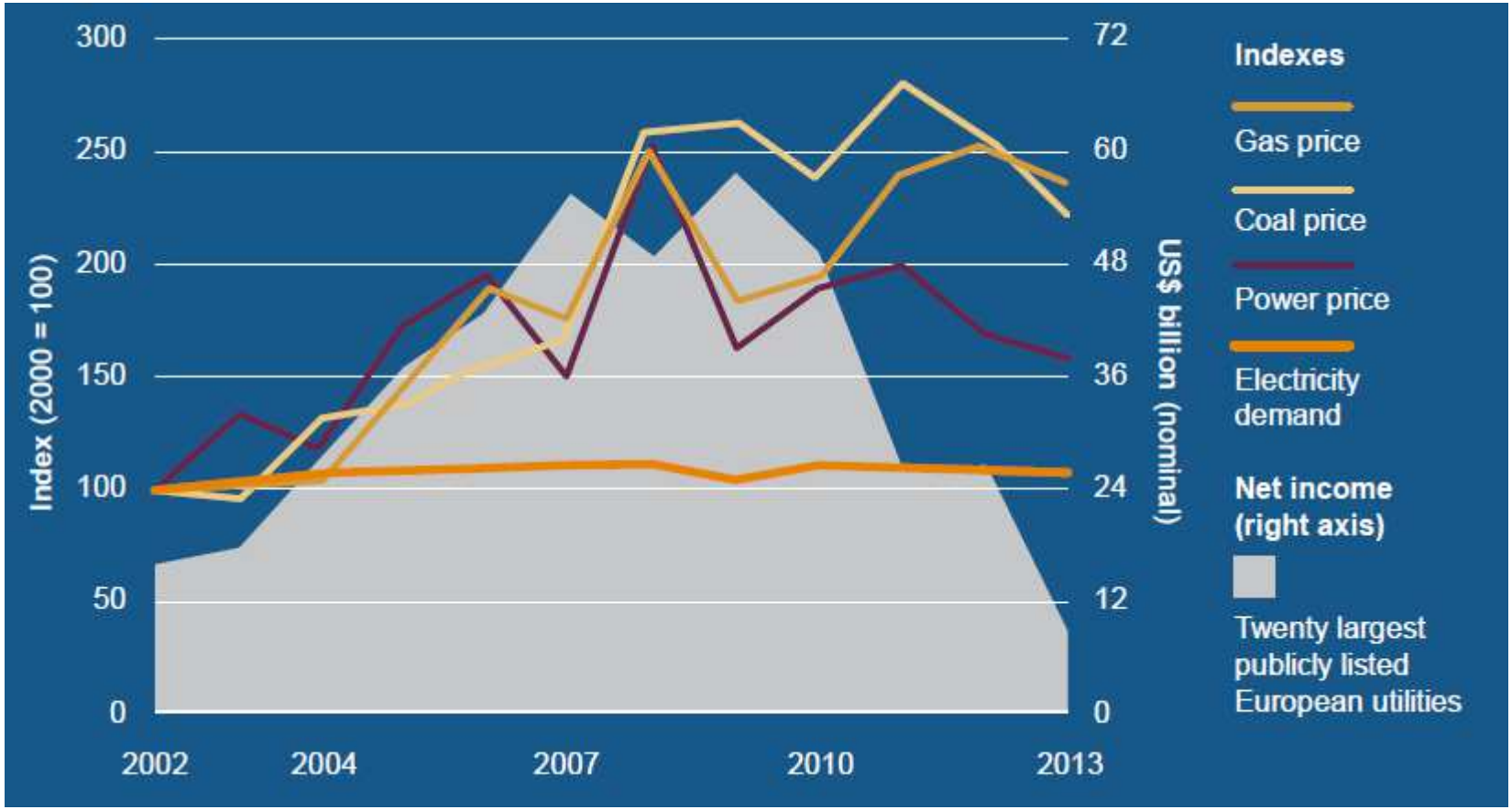
WORLD ENERGY COUNCIL
CONSEIL MONDIAL DE L'ÉNERGIE
For sustainable energy.

World Energy Trilemma

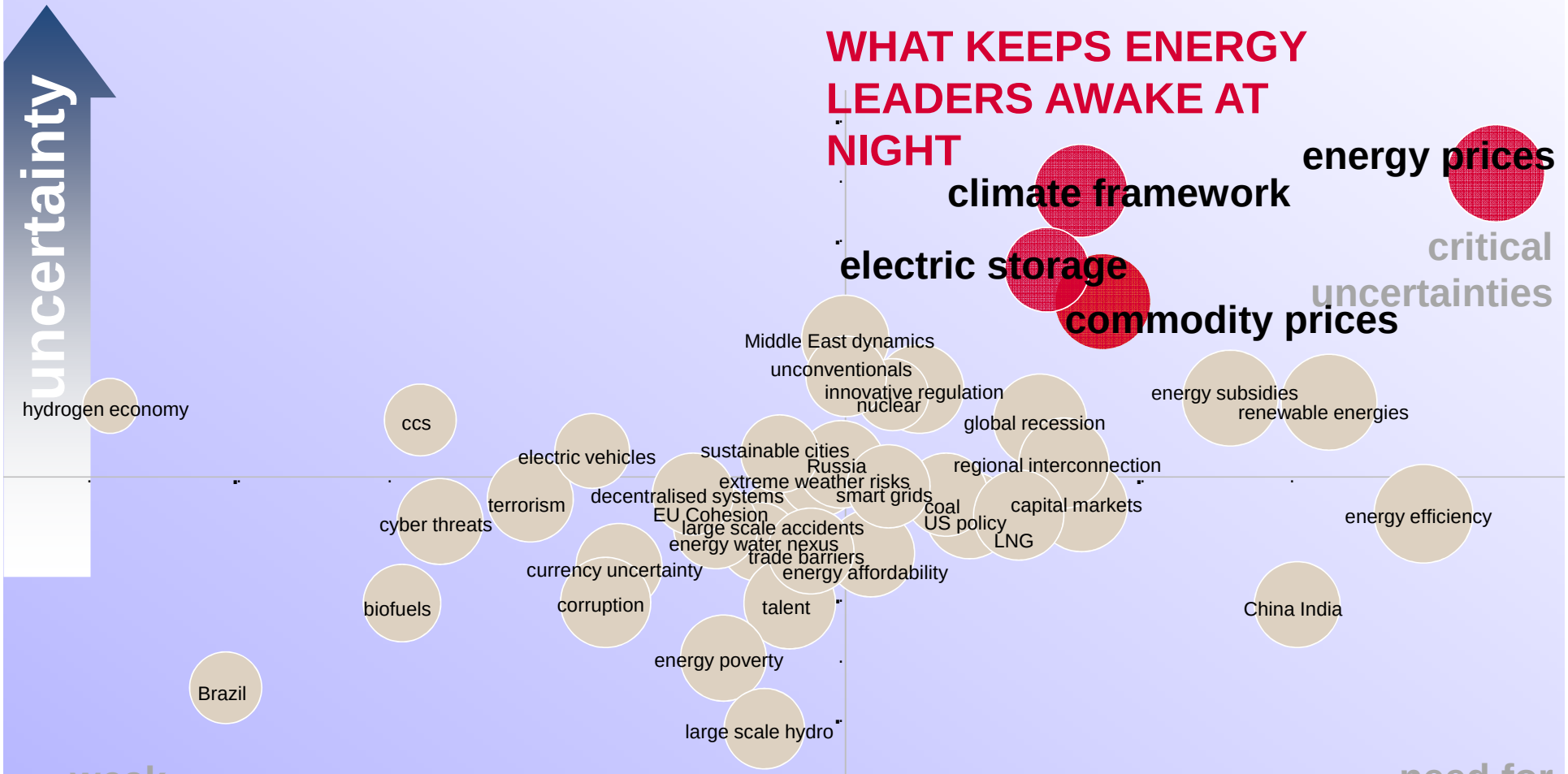
Univ.Prof. DI Karl Rose

Top 10 - Energy Trilemma Performers

Net income for EU‘s top 20 utilities

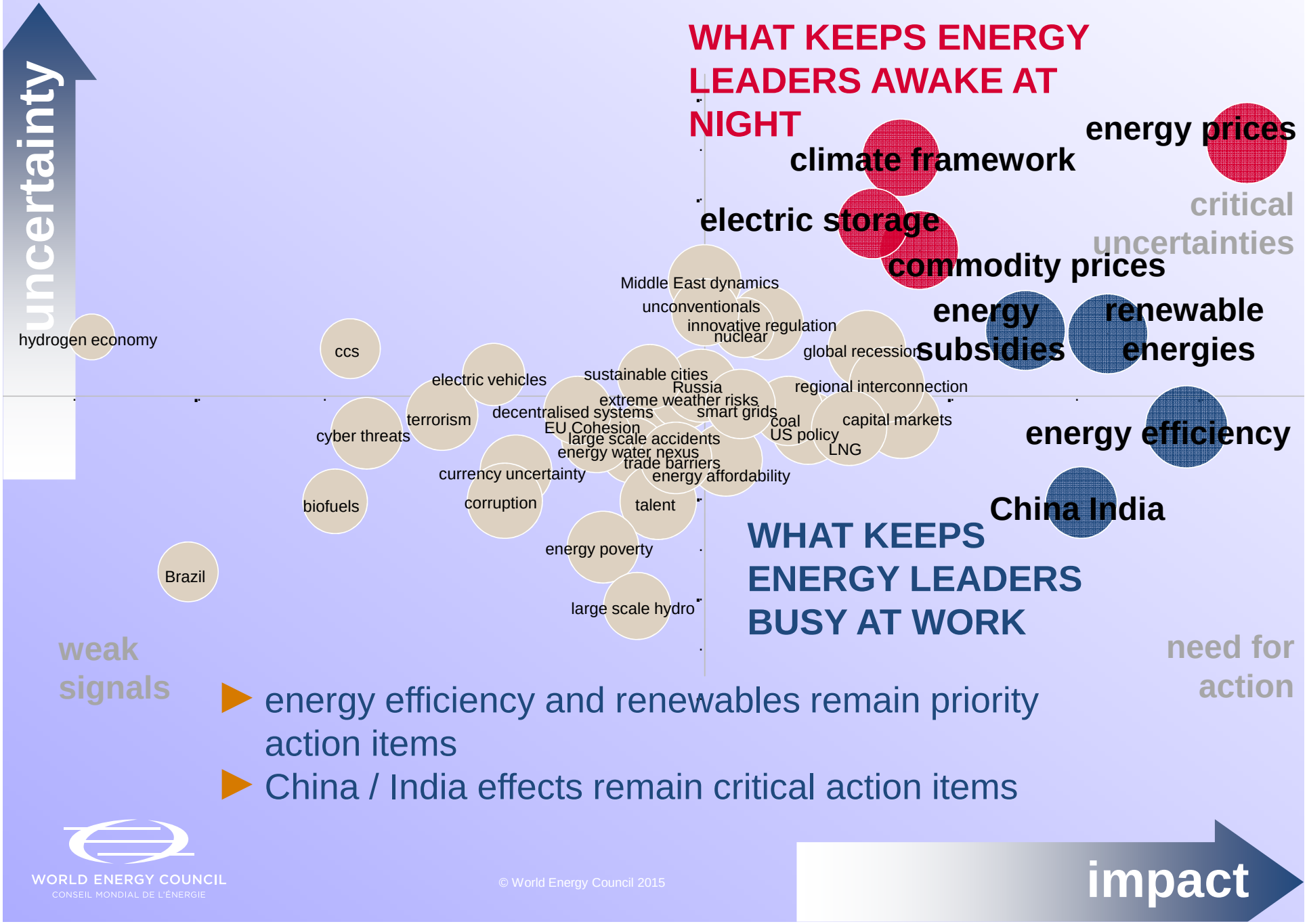


WHAT KEEPS ENERGY LEADERS AWAKE AT NIGHT



- high volatility is the ‘new normal’
- CO2 uncertainty and storage are the other key uncertainties

impact



- energy efficiency and renewables remain priority action items
- China / India effects remain critical action items

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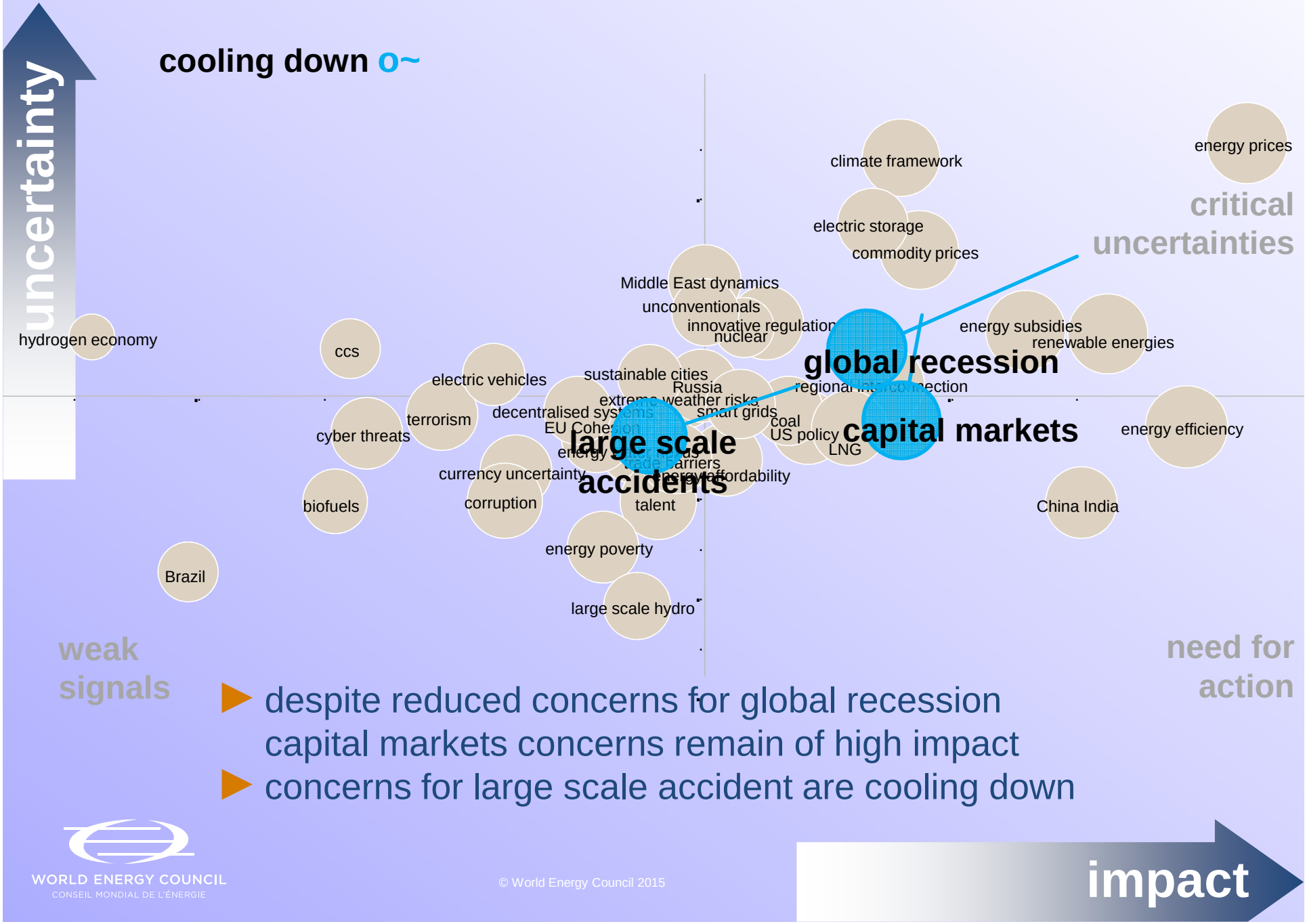

- despite reduced concerns for global recession capital markets concerns remain of high impact
- concerns for large scale accident are cooling down

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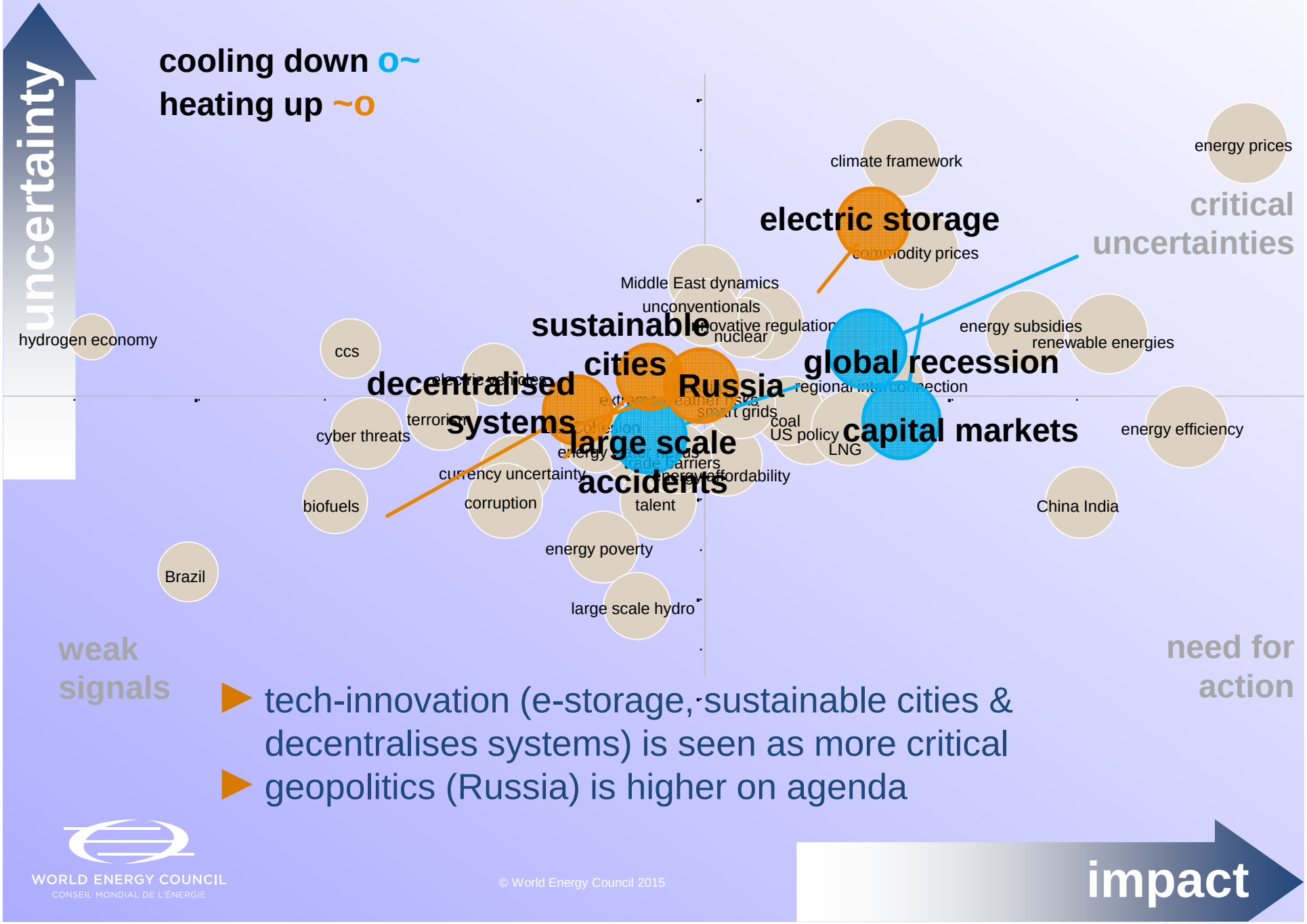

- tech-innovation (e-storage, sustainable cities & decentralises systems) is seen as more critical
- geopolitics (Russia) is higher on agenda

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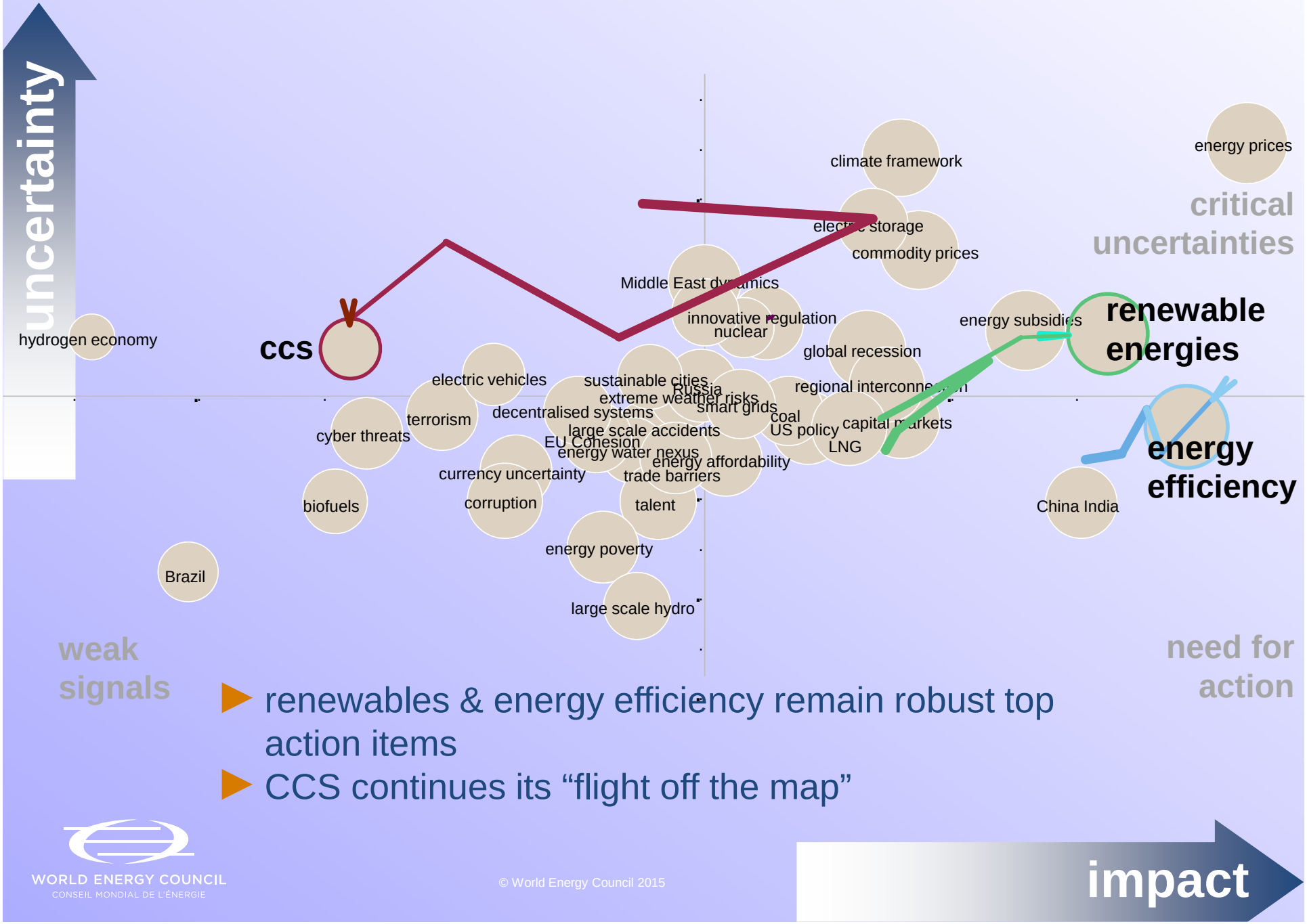

- renewables & energy efficiency remain robust top action items
- CCS continues its “flight off the map”

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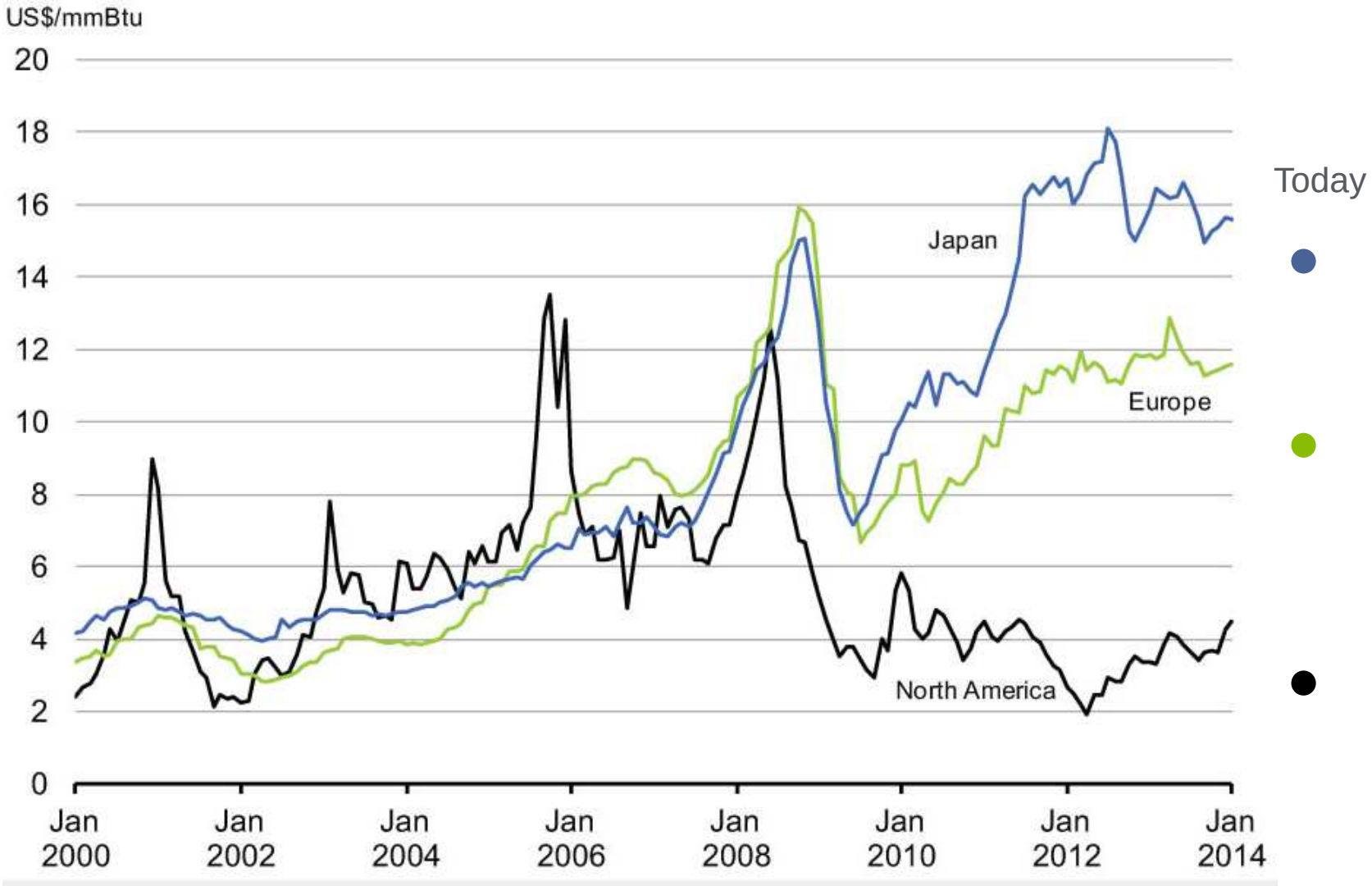
Globaler Vergleich der Gaspreise



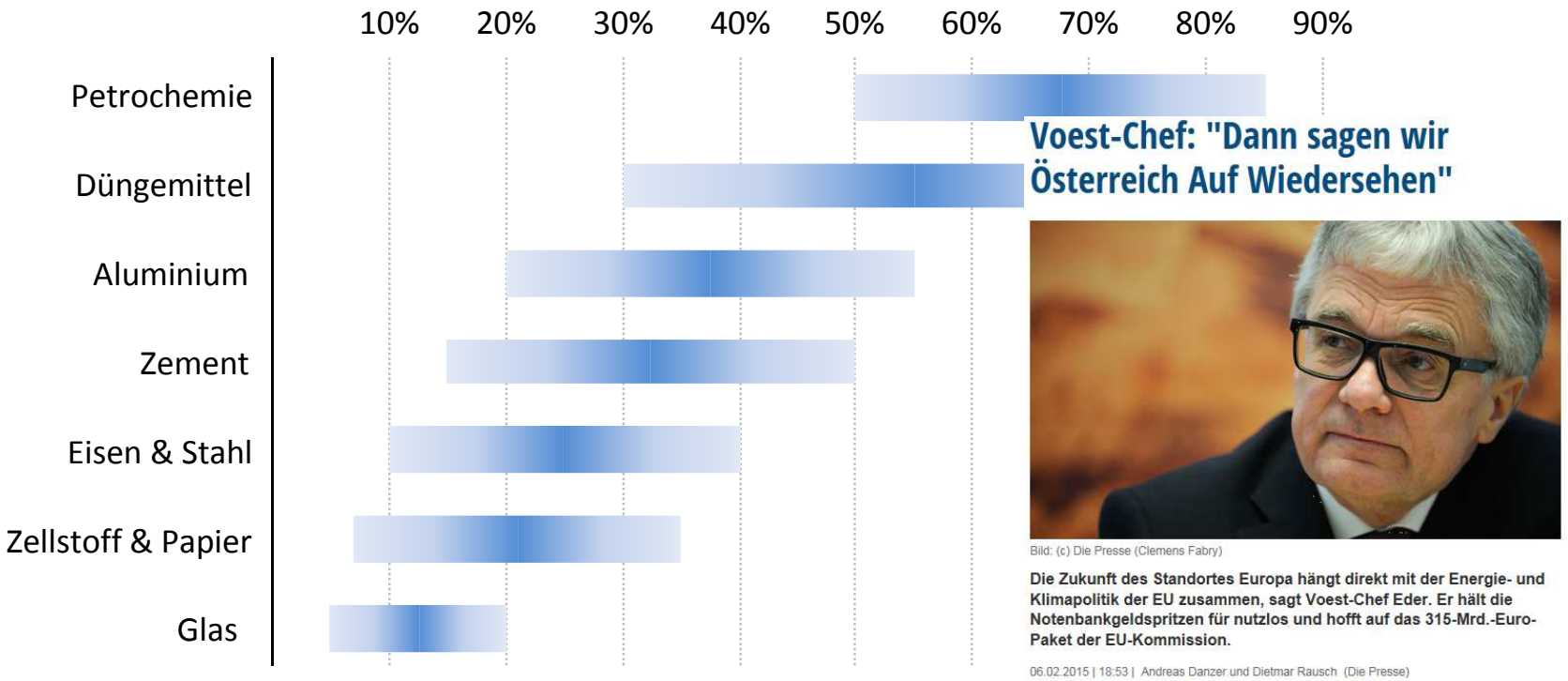
Source: World Bank

Wirtschaftlicher Wettbewerb und Klima

- Gas, nicht Strom, ist das eigentliche Problem für den Standort
- Billiges Gas (und billige Kohle) sind durch Erneuerbare Energien im globalen Wettbewerb auch mittel- bis langfristig nicht zu ersetzen
- EU Energiepolitik der letzten Jahre mit starkem Fokus auf der Umsetzung von Umweltzielen (20/20/20)
- Kooperation mit Russland oder USA ist eine energiepolitische Notwendigkeit von höchster Priorität
- EU wird in energieintensiven Sektoren als Standort zurückfallen
- Ohne einen globalen Klimavertrag werden wir die wirtschaftliche Wettbewerbsfähigkeit des Standorts Europa nicht erhalten können

Auswirkung auf energieintensive Industrien

Anteil der Energie an den gesamten Produktionskosten



Voest-Chef: "Dann sagen wir Österreich Auf Wiedersehen"

Bild: (c) Die Presse (Clemens Fabry)

Die Zukunft des Standortes Europa hängt direkt mit der Energie- und Klimapolitik der EU zusammen, sagt Voest-Chef Eder. Er hält die Notenbankgeldspritzen für nutzlos und hofft auf das 315-Mrd.-Euro-Paket der EU-Kommission.

06.02.2015 | 18:53 | Andreas Danzer und Dietmar Rausch (Die Presse)

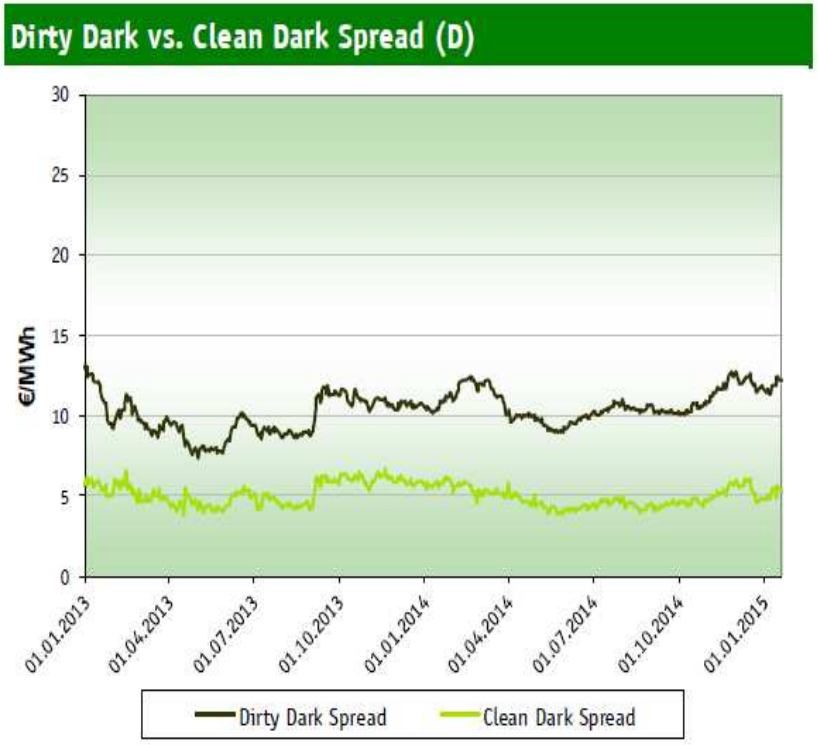
Energieintensive Industrien repräsentieren weltweit ungefähr 20% der industriellen Wertschöpfung, 25% der Beschäftigung und 70% des industriellen Energieverbrauchs

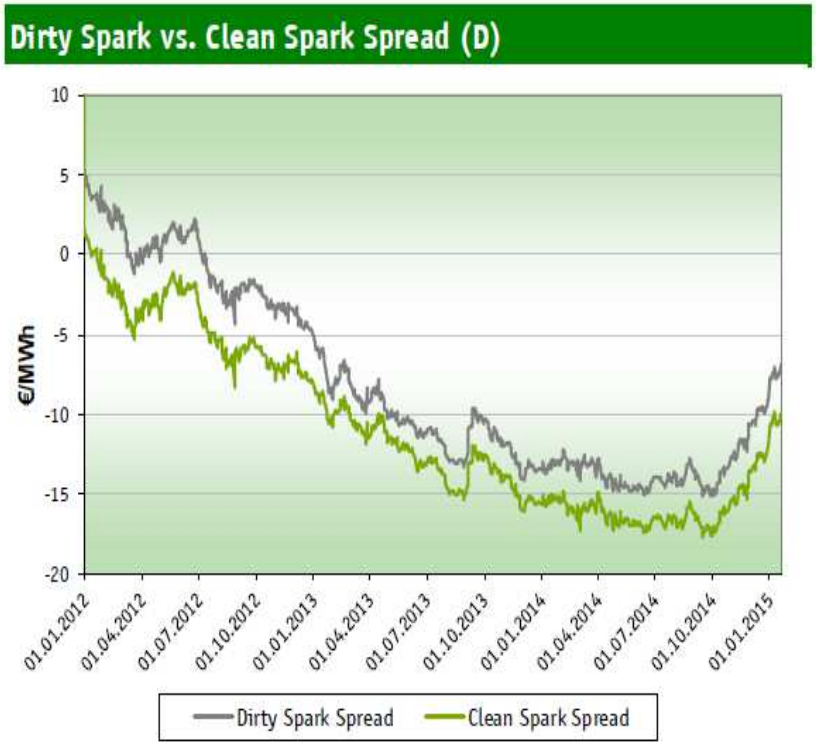
Quelle: World Energy Outlook 2013; IEA

Auswirkungen auf den Strommarkt

Quelle: ESTAG Übersicht Energiemärkte

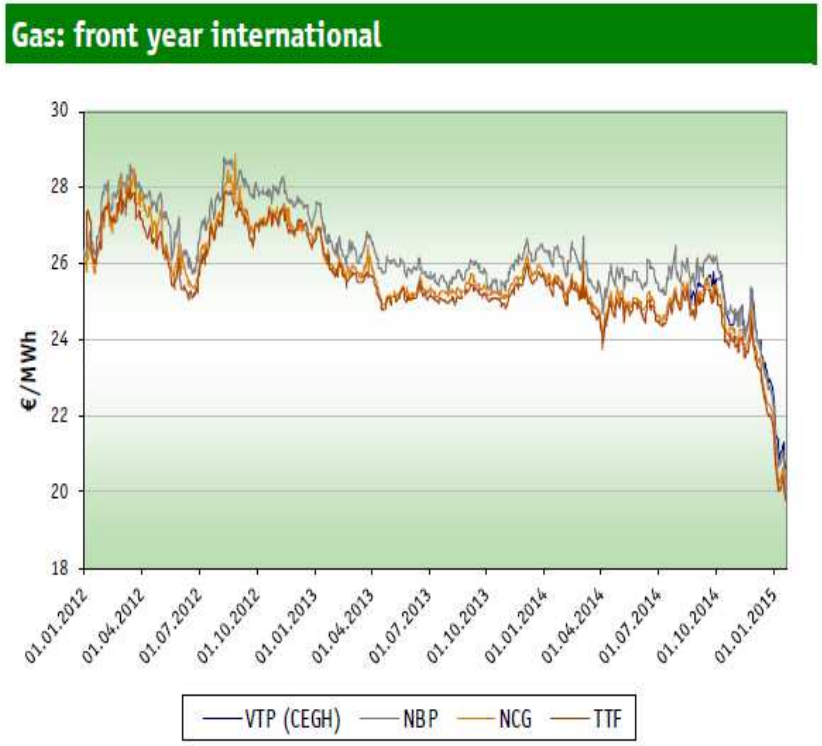
Energiemärkte





Quelle: ESTAG Übersicht Energiemärkte

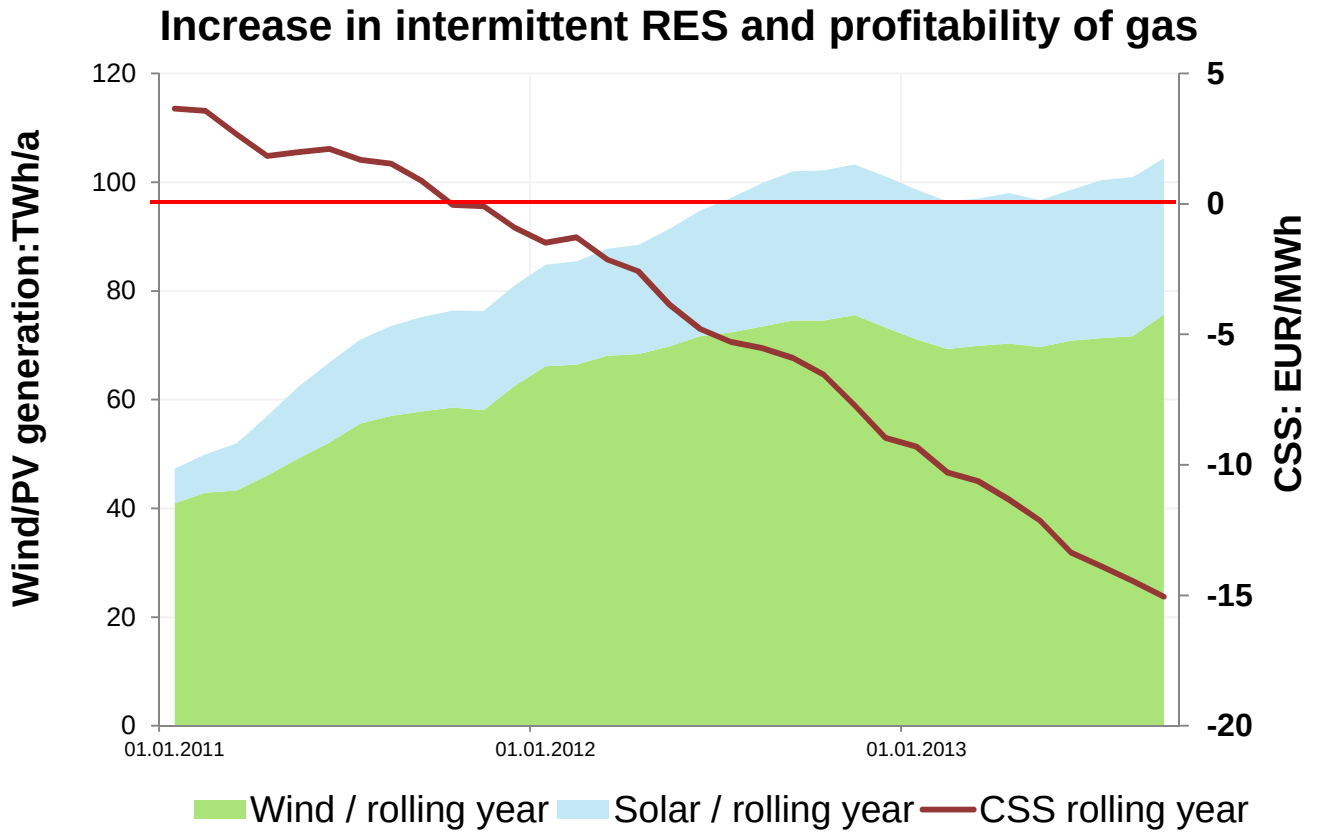
Energiemärkte



Quelle: ESTAG Übersicht Energiemärkte

Wirtschaftlichkeit von Gaskraftwerken

Since 2011 no profitability of gas generation.
Highly efficient CCGT plants need to be mothballed



CSS: Clean Spark Spread

– margin between power prices and short run marginal cost of gas condense generation

Wirtschaftlichkeit von Gaskraftwerken

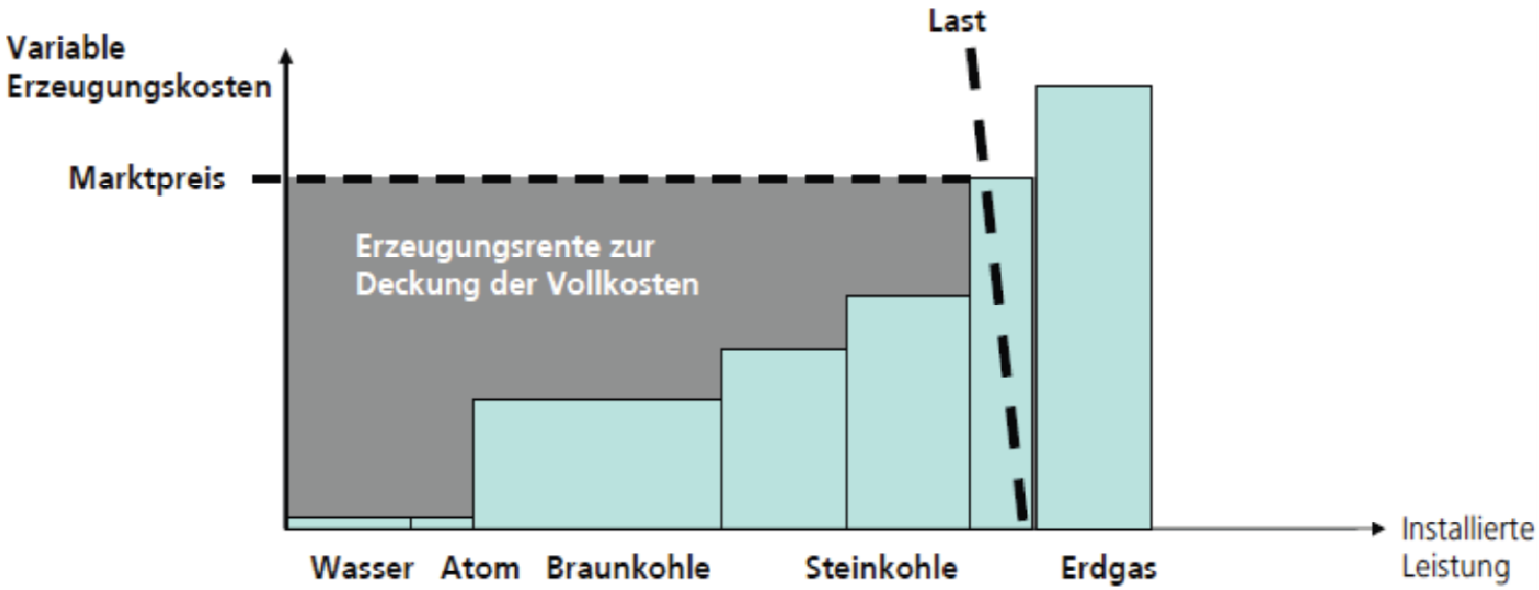
Kraftwerkspläne: Grazer "Nahwärme" als Gespenst

Will Graz wirklich im Stadtgebiet Wärme erzeugen, während das Kraftwerk Mellach stillsteht? Der mutig vorgetragene Plan erweist sich letztlich als eine Fiktion. *Von Ernst Sittinger*

Verbund-Kraftwerk in Mellach

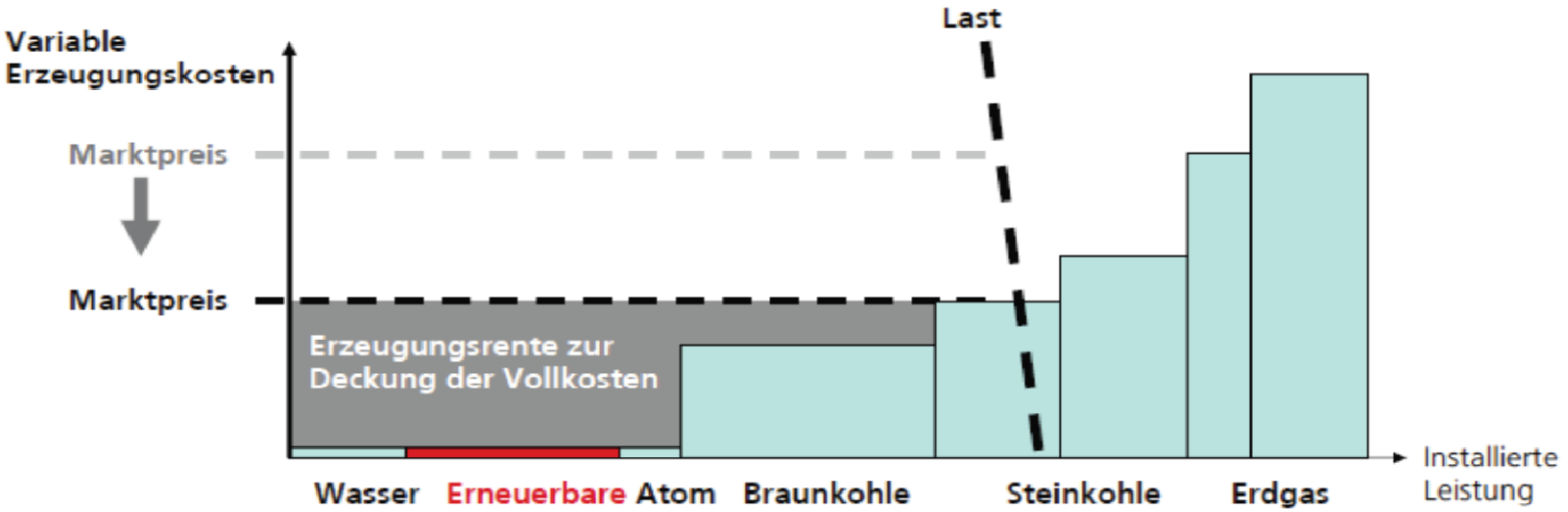
Foto © Sabine Hoffmann

Preisbildung im Stromgroßhandel 1/2



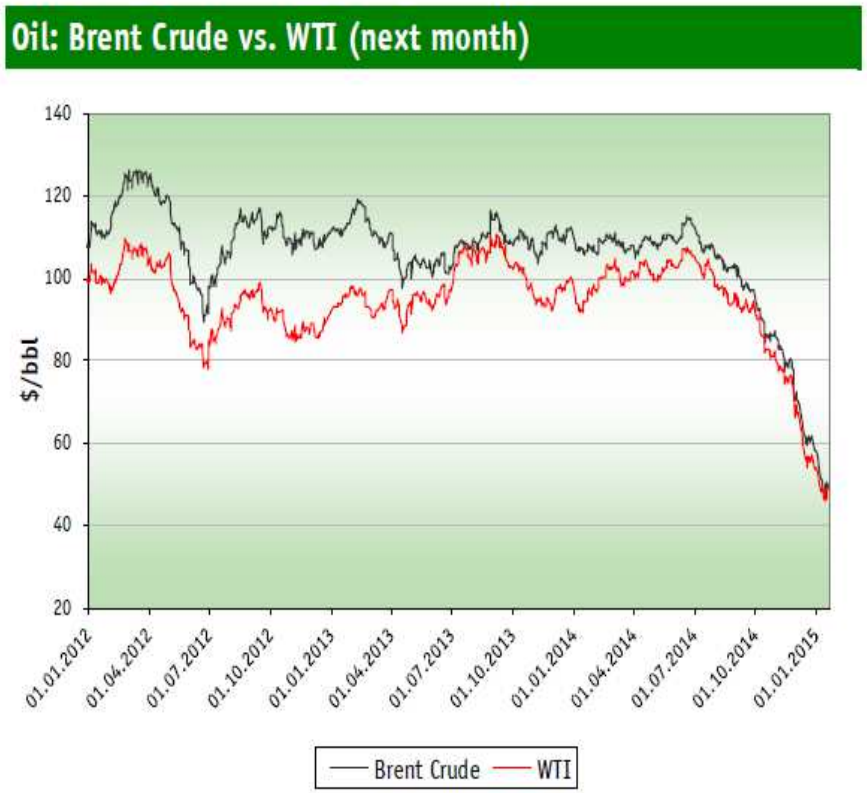
Die Preisbildung im Stromgroßhandelsmarkt (Merit-Order). Quelle: Kopp (2010, S.2)

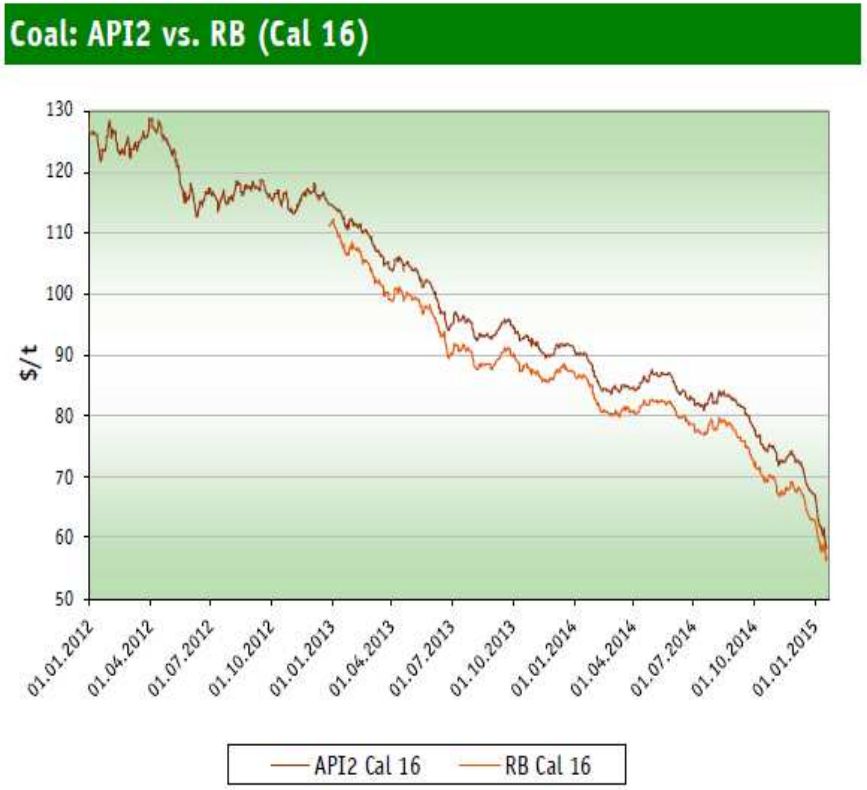
Preisbildung im Stromgroßhandel 2/2



Der Merit-Order-Effekt. Quelle: Kopp (2010, S. 3)

Energiemärkte

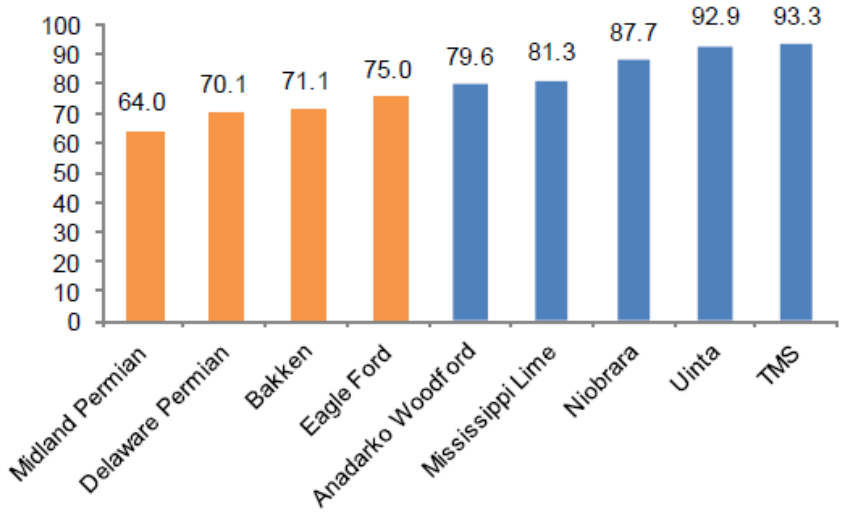




Quelle: ESTAG Übersicht Energiemärkte

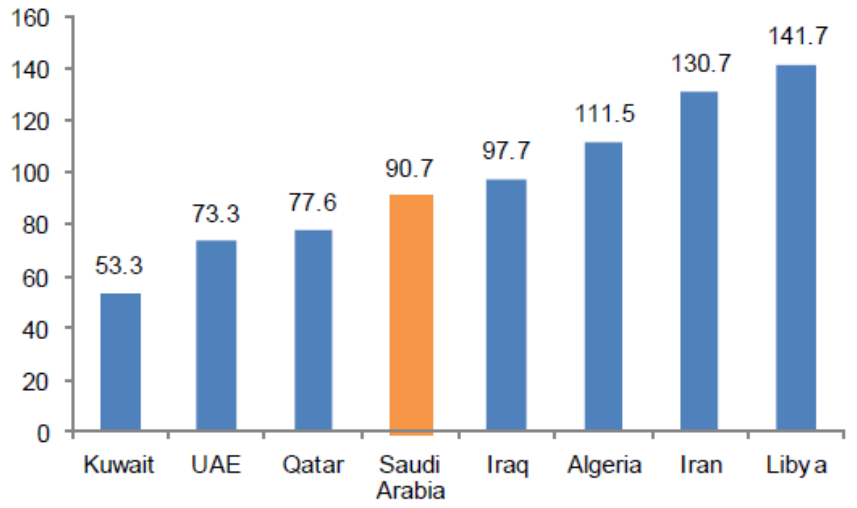
Oil breakeven costs

US shale oil breakeven costs by basin (WTI equivalent) $/bbl



Source: SG Cross Asset Research – Equities. Note: Median costs by company are shown.

OPEC Middle East/North Africa 2015 fiscal breakeven prices

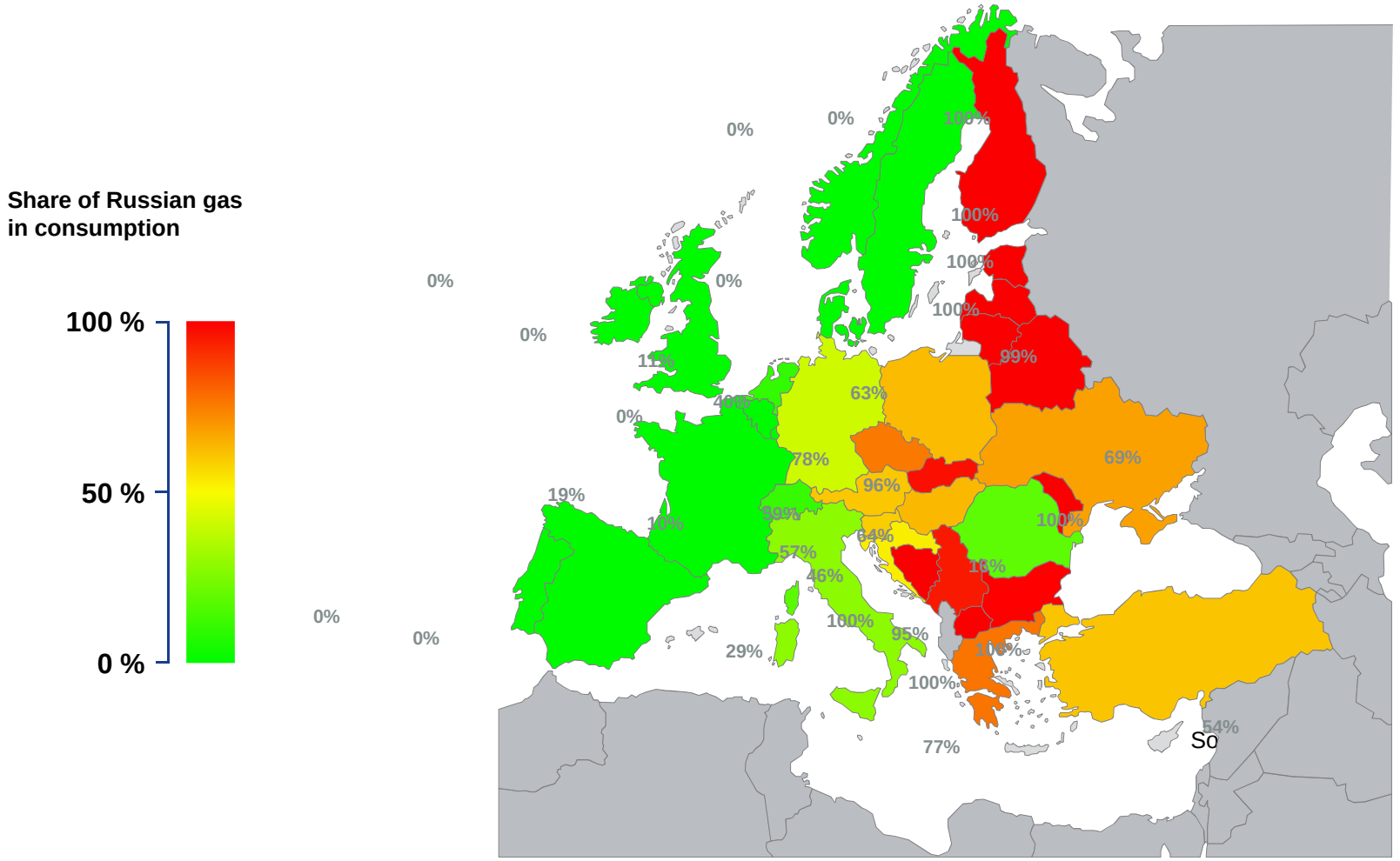


Source: IMF May 2014 Regional Economic Outlook, SG Cross Asset Research

Implications for the global economy

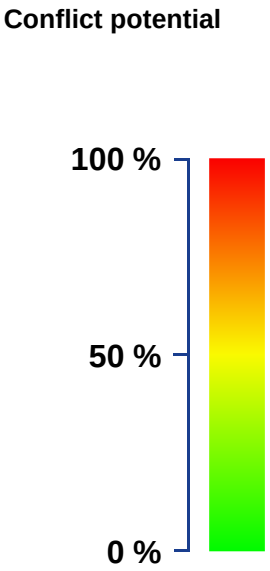
- China is the world's second-largest net importer of oil. Based on 2013 figures, every $1 drop in the oil price saves it an annual $2.1 billion. The recent fall, if sustained, lowers its import bill by $115 billion, or 6%. Most of its exports are manufactured goods whose prices have not fallen.
- Cheaper oil could make more of a difference to monetary policy. Fears of deflation apply in Europe. Energy imports into the European Union cost $500 billion in 2013, of which 75% was oil.
- But one group of countries gains unambiguously: those most dependent on agriculture. Agriculture is more energy-intensive than manufacturing. Energy is the main input into fertilizers, and in many countries farmers use huge amounts of electricity to pump water from aquifers far below, or depleted rivers far away. Farmers benefit from cheaper oil. And since most of the world's farmers are poor, cheaper oil is, on balance, good for poor countries.
- Cheaper oil cuts India's budget deficit, now 4.5% of GDP, by reducing fuel and fertilizer subsidies. These are huge: along with food subsidies, the total is $41 billion, or 14% of public spending and 2.5% of GDP.

Gas aus Russland



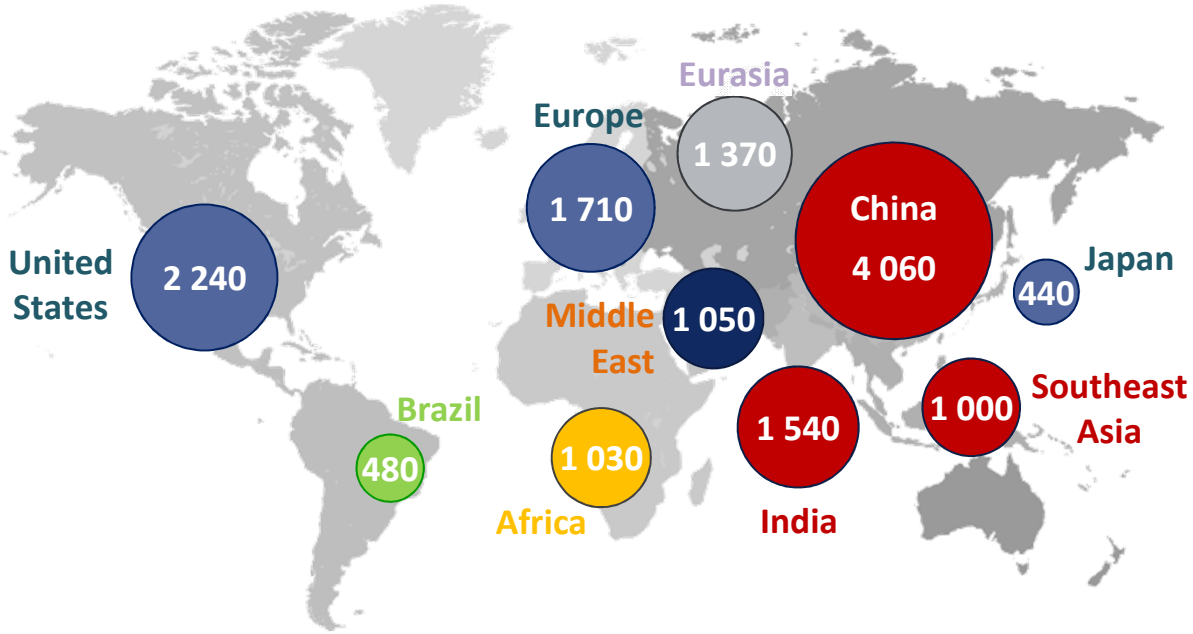
Source : CEDIGAZ- Estimate of international gas trade by pipeline in 2009

Russland

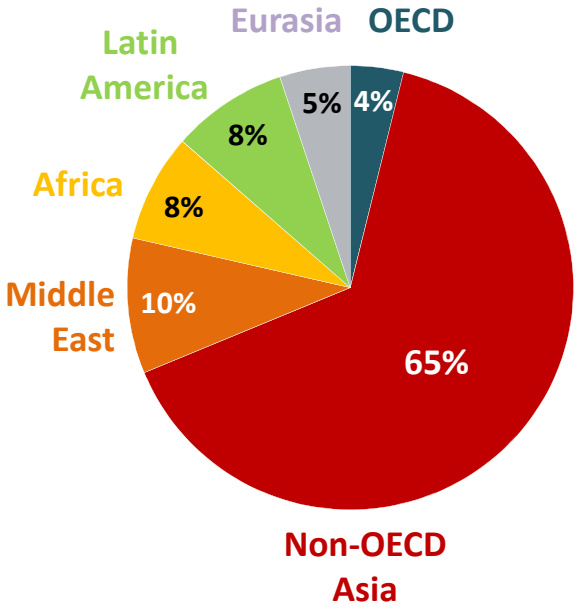


Sehr unterschiedliches regionales Wachstum

Primary energy demand, 2035 (Mtoe)



Share of global growth 2012-2035



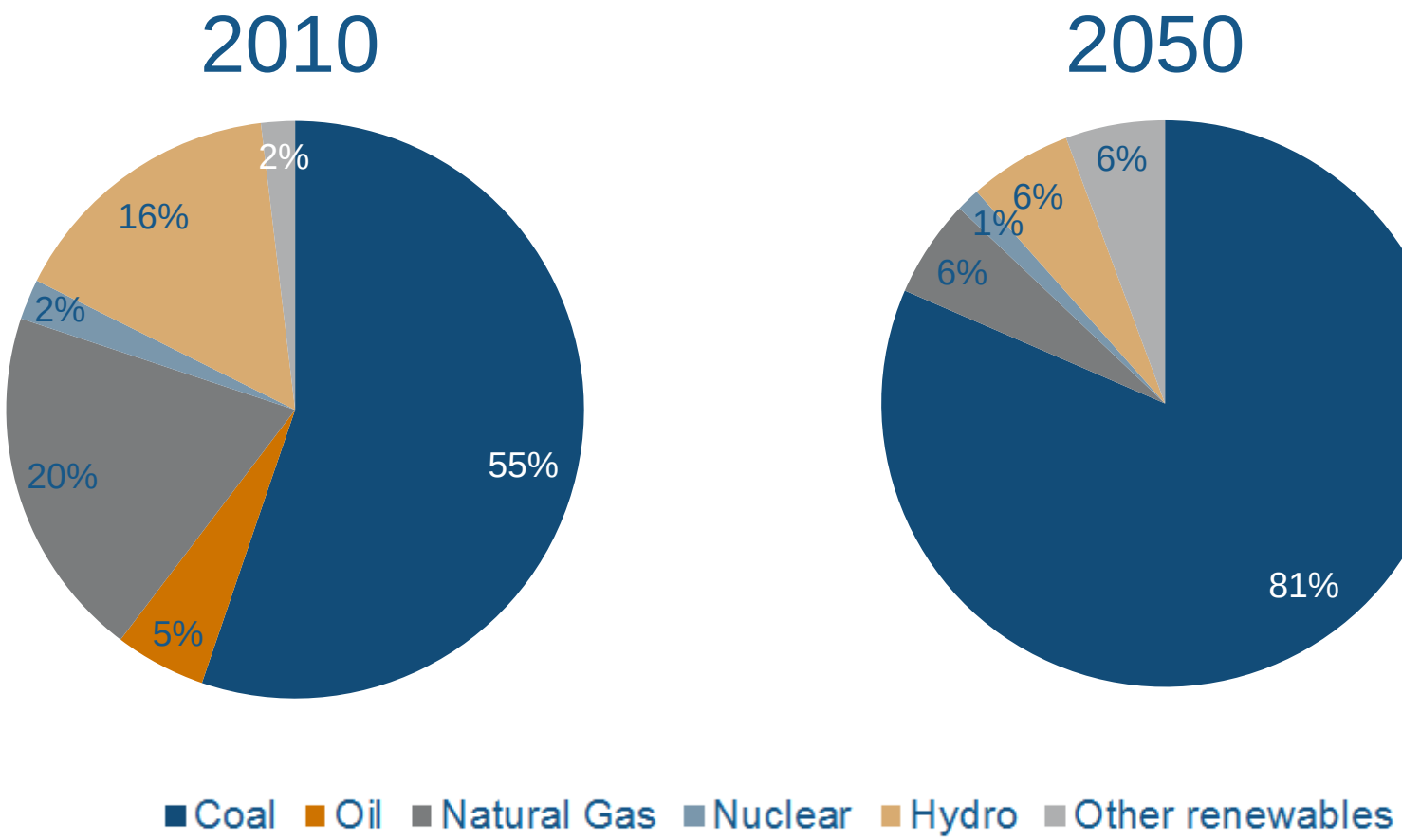
China dominiert die steigende Nachfrage im laufenden Jahrzehnt, danach übernimmt Indien die Rolle des primären Wachstumstreibers.

Quelle: IEA, WEO 2013

Energy supply challenges

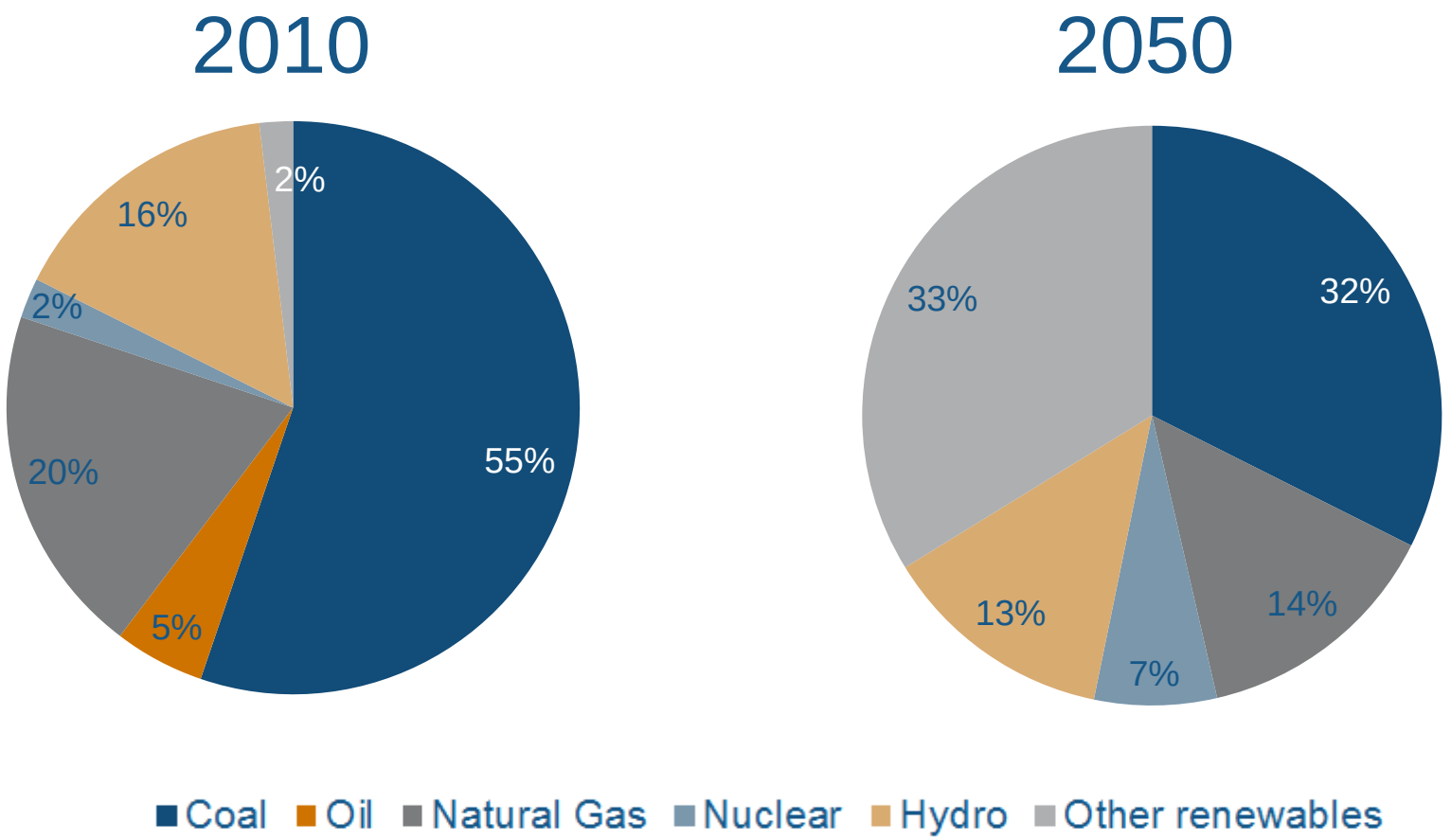
- Primary energy supply needs to be increased four to five times
- Electricity generation capacity/supply by six to seven times up to 2030/31 (as compared to 2003/04)
- Demand could reach 1500 GW by 2050.
- Coal accounts for 69% of TPES
- India's coal imports have more than doubled over the last five years
- National Action Plan stipulates 15% renewable contribution to the electricity generation mix by 2020
- All options are to be kept open including Nuclear
- Relatively low car ownership **India: 9%** vs Malaysia 67%

Regional Energy mix, Jazz



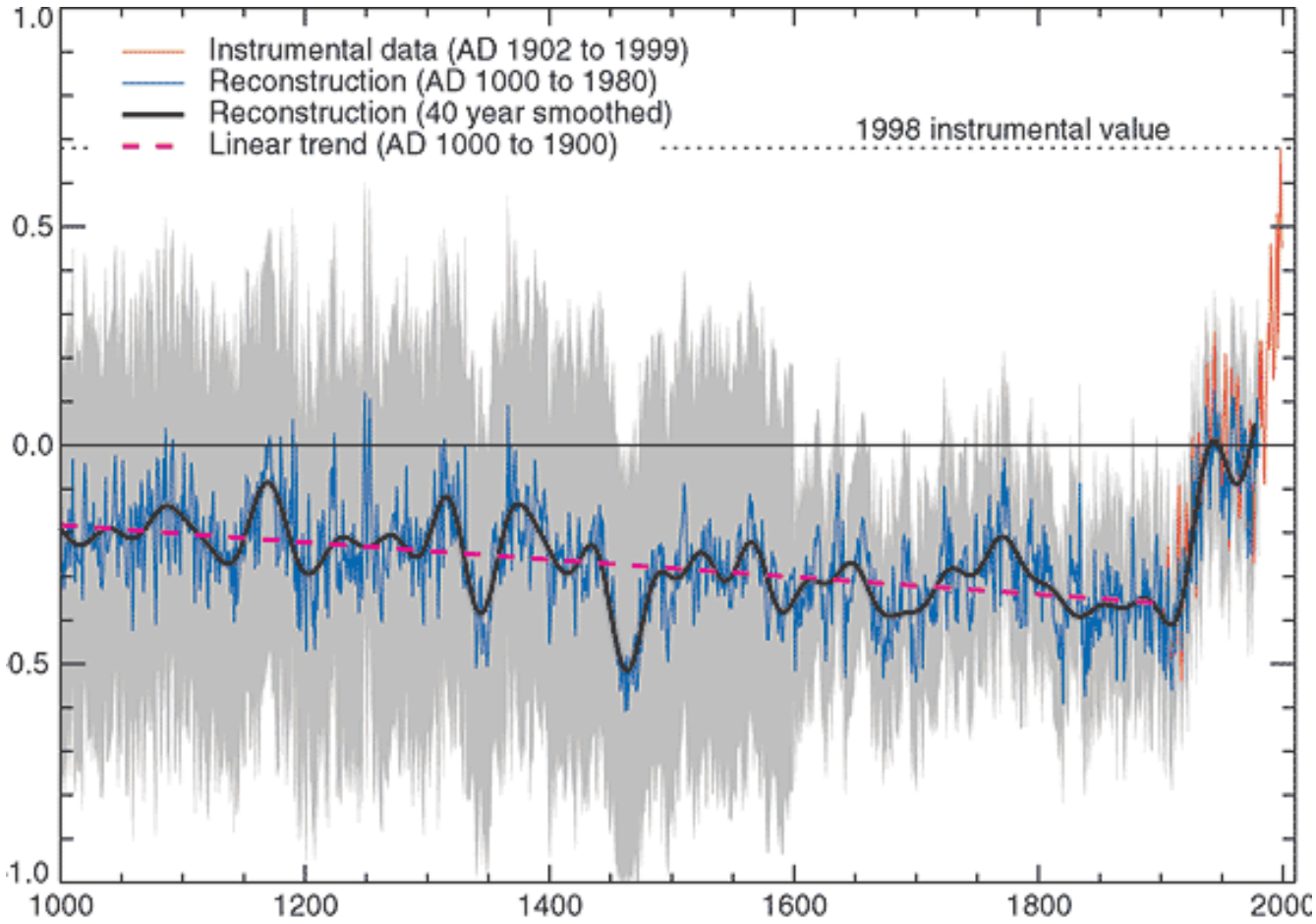
Source: World Energy Scenarios report, 2013

Regional Energy mix, Symphony



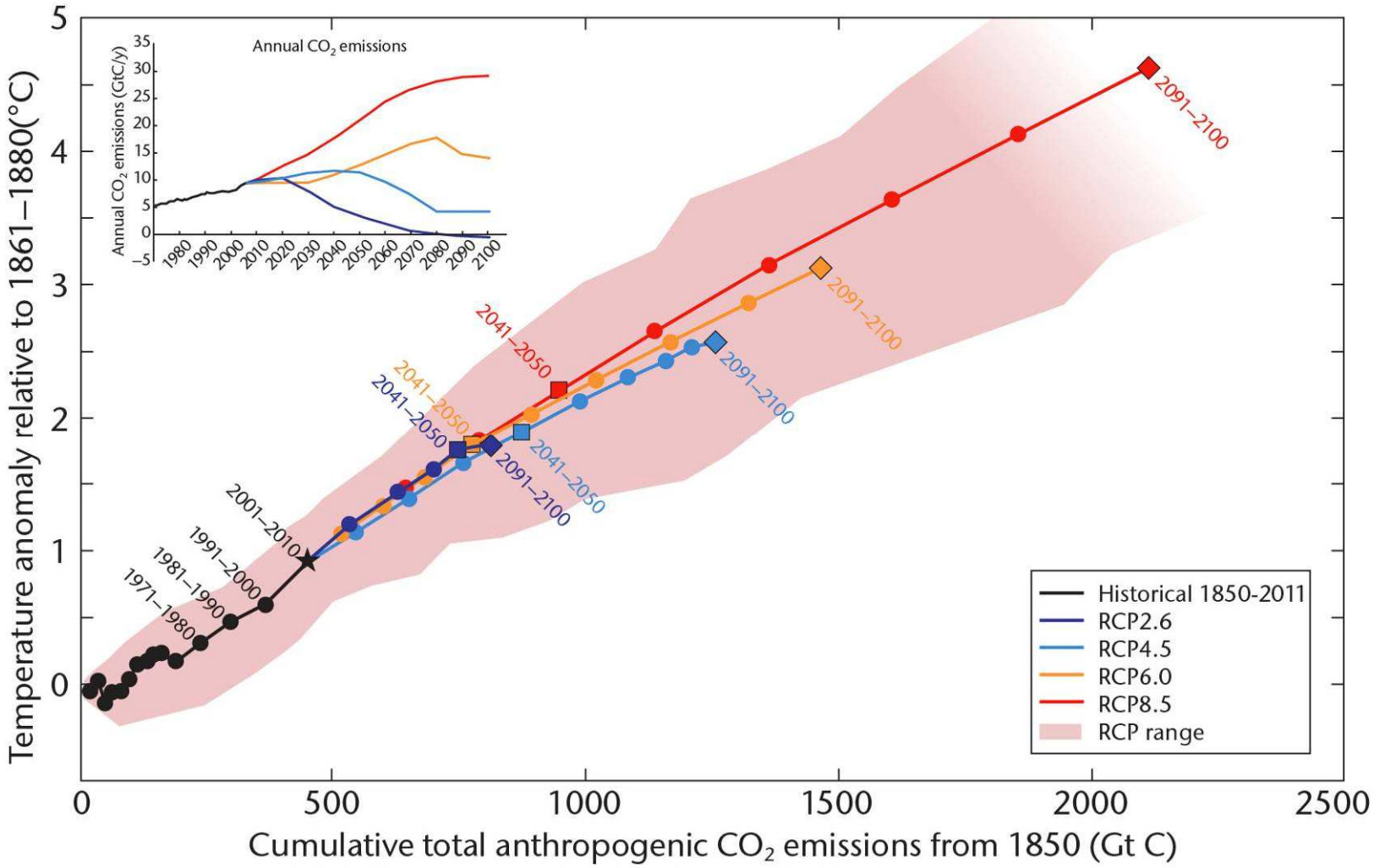
Source: World Energy Scenarios report, 2013

Problem Klimawandel



Quelle: Hockeystick nach Mann, M.E., R.S. Bradley and M.K. Hughes (1999) blau, schwarz: Rekonstruktionen aus Baumringen, Korallen, Bohrkernen, etc. rot: direkte Temperaturmessungen mittels Meßstationen ab 1860

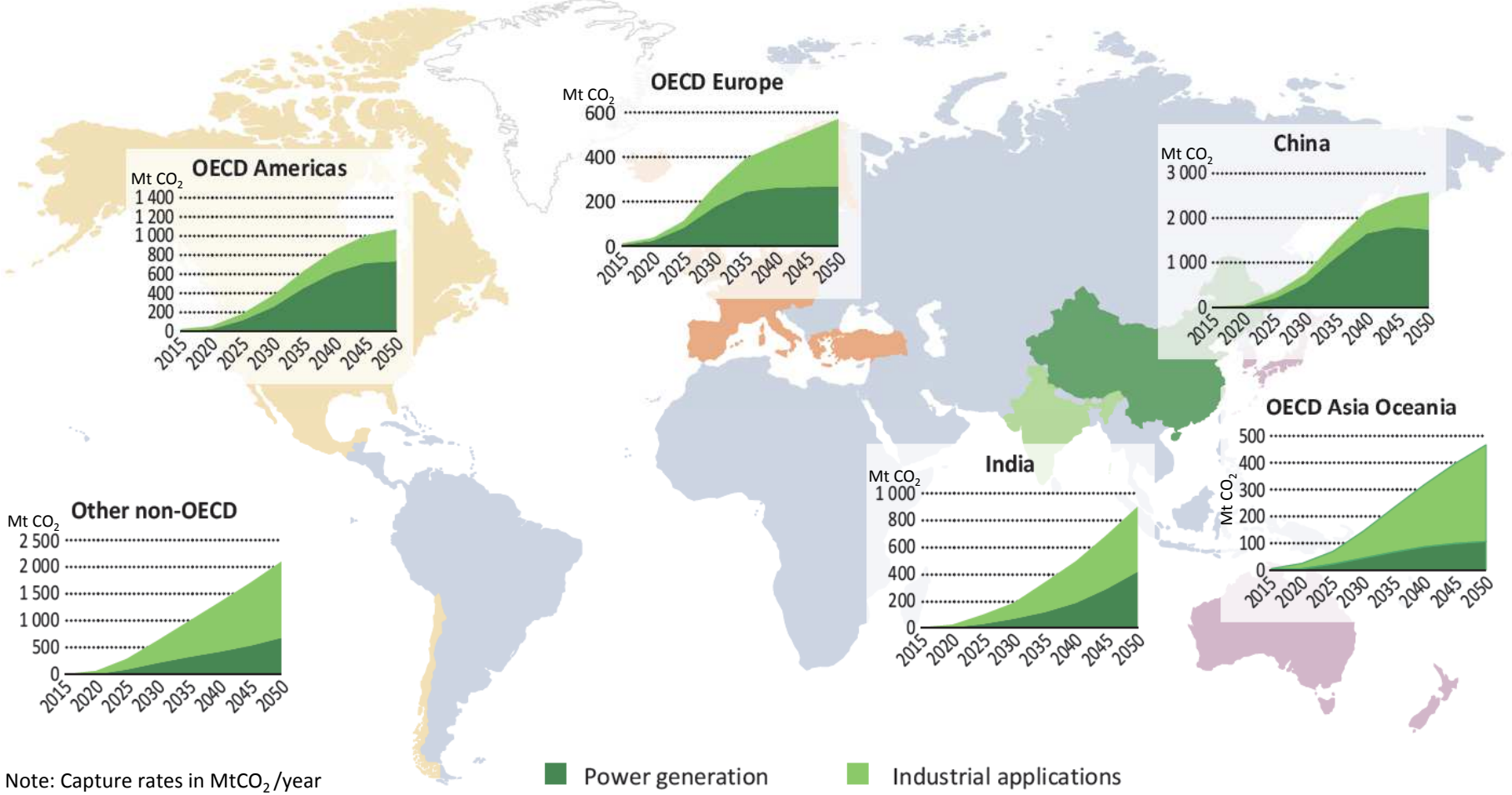
Szenarien des Temperaturanstiegs



Source: Met Office, 2013 (adapted from IPCC AR5 (2013))

The CCS infant must grow quickly

ETP 2012



Note: Capture rates in $MtCO_2$/year

International Energy Agency

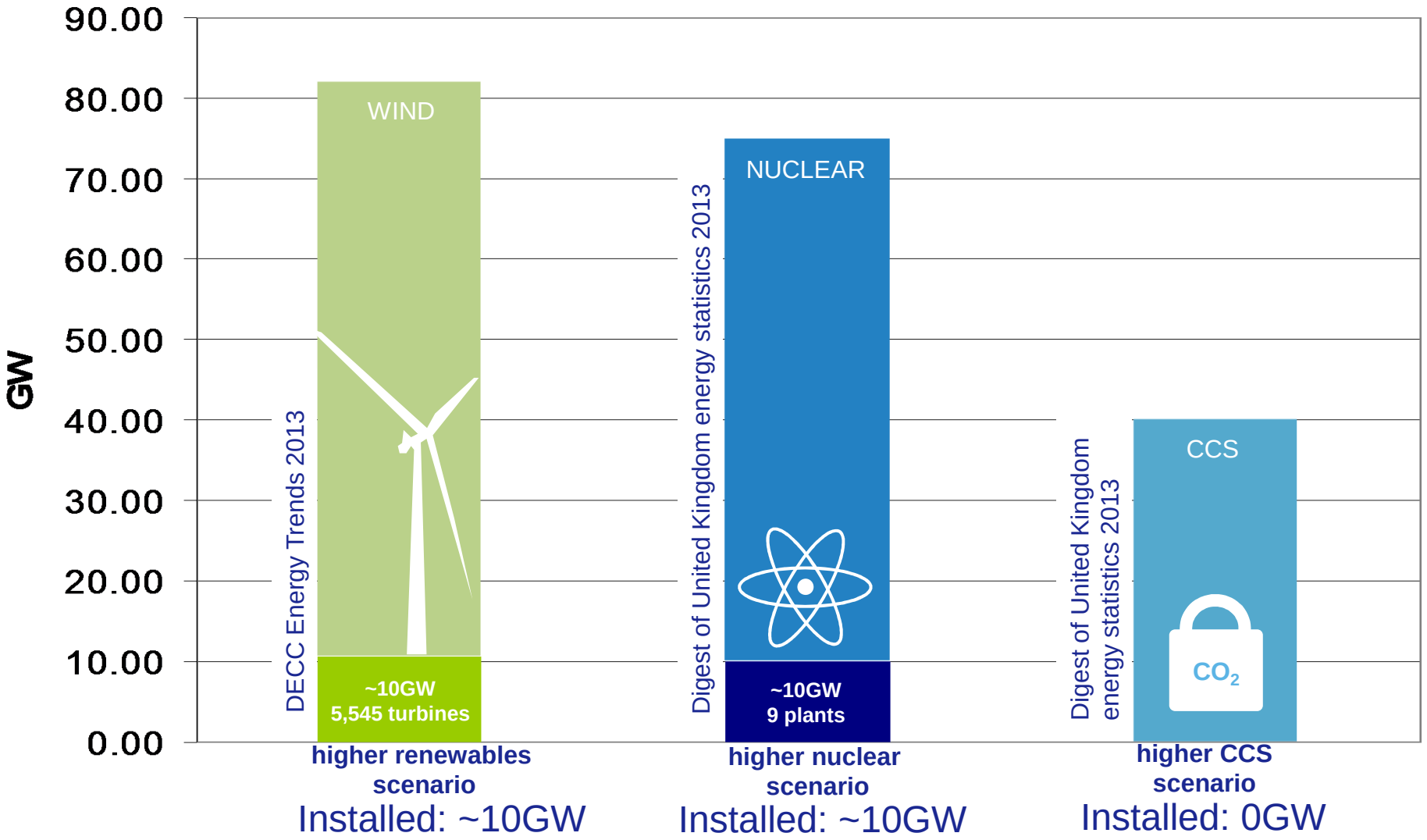
Government Office for Science

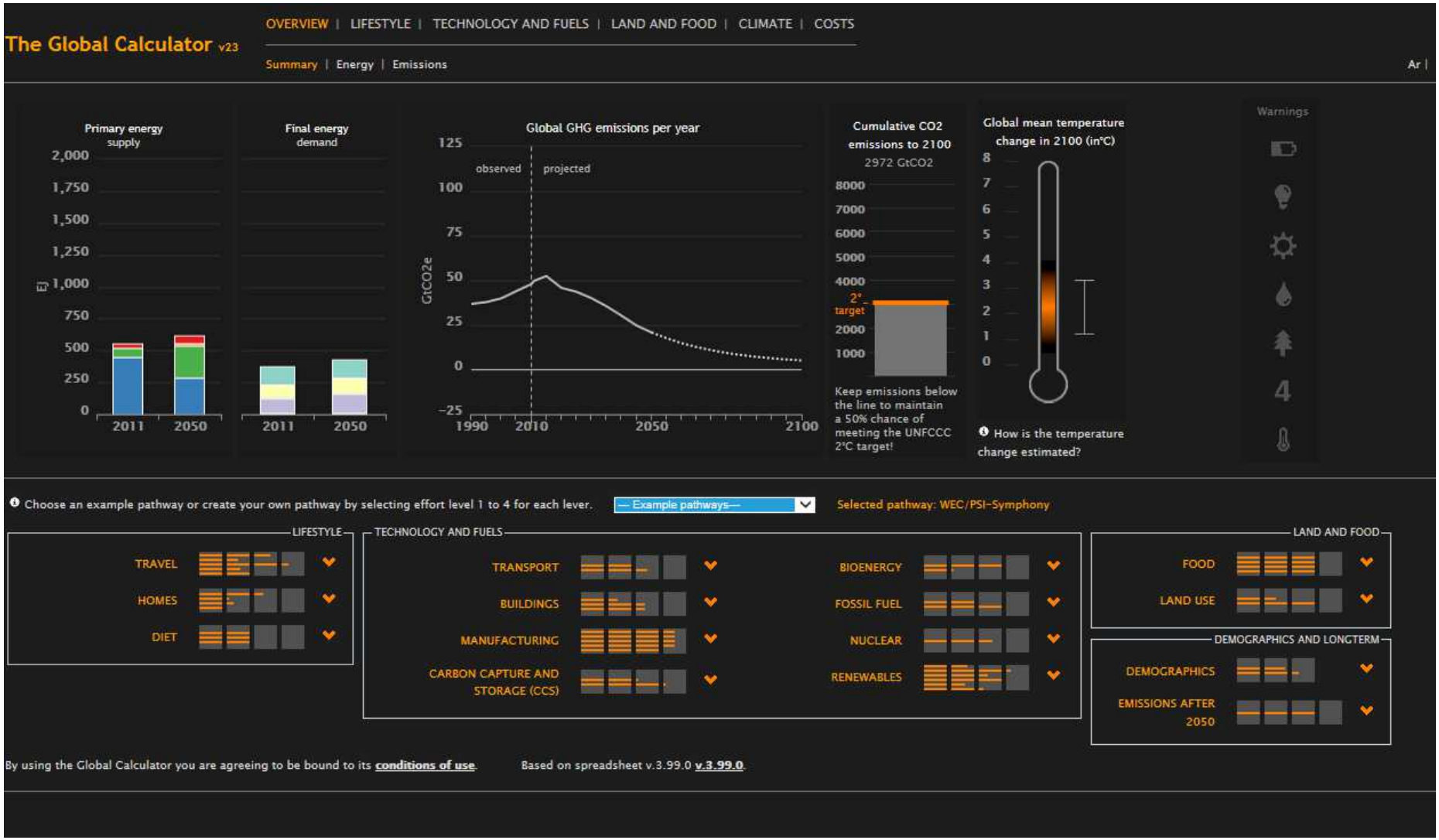
There are different possible scenarios which meet the UK's legislated emissions reduction targets

	Cost optimised		Higher renewables; more efficient		Higher nuclear; less efficient		Higher CCS; more bioenergy	
	Energy saving per capita **50% reduction**	Electricity Demand **470 TWh**	Energy saving per capita **54% reduction**	Electricity Demand **530 TWh**	Energy saving per capita **31% reduction**	Electricity Demand **610 TWh**	Energy saving per capita **43% reduction**	Electricity Demand **490 TWh**
Electricity	33 GW nuclear 18 GW wind 28 GW CCS 27 GW other renew 33 GW gas		16 GW nuclear 82 GW wind 13 GW CCS 14 GW solar 10 GW marine 24 GW back-up gas		75 GW nuclear 20 GW wind 2 GW CCS 2 GW hydro 11 GW back-up gas		20 GW nuclear 34 GW wind 40 GW CCS 2 GW hydro No back-up gas	
Buildings	Heating mix of heat pumps, resistive heat, biomass pellets, district heat		7.7m SWIs, 8.8m CWIs, 100% house-level heating systems		5.6m SWIs, 6.9m CWIs, 90% house-level heating systems, 10% network-level		5.6m SWIs, 6.9m CWIs, 50% house-level heating systems, 50% network-level	
Transport	75% ULEVs, unclear on modal shift		100% ULEVs, high modal shift		80% ULEVs, 20% ICEs, low modal shift		65% ULEVs, 35% ICEs, medium modal shift	
Industry	Medium growth, over half of emissions captured by CCS		Medium growth, 48% of emissions captured by CCS		Medium growth, 0% of emissions captured by CCS		Medium growth, 48% of emissions captured by CCS	
Bio energy / land use	~350 TWh of bioenergy, low ambition on land mgmt		181 TWh of bioenergy, low ambition on land mgmt		461 TWh of bioenergy, high ambition on land mgmt		471 TWh of bioenergy, medium ambition on land mgmt	

Government Office for Science

Meeting any one of these scenarios presents challenges

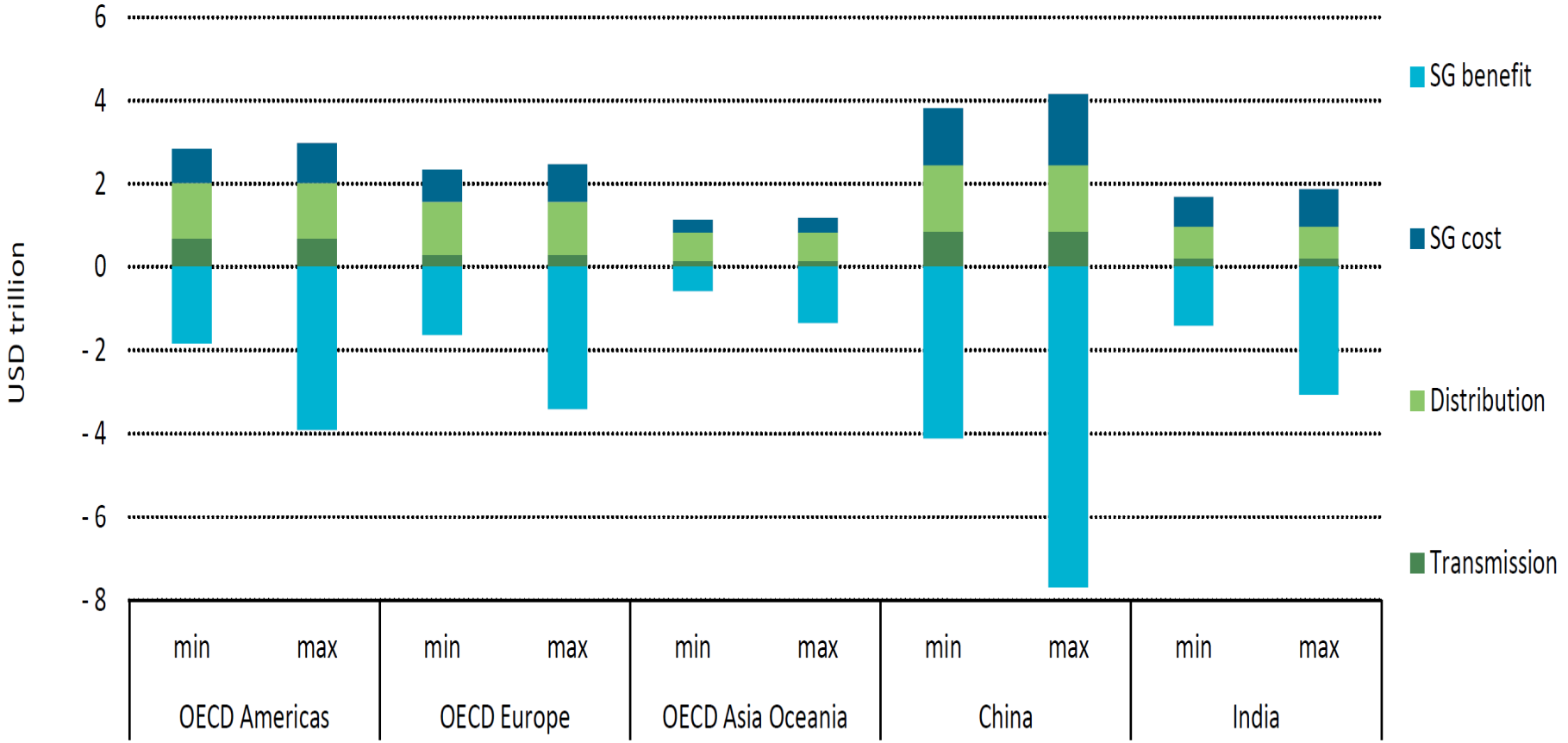




http://tool.globalcalculator.org

Smart grids offer net benefits

ETP 2012



Total benefits of smart-grid investments outweigh costs – but direct benefits of investment may be found in other sectors.

International Energy Agency

Neue Geschäftsmodelle entstehen

Grid-level system costs in OECD countries (USD/MWh)

Germany												
Technology	Nuclear		Coal		Gas		Onshore wind		Offshore wind		Solar	
Penetration level	10%	30%	10%	30%	10%	30%	10%	30%	10%	30%	10%	30%
Back-up costs (adequacy)	0.00	0.00	0.04	0.04	0.00	0.00	7.96	8.84	7.96	8.84	19.22	19.71
Balancing costs	0.52	0.35	0.00	0.00	0.00	0.00	3.30	6.41	3.30	6.41	3.30	6.41
Grid connection	1.90	1.90	0.93	0.93	0.54	0.54	6.37	6.37	15.71	15.71	9.44	9.44
Grid reinforcement and extension	0.00	0.00	0.00	0.00	0.00	0.00	1.73	22.23	0.92	11.89	3.69	47.40
Total grid-level system costs	**2.42**	**2.25**	**0.97**	**0.97**	**0.54**	**0.54**	**19.36**	**43.85**	**27.90**	**42.85**	**35.64**	**82.95**

Republic of Korea												
Technology	Nuclear		Coal		Gas		Onshore wind		Offshore wind		Solar	
Penetration level	10%	30%	10%	30%	10%	30%	10%	30%	10%	30%	10%	30%
Back-up costs (adequacy)	0.00	0.00	0.03	0.03	0.00	0.00	2.36	4.04	2.36	4.04	9.21	9.40
Balancing costs	0.88	0.53	0.00	0.00	0.00	0.00	7.63	14.15	7.63	14.15	7.63	14.15
Grid connection	0.87	0.87	0.44	0.44	0.34	0.34	6.84	6.84	23.85	23.85	9.24	9.24
Grid reinforcement and extension	0.00	0.00	0.00	0.00	0.00	0.00	2.81	2.81	2.15	2.15	5.33	5.33
Total grid-level system costs	**1.74**	**1.40**	**0.46**	**0.46**	**0.34**	**0.34**	**19.64**	**27.84**	**35.99**	**44.19**	**31.42**	**38.12**

Grid-level system costs in OECD countries (USD/MWh)

United Kingdom												
Technology	Nuclear		Coal		Gas		Onshore wind		Offshore wind		Solar	
Penetration level	10%	30%	10%	30%	10%	30%	10%	30%	10%	30%	10%	30%
Back-up costs (adequacy)	0.00	0.00	0.06	0.06	0.00	0.00	4.05	6.92	4.05	6.92	26.08	26.82
Balancing costs	0.88	0.53	0.00	0.00	0.00	0.00	7.63	14.15	7.63	14.15	7.63	14.15
Grid connection	2.23	2.23	1.27	1.27	0.56	0.56	3.96	3.96	19.81	19.81	15.55	15.55
Grid reinforcement and extension	0.00	0.00	0.00	0.00	0.00	0.00	2.95	5.20	2.57	4.52	8.62	15.18
Total grid-level system costs	**3.10**	**2.76**	**1.34**	**1.34**	**0.56**	**0.56**	**18.60**	**30.23**	**34.05**	**45.39**	**57.89**	**71.71**

United States												
Technology	Nuclear		Coal		Gas		Onshore wind		Offshore wind		Solar	
Penetration level	10%	30%	10%	30%	10%	30%	10%	30%	10%	30%	10%	30%
Back-up costs (adequacy)	0.00	0.00	0.04	0.04	0.00	0.00	5.61	6.14	2.10	6.85	0.00	10.45
Balancing costs	0.16	0.10	0.00	0.00	0.00	0.00	2.00	5.00	2.00	5.00	2.00	5.00
Grid connection	1.56	1.56	1.03	1.03	0.51	0.51	6.50	6.50	15.24	15.24	10.05	10.05
Grid reinforcement and extension	0.00	0.00	0.00	0.00	0.00	0.00	2.20	2.20	1.18	1.18	2.77	2.77
Total grid-level system costs	**1.72**	**1.67**	**1.07**	**1.07**	**0.51**	**0.51**	**16.30**	**19.84**	**20.51**	**28.26**	**14.82**	**28.27**

Severe accidents with at least five fatalities from 1970 to 2005

Table 4.4: **Severe accidents with at least five fatalities from 1970 to 2005**

Energy chain	OECD		EU 27		Non-OECD		World total	
	Accidents	Fatalities	Accidents	Fatalities	Accidents	Fatalities	Accidents	Fatalities
Coal	81	2 123	41	942	1 507	29 816	1 588	31 939
Oil	174	3 338	64	1 236	308	17 990	482	21 328
Gas	103	1 204	33	337	61	1 366	164	2 570
LPG	59	1 875	20	559	61	2 610	120	4 485
Hydro	1	14	1	116	12	30 007 (a)	13	30 021
Nuclear	–	–	–	–	1	4 031 (b)	1	4 031
Total	**418**	**8 554**	**159**	**3 190**	**1 950**	**85 820**	**2 368**	**94 374**

(a) The Banqiao and Shimantan dam failures of 1975 in China together caused 26 000 immediate fatalities and 126 000 indirect fatalities due to epidemic and starvation (Wayne, 1999).

(b) According to WHO Factsheet 303 (www.who.int/mediacentre/factsheets/fs303/en/index.html) the Chernobyl accident caused 28 immediate fatalities due to radiation (to which 3 immediate fatalities due to the explosion itself must be added) as well as up to 4 000 potential latent fatalities due to cancer among the most heavily affected groups of population ("liquidators", evacuees and people living in the "strictly controlled zone"). The latter figure was derived by a WHO Expert Group based on the linear no threshold methodology adopted by the International Commission on Radiological Protection. It corresponds to a 3-4% increase in the number of cancers that would have been likely to happen otherwise in the concerned groups.

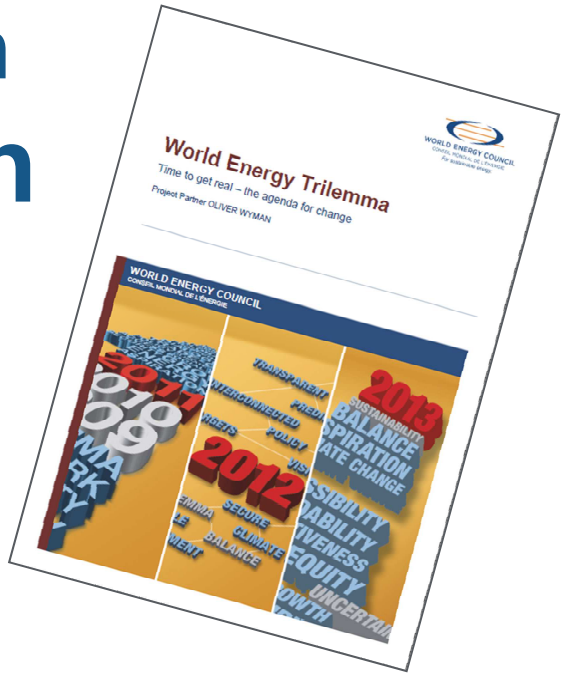
Source: Wayne, 1999.

Wir sind in einer herausfordernden Situation

Wir sind weit davon entfernt ein nachhaltiges Energiesystem zu erreichen:

- 1.2 Milliarden Menschen leben ohne Zugang zu Elektrizität
- 2.8 Milliarden Menschen haben keinen Zugang zu hygienischen Kochmöglichkeiten
- Weltbevölkerung wächst von 7 auf 9,3 Milliarden Menschen bis 2050
- Die Nachfrage nach Energie wird sich bis 2050 um 30-60% erhöhen
- CO_2 Emissionen steigen weiter an
- Benötigte Investitionen bis 2050 : zwischen US$ 20,000 und 27,000 Milliarden in Infrastruktur

“Wir müssen akzeptieren, dass wir harte Entscheidungen in dieser Generation treffen müssen um wirkliche Veränderungen für zukünftige Generationen und unsere Umwelt herbeizuführen.



Politik und Industrie müssen den Realitäten ins Auge schauen.”