL SUPPLY CHAINS
ELECTRIC POWER INDUSTRY

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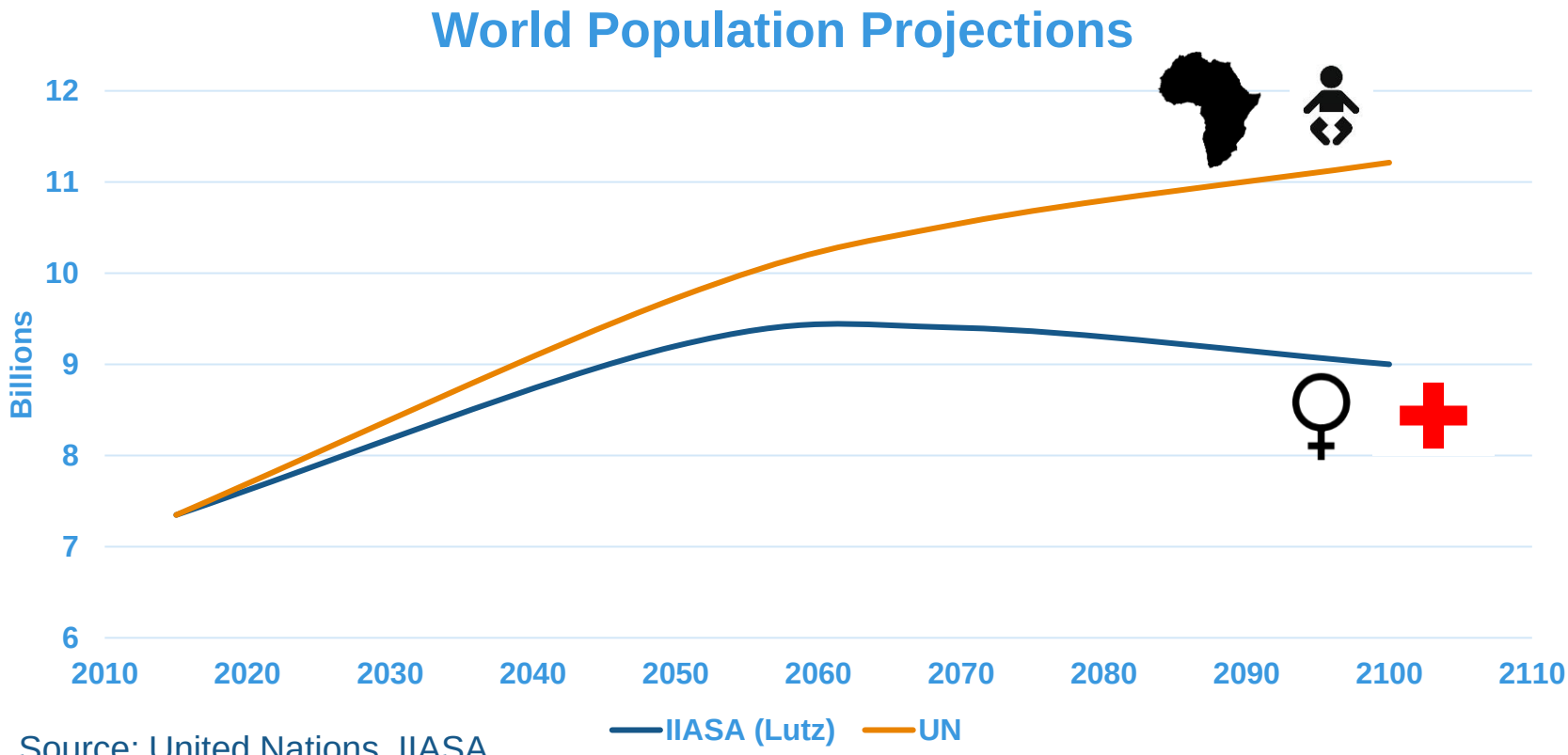
Maailma rahvastiku kasv

Haridus, majanduskasv, demokraatia levik, meditsiin ja paljud teised faktorid mõjutavad rahvastiku kasvu.

Rahvastiku kasv mõjutab otseselt energiasektorit.



Source: United Nations, IIASA

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Veel rahvastikust

- Mida me teame:
  - Rahvastik kasvab jätkuvalt (3-4 mld)
  - Peaaegu kogu kasv on linnades
  - Rahvastik vananeb jätkuvalt
  - Kogu rahvastiku kasv toimub arengumaades
  - Peaaegu kõikide riikide populatsioonid vananevad

- Mida me ei tea:
  - Kliima muutuste mõju rahvastikule
  - Miks inimesed üldse lapsi saavad
  - Millised on eluea piirid
  - Rahvastiku vähenemise tulemused

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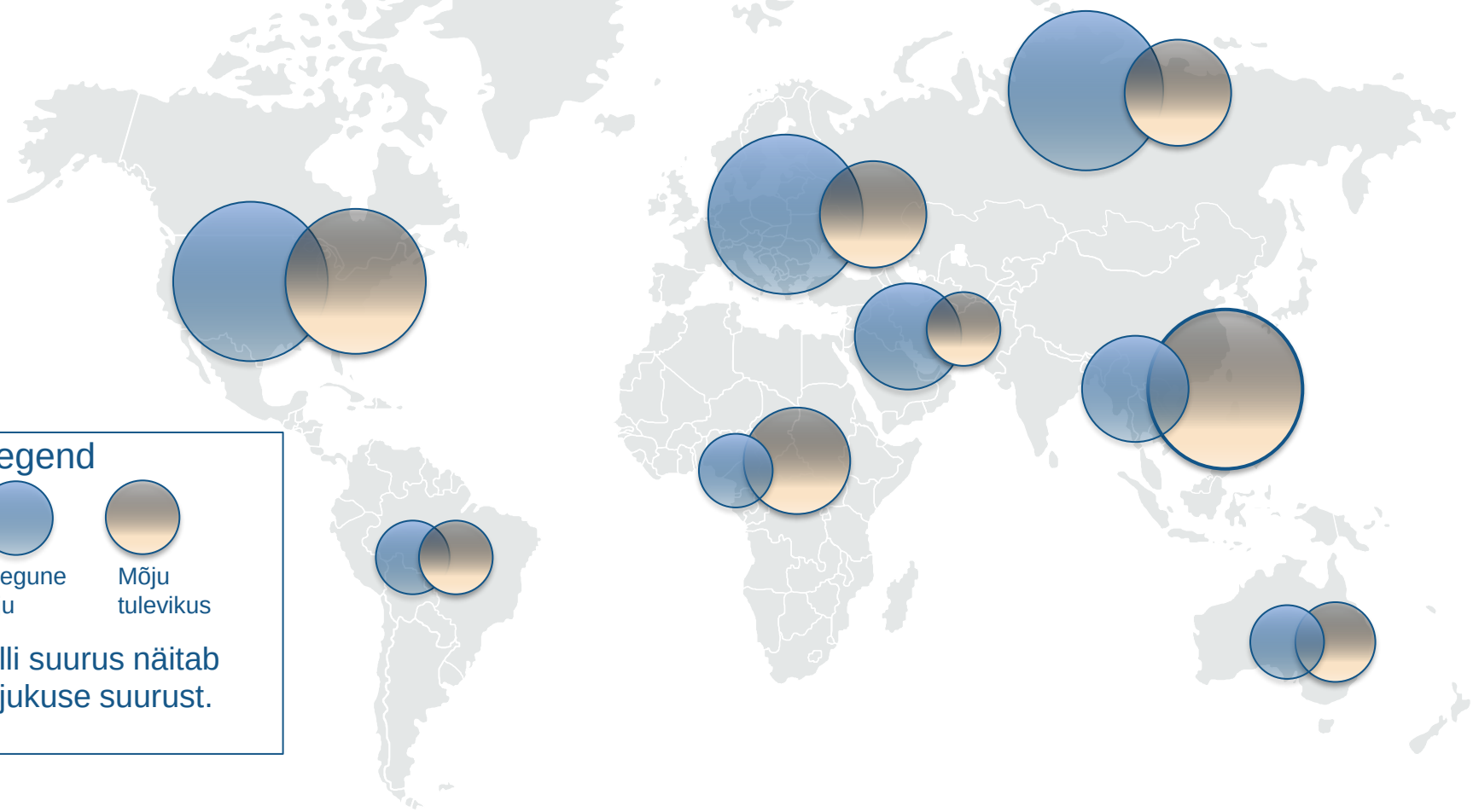
Mõjuvõim maailmas

Mõju	Kasvab	Stabiilne	Väheneb
Energiaressursid	USA Aafrika Austraalia	Ladina-Ameerika	Venemaa, EL Lähis-Ida
Majandus	Asia Middle East Africa	USA Ladina-Ameerika EL	Venemaa
Energia tarbimine	Asia Middle East Africa Latin America	EL Jaapan USA Venemaa	



Legend

Praegune mõju

Mõju tulevikus

Mulli suurus näitab mõjukuse suurust.

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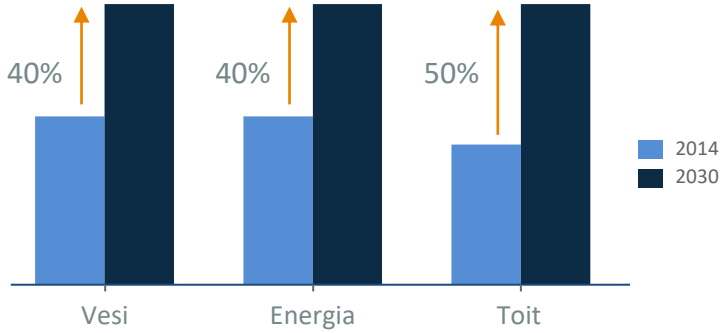
Tarbimine aastal 2050

Riik	2050 SKP inimese kohta (USD)
USA	$182,359
Saksamaa	$156,940
Jaapan	$106,234
Hiina	$91,179
Indoneesia	$47,925
India	$43,766

Linnad peavad hakkama saama oluliselt kasvanud nõudlusega erinevate teenuste järele

Nõudlus teenuste järele linnades



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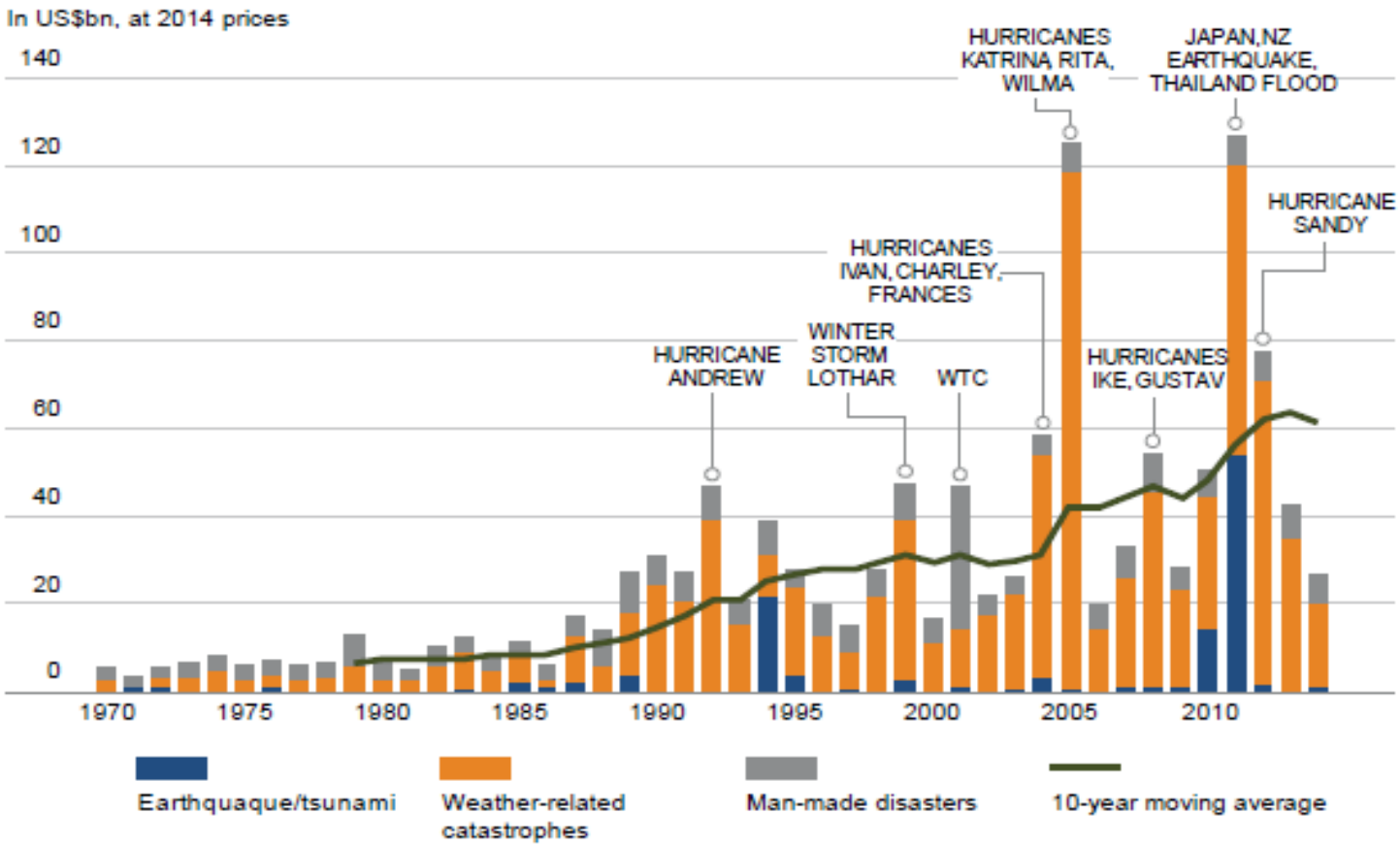
Kliima muutub

Insured catastrophe losses, 1970–2014

Source: Swiss Re, 2015: Sigma Report No. 2/2015



"Ekstreemsete ilmastikunähtuste sagedus on kasvanud 4 korda, 1980 registreeriti 38, 2014 aga 174 juhust."

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Source: 2015 - **World Energy Perspective -** The road to resilience − managing and financing extreme weather risks

Arvutustehnika areng

Moore'i seadus peab jätkuvalt paika, kas ka kui kaua ka edaspidi?

www.intel.com/pressroom/kits/events/moores_law_40th/

(Gordon) Moore's Law: 1965

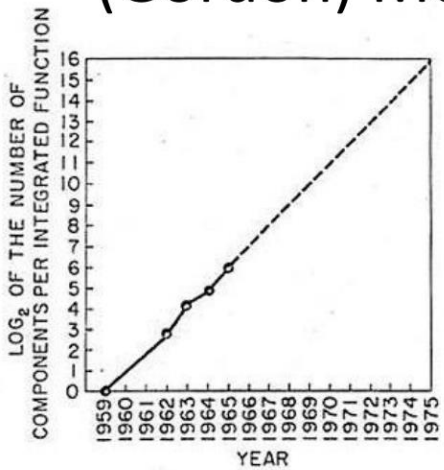

Fig. 2 Number of components per integrated function for minimum cost per component extrapolated vs time.

Võimalikud tagajärjed:

- *Geo-engineering*
- Kaugtöö
- Kaugpuhkus
- Masinad disainivad masinaid
- Optimaalne transport
- …

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Veel potentsiaalselt olulisi trende

Tehnoloogia	Ärimudelid	Kliimamuutus
• 3D printimise mõju transpordile • Elektri salvestamine • Arvutustehnika areng • Võrkude tulevik • Elektrisõidukid	• CO2 hind • Jagamise-majandus	• COP21 • Kohanemine või ennetamine

Energia	Tarbimine	Geopoliitika
• Energia, vesi, toit	• Aafrika • Hiina keskklass	• Demokraatia lõpp? • OPEC-i lõpp? • Natsionalism, regionalism, globalisatsioon

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SCENARIOS 2050

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Džäss või sümfoonia?

JAZZ

As an energy scenario, Jazz has a focus on energy equity with priority given to achieving individual access and affordability of energy through economic growth.

SYMPHONY

As an energy scenario, Symphony has a focus on achieving environmental sustainability through internationally coordinated policies and practices.

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Kliima ja majandus

JAZZ	SYMPHONY
CO_2 emissions in the Jazz scenario follow a trajectory consistent with a long-term atmospheric concentration of all GHGs of between 590 and 710 parts per million CO_2 equivalent.	Symphony is on track for 490-535 ppm CO_2 equivalent.

GDP per capita (US$2010 MER)

$9,160
in 2010

$23,140
Jazz 2050

$18,320
Symphony 2050

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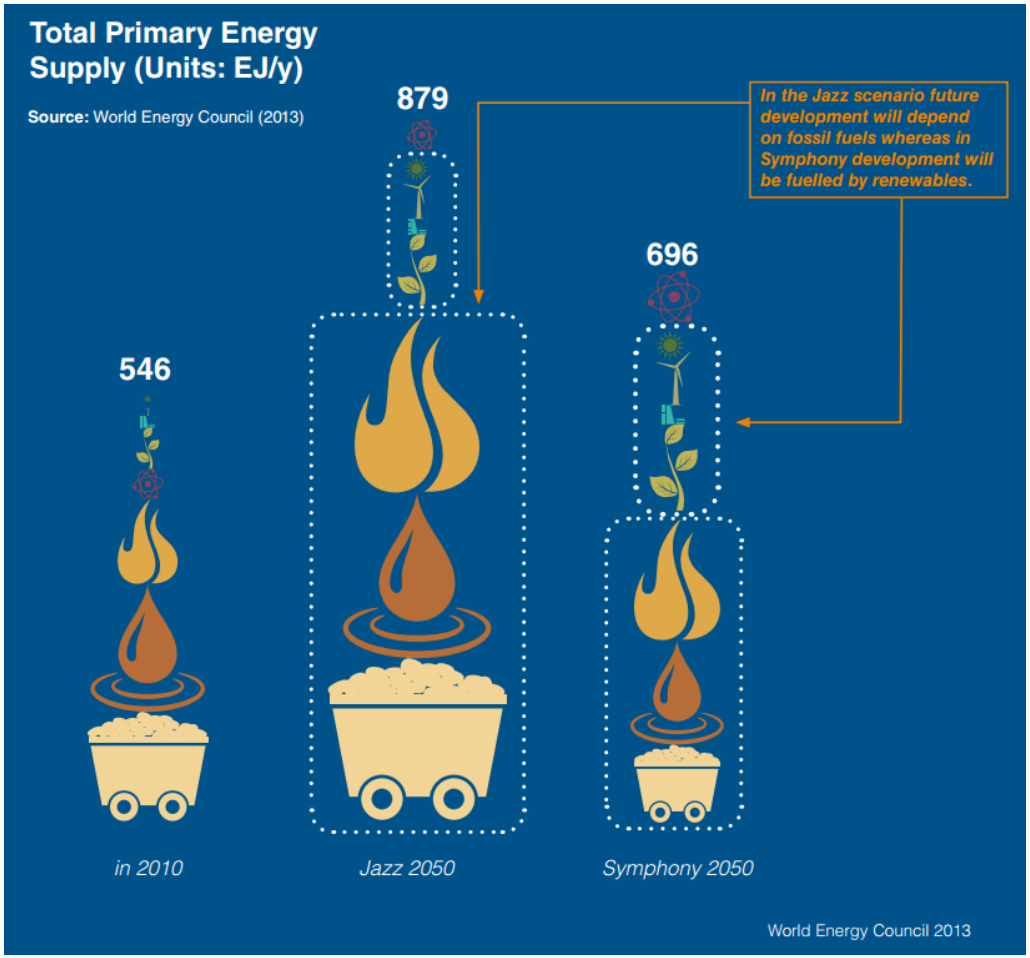
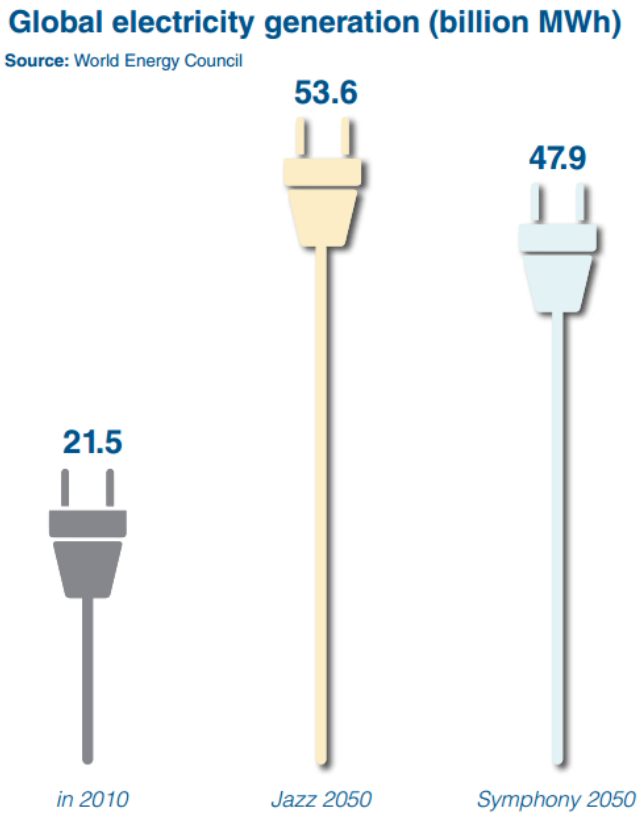
Energiaga varustatus 2050. a





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Mõned olulisemad näitajad

	2010	Jazz	Symphony
Maailma rahvastik	7 mld	8,7 mld	9,3 mld
SKP in kohta	9 000 USD	23 000 USD	18 000 USD
Autode arv 1000 in kohta	124	244	193
Kliimapoliitika		Piiratud	Tugev
Energia efektiivsus		Kasvab	Kasvab kiiresti
Primaarenergiaga varustatus	546 EJ	879 EJ (+61%)	696 EJ (+27%)
Fossiilkütuste osakaal	79%	77%	59%
CO2 emissioon	30,5 Gt/aastas	44,1 Gt/aastas	19,1 Gt/aastas

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Arutelu

- Millised olulised trendid on puudu?
- Millised ebaolulised trendid on käsitletud?
- Millised trendid on valesti käsitletud?

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Tänan!

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