

Geopolitics of Energy: Key Challenges

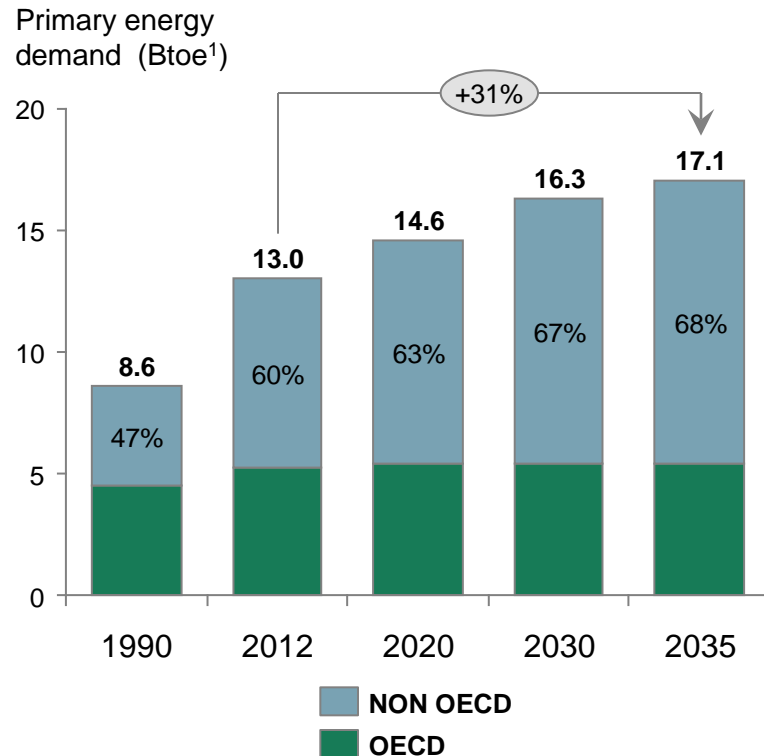
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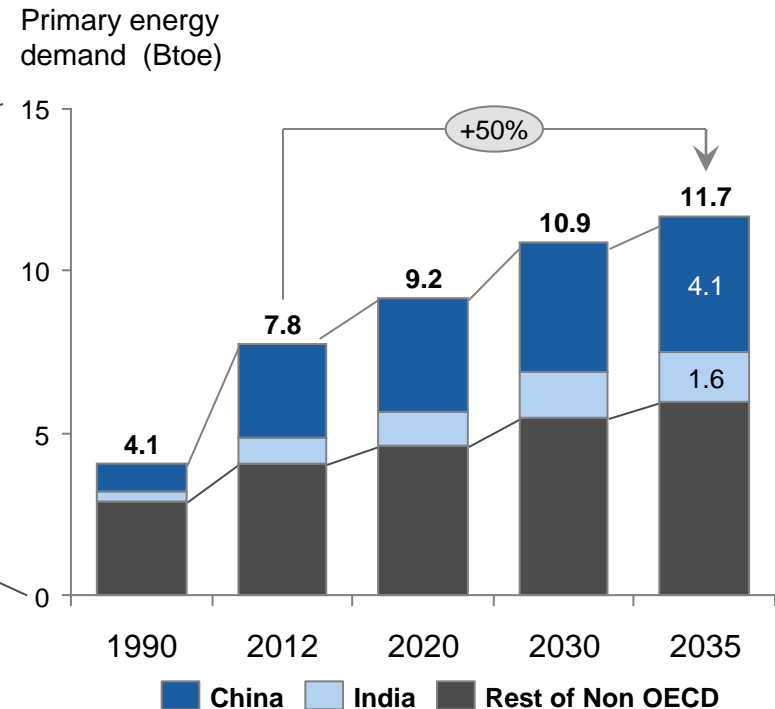
February 17, 2015

1. Global energy demand will continue to grow fast

Global demand will rise 31% to 2035



Non-OECD demand will rise 50% to 2035, driven by China and India

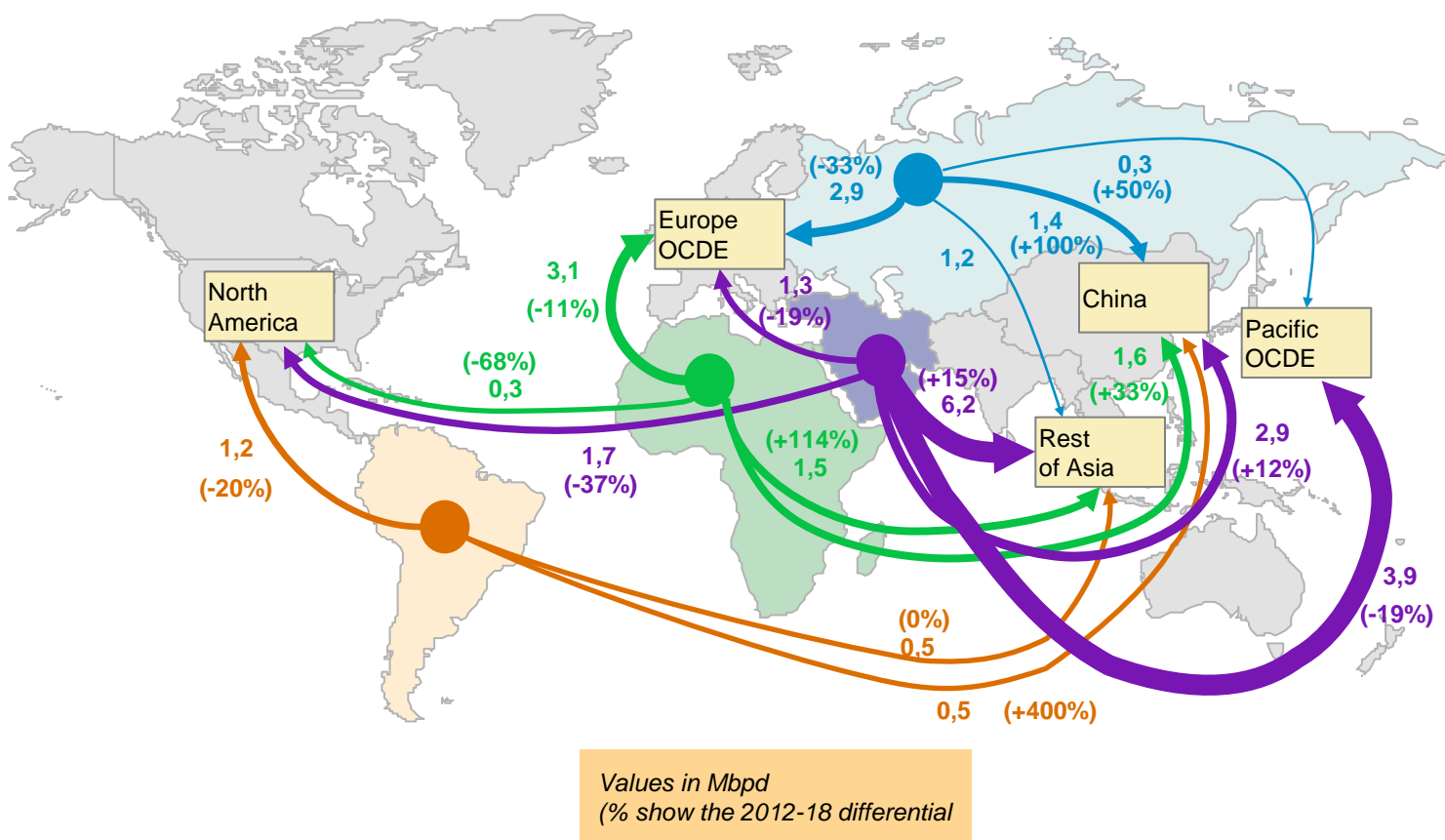


>90% of new growth is forecast to come from non-OECD countries

The world is moving East

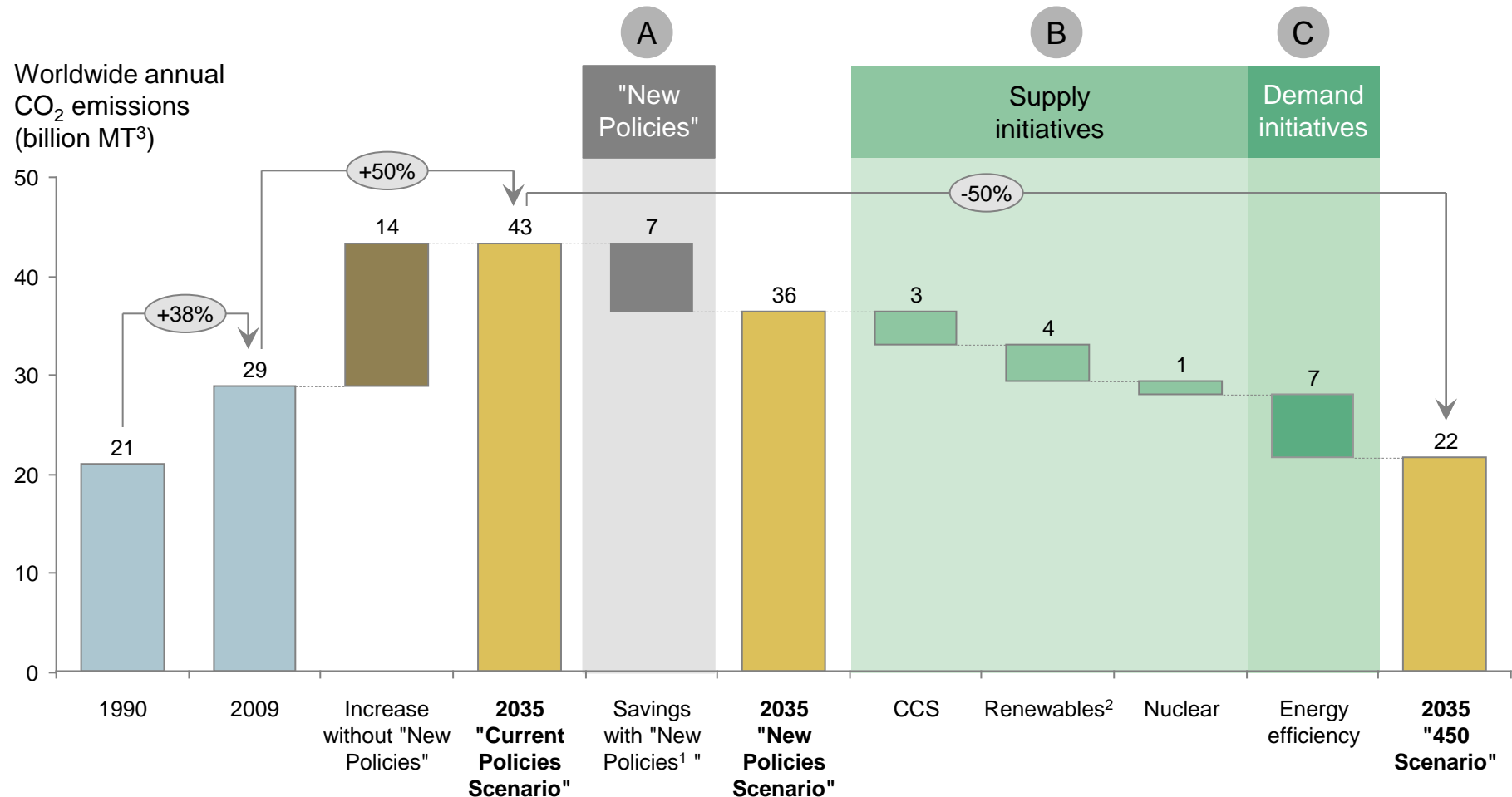
Crude imports to the US expected to be significantly reduced

Crude exports in 2018



Exports from...	2012	2018	Dif '18-'12
... LatAm to:			
North America	1,5	1,2	-20%
China	0,1	0,5	400%
Rest of Asia	0,5	0,5	0%
... Africa to:			
North America	1,1	0,3	-68%
Europe OCDE	3,7	3,1	-16%
China	1,2	1,6	33%
Rest of Asia	0,7	1,5	114%
... Middle East to:			
North America	2,7	1,7	-37%
Europe OCDE	1,6	1,3	-19%
China	2,6	2,9	12%
Pacific OCDE	4,8	3,9	-19%
Rest of Asia	5,4	6,2	15%
... Rusia to:			
Europe OCDE	4,3	2,9	-33%
China	0,7	1,4	100%
Pacific OCDE	0,2	0,3	50%
Rest of Asia	1,5	1,2	-20%

2. Climate change challenge requires bold actions

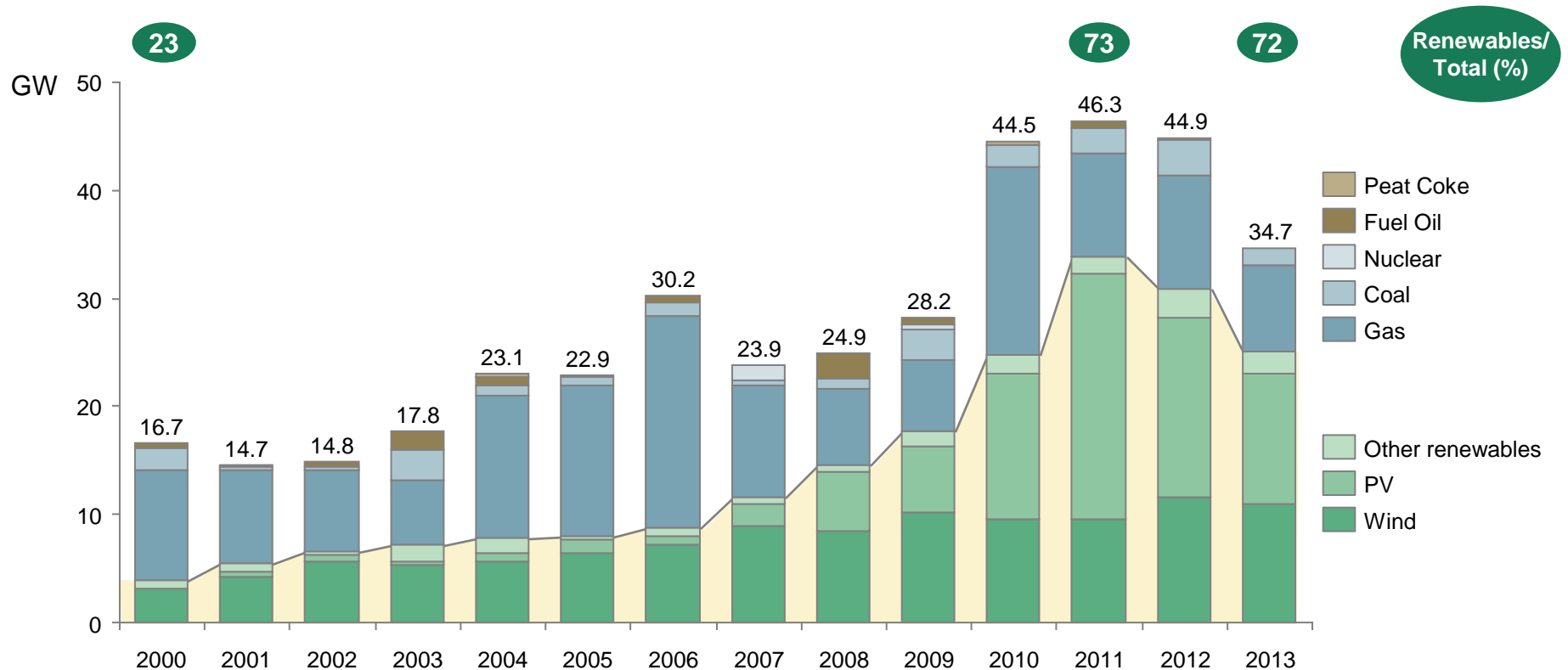


Meeting the climate challenge implies action on both the Supply and Demand side

1. New Policies Scenario assumes policies announced to date are implemented 2. Renewables including Biofuels 3. MT: million ton
Sources: IEA World Energy Outlook 2011

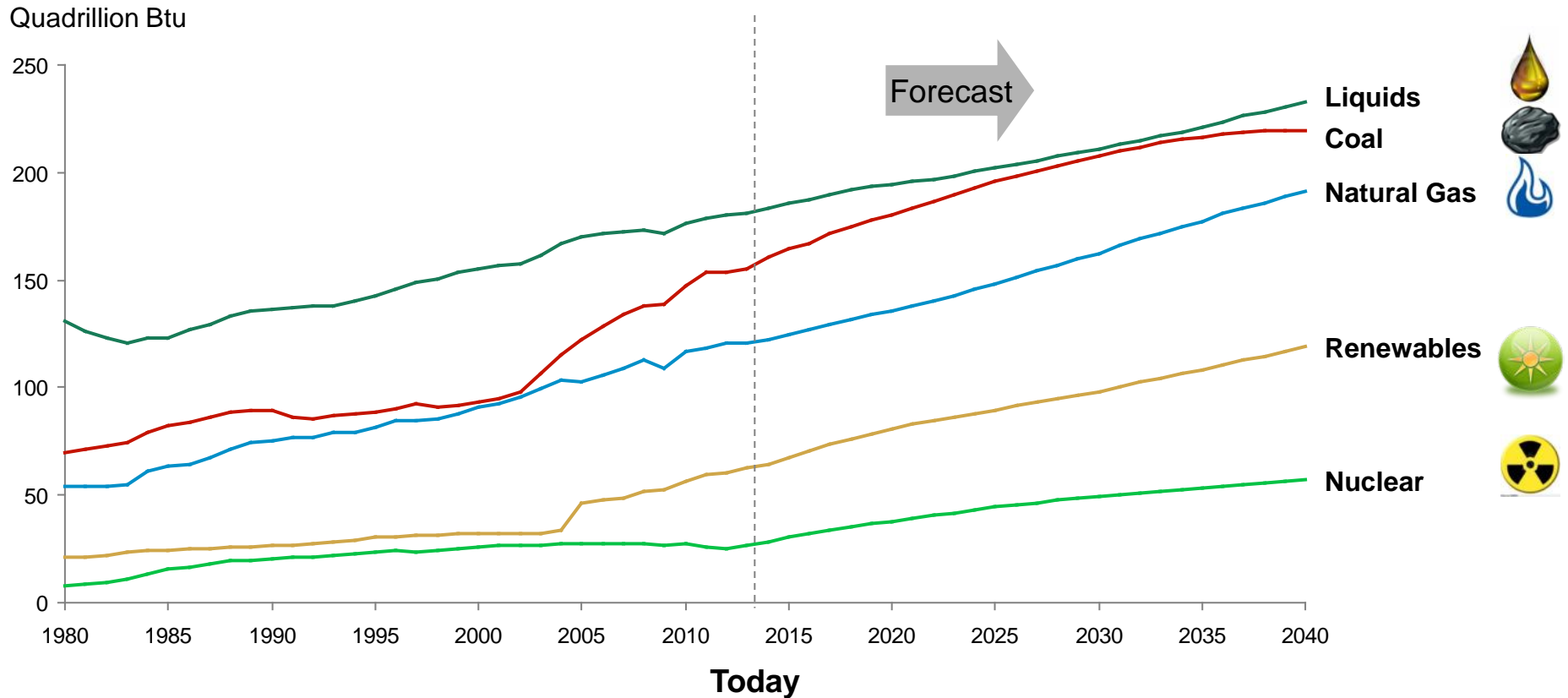
Renewables' annual installed capacity in the EU increased from 23% to 72%

Annual new installed capacity in the EU 27



3. We live in a fossil fuel based society

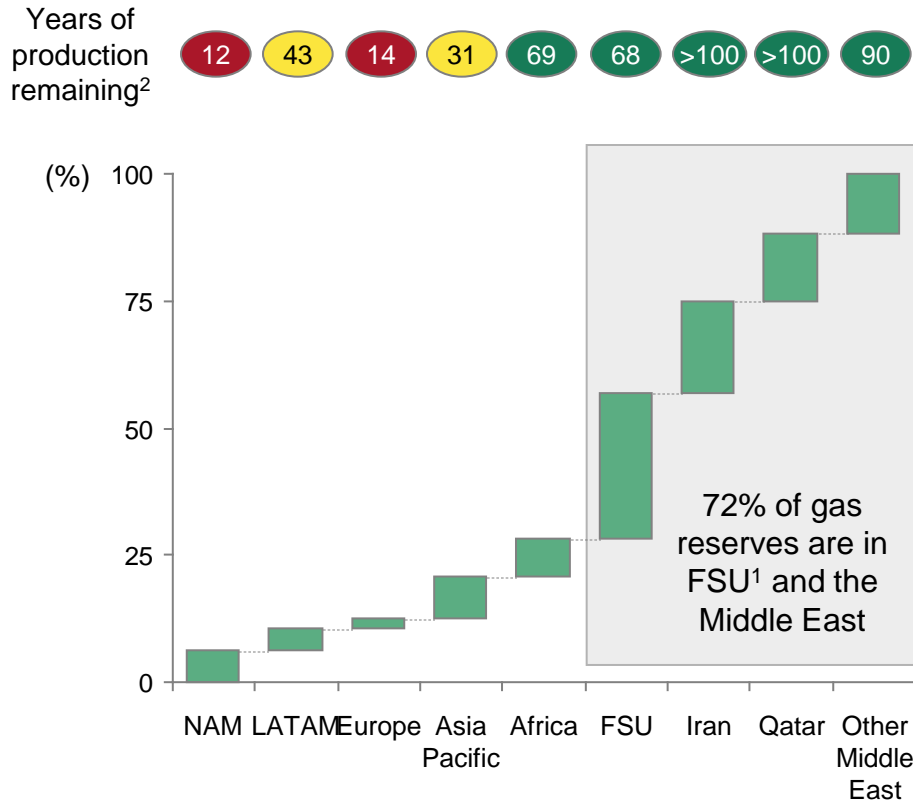
World Total Energy Consumption 1980–2040



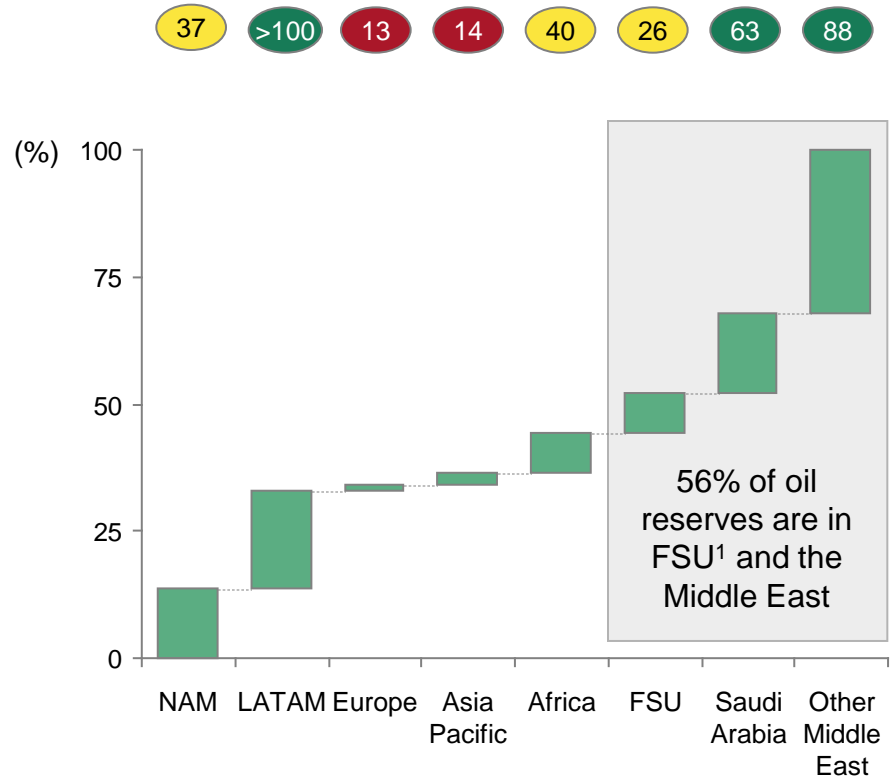
Source: EIA, International Energy Outlook, 2013

4. Energy reserves are highly concentrated

Distribution of Global Gas Reserves 2013



Distribution of Global Oil Reserves 2013



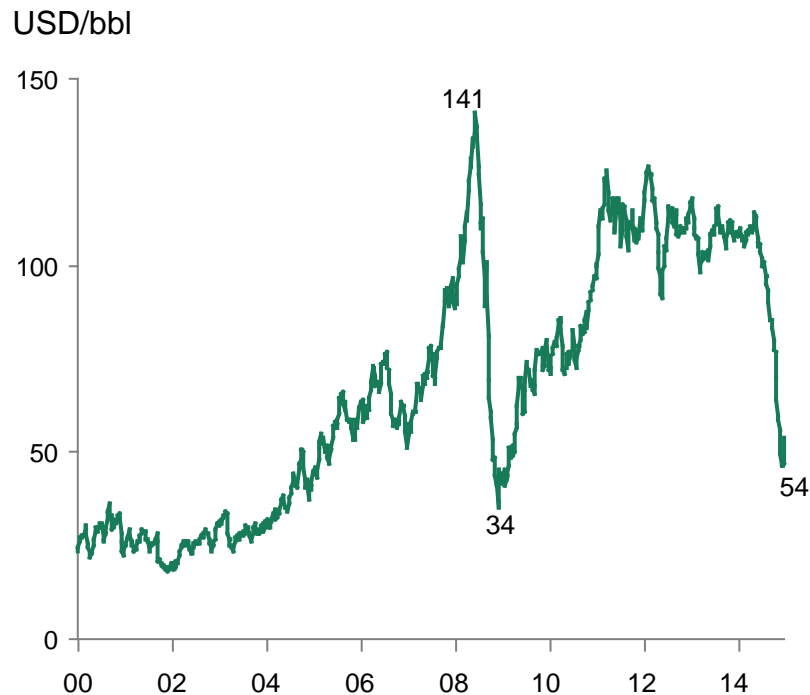
1. FSU= Former Soviet Union 2. At current rates of production
Source: BP Statistical Review 2014

5. The Energy ecosystem is very fragile

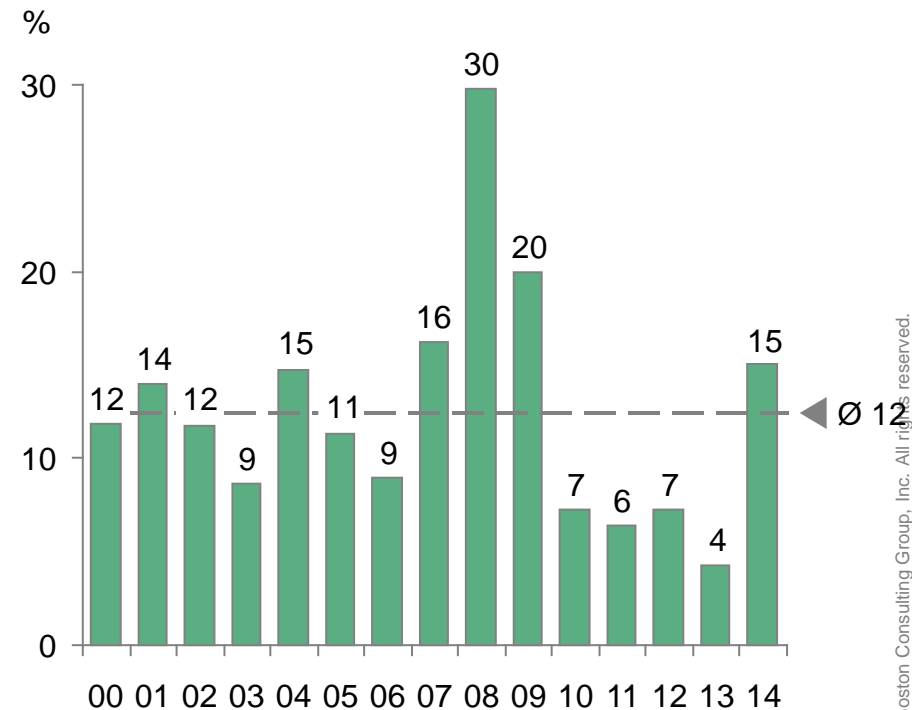


6. Energy prices are very volatile

Evolution of the Brent price 2000 - 2015



Annual volatility¹ of oil prices



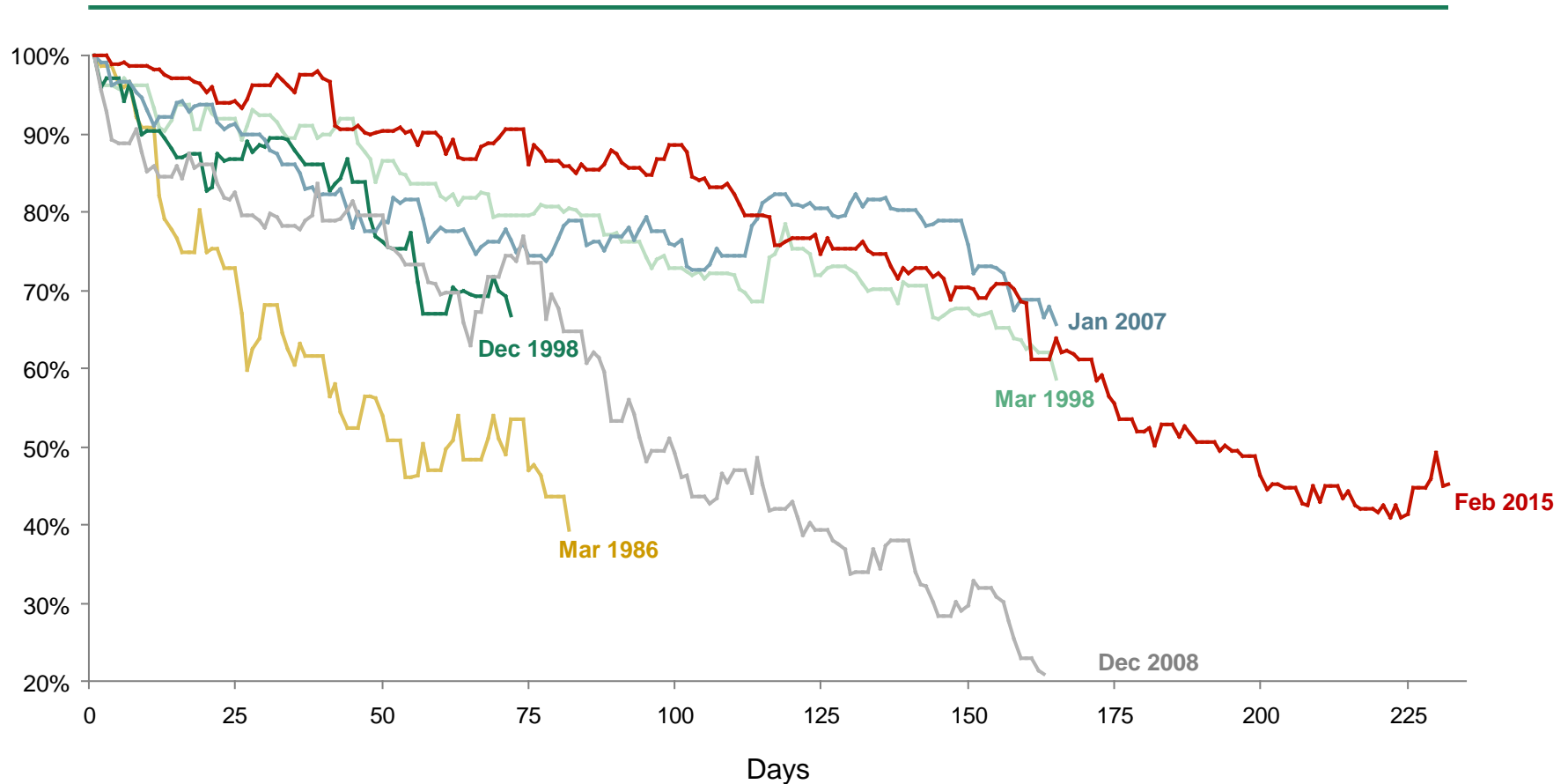
1. Calculated as the standard deviation and divided by the average throughout the period, using daily Brent prices

Note: Average weekly prices until February 4th 2015

Source: EIA

The current oil price decline is exceptionally long-lasting

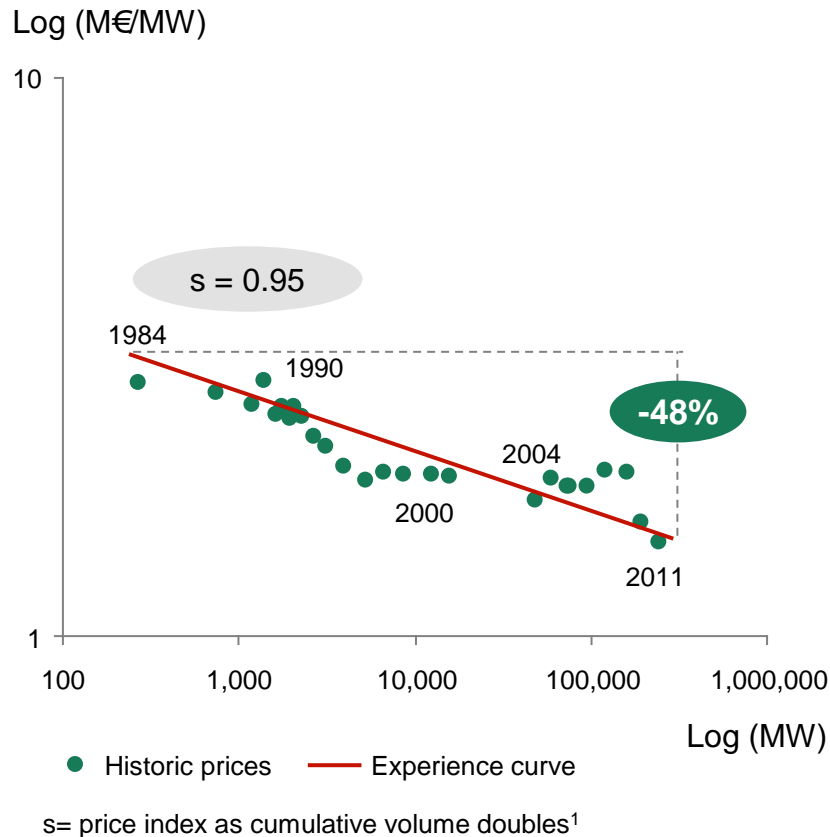
Oil price crashes since 1986 (peak to trough)



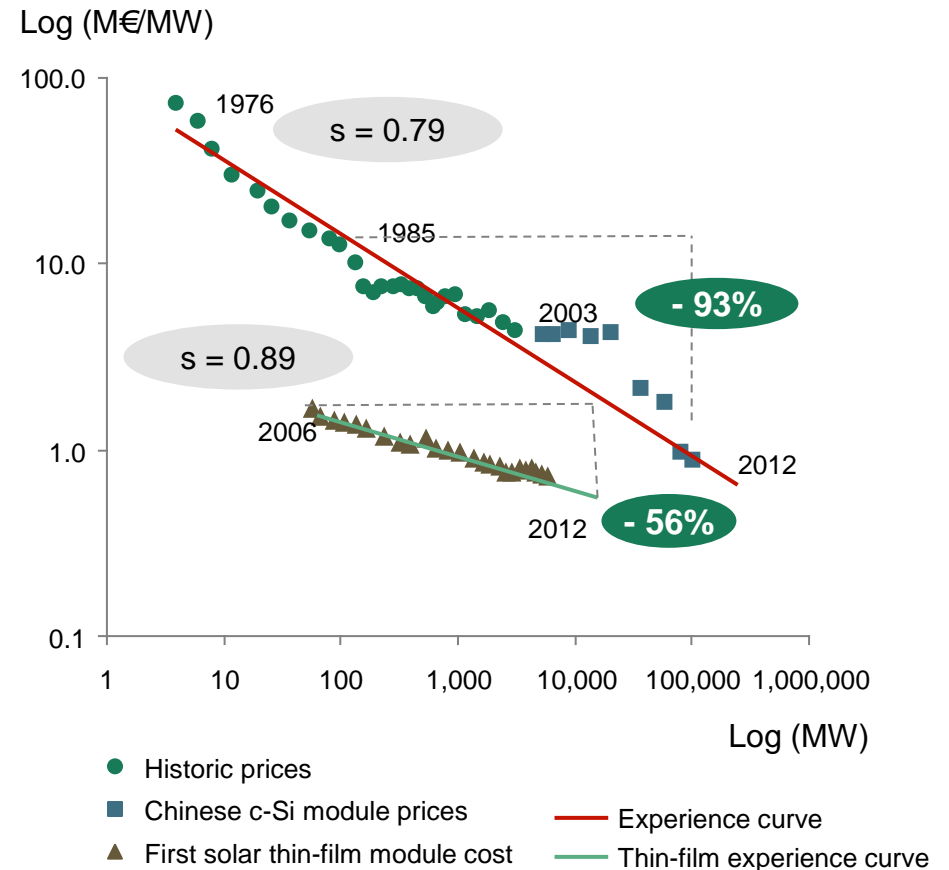
7. Technology has a huge impact in energy (I)

Wind and Solar costs are moving down the experience curve

**Wind turbine price index,
1984–2011**



**The Solar PV module experience curve,
1976–2012**



1. S: price index as cumulative volume doubles; S= 0.95 means as cumulative volume doubles, price drops to 95% of before

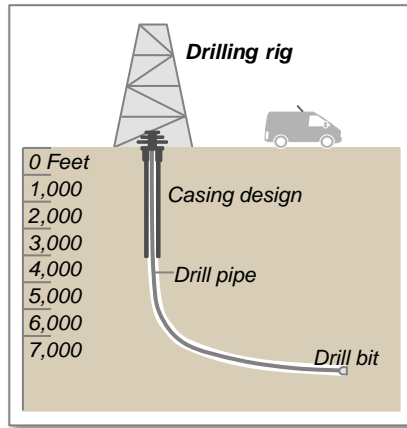
Note: WTPI is wind turbine price index, WTPI excl comm is adjusted for commodity prices 2002–10, Inflation adjustment using US PPI, R2 of c-Si regression = 0.94, R2 of FSLR regression = 0.98

Source: Bloomberg new energy finance; Extool; Lawrence Berkeley laboratory; FSLR filings

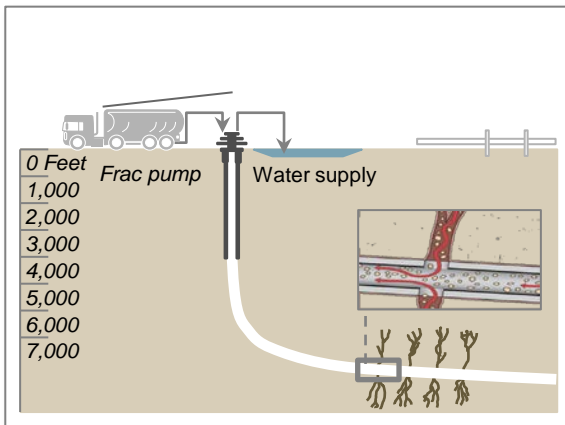
7. Technology has a huge impact in energy (II)

Horizontal drilling and hydraulic fracturing

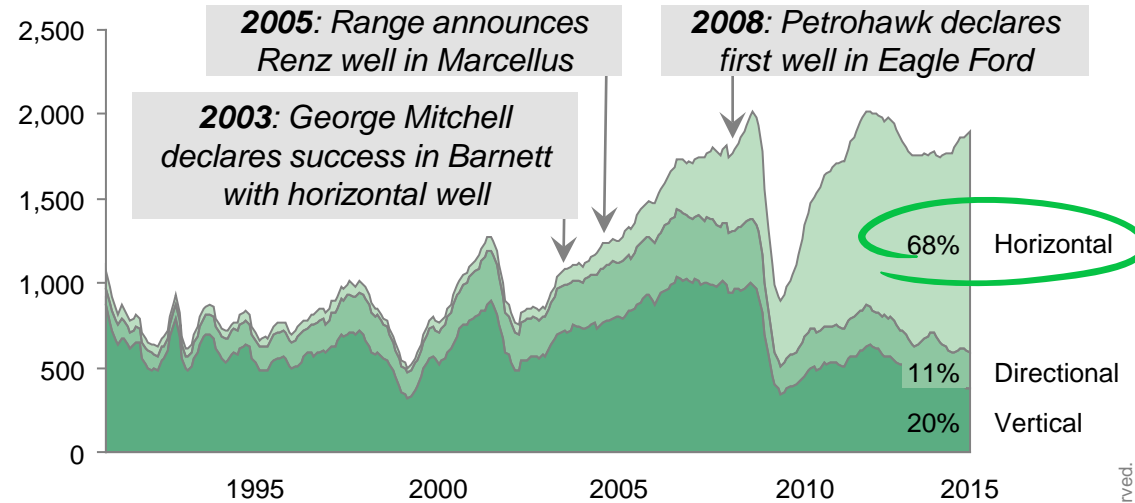
Horizontal well drilling



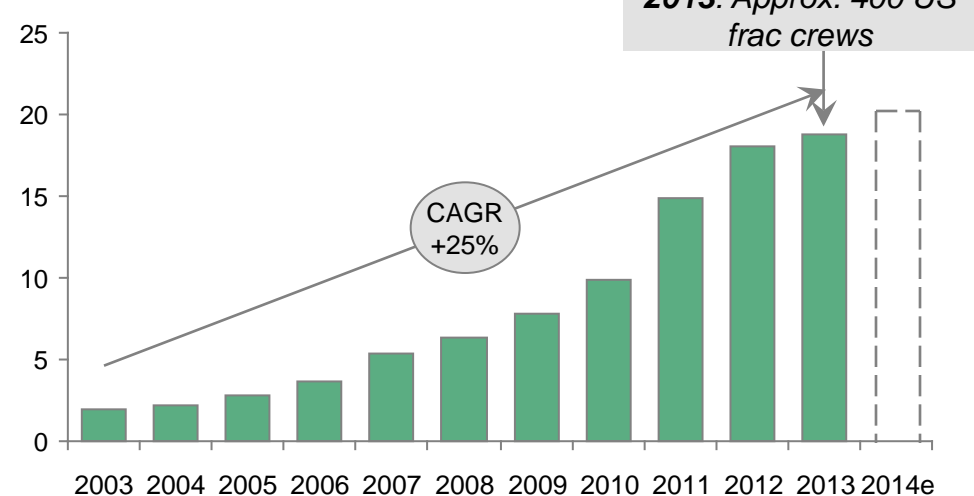
Hydraulic fracturing well completion



Active NA Rig Count

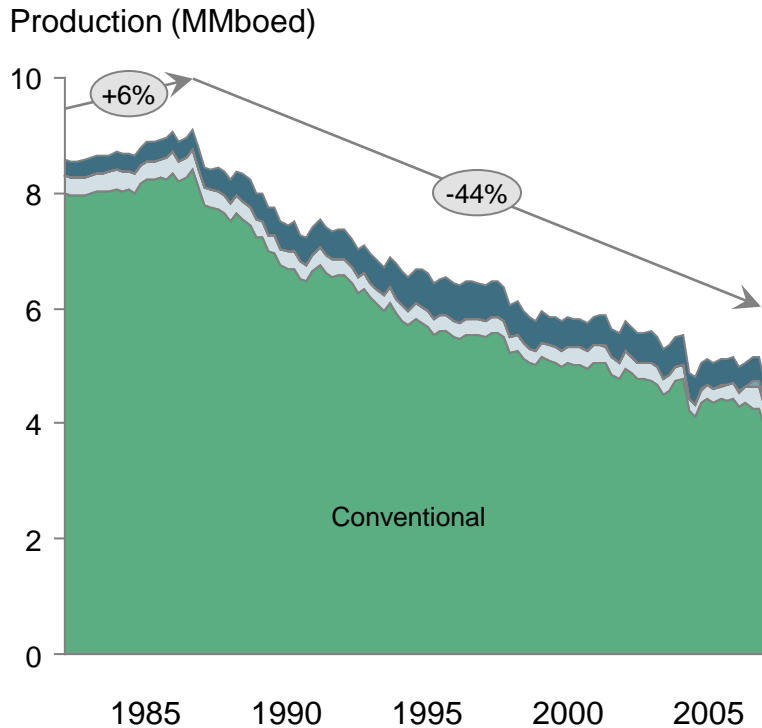


Million Hydraulic Horsepower (MMhhp)

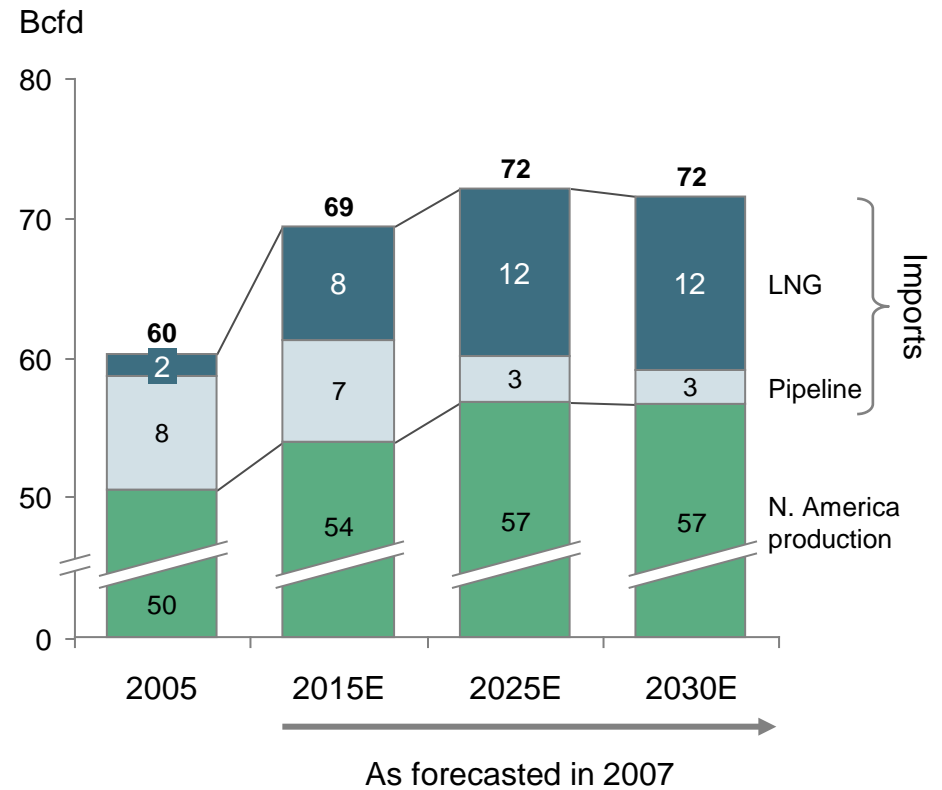


8. The energy sector is very difficult to predict

As US crude production was on a steady decline for about 20 years and...



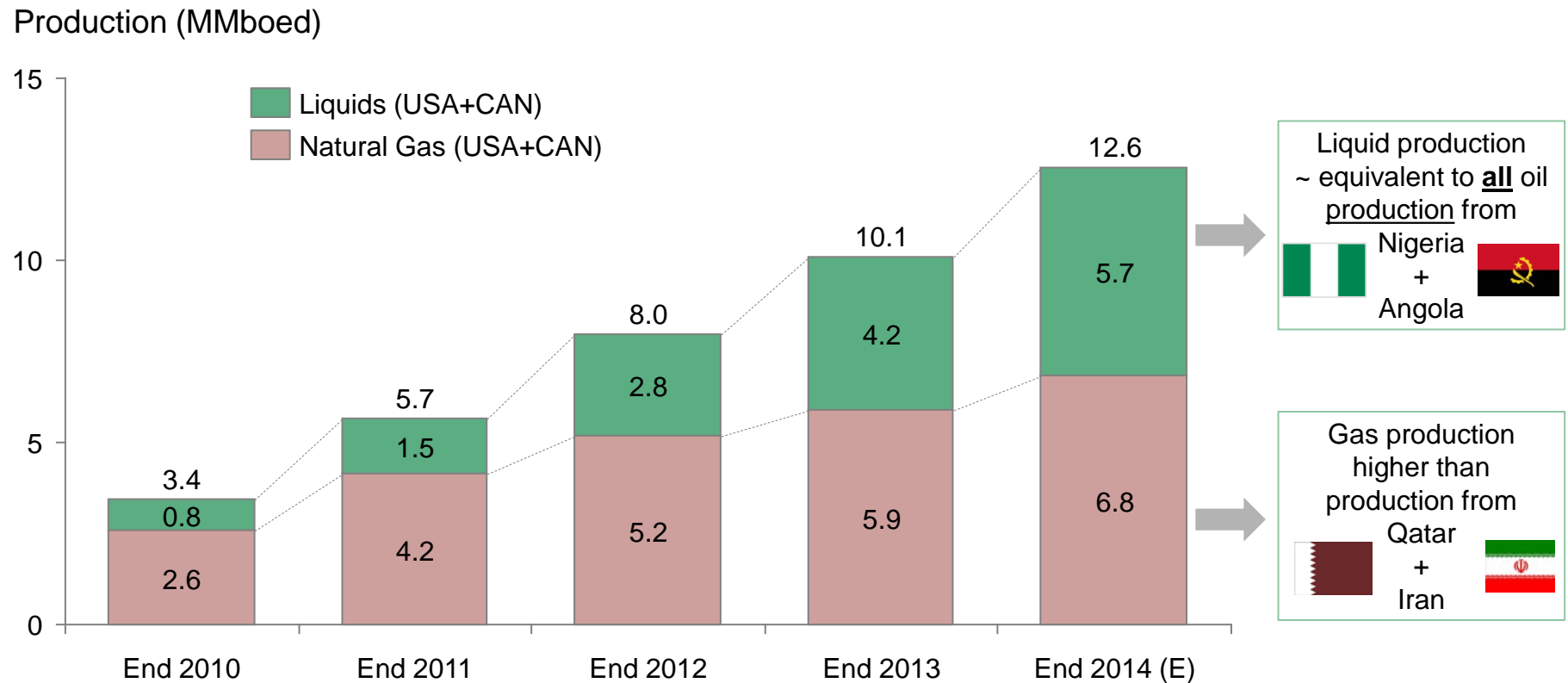
...2007 forecasts anticipated the US would need LNG imports



The US Shale "revolution" surprised many experts

Production from North American Shale plays has boomed

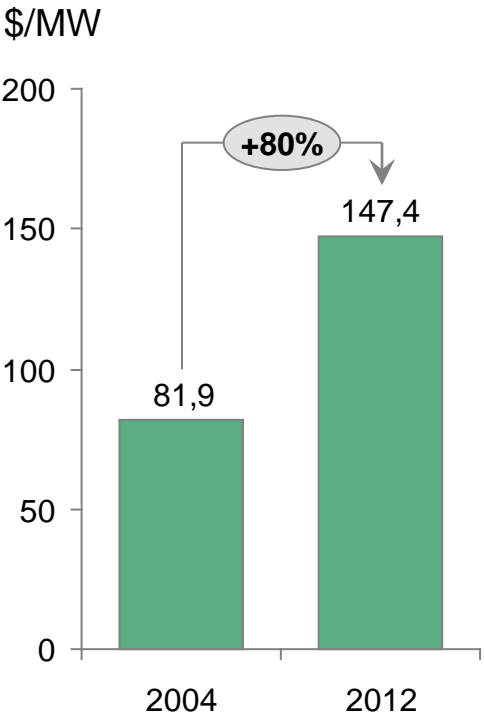
Evolution of daily production from North American Shale basins (2010–2013)



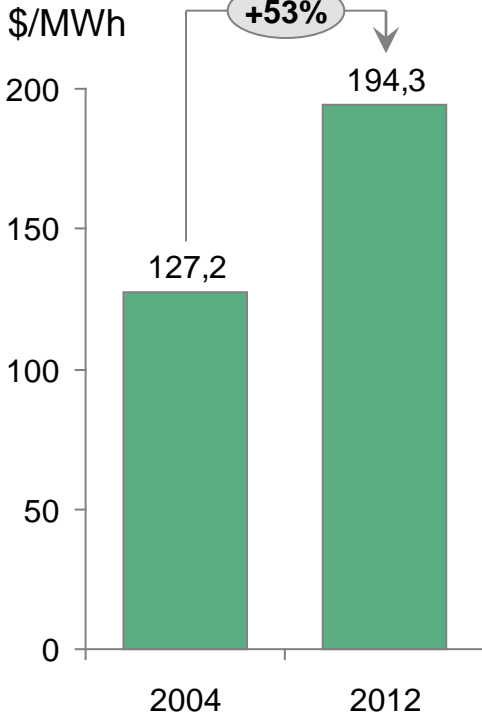
9. Energy agenda has a competitive impact in the industrial sector

Electricity price for Industry

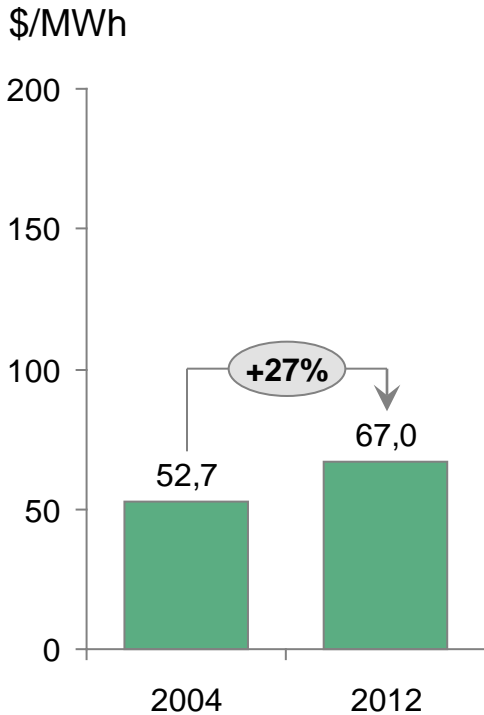
OCDE Europe



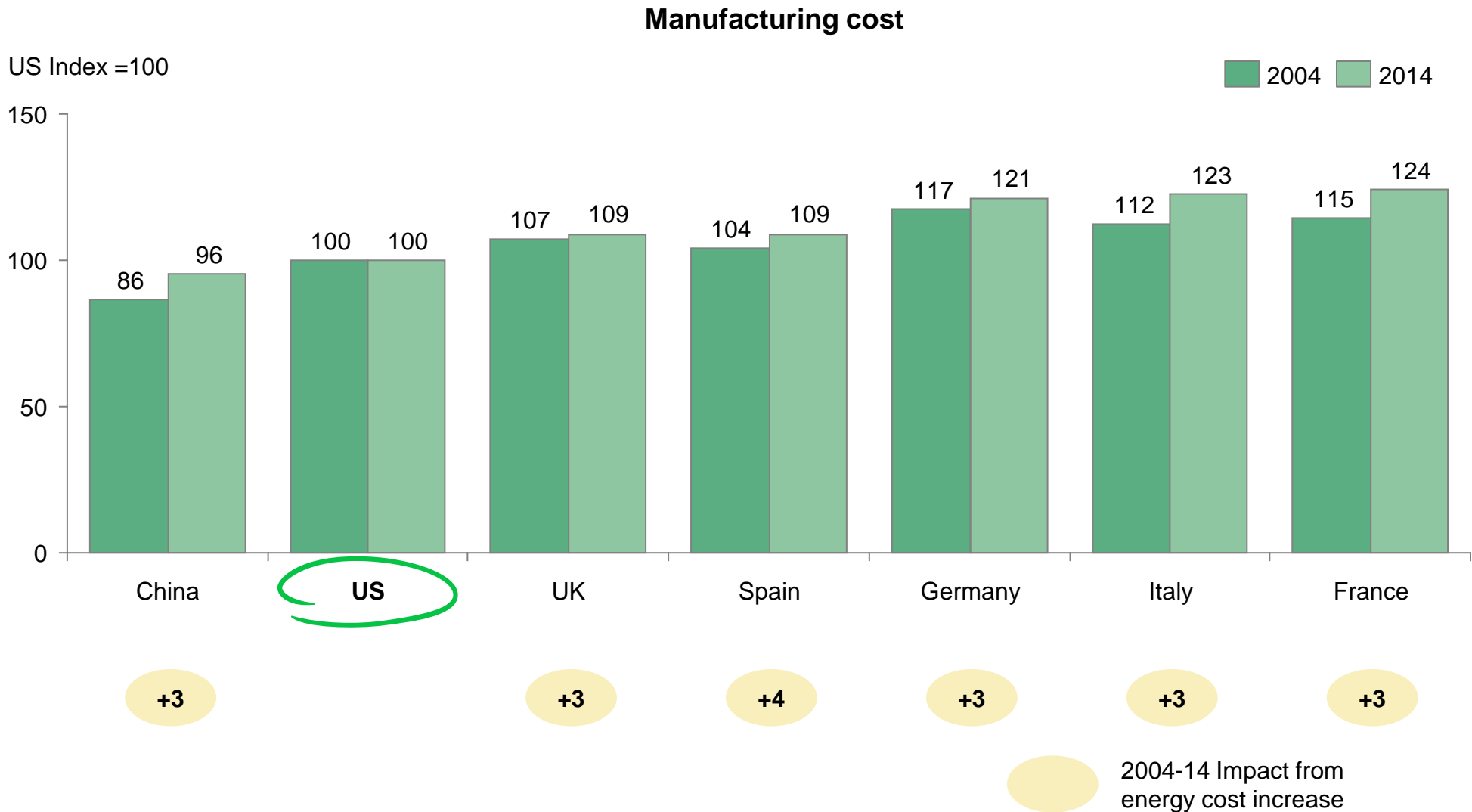
Japan



USA



European industry is losing competitiveness vs. US industry



Key challenges of the energy sector

- 1 **Global energy demand will continue to grow fast**
- 2 **Climate change challenge requires even bolder actions**
- 3 **We live in a fossil fuel based society**
- 4 **Energy reserves are highly concentrated**
- 5 **The Energy ecosystem is very fragile**
- 6 **Energy prices are very volatile**
- 7 **Technology has a huge impact in energy**
- 8 **The energy sector is very difficult to predict**
- 9 **Energy agenda has a competitive impact in the industrial sector**

Energy is reshaping the world

North America:
The
unconventional
boom

1



2



Europe:
Renewables
under
pressure

Asia:
Multi-source
demand
growth

3



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