



International
Energy Agency

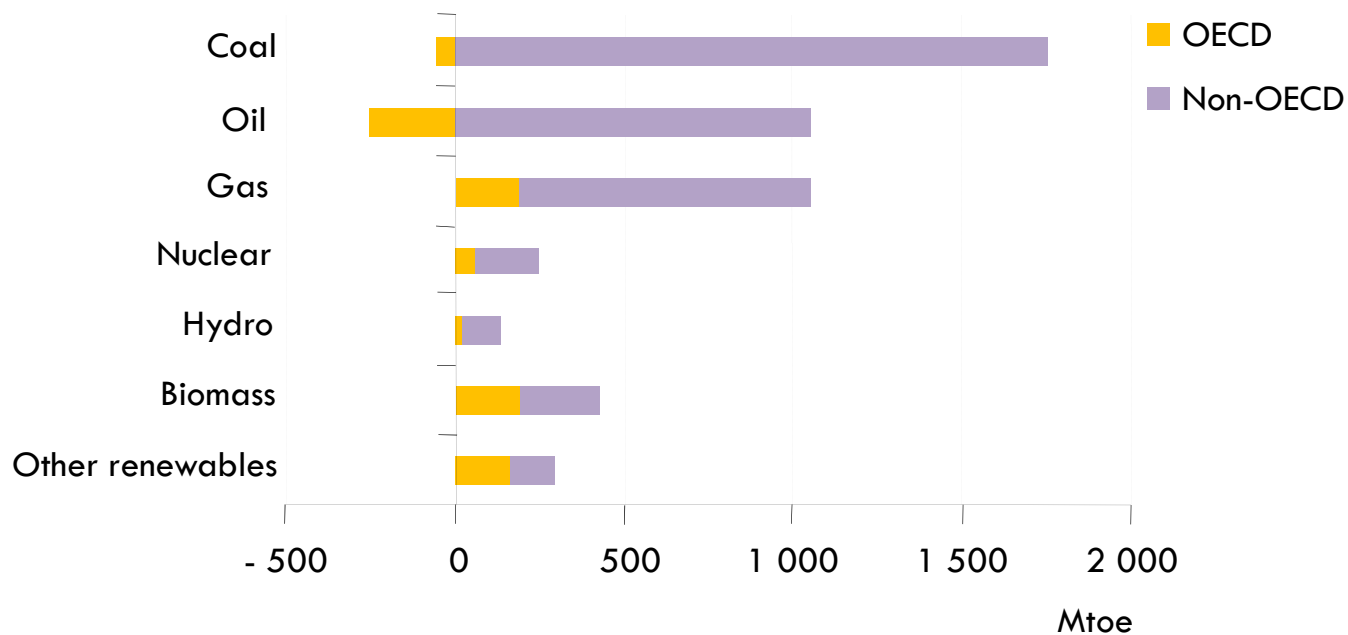
World Energy Outlook

World Energy Outlook 2009

Washington, D.C.,
1-3 December 2009

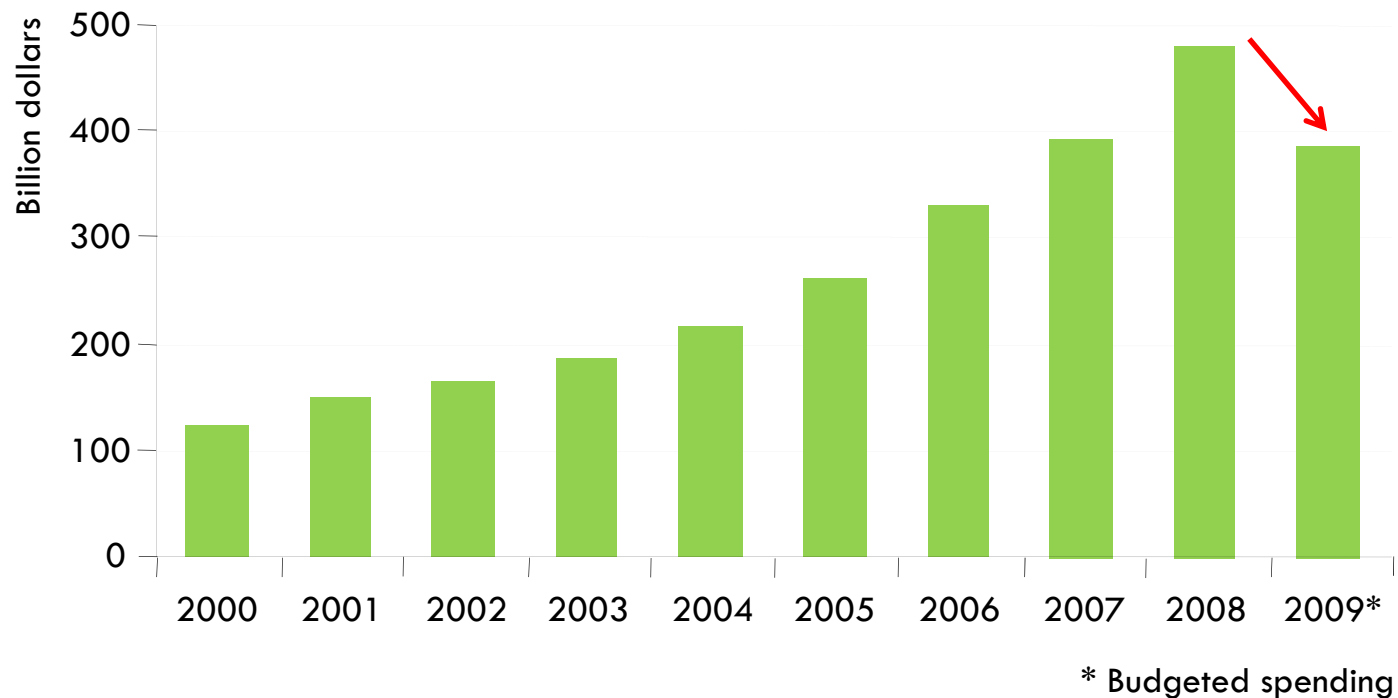
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Change in primary energy demand in the Reference Scenario, 2007-2030



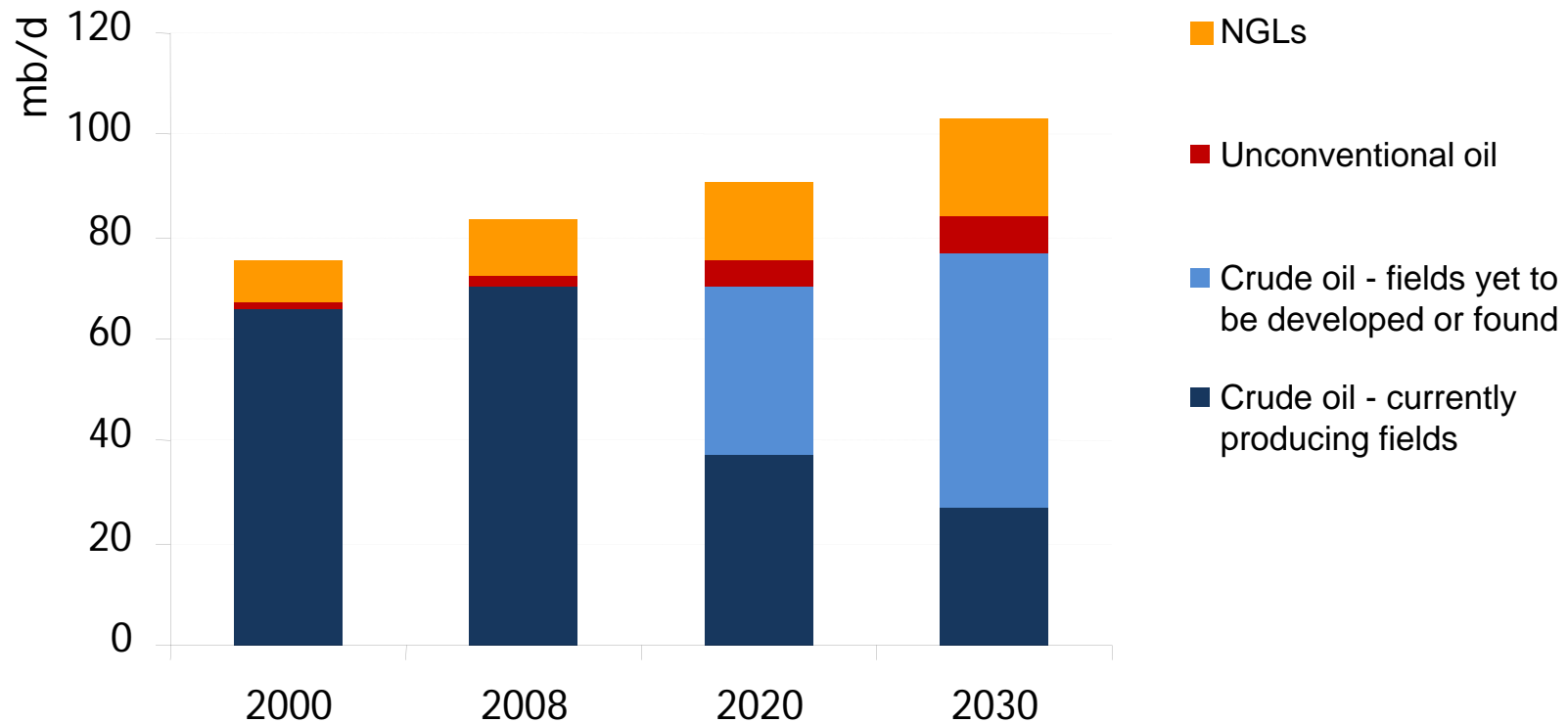
Fossil fuels account for 77% of the increase in world primary energy demand in 2007-2030, with oil demand rising from 85 mb/d in 2008 to 88 mb/d in 2015 & 105 mb/d in 2030

Worldwide upstream oil & gas capital expenditures



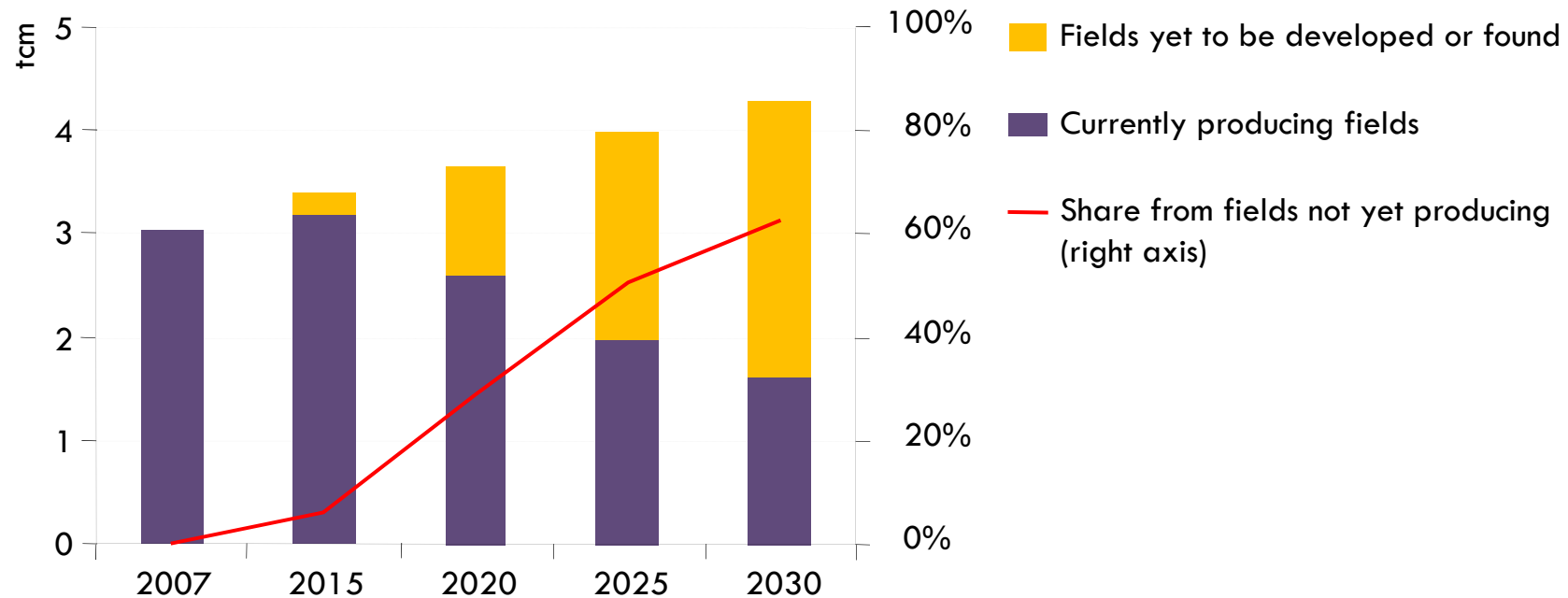
Global upstream spending is budgeted to fall by over \$90 billion, or 19%, in 2009; the first fall in a decade

Oil production in the Reference Scenario



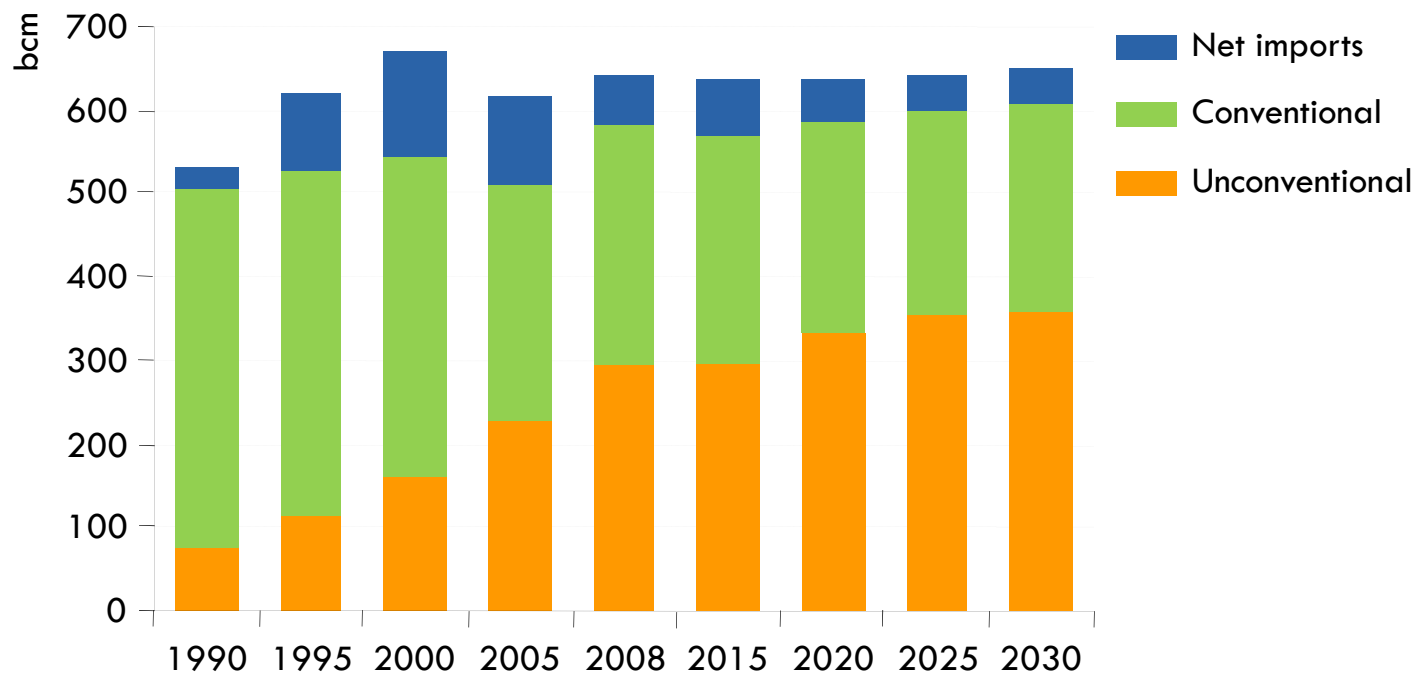
Sustained investment is needed mainly to combat the decline in output at existing fields, which will drop by almost two-thirds by 2030

Impact of decline on world natural gas production in the Reference Scenario



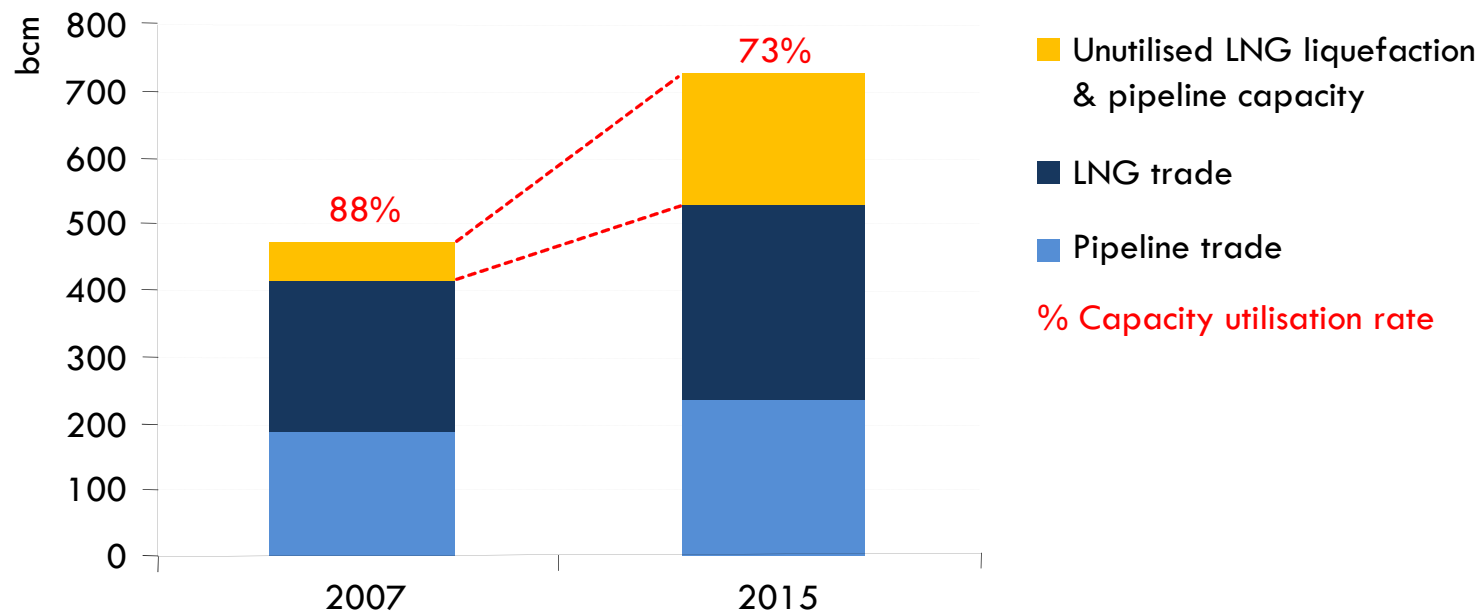
Additional capacity of around 2 700 bcm, or 4 times current Russian capacity, is needed by 2030 – half to offset decline at existing fields & half to meet the increase in demand

US natural gas supply in the Reference Scenario



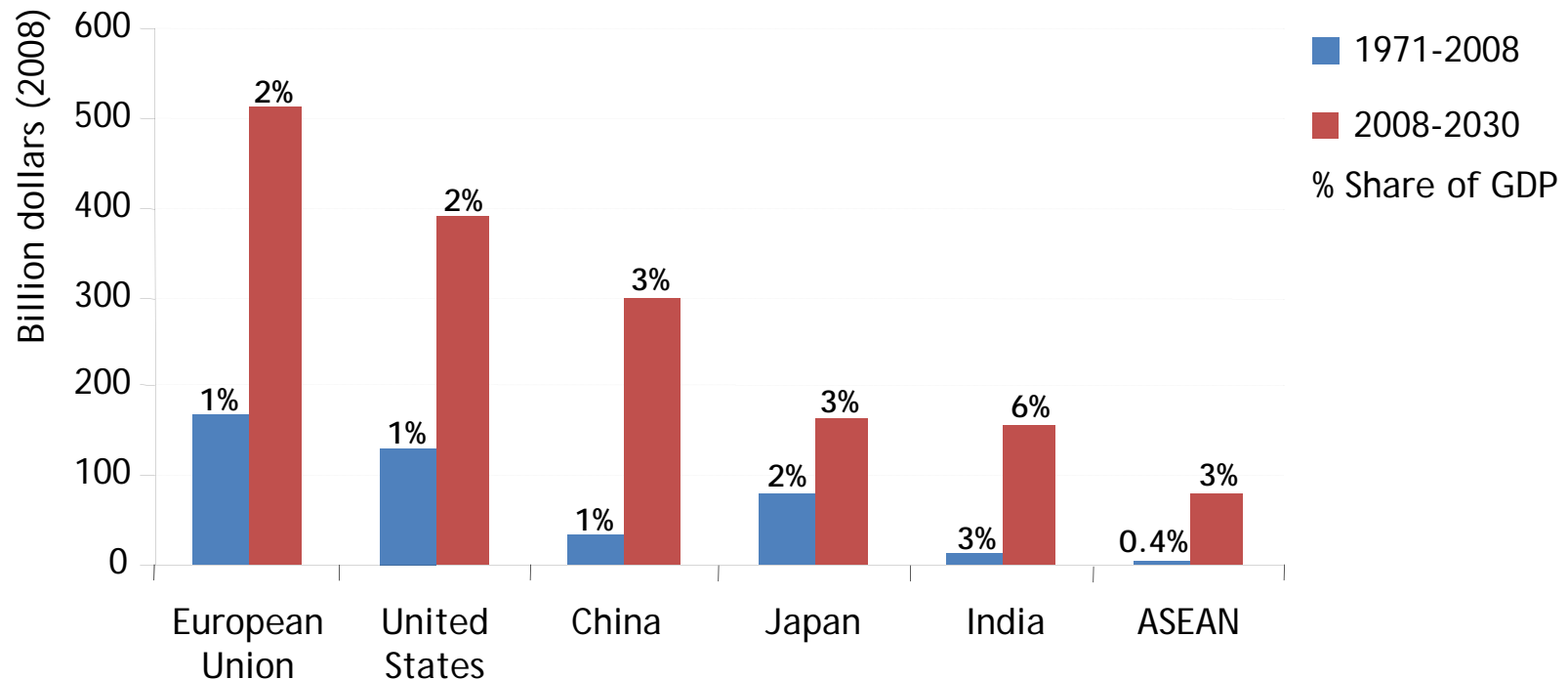
Thanks mainly to shale gas, US gas output grows gradually through to 2030, outstripping demand & squeezing imports

Natural gas transportation capacity



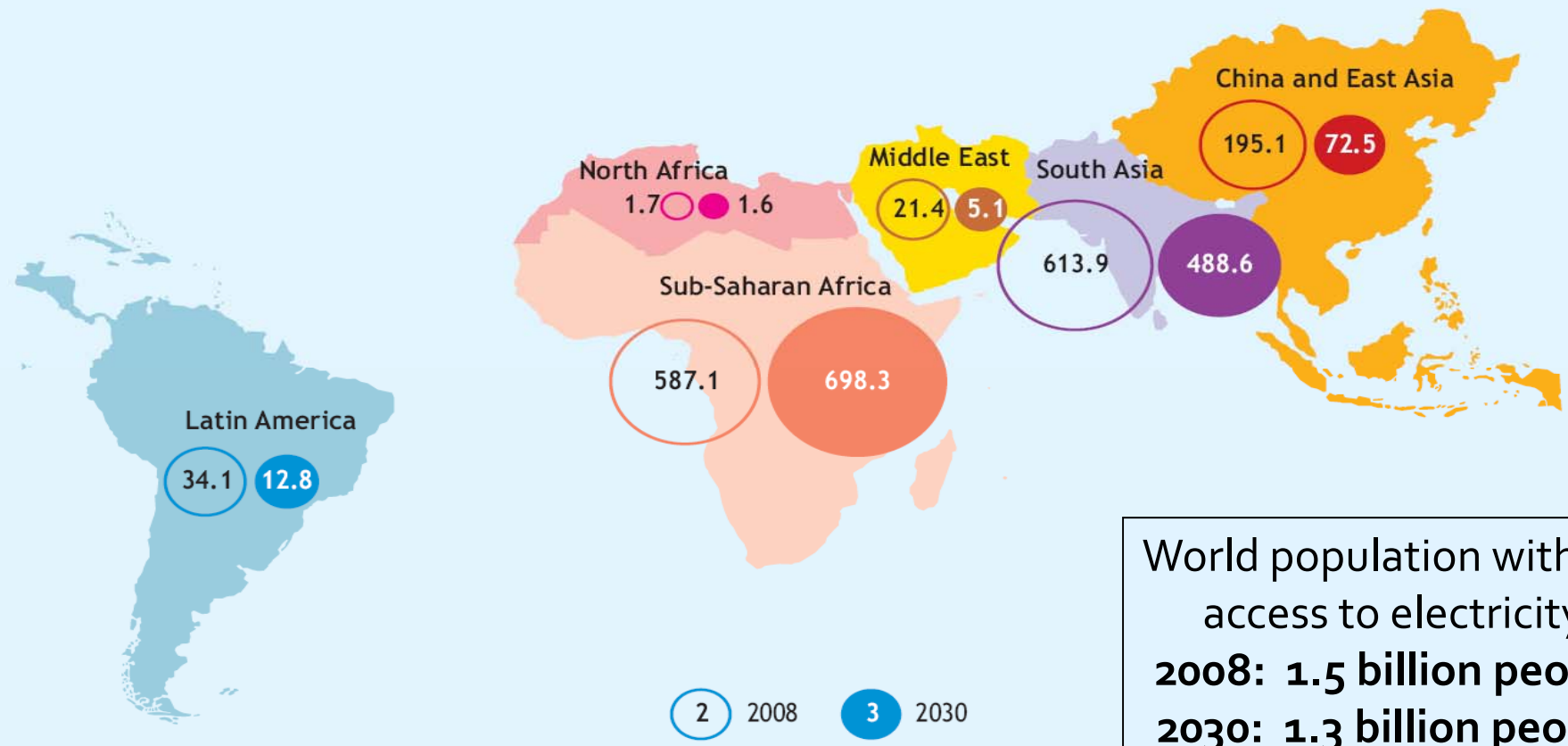
A glut of gas is developing – reaching 200 bcm by 2015 – due to weaker than expected demand & plentiful US unconventional supply, with far-reaching implications for gas pricing

Average annual expenditure on net imports of oil & gas in the Reference Scenario



The Reference Scenario implies persistently high spending on oil & gas imports, with China overtaking the United States by around 2025 to become the world's biggest spender

Number of people without access to electricity in the Reference Scenario (millions)



World population without access to electricity
 2008: 1.5 billion people
 2030: 1.3 billion people

2 2008 3 2030

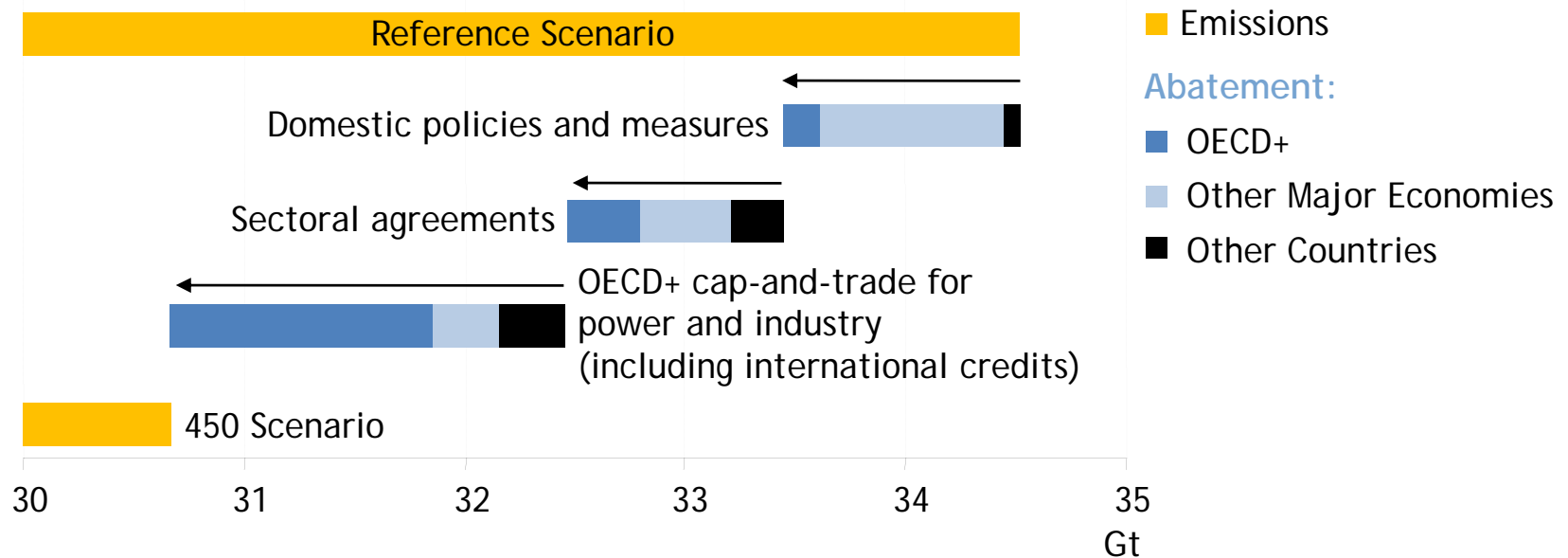
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\$35 billion per year more investment than in the Reference Scenario would be needed to 2030 – equivalent to just 5% of global power-sector investment – to ensure universal access

The policy mechanisms in the 450 Scenario

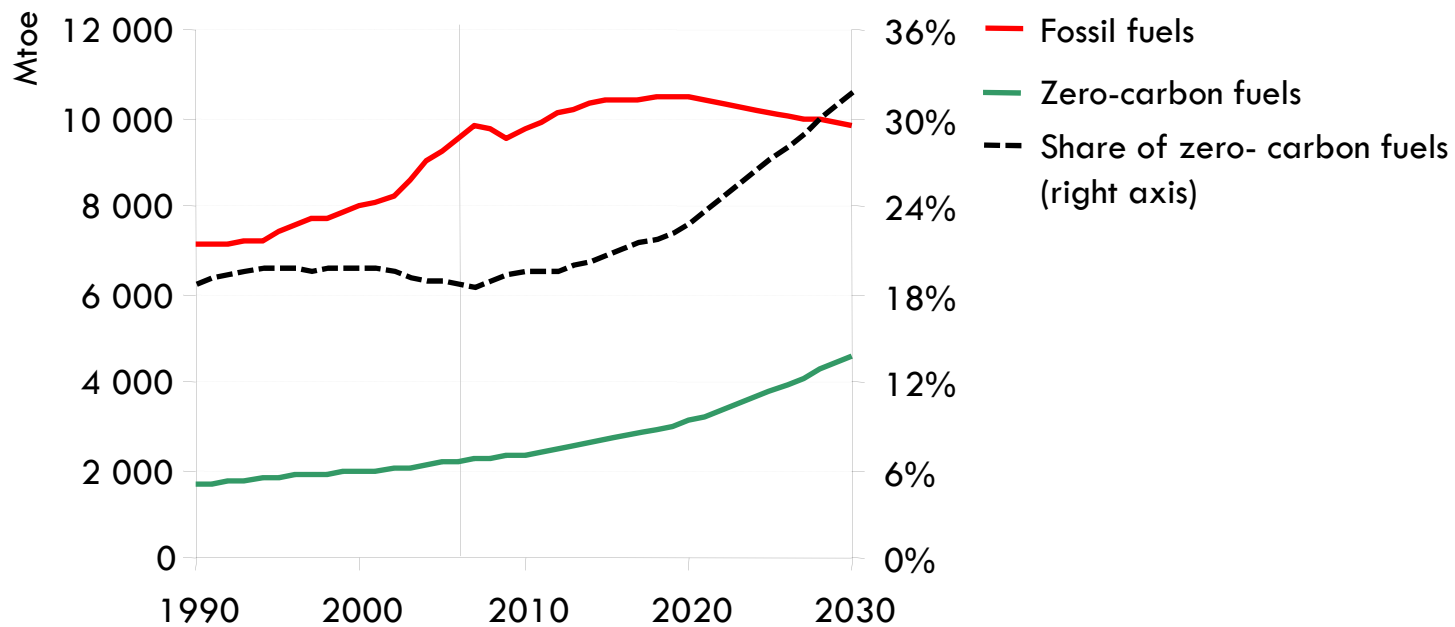
- A combination of policy mechanisms, which best reflects nations' varied circumstances & negotiating positions
- We differentiate on the basis of three country groupings
 - > *OECD+:* OECD & other non-OECD EU countries
 - > *Other Major Economies (OME):* Brazil, China, Middle East, Russia & South Africa
 - > *Other Countries (OC):* all other countries, including India
- A graduated approach
 - > *Up to 2020, only OECD+ have national emissions caps*
 - > *After 2020, Other Major Economies are also assumed to adopt emissions caps*
 - > *Through to 2030, Other Countries continue to focus on national measures*
- Emissions peaking by 2020 will require
 - > *A CO₂ price of \$50 per tonne for power generation & industry in OECD+*
 - > *Investment needs in non-OECD countries of \$200 billion in 2020, supported by OECD+ through carbon markets & co-financing*

Abatement by policy type in the 450 Scenario relative to the Reference Scenario, 2020



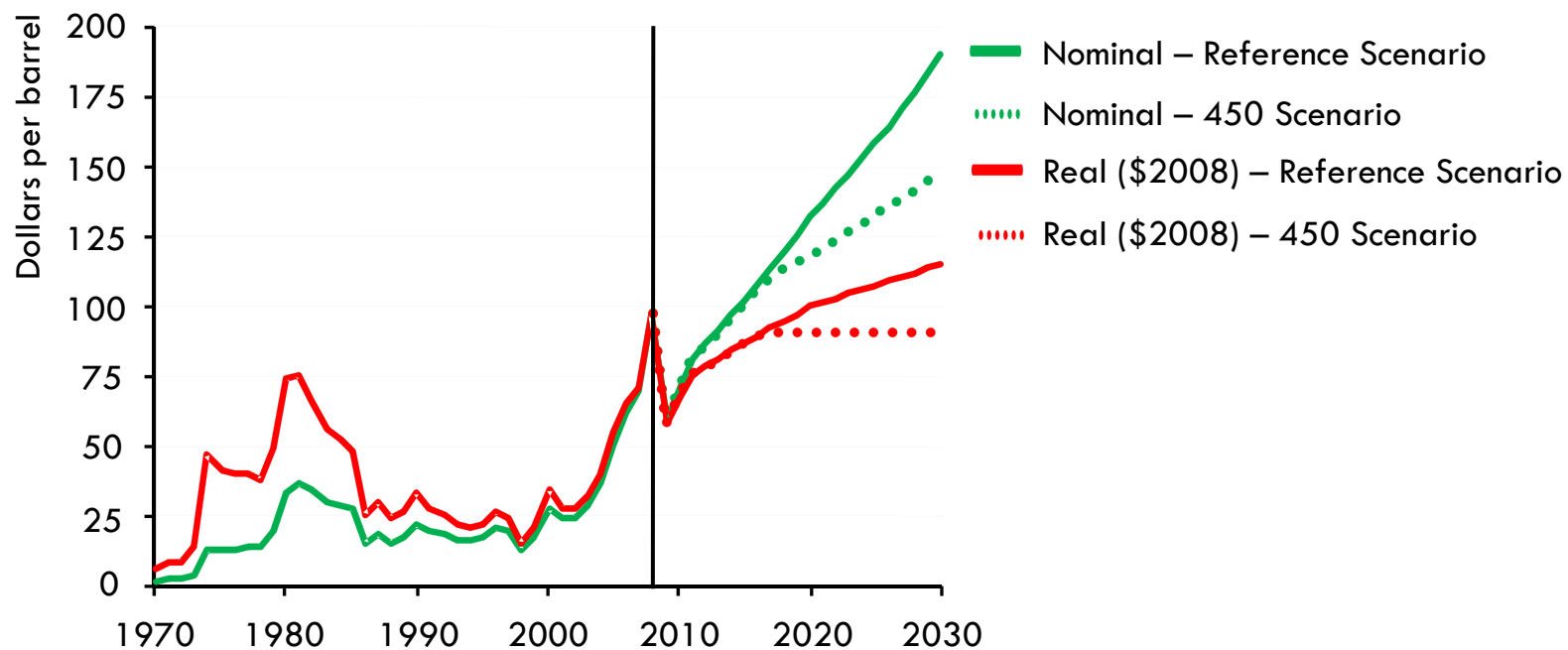
After realising the abatement potential of policies & measures and sectoral approaches, cap-and-trade in OECD+ yields a further 1.8 Gt

World primary energy demand by fuel in the 450 Scenario



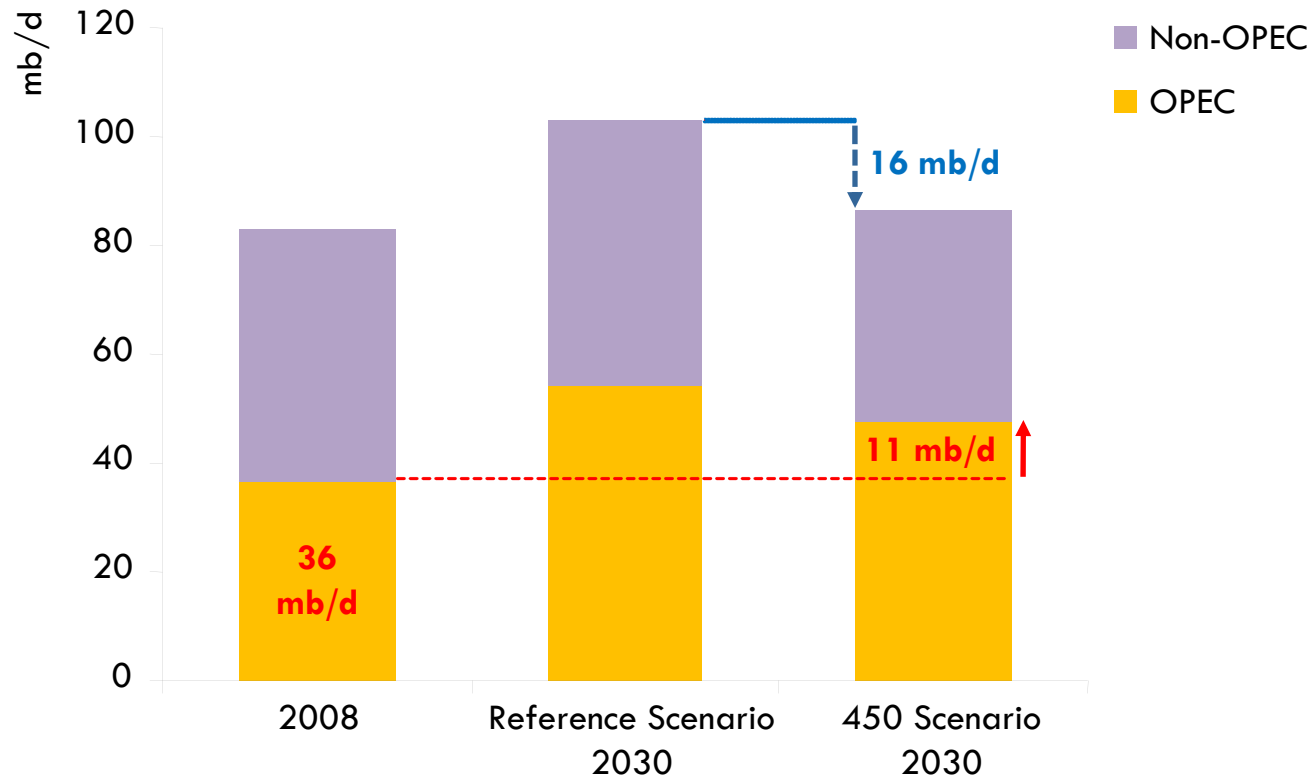
In the 450 Scenario, demand for fossil fuels peaks by 2020, and by 2030 zero-carbon fuels make up a third of the world's primary sources of energy demand

Average IEA crude oil import price



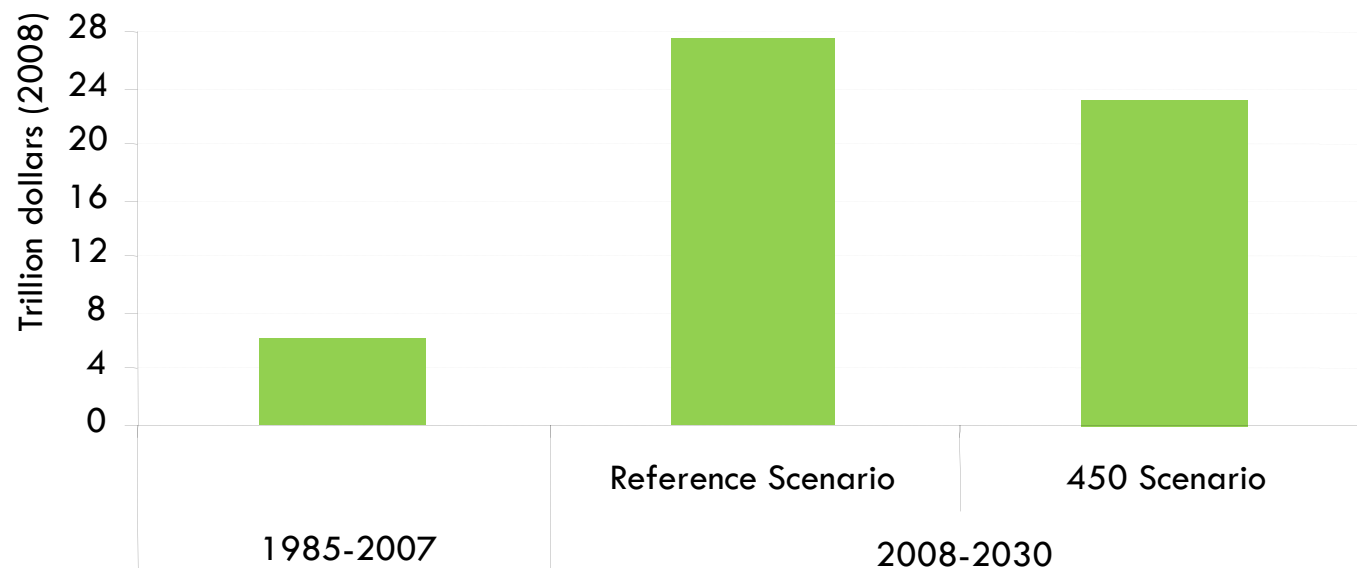
The oil price in real terms is assumed to rebound from around \$60 per barrel in 2009 with the economic recovery, reaching \$100 by 2020 & \$115 per barrel by 2030 in Reference Scenario

World oil production by scenario



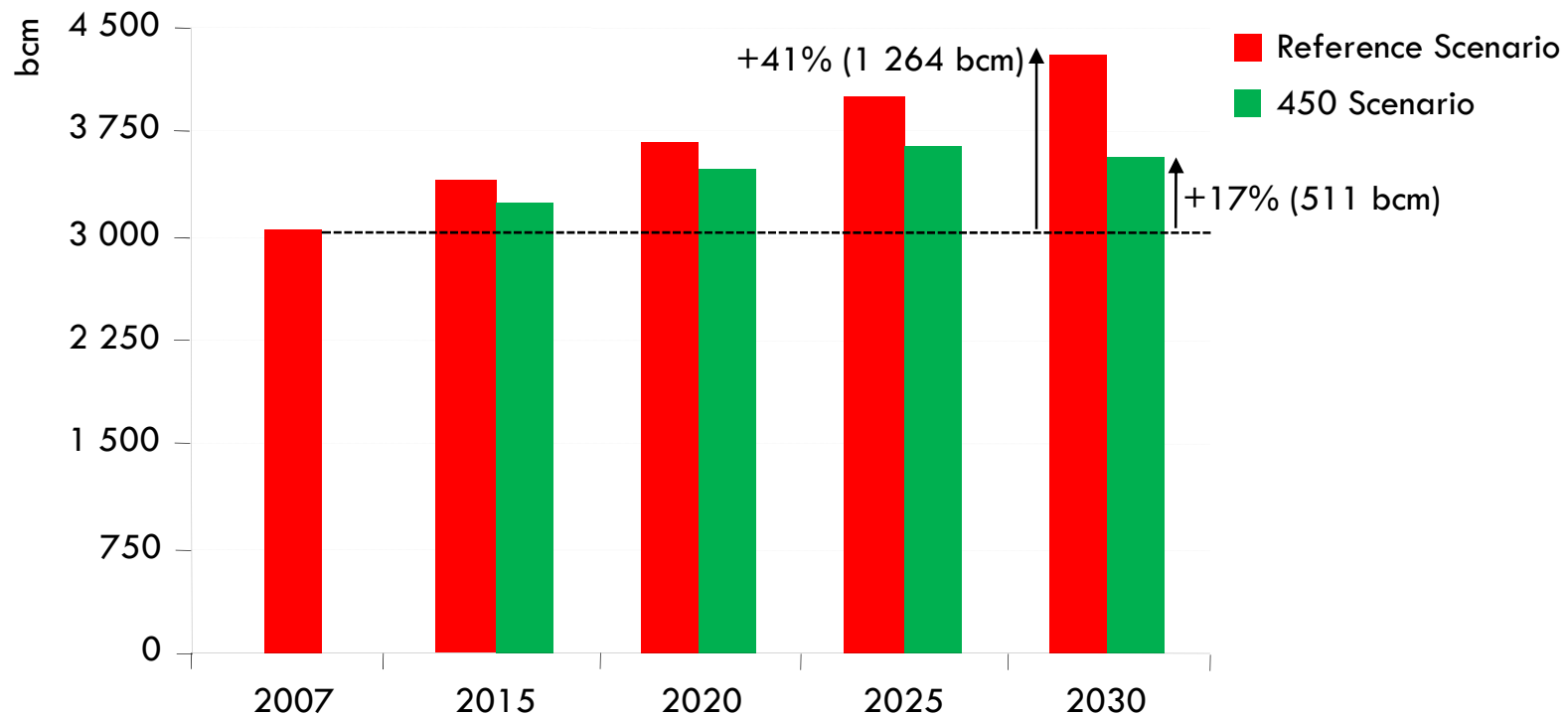
Curbing CO₂ emissions would also improve energy security by cutting oil demand, but even in the 450 Scenario, OPEC production increases by 11 mb/d between now and 2030

Cumulative OPEC oil export revenues by scenario



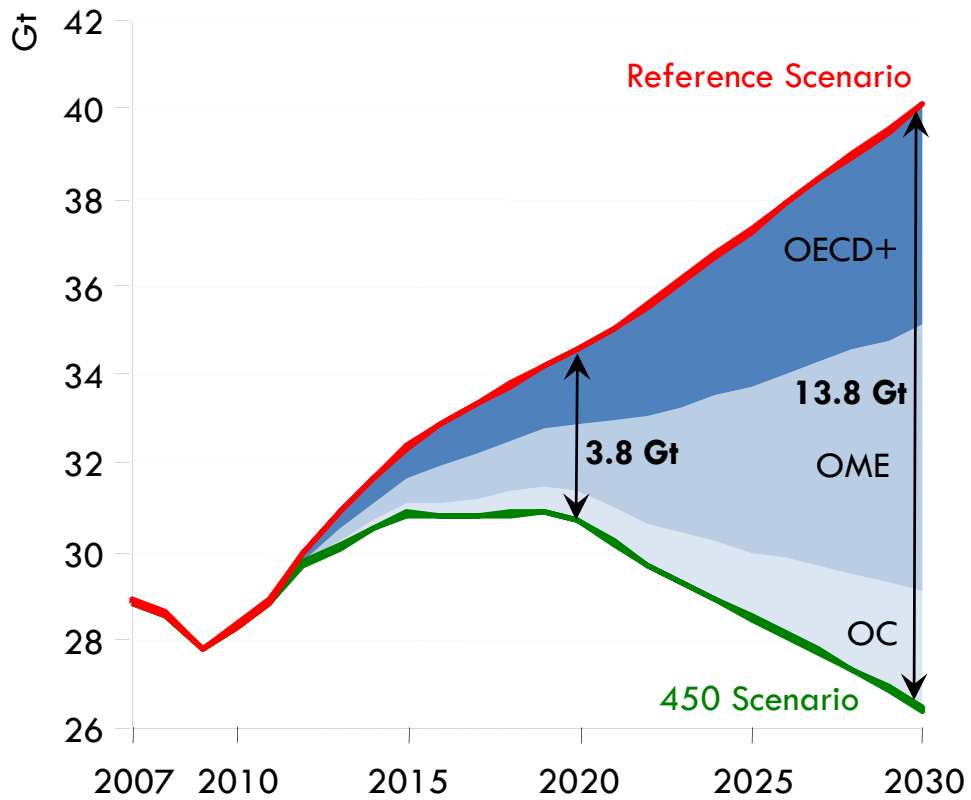
Though slightly lower than in the Reference Scenario, OPEC revenues in the 450 Scenario are over four times as high as in the last 20 years

World primary natural gas demand by scenario

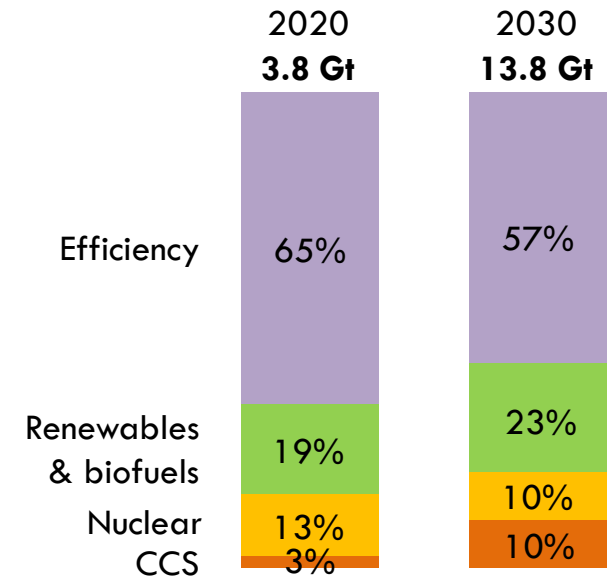


Gas demand continues to grow in both scenarios, peaking by around 2025 in the 450 Scenario & highlighting the potential role of gas as a transition fuel to a clean energy future

World abatement of energy-related CO₂ emissions in the 450 Scenario

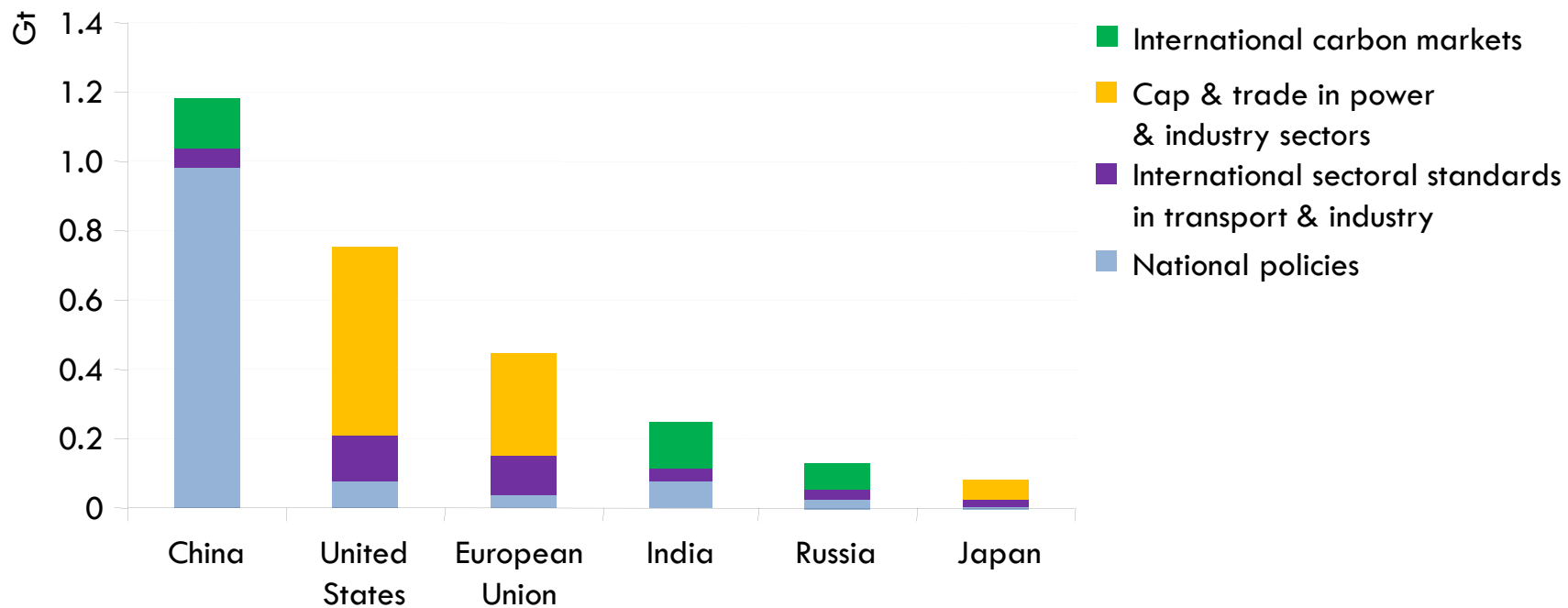


World abatement by technology



An additional \$10.5 trillion of investment is needed in total in the 450 Scenario, with measures to boost energy efficiency accounting for most of the abatement through to 2030

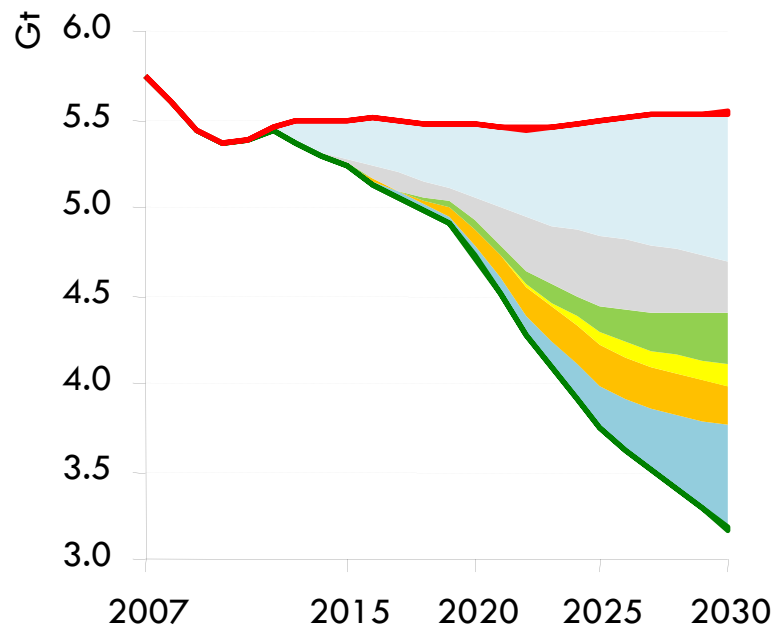
Abatement in the 450 Scenario by key emitters, 2020



China, the United States, the European Union, India, Russia & Japan account for almost three-quarters of the 3.8 Gt reduction in the 450 Scenario

US energy-related CO₂ emissions abatement

2009

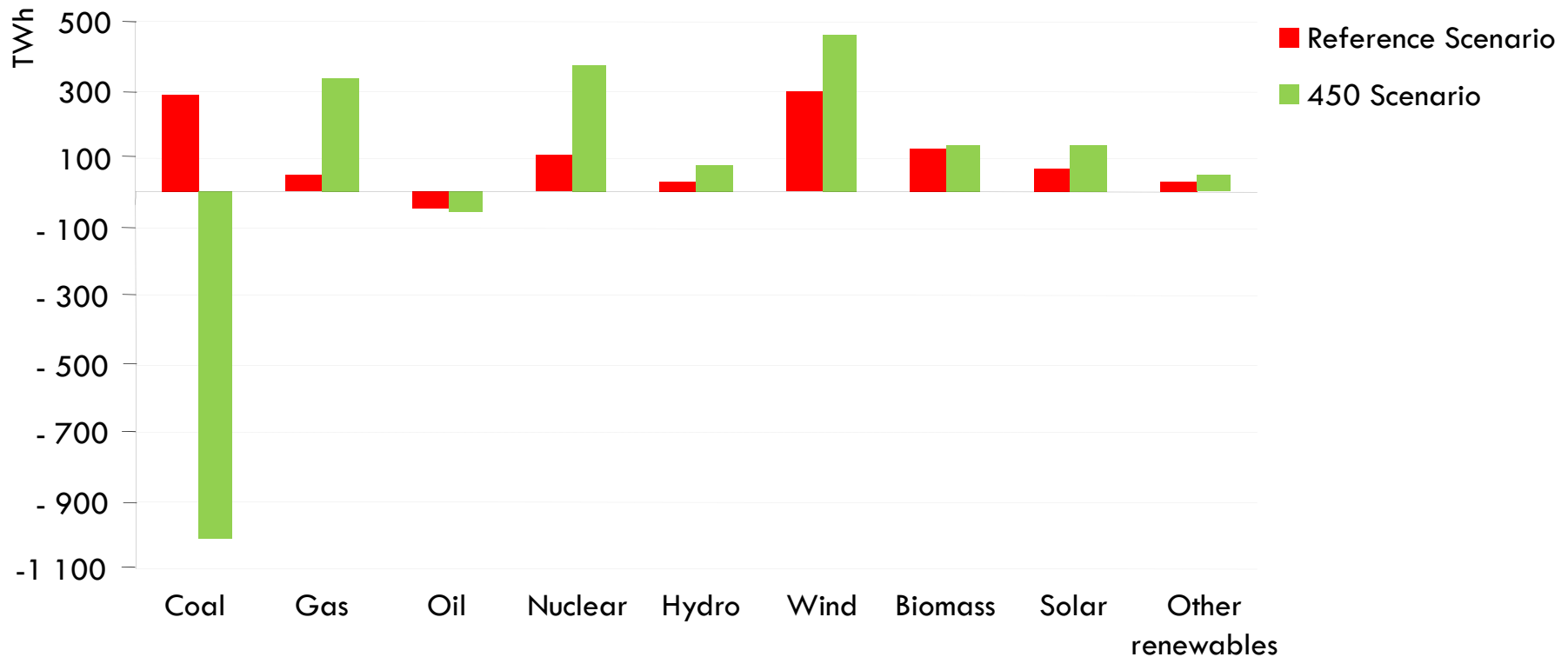


Abatement in 450 vs. Reference Scenario
(Mt CO₂)

	2020	2030
Efficiency	548	1141
End-use	411	855
Power plants	137	286
Renewables	43	288
Biofuels	0	136
Nuclear	101	206
CCS	57	593
TOTAL	749	2 364

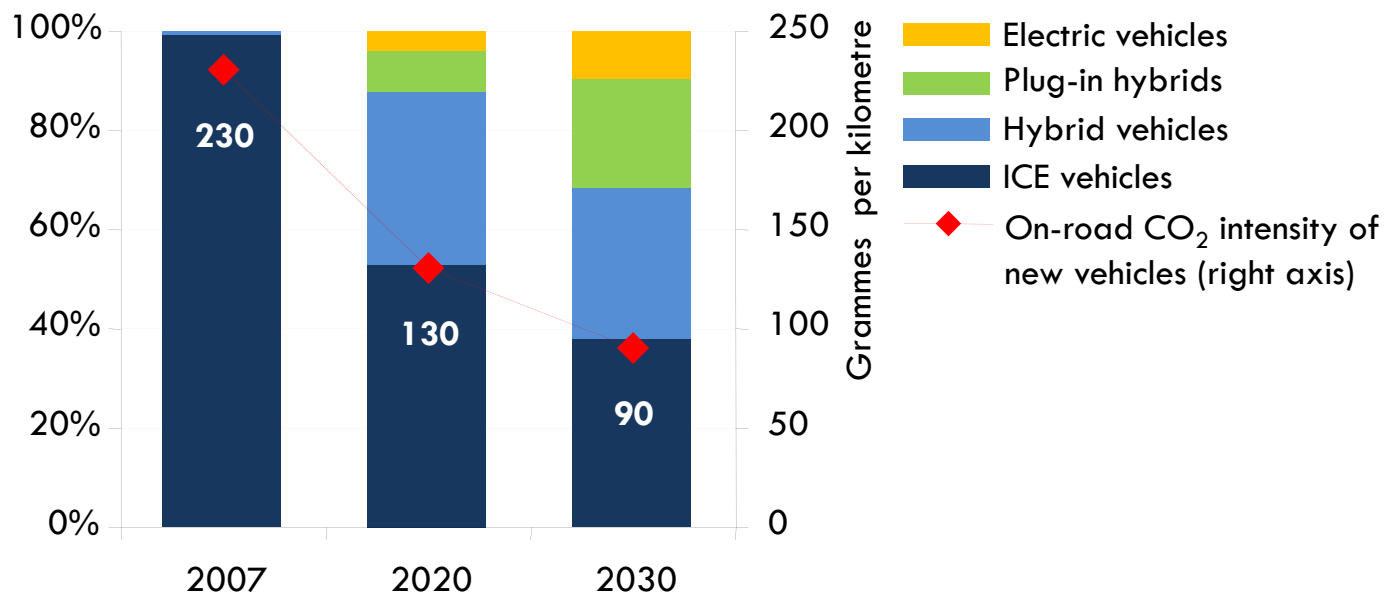
Total investment in the 450 Scenario of nearly \$1 100 billion in low-carbon power generation over 2010-2030 (53% renewables, 19% nuclear, 27% CCS)

Incremental US electricity production by scenario, 2007-2030



Renewables and nuclear account for over half of US electricity generation in 2030 in the 450 Scenario, up from 28% today

US passenger vehicle sales and average new vehicle CO₂ intensity in the 450 Scenario



Improvements to the internal combustion engine and the uptake of biofuels and next-generation vehicles lead to an 100 g/km reduction in new-car emissions by 2020

Summary & conclusions

- The financial crisis has halted the rise in global fossil-energy use, but its long-term upward path will resume soon *on current policies*
- Tackling climate change & enhancing energy security require a massive decarbonisation of the energy system
 - > We are now on course for a 6°C temperature rise & rising energy costs
 - > Limiting temperature rise to 2°C will require big emission reductions in all regions
- *A 450 path towards 'Green Growth' would bring substantial benefits*
 - > Avoiding the worst effects & costs of climate change
 - > Energy-security benefits, lower oil & gas imports bills
 - > Much less air pollution & huge health benefits
- *Natural gas can play a key role as a bridge to a cleaner energy future*
- *The challenge is enormous – but it can and must be met*
 - > Improved energy efficiency & technology deployment are critical
 - > Each year of delay adds \$500 billion to mitigation costs

Implications for the United States

- The recent announcements made by the US to cut greenhouse gas emissions is a key step to get a global, meaningful agreement in Copenhagen
- Continue strong support for less-polluting, zero-carbon technologies including renewables, nuclear power, cleaner coal/CCS, advanced vehicles, and advanced grids to integrate them
- Establish a cap-and-trade scheme that promotes domestic reductions and allows the purchase of credits to support emissions reductions in other countries and sectors
- Fully exploit the potential of unconventional gas resources as they could serve as an important bridge to a cleaner and more secure energy future

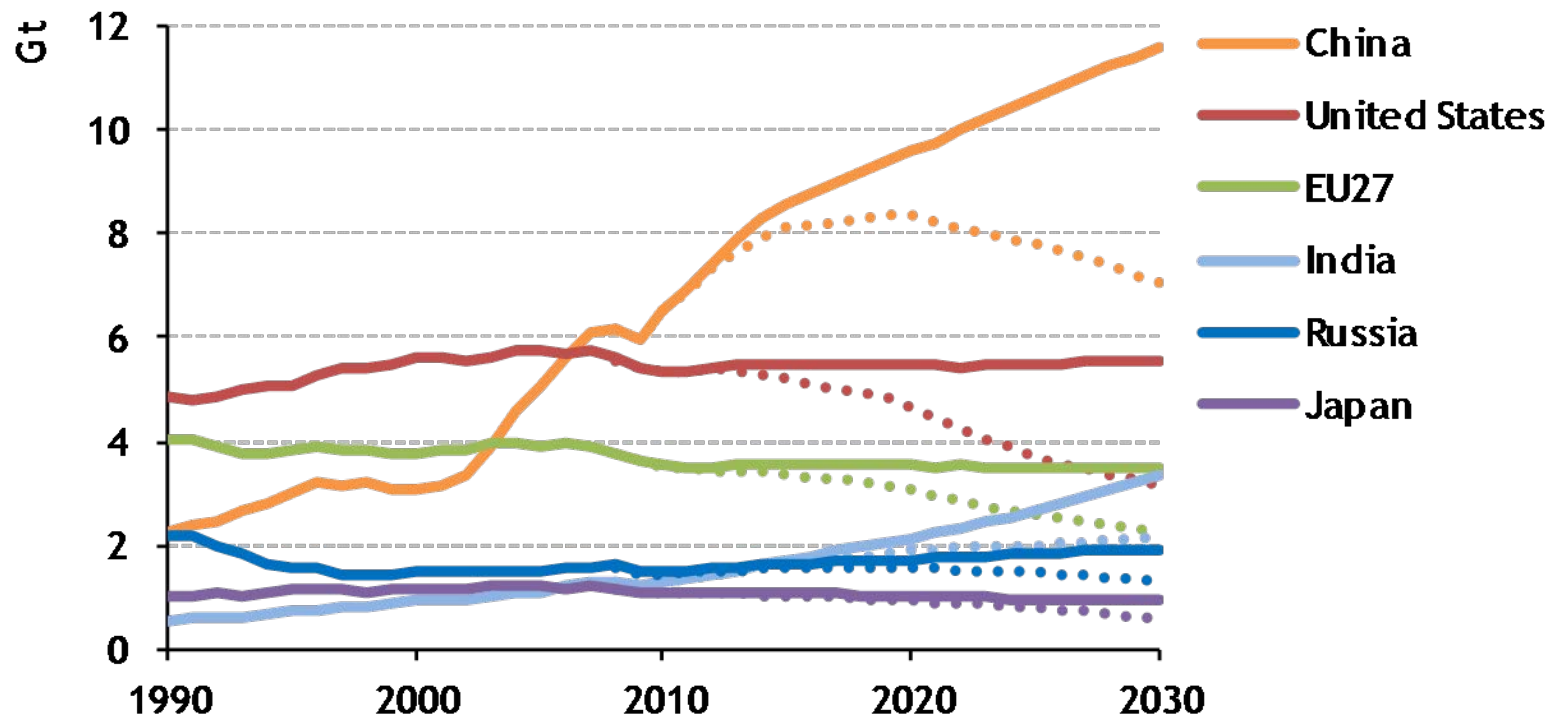
ANNEX

Real GDP growth assumptions by region (compound average annual growth rates)

	1980-1990	1990-2007	2007-2015	2015-2030	2007-2030
OECD	3.0%	2.5%	1.4%	1.9%	1.8%
North America	3.1%	2.9%	1.8%	2.3%	2.1%
<i>United States</i>	3.3%	2.9%	1.8%	2.2%	2.0%
Europe	2.4%	2.3%	1.0%	1.8%	1.5%
Pacific	4.3%	2.3%	1.3%	1.3%	1.3%
<i>Japan</i>	3.9%	1.4%	0.7%	1.1%	1.0%
Non-OECD	2.1%	4.6%	5.7%	4.1%	4.6%
E. Europe/Eurasia	-0.2%	0.5%	3.3%	3.3%	3.3%
<i>Russia</i>	<i>n.a.</i>	0.3%	3.3%	3.4%	3.4%
Asia	6.6%	7.4%	7.2%	4.6%	5.5%
<i>China</i>	8.9%	10.0%	8.8%	4.4%	5.9%
<i>India</i>	5.8%	6.3%	7.0%	5.9%	6.3%
Middle East	-1.3%	3.8%	4.5%	4.0%	4.2%
Africa	2.3%	3.7%	4.7%	3.1%	3.7%
Latin America	1.2%	3.4%	3.1%	2.5%	2.7%
<i>Brazil</i>	1.5%	2.9%	3.1%	2.5%	2.7%
World	2.7%	3.3%	3.3%	3.0%	3.1%
<i>European Union</i>	<i>n.a.</i>	2.2%	1.1%	1.8%	1.5%

World GDP is assumed to grow by an average of 3.1% per year over the period 2007-2030, compared with 3.3% from 1990 to 2007

Energy-related CO₂ emissions by scenario



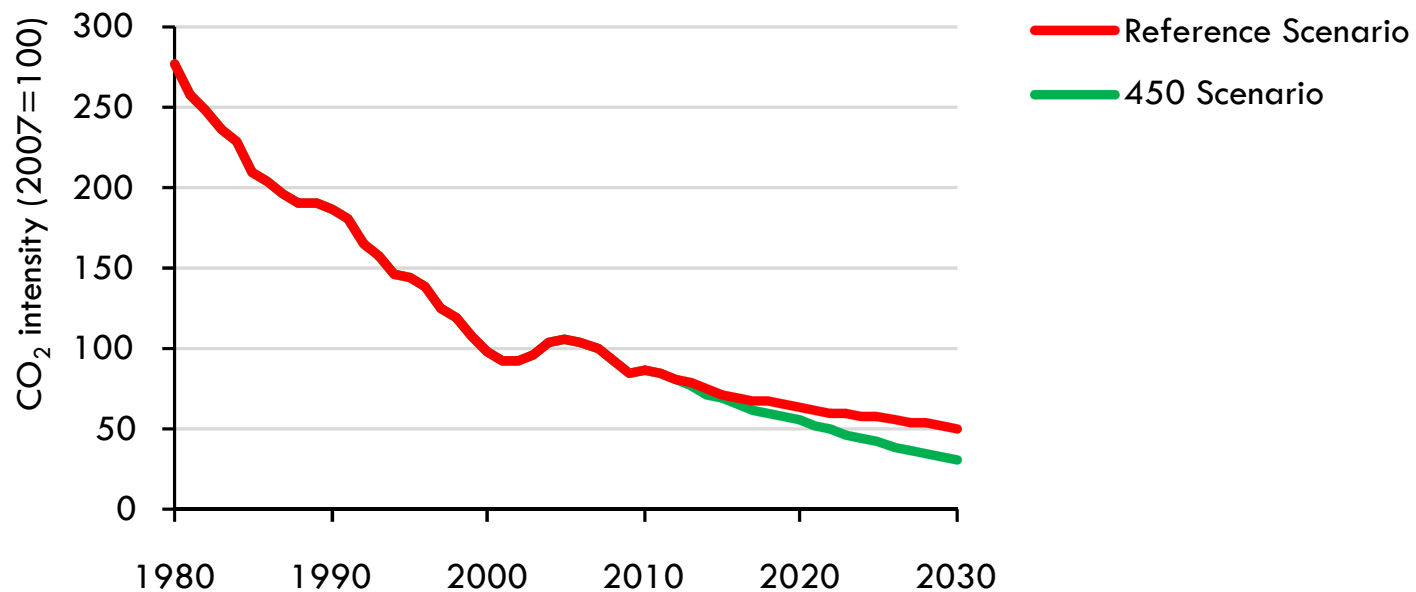
The OECD sees a decline in emissions in the Reference Scenario, while, in the 45 Scenario, China's emissions peak by 2020, although India's continue to rise beyond 2030

Emissions in 2020 in the 450 Scenario – comparison with announced targets

	Announced emissions reduction target for 2020	Relative to 1990 emissions		Relative to 2005 emissions		Abatement in 450 Scenario v Reference Scenario (Mt)
		Target	450 Scenario	Target	450 Scenario	
US	-17% v 2005	-1 %	-3 %	-17 %	-18 %	749
EU	-20%/-30% v 1990	-20 %	-23 %	-18 %	-21 %	444
Japan	-25% v 1990	-25 %	-10 %	-34 %	-21 %	84
Russia	-10% to -25% v 1990	-10 %	-27 %	+29 %	+5 %	134
China	-		+275 %		+65 %	1 178
India	-		+224 %		+66 %	249
OECD+	-		-4 %		-17 %	1 656
Non-OECD+	-		+107 %		+41 %	2 194
World	-		+46 %		+13 %	3 850

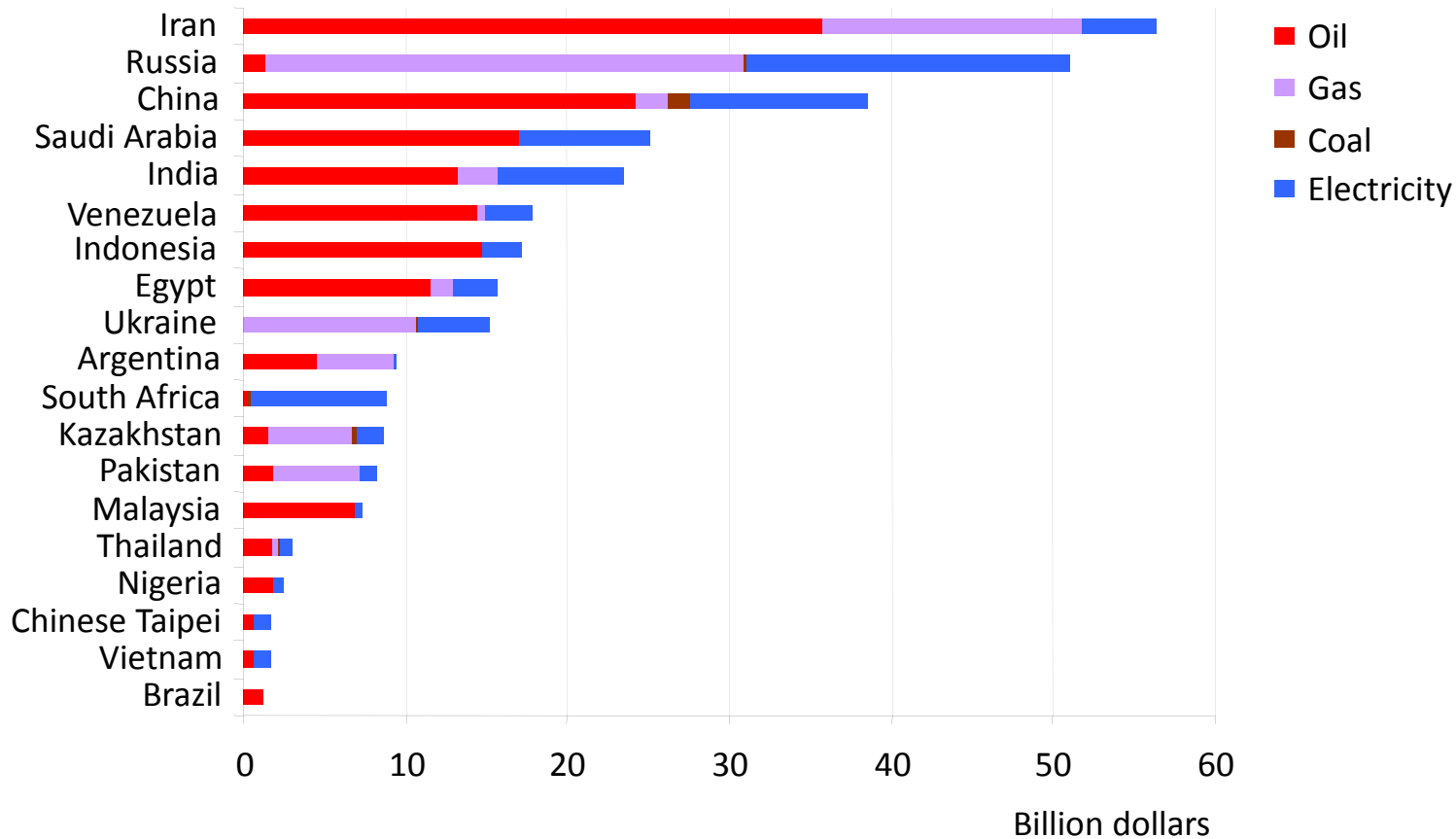
Existing pledges for 2020 – if met – could put the world in line with a 550 trajectory... assuming global action to hold emissions at this level & a subsequent decline

China's energy-related CO₂ intensity in the Reference and 450 Scenarios



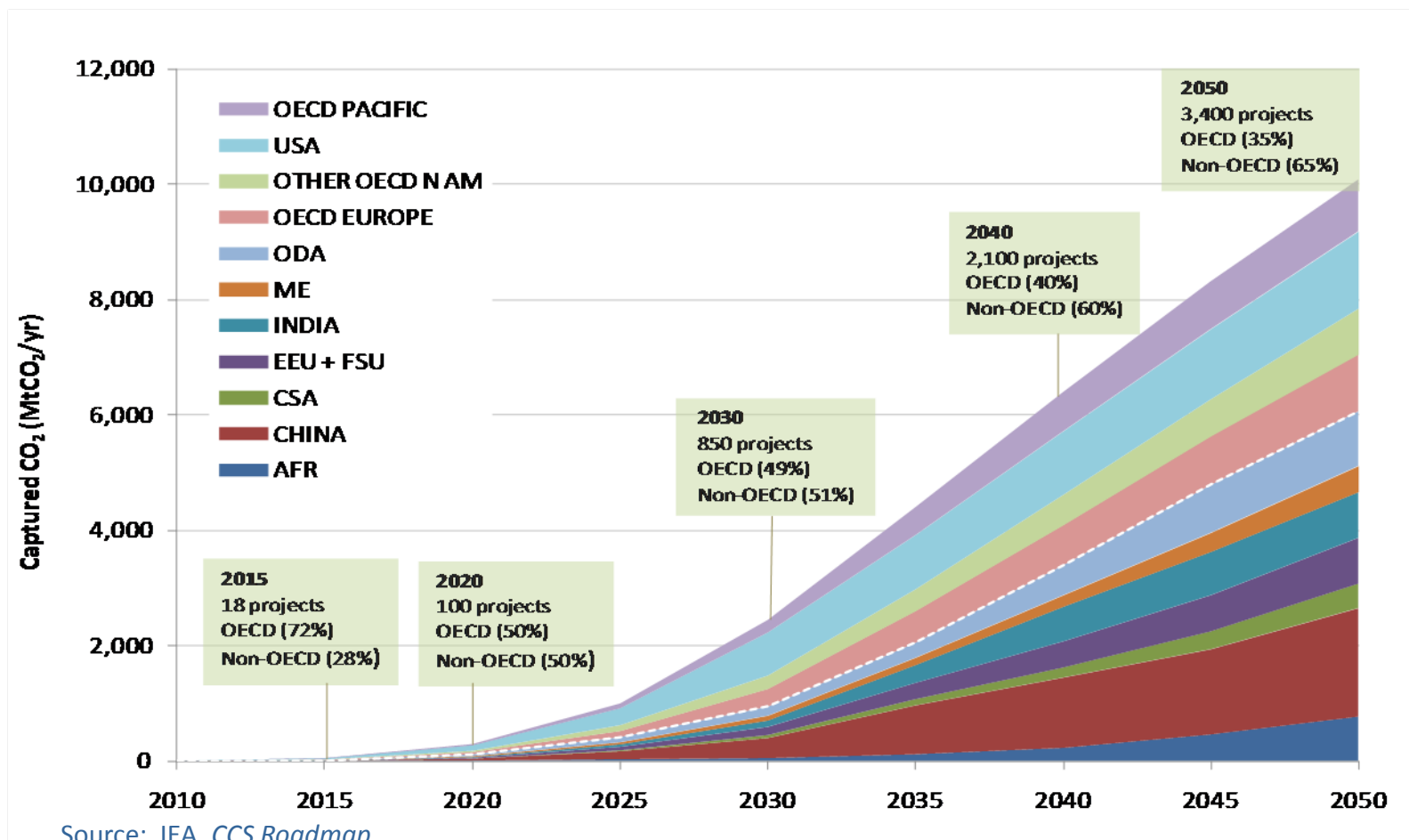
Having fallen by almost 4% a year since 1980, China's CO₂ intensity declines by a further 37% in the Reference Scenario and 44% in the 450 Scenario between 2007 and 2020

Energy subsidies in non-OECD countries, 2007



Energy subsidies in the 20 largest non-OECD countries hit \$310 billion in 2007 – creating, in many cases, an unsustainable economic burden & exacerbating environmental effects

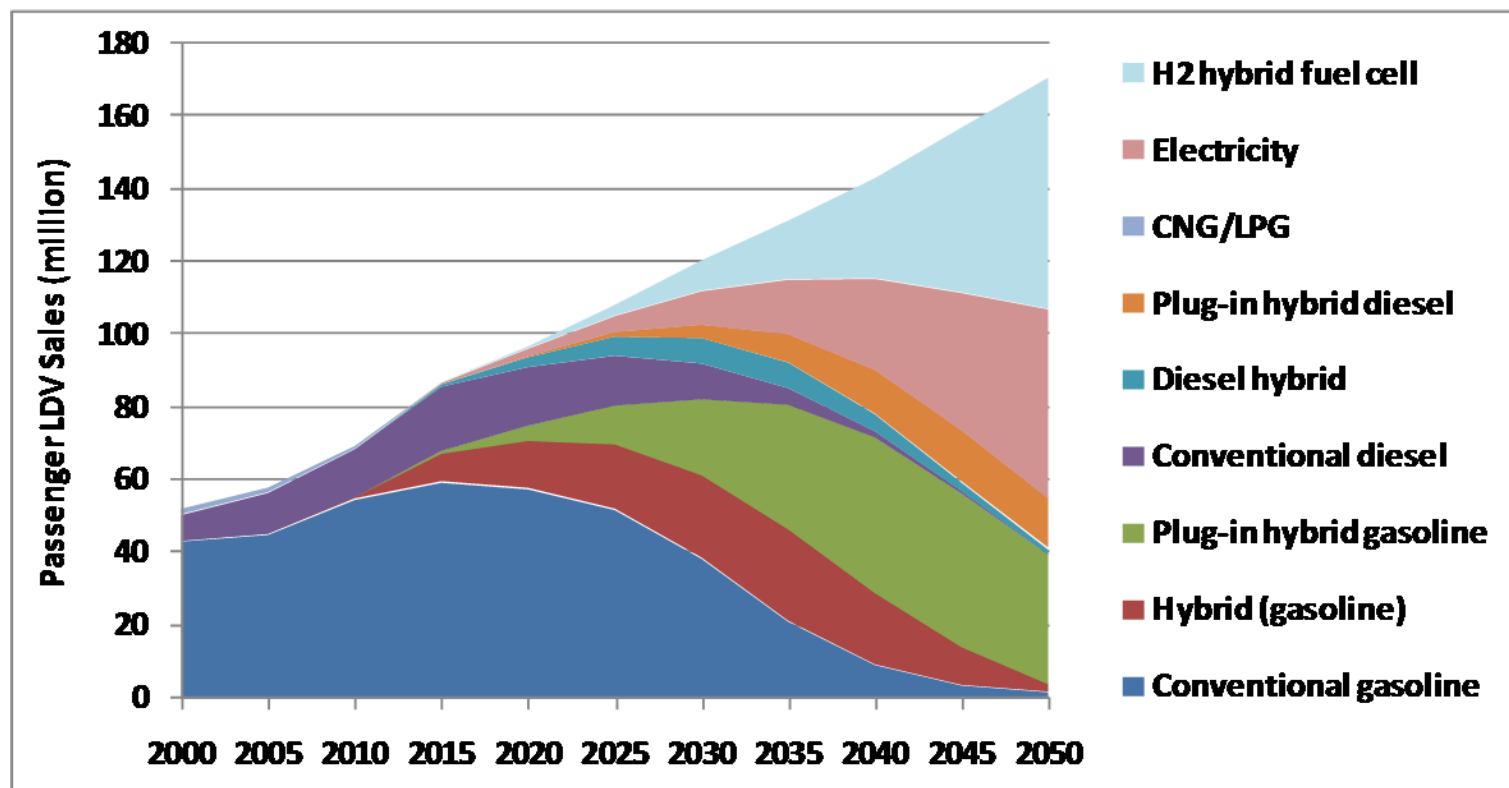
CCS: A roadmap to 2050



CCS will require additional investment of 2.5-3 trn by 2050

Electric Vehicles: A roadmap to 2050

Light-duty vehicle sales by technology type to 2050, ETP BLUE Map Scenario



Source: IEA, *EV Roadmap*

Unprecedented rates of change in market penetration of advanced technologies