The Role of Extractive Industries in a Carbon Constrained World

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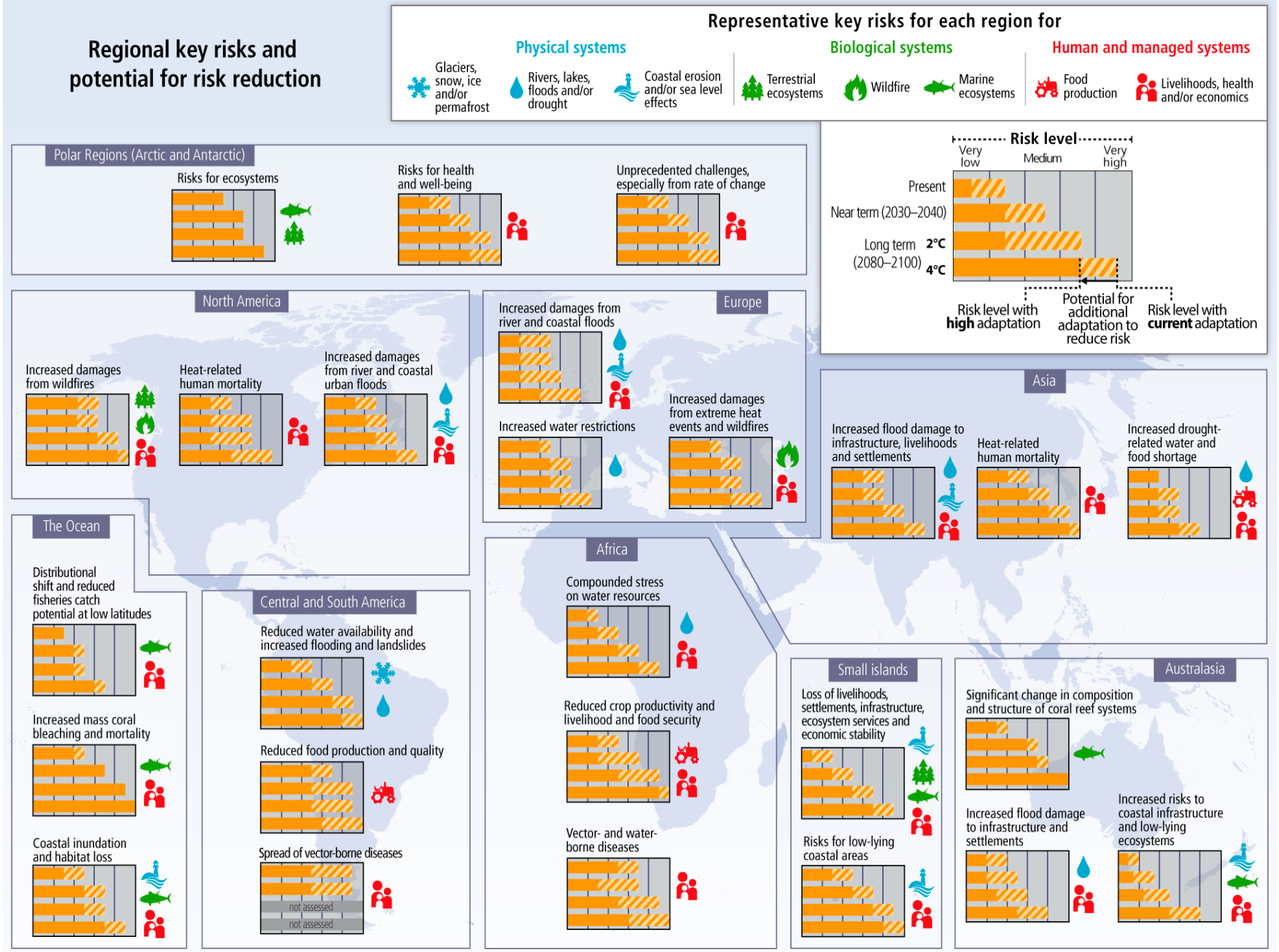
Columbia Center
on Sustainable Investment

A JOINT CENTER OF COLUMBIA LAW SCHOOL
AND THE EARTH INSTITUTE, COLUMBIA UNIVERSITY

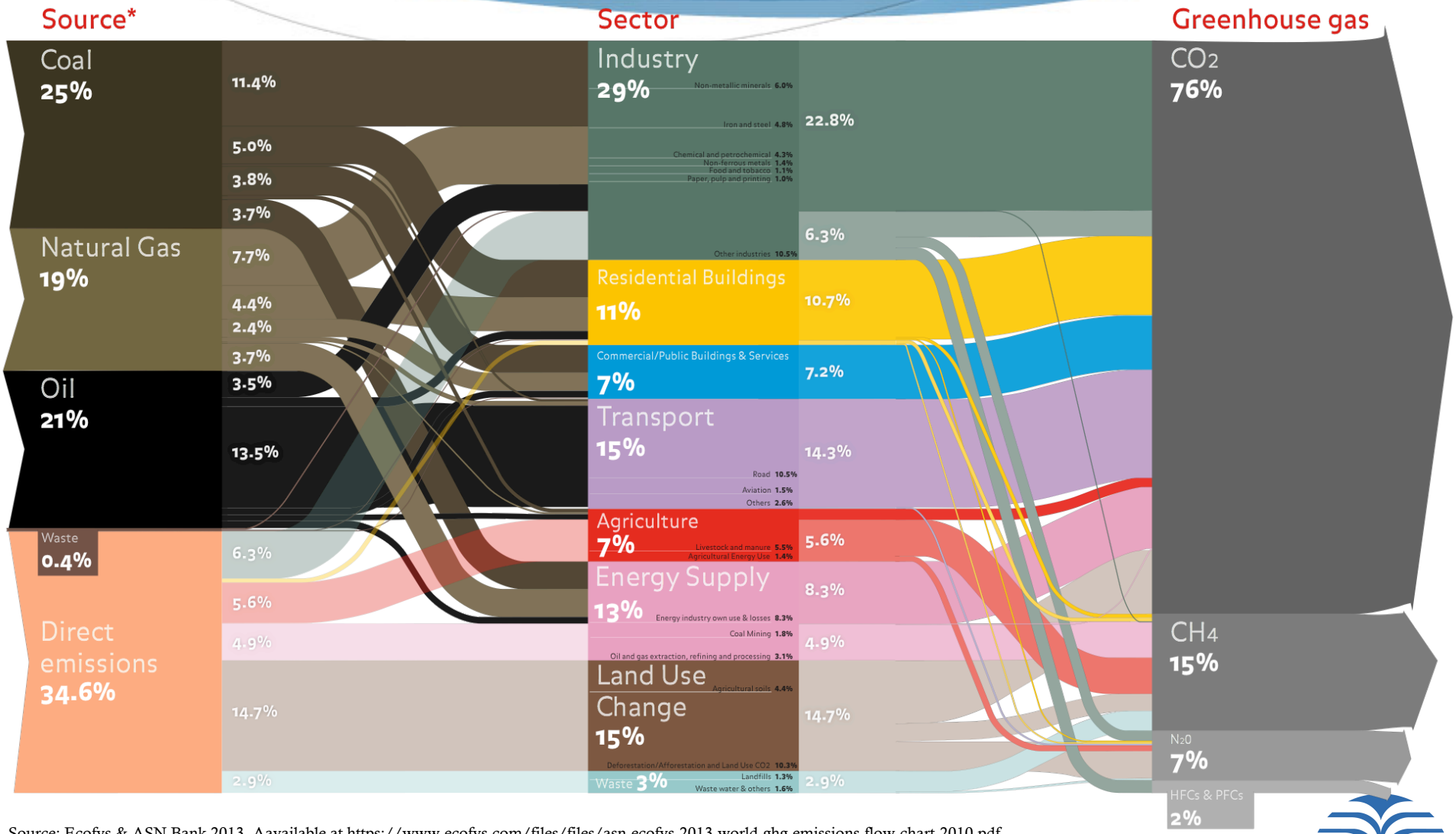
Outline

- **Climate change & the role of fossil fuels**
- Government response
- Fossil fuel company response
- Meeting the Paris Agreement
- Implications for resource rich developing countries



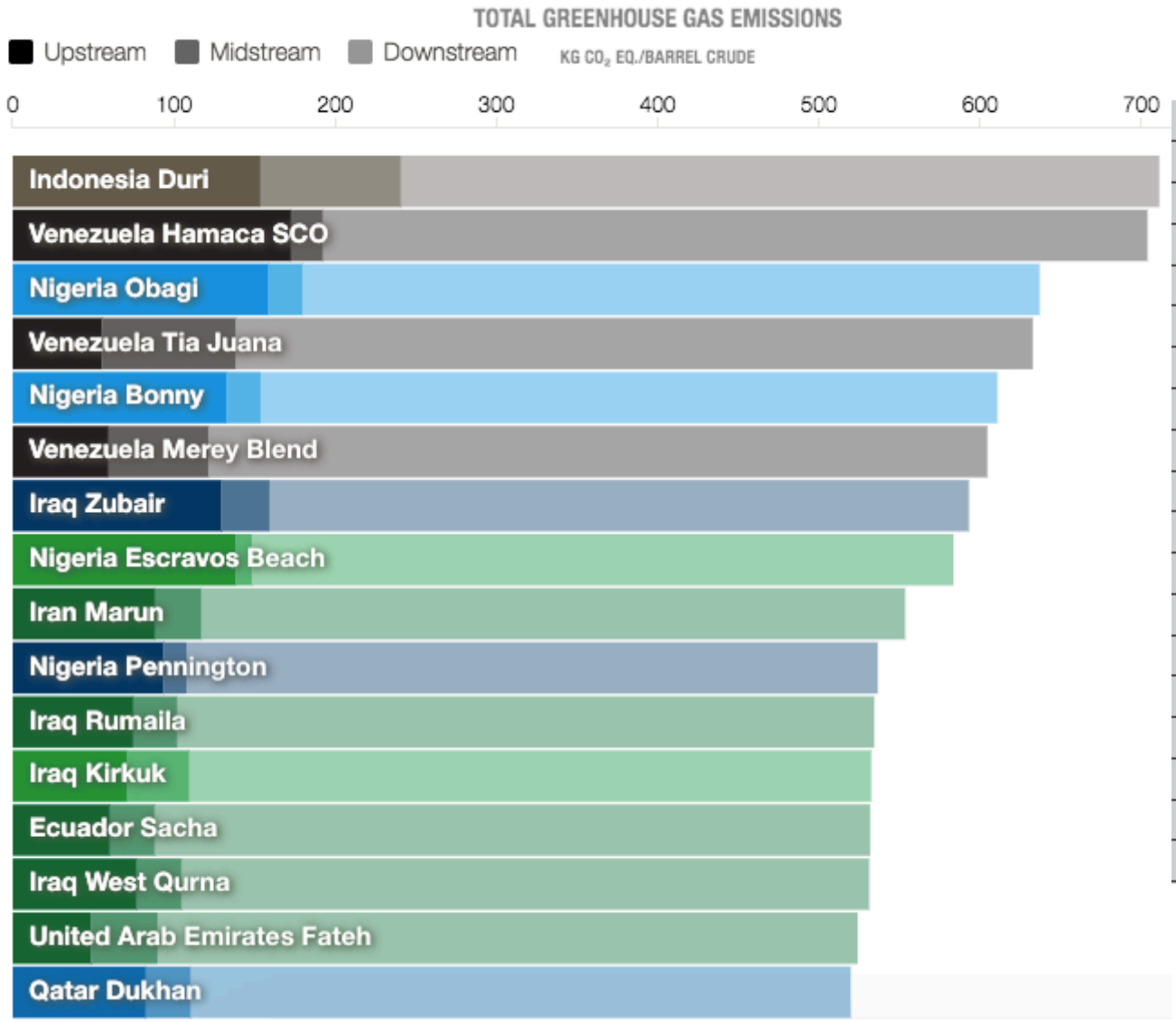
Source: IPCC, 2014: Summary for Policymakers, In: Climate Change 2014, Mitigation of Climate Change. *Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Composition of GHG emissions



Source: Ecofys & ASN Bank 2013, Aavailable at https://www.ecofys.com/files/files/asn-ecofys-2013-world-ghg-emissions-flow-chart-2010.pdf

CO2 contained in coal, oil & gas varies



Source: Carnegie Endowment, available at http://oci.carnegieendowment.org/#supply-chain

Average CO2 emissions per kWh of electricity produced in OECD countries, 2009-2013

Product	gCO_2 / kWh
Anthracite*	925
Coking coal*	825
Other bituminous coal	875
Sub-bituminous coal	945
Lignite	1035
Gas works gas*	335
Coke oven gas*	390
Blast furnace gas*	2390
Other recovered gases*	1570
Oil shale*	1160
Peat*	750
Natural gas	400
Crude oil*	645
Refinery gas*	415
Liquefied petroleum gases*	535
Kerosene*	655
Gas/diesel oil*	725
Fuel oil	675

Source: IEA 2015, CO2 emissions from fuel combustion: Highlights, Second edition

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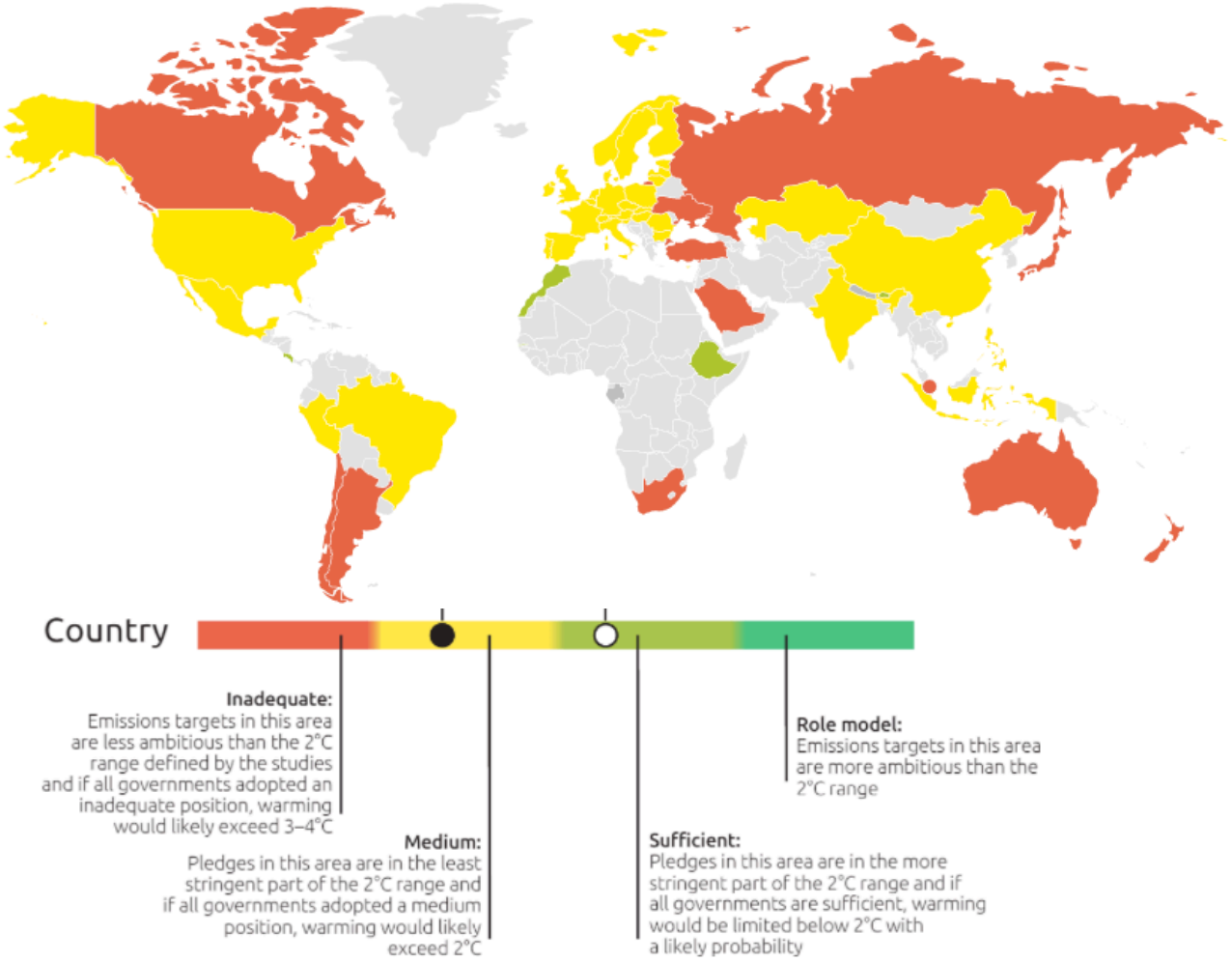
The Paris Agreement

Why 2 °C?

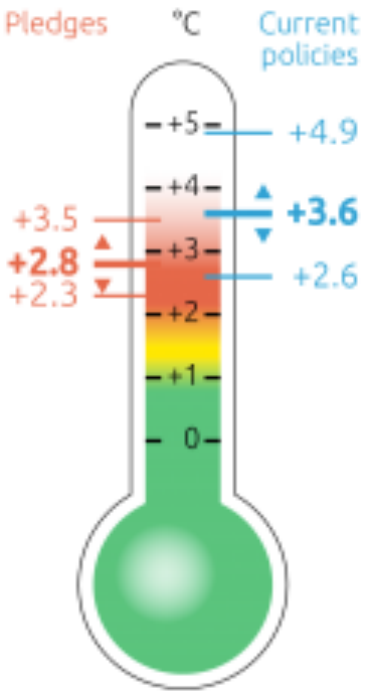
Source: UNFCCC, JRC, World Bank, IEA, WMO, Green Climate Fund, US EPA, World Wide Views on Climate and Energy. December 2015

(Intended) Nationally Determined Contributions a step in the right direction

(I)NDC country assessments



Global-mean temperatures with and without pledges



Source: Climate Action Tracker, Accessible at www.climateactiontracker.org

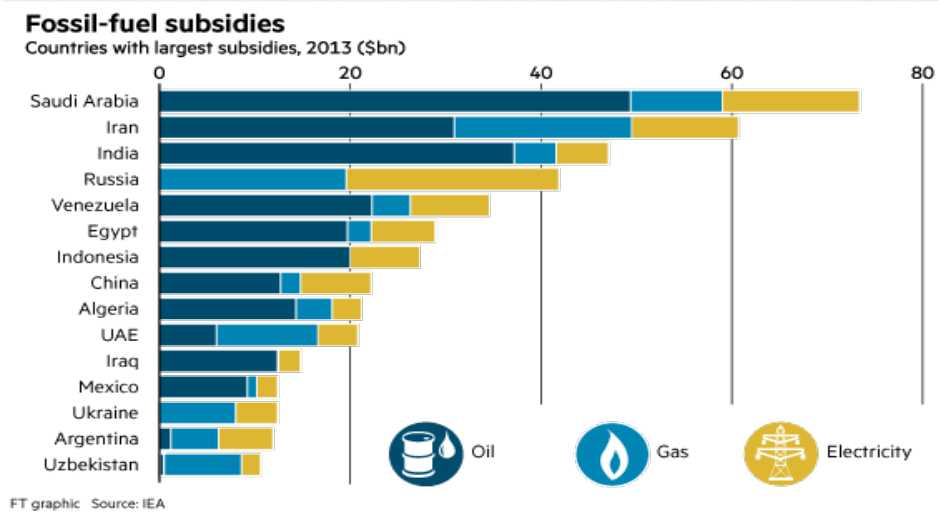
Government policy responses

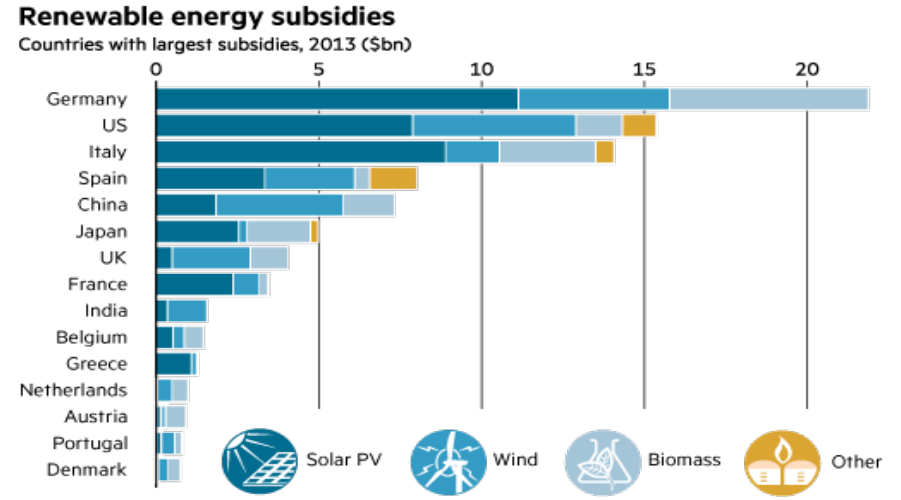
- Subsidies
- Carbon pricing
- Incentives for fuel switching
- Tighter emission controls
- Government co-investment in R&D

- Countries around the world have adopted more than 1,200 climate change laws, up from about 60 two decades ago

(Grantham Research Institute on Climate Change and the Environment and the Sabin Center on Climate Change Law at the Columbia Law School).

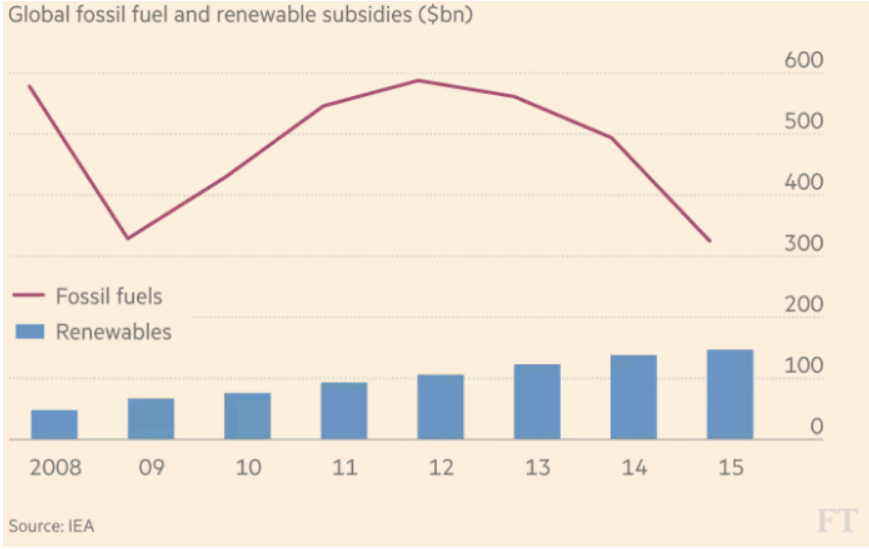
Fossil fuel and renewable energy subsidies





Source: Financial Times 2016, A world map of subsidies for renewable energy and fossil fuels
Accessible at http://blogs.ft.com/the-world/files/2016/07/GR262Xcarbon_tax_modern_energy_SR_CHART.png

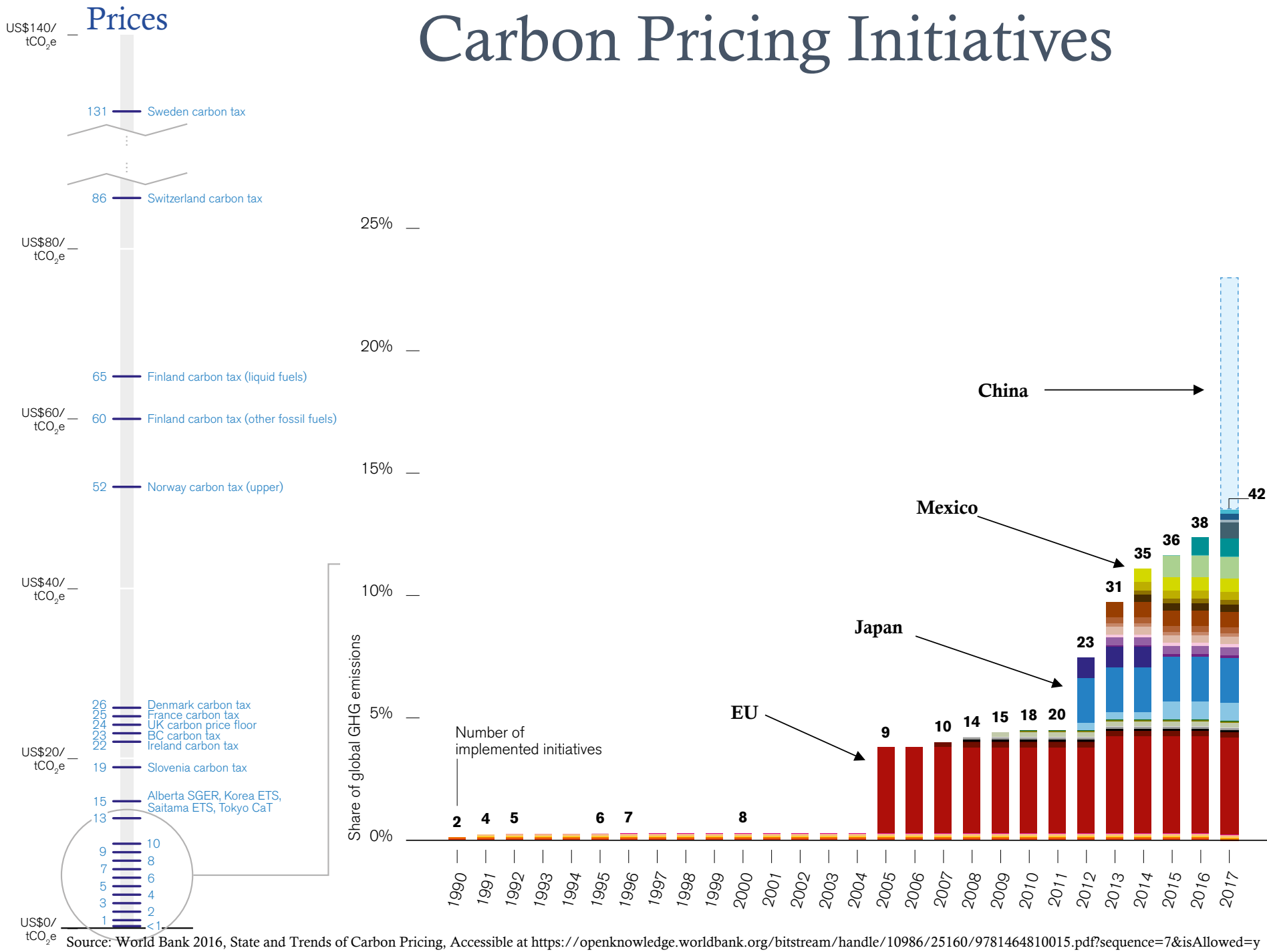
Fossil fuel receive the greatest amount of subsidies but the gaps is decreasing.



Source: Financial Times 2017, The Big Green Bang: how renewable energy became unstoppable, Accessible at https://www.ft.com/content/44ed7e90-3960-11e7-ac89-b01cc67cfeec

IMF (2015): Scrapping subsidies = savings of $3 trillon/year = more than CIT collection effort

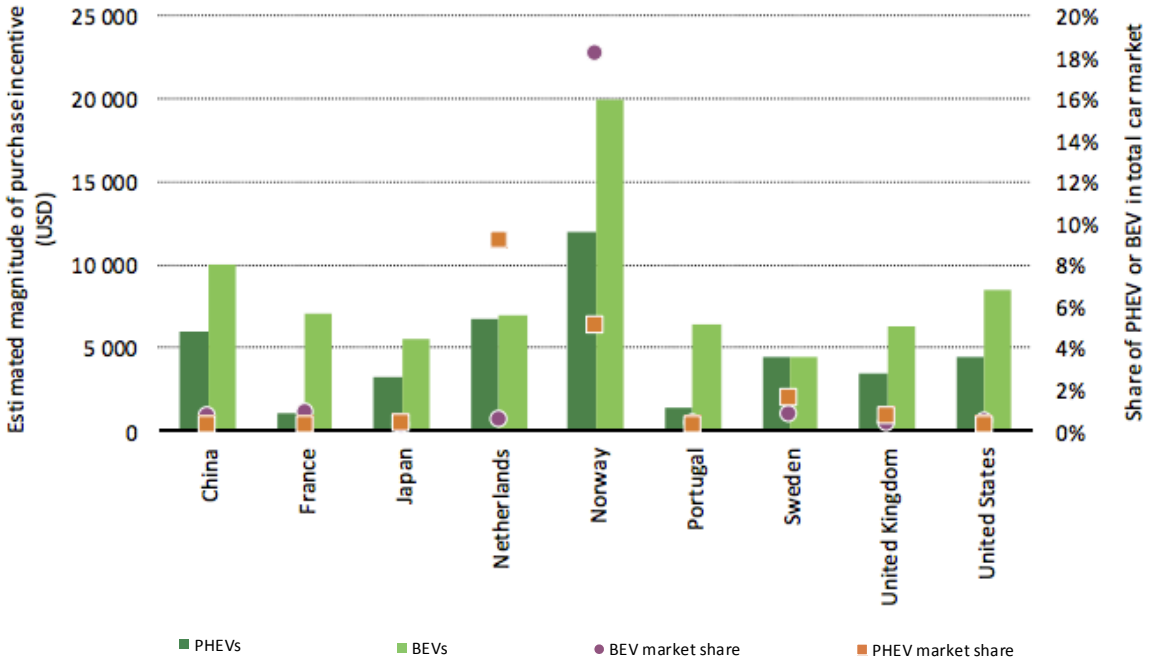
Carbon Pricing Initiatives



Source: World Bank 2016, State and Trends of Carbon Pricing, Accessible at https://openknowledge.worldbank.org/bitstream/handle/10986/25160/9781464810015.pdf?sequence=7&isAllowed=y

Incentives for fuel switching

Purchase incentives and market shares for Batter Electric Vehicles (BEVs) and and Plug-in Hybrid Electric Vehicles (PHEVs), 2015



Norwegian Electric Vehicle owner Survey 2015: Rank the electric car incentives

4. Low electricity cost
5. Low annual road tax
6. Charging network
7. Free parking
8. Free charging
9. Access to bus lanes
10. Free ferries

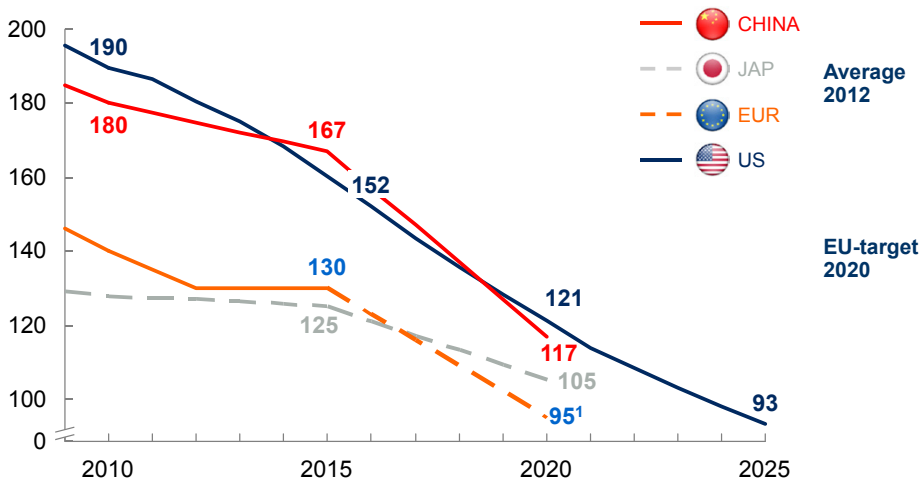
IEA 2016, Global EV outlook 2016: Beyond one million electric cars, Accessible at https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

Source: Norwegian EV Association 2016, The Norwegian EV owner survey 2015

Emission controls

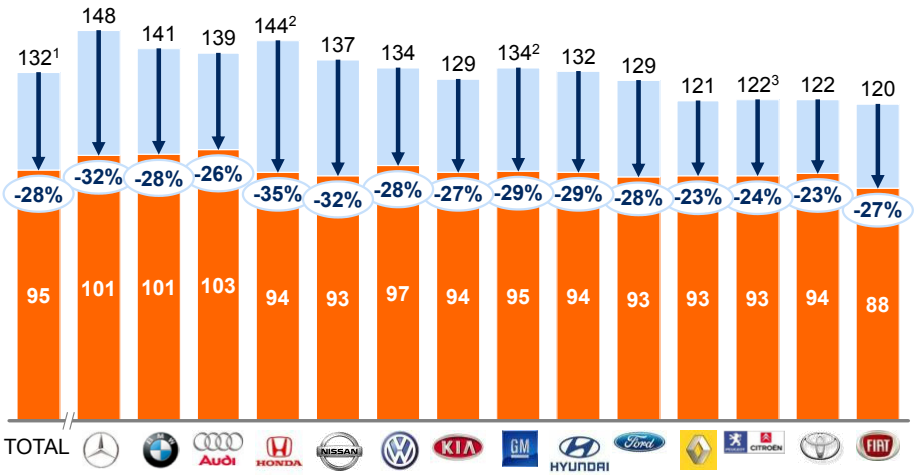
Planned emission standards in select regions

g CO_2/km normalized to New European Driving Cycle



CO_2 emissions of selected OEMs and brands 2012 in Europe (NEDC)

in g CO_2/km

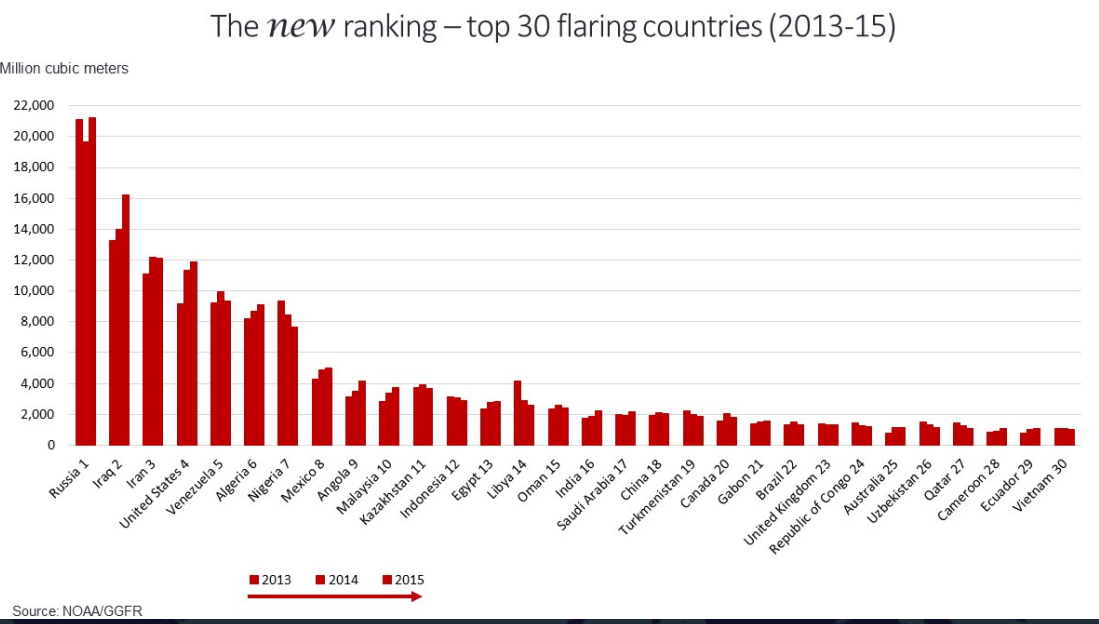


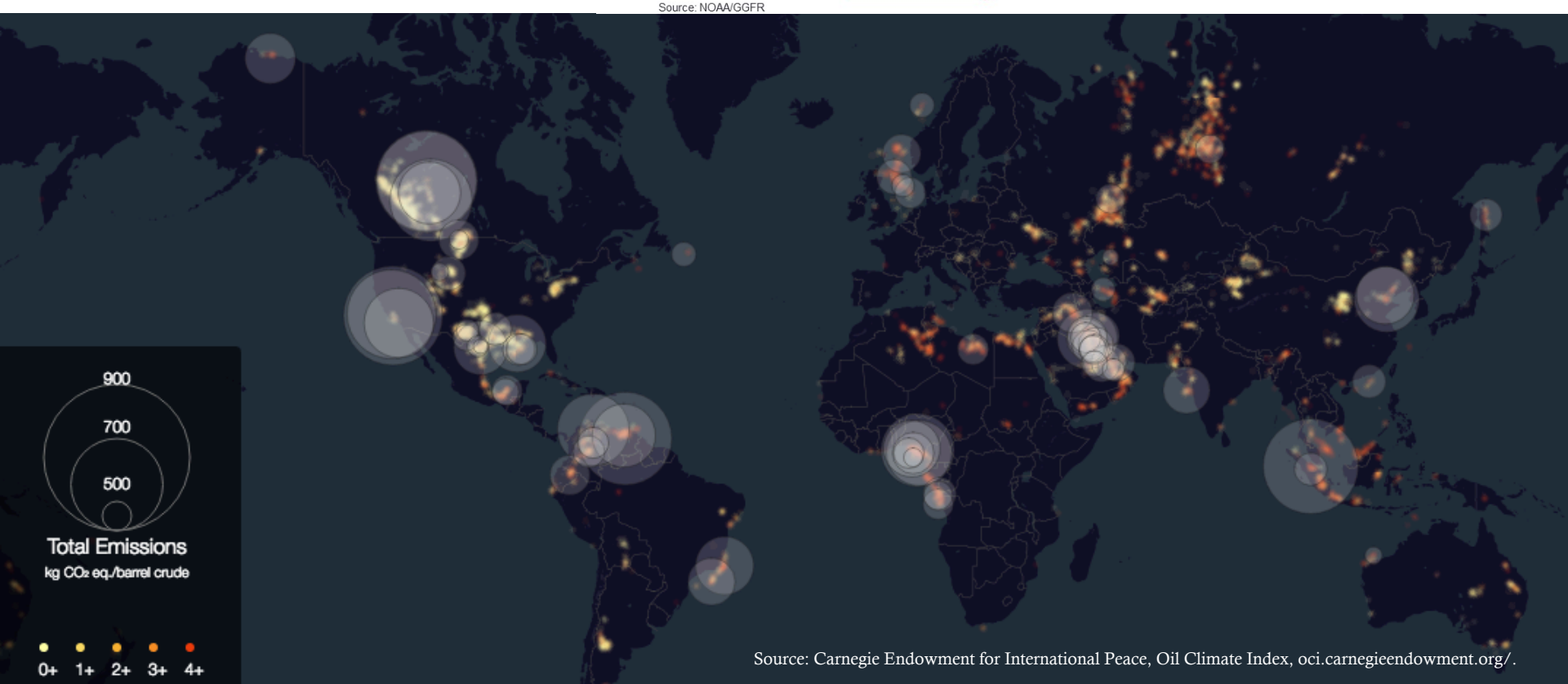
Major OEMs need to cut fleet emissions by ~30% by 2020 to meet EU emissions target

Source: Amsterdam Roundtable Foundation and McKinsey & Company 2014, Evolution: Electric vehicles in Europe: Gearing up for a new phase?

Zero routine flaring

[Check CCSI's associated gas case studies and framework]





Source: Carnegie Endowment for International Peace, Oil Climate Index, oci.carnegieendowment.org/.

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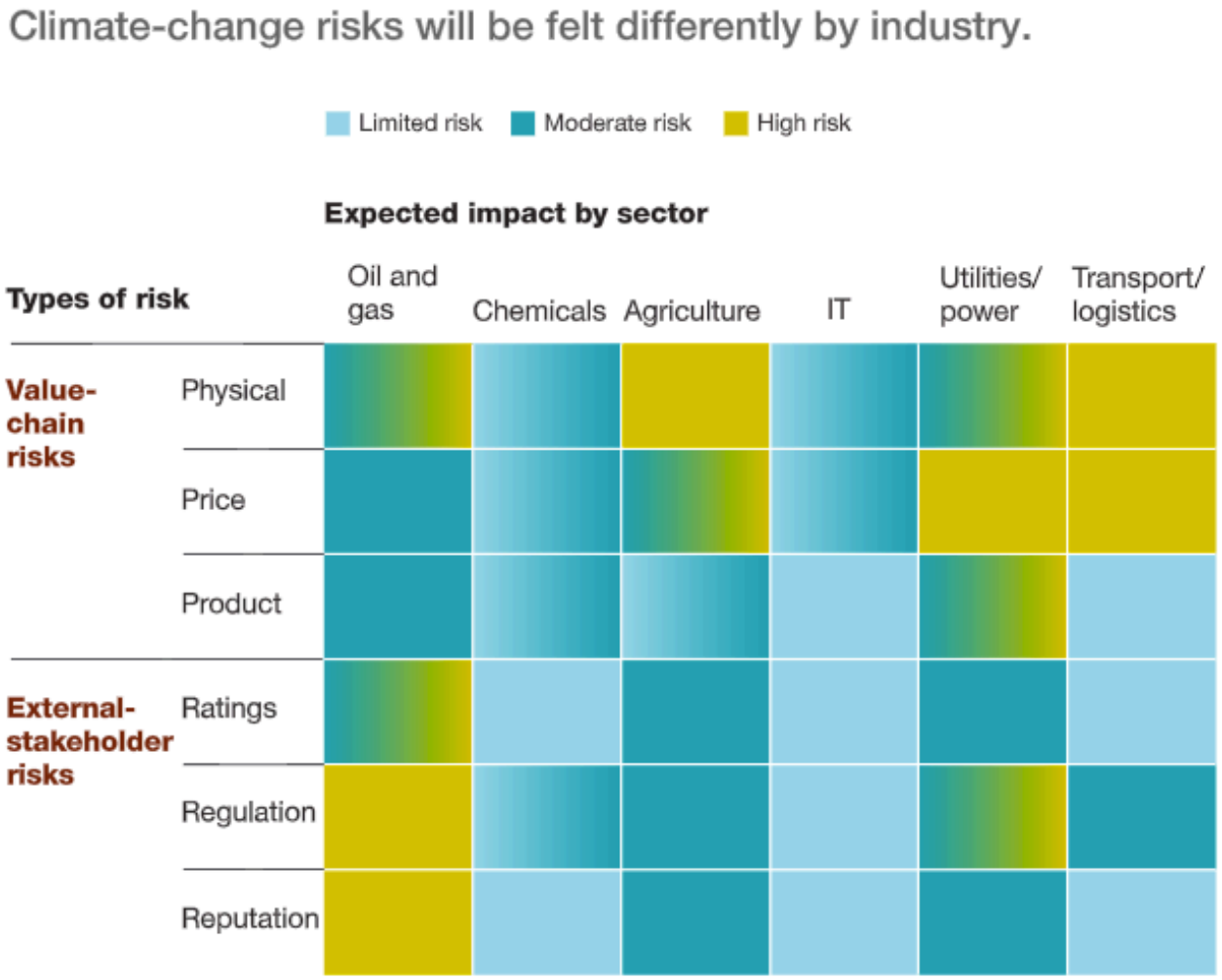
Why FF companies should care?

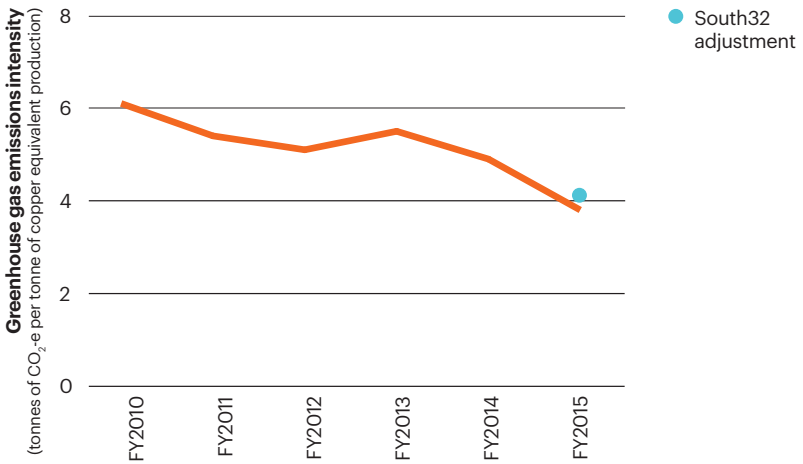


- Moral & ethical reasons
- Attract top talent for future workforce
- Secure social license to operate
- Secure financing & investor support
- Play a prominent role in energy supply in the future

Source: McKinsey & Company 2015, How companies can adapt to climate change, Accessible at https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/how-companies-can-adapt-to-climate-change

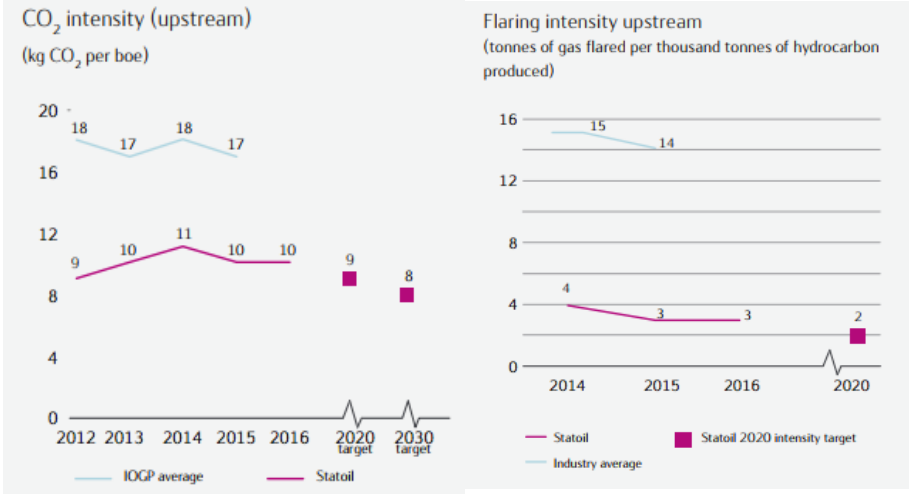
Reduce carbon footprint of operations & eliminate flaring

BHP GHG Emission Intensity



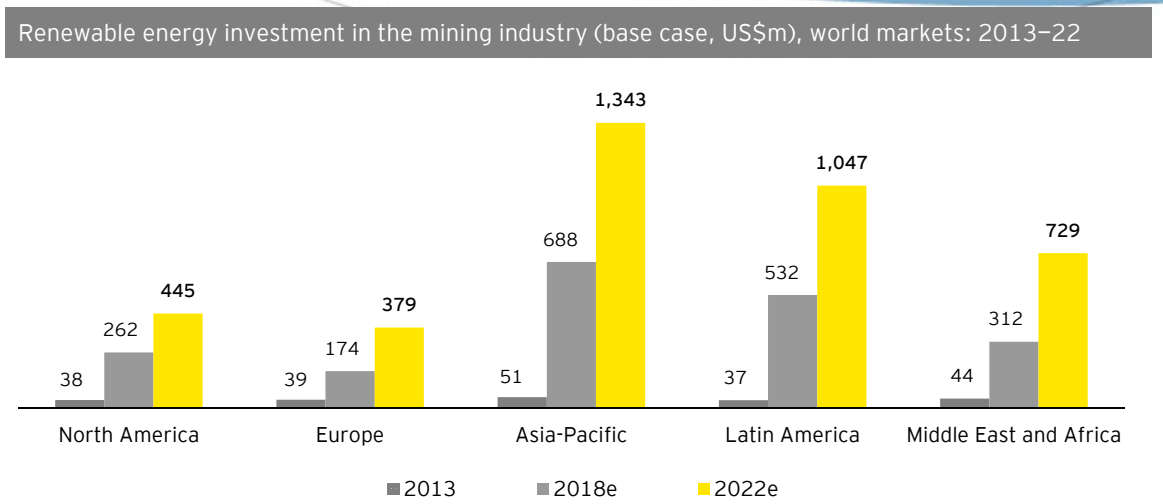
Source: BHPBilliton 2016, Climate Change: Portfolio Analysis Report

Statoil CO2 intensity & flaring intensity



Source: Statoil 2017, 2016 Sustainability Report

Power operations with renewables



Source: Ernst & Young 2014, Renewables in Mining: Futuristic or realistic?

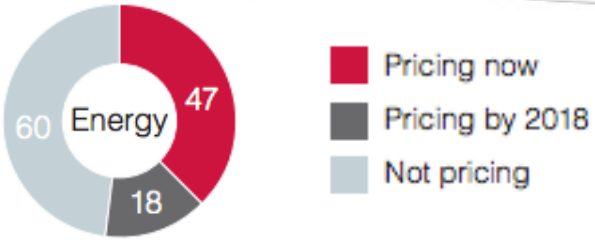
***Pictured**: Aerial view of the Weipa Solar Plant .*

Source: Rio Tinto

In Queensland, Weipa bauxite mine: Rio Tinto in a 15 year PPA with First Solar co. with help from ARENA, the Australian Renewable Energy Agency.

- Equipped the mine with a 18-000 solar panel PV farm to complement diesel base load in times of peak
- Capacity : 1.7 MW and potential to expand to 5 MW
- **Saving**: 600 000 liters of fuel annually – 1,600 t/ year of GHG emissions = 700 cars
- **Shared use**: covers 20% of electricity demand of township on the Western Cape York Peninsula.

Use of carbon price



1. Provides an incentive to reallocate resources toward low-carbon activities;
2. Used to determine the business case for R&D investments
3. Assigning a financial value to both emitted and avoided carbon emissions helps reveal hidden risks and opportunities

Company	Country	Carbon Price
Exxaro Resources Ltd	South Africa	$8.17
AngloGold Ashanti	South Africa	$7.70
Essar Oil	India	$15.00
Total	France	$27.92
Eni SpA	Italy	$40.00
Royal Dutch Shell	Netherlands	$40.00
Statoil ASA	Norway	$ 50–64
BP	UK	$40.00
Anglo American	UK	$ 3.27–8.17
BHP Billiton	UK	$24.00
Exxon Mobil Corporation	USA	$80.00
ConocoPhillips	USA	$ 6–38
HudBay Minerals Inc.	Canada	$ 15.32–38.29
Teck Resources Limited	Canada	$ 11.49–30.64

Source: CDP 2016, Embedding a carbon price into business strategy

Make a low carbon business model a comparative advantage - Example: Statoil

A STRATEGY TO CREATE A LOW CARBON ADVANTAGE

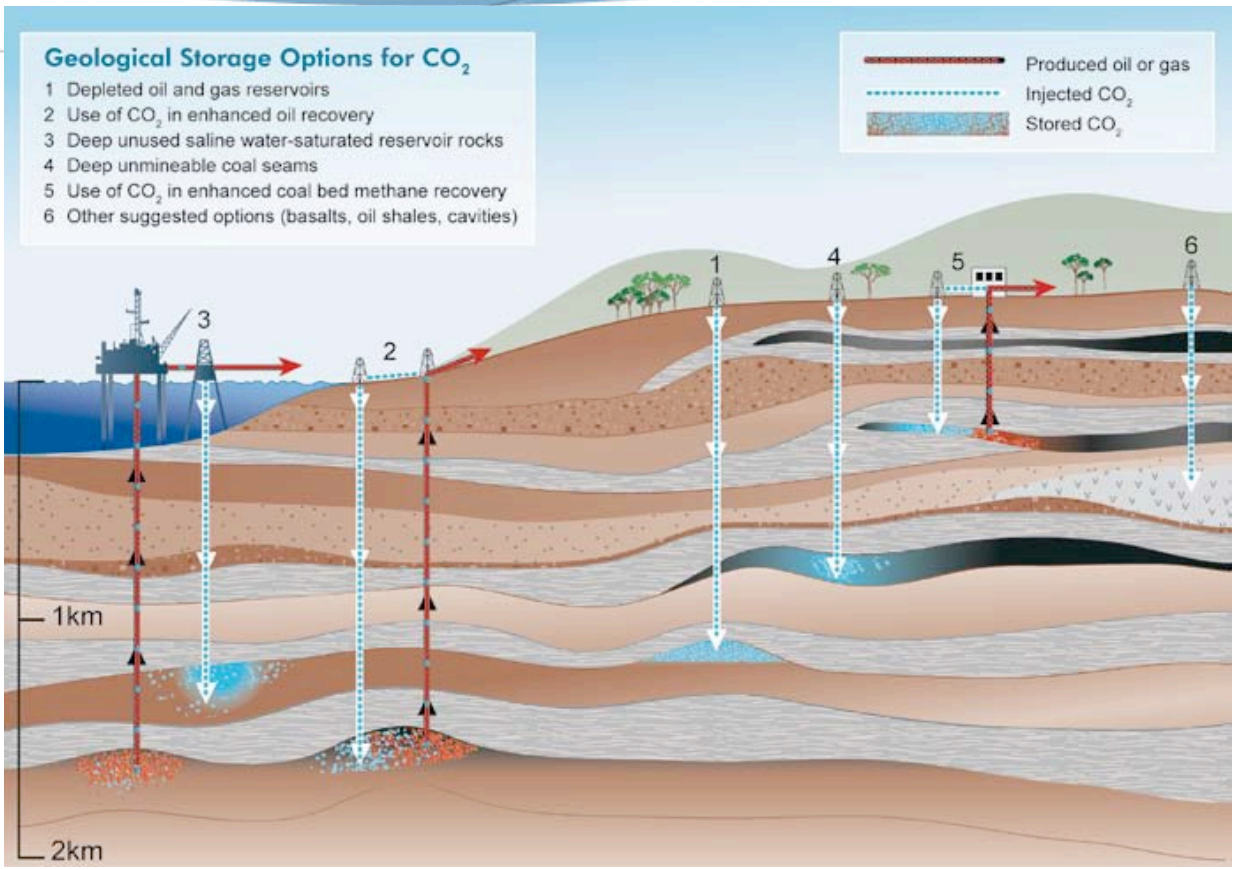
Build a high value and lower carbon oil and gas portfolio	Create a material industrial position in new energy solutions	Accountability and collaboration
CO_2 emission reductions of **3 million** tonnes per year by **2030***	New energy solutions with potential to represent around **15-20%** of capex by **2030**	Continued support for carbon pricing
Portfolio carbon intensity of 8kg CO_2/boe** by 2030	Up to **25%** of research funds to new energy solutions and energy efficiency by **2020**	Minimum internal carbon price of **USD 50** per tonne CO_2
Methane emissions from the Norwegian gas value chain below **0.3%**	Invest **USD 200 million** through our new energy ventures fund	Climate risk and performance embedded into strategy, incentives and decision-making
Eliminate routine flaring by **2030**	Partner in the **USD 1 billion** OGCI Climate Investments	Amplifying our climate actions through collaboration

*Compared to 2017 **Barrel of oil equivalent.

Source: Statoil 2017, Statoil's Climate Roadmap

Invest in Carbon capture and sequestration (CCS)

- **To capture CO2:** pre-combustion capture, post-combustion capture, and oxy-fuel combustion capture (during fuel combustion).
- **To store CO2:** underground or stored in the ocean.



Source: Global CCS Institute, Module 1 (courtesy of CO2CRC)

If CCS is to provide 20% of the CO_2 reductions this would require:

- To build 3,400 commercial-scale projects worldwide by 2050 (only a few small scale projects today)
- Global investment to grow to an average of US$70 billion per year in the 2020s and US$110 billion per year in the 2030s (only a few billions $ today)

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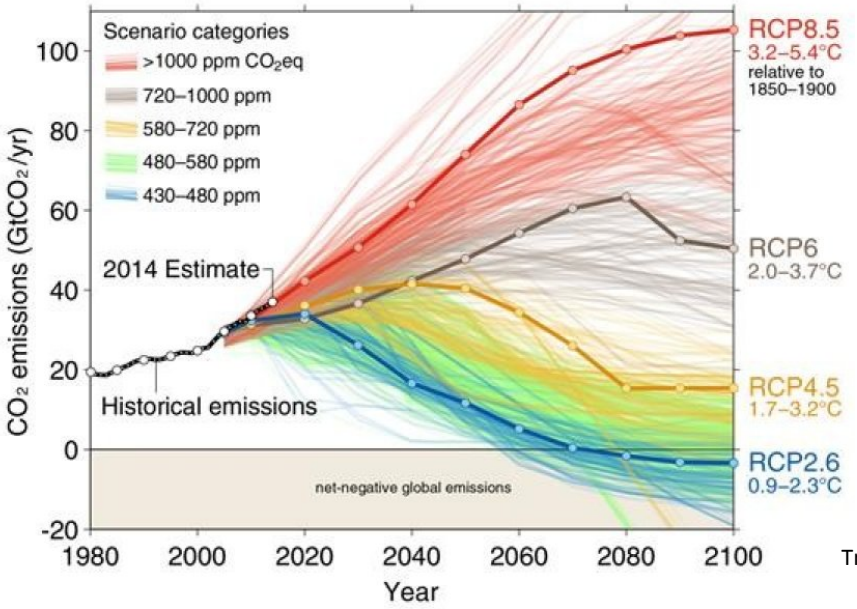
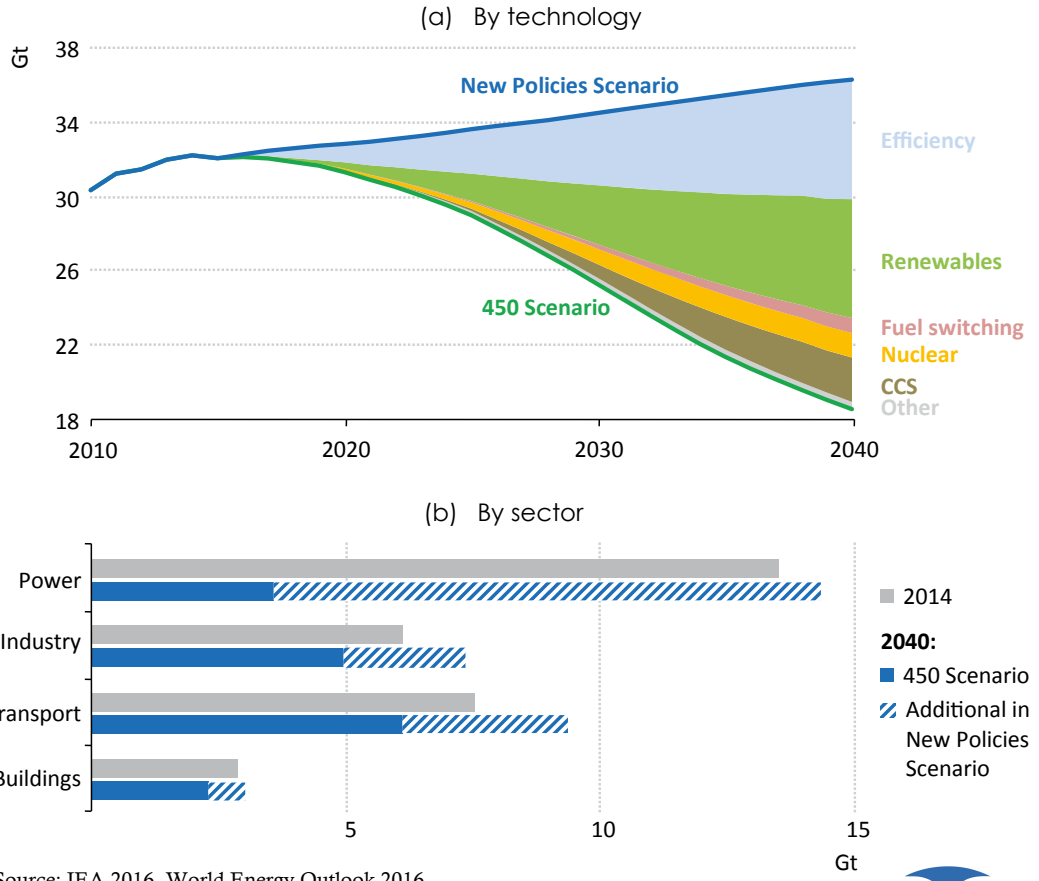
To meet agreed target in Paris, will need to cut emissions sharply

Observed emissions and future scenarios



Source: Fuss et al 2014, Betting on negative emissions, Nature Climate change, Vol. 4

Emission reduction requirements to meet 2º target



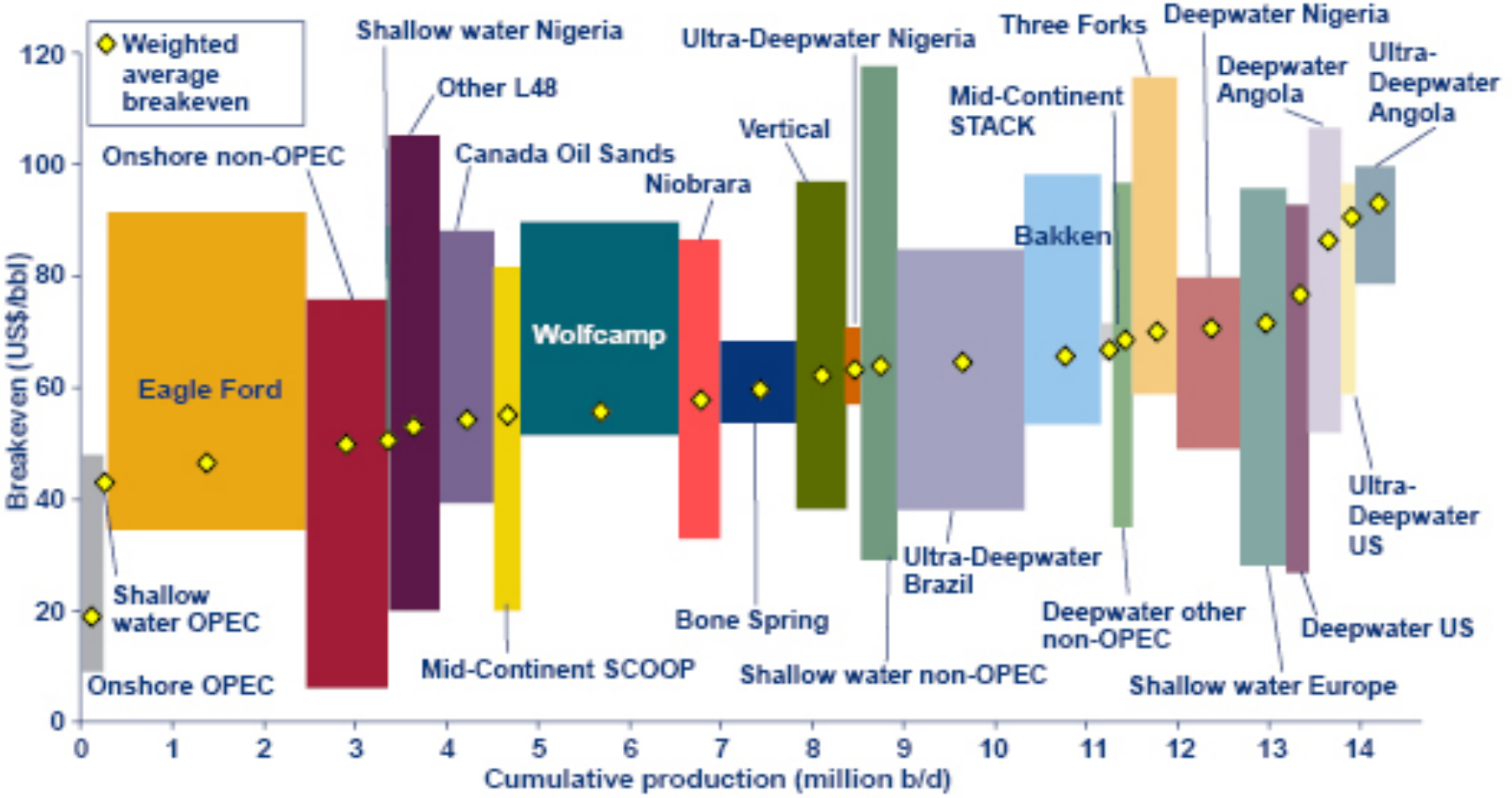
Source: IEA 2016, World Energy Outlook 2016

… and would need to leave FF under the ground

How can this be achieved?

Stranding according to market forces

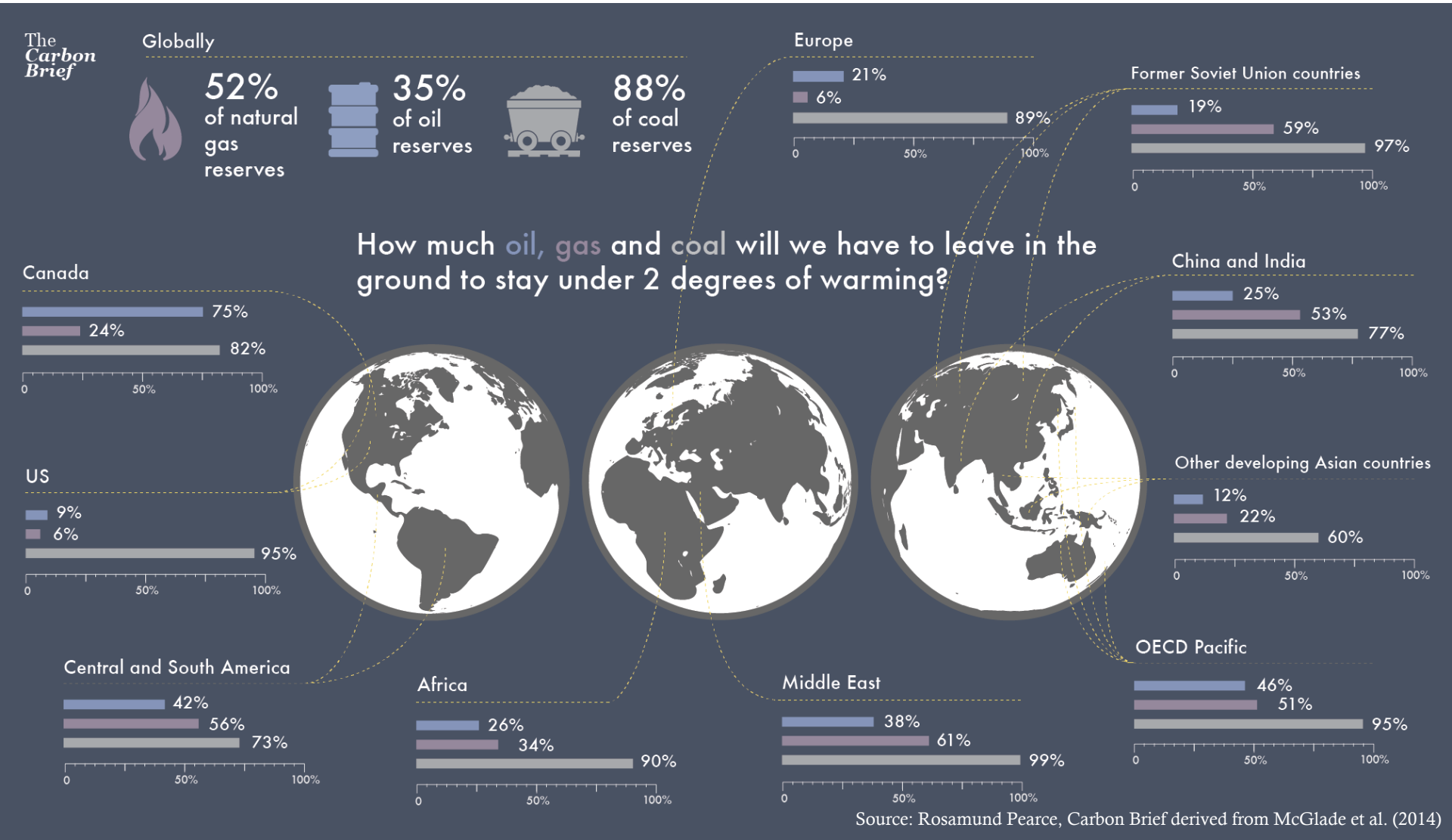
Pre-FID and US L48 future drilling cumulative production by breakeven in 2025 – by resource theme



Source: Wood Mackenzie, onshore breakevens at 10% discount rate, offshore at 15% discount rate, breakevens in US$ Brent equivalent

This is what it would look like

Unburnable reserves before 2050 for the 2 degree scenario (without CCS)



Source: Rosamund Pearce, Carbon Brief derived from McGlade et al. (2014)

Should take equity dimension into account? If so, how?

1. Level of development?
2. Historical responsibility?
3. Availability of alternative energy sources?
4. Carbon intensity of the economy?
5. Climate vulnerability?
6. Governance structure?

Can gas be a transition fuel?

- **Makes power generation less carbon intensive** than coal
- **Complementary energy source** to renewables
- BUT: still produces **significant CO2 emissions**
- **Long payback periods for infrastructure- >** delay of investment in renewable energy projects
- **Methane leaks ->** more problematic than CO2 for CC in short term

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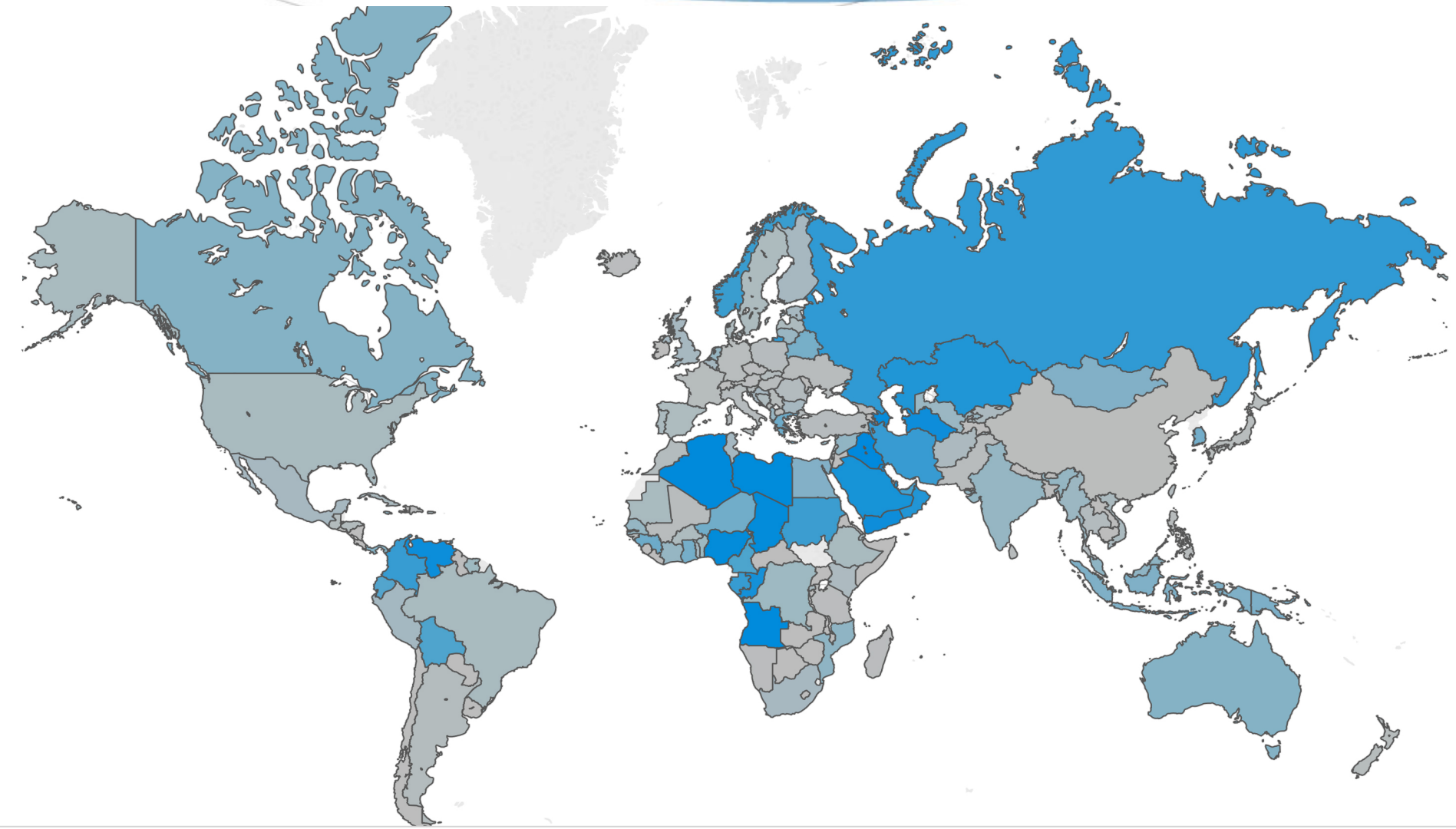
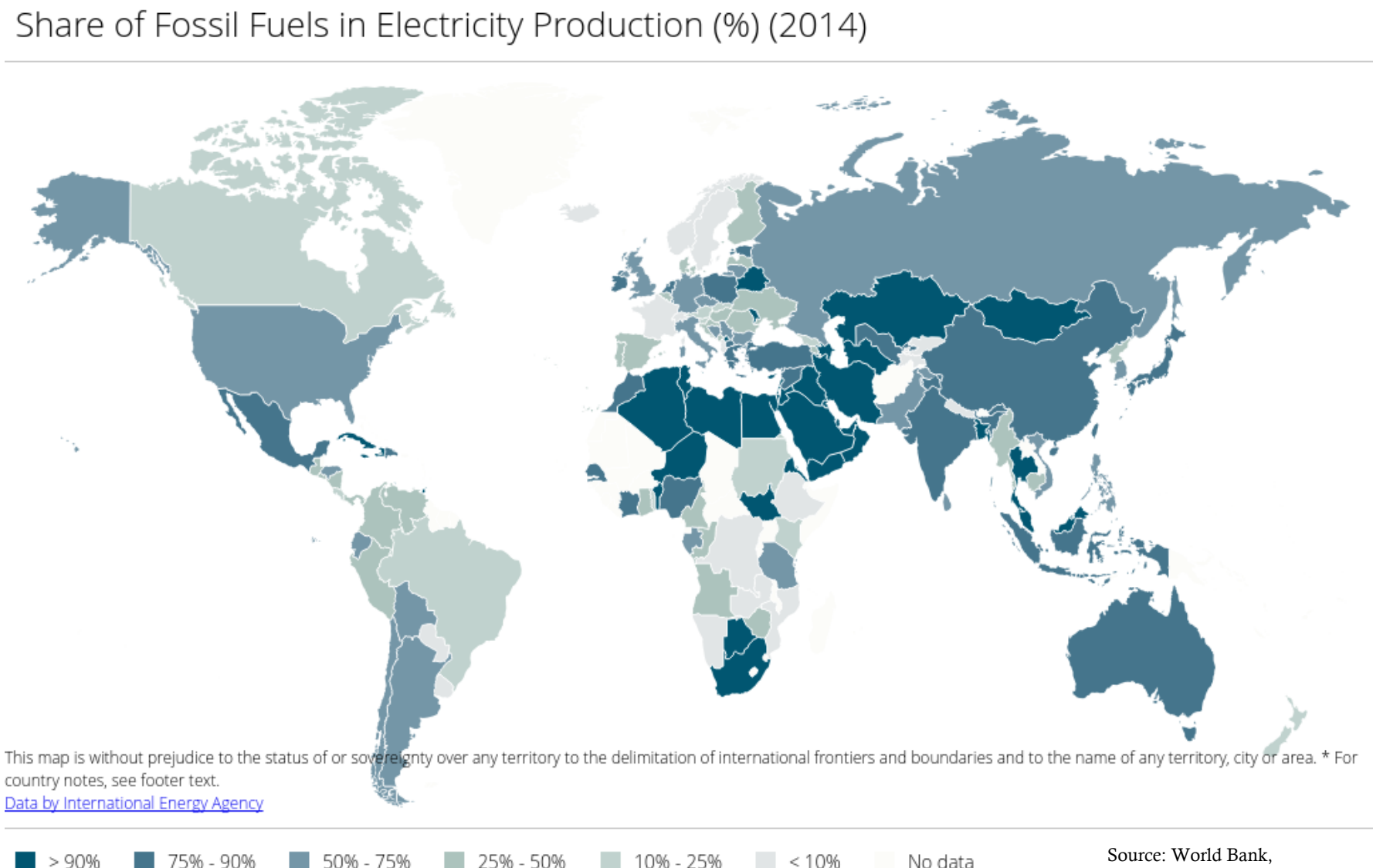
Many developing countries dependent on fossil fuel exports…



Source: UN Comtrade data 2014

…and rely on fossil fuels for power generation



Source: World Bank, World Development Indicators

Implications for resource rich developing countries?

1. The role of fossil fuels is going to decrease over the coming decades
2. Economic diversification becomes even more critical to reduce reliance on fossil fuels
3. Fossil fuel subsidies should be eliminated to reduce dependency
4. Public investments through State Owned Companies in fossil fuels is increasingly at risk
5. The new global energy system will rely on extractive industries. How can we avoid the mistakes made during the fossil fuel era?

What minerals needed in the new energy system?

	Wind	Solar photovoltaic	Concentrating solar power	Carbon capture and storage	Nuclear power	Light-emitting diodes	Electric vehicles	Energy storage	Electric motors
Aluminum	X	X	X	X		X		X	X
Chromium	X			X	X	X			
Cobalt				X	X		X	X	
Copper	X	X		X	X	X	X		X
Indium		X			X	X	X		
Iron (cast)	X		X			X		X	
Iron (magnet)	X								X
Lead	X	X			X	X			
Lithium							X	X	
Manganese	X			X			X	X	
Molybdenum	X	X		X	X	X			
Neodymium (proxy for rare earths)	X						X		
Nickel	X	X		X	X	X	X	X	
Silver		X	X		X	X	X		
Steel (Engineering)	X								
Zinc		X				X			

Source: World Bank 2017, The growing role of minerals and metals for a low carbon future

References

- CCSI' timeline on O&G's sector re Climate Change, Renewable energy and shareholders' engagement:
  - http://www.tiki-toki.com/timeline/entry/486412/Oil-and-Gas-Majors-Activities-with-Relation-to-Climate-Change/
- CCSI's blog series on Climate Change:
  - http://blogs.ei.columbia.edu/tag/ccsi-annual-conference/
- CCSI's work on Flaring:
  - http://ccsi.columbia.edu/work/projects/a-regulatory-operational-and-commercial-framework-for-the-utilization-of-associated-gas/
- CCSI's work on role of FF companies:
  - http://ccsi.columbia.edu/work/projects/fossil-fuel-companies-and-climate-change/
- Deep Decarbonization Project:
  - http://deepdecarbonization.org