THE OXFORD INSTITUTE FOR ENERGY STUDIES

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UNIVERSITY OF OXFORD

# Revenue Analysis

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*The Economics of Energy Corporations (2)*

# A major offshore oil production facility

- Multi-billion dollar projects offshore require huge up-front spending
- Onshore projects can be more incremental with production

# Shale oil development in Texas

- Each well in a shale development is an individual investment with its own economics
- The numbers are smaller, but equally important to investors

# A giant gas field in West Siberia




- Even onshore fields require large infrastructure, and geography / weather play a key role in costs

# Production Profile

*A conventional oil or gas field production profile*

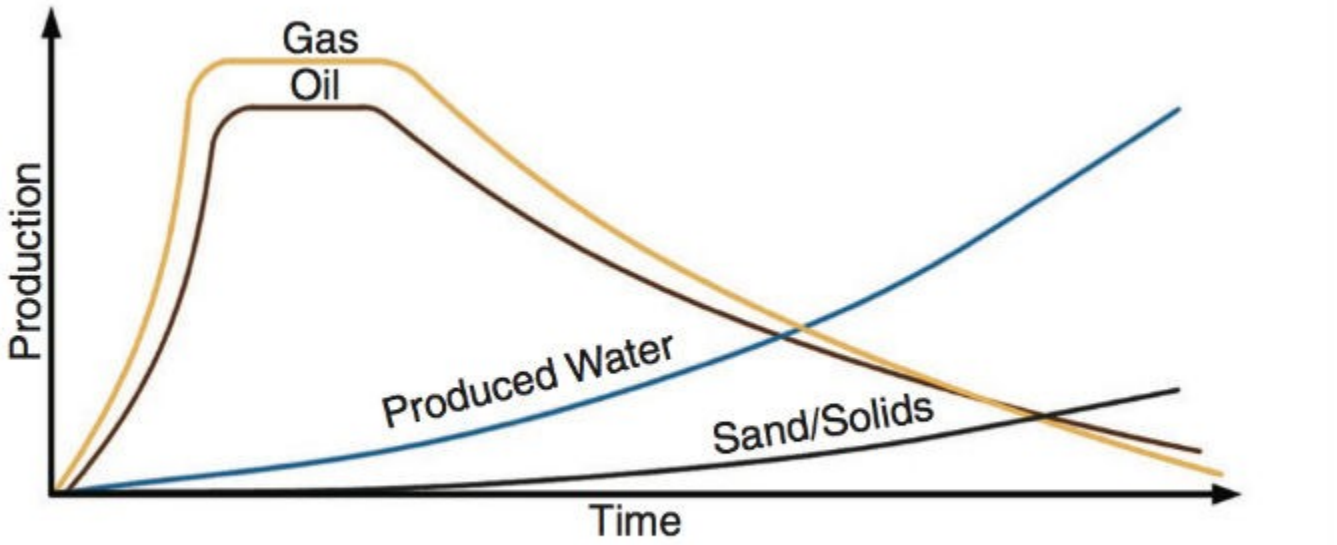
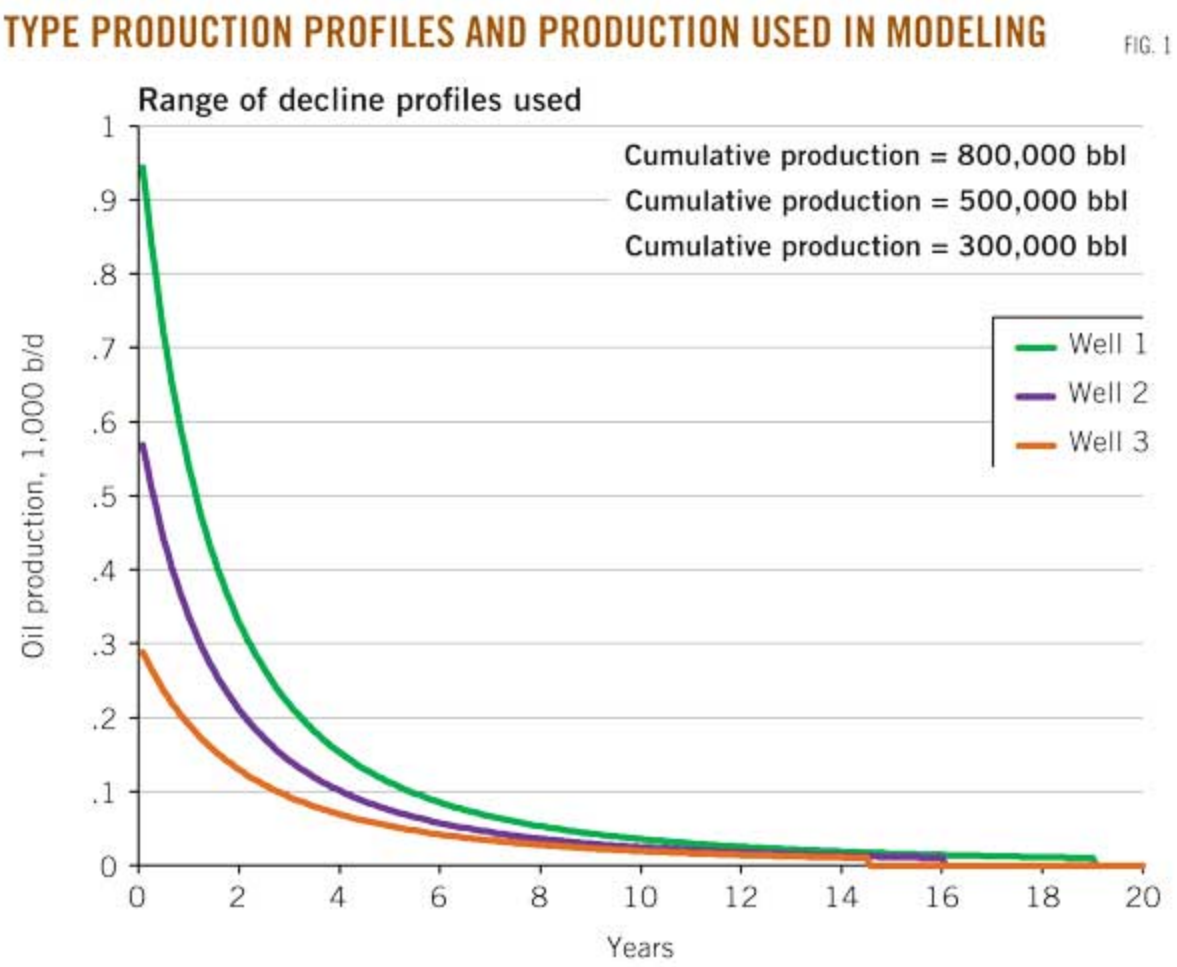



**Fig. 1—A typical oilfield production profile.**

1. Initial surge to peak production
2. Plateau at peak for a number of years
3. Gradual decline towards abandonment
4. Water and solids production increases, undermining performance

# Shale Oil Production Profile

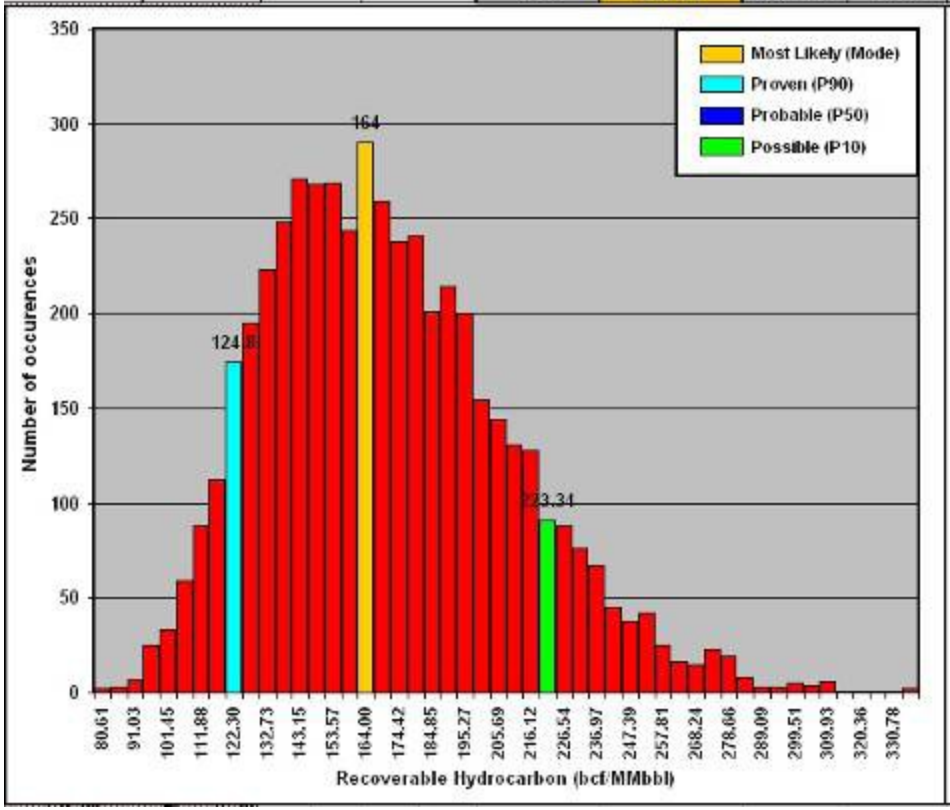


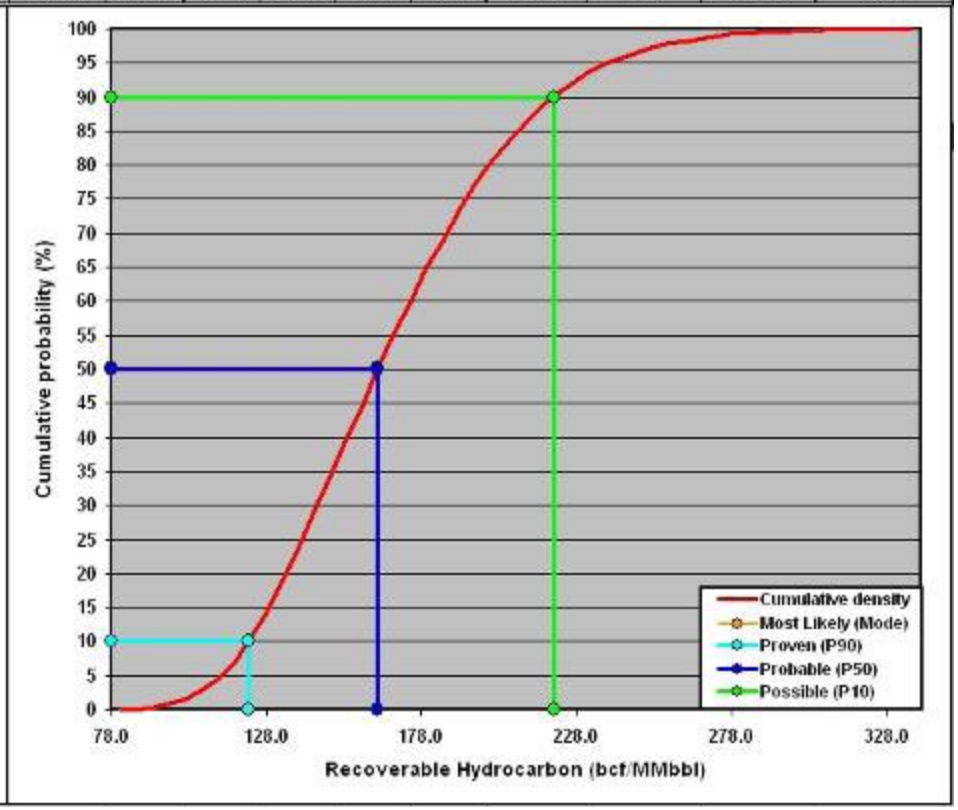

1. Immediate surge to peak production
2. Rapid decline over the first few years
3. Long plateau at low production rates

# Create a theoretical cashflow based on assumptions known to date

## Monte Carlo reserve simulation: results and input parameter summary

| Prospect Name | Modelling and structural parameters | | | Statistics | Recoverable hydrocarbon (bcf/MMbbl) | Volumetric parameters | | | | Petrophysical parameters | | | | PVT parameters | | | Field development parameters |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of Iterations | Reservoir Type | Trap Type | | | OWC/GWC depth (m) | Reservoir thickness (m) | Reservoir area ($km^2$) | GRV ($10^8$ $m^3$) | Φ (%) | Sw (%) | $S_{hc}$ (%) | Area N/G | Reservoir Pressure (MPa) | Reservoir Temperature (°C) | Expansion Factor ($Sm^3/Rm^3$) | Recovery factor |
| M11-1 Preliminary results | 5000 | GAS | Simple Layer | Minimum | 78.13 | 2800.01 | 18.25 | 8.002 | 148.12 | 9.52 | 20.15 | 60.30 | 1.00 | 46.08 | 97.00 | 322.00 | 0.604 |
| | | | | Most Likely | 164.00 | 2803.41 | 25.29 | 8.070 | 224.85 | 12.23 | 30.15 | 69.85 | 1.00 | 46.08 | 97.00 | 322.00 | 0.704 |
| | | | | Maximum | 338.45 | 2849.96 | 39.77 | 11.171 | 412.92 | 14.09 | 39.70 | 79.85 | 1.00 | 46.08 | 97.00 | 322.00 | 0.849 |
| | | | | P90 | 124.80 | 2804.86 | 21.79 | 8.158 | 193.22 | 10.66 | 24.55 | 64.52 | 1.00 | 46.08 | 97.00 | 322.00 | 0.650 |
| | | | | P50 | 166.48 | 2824.61 | 27.01 | 8.947 | 245.14 | 12.02 | 29.97 | 70.03 | 1.00 | 46.08 | 97.00 | 322.00 | 0.714 |
| | | | | P10 | 223.34 | 2844.68 | 34.13 | 10.192 | 315.06 | 13.19 | 35.48 | 75.45 | 1.00 | 46.08 | 97.00 | 322.00 | 0.790 |



# Oil Production Forecast

**Key Elements**

- Time from first investment to first oil
- Ramp up period
- Peak production
- Peak production period
- Decline rate

# Let’s model a conventional production profile

- Reserves – 1 billion barrels
- Start date – 5 years after first investment
- Peak production – 5% of reserves
- Time to peak – 4 years
- Length of peak – 7 years
- Decline rate – 5%

# Let’s model a shale production profile

- Resources – 100 million barrels
  - Recovery factor 5%

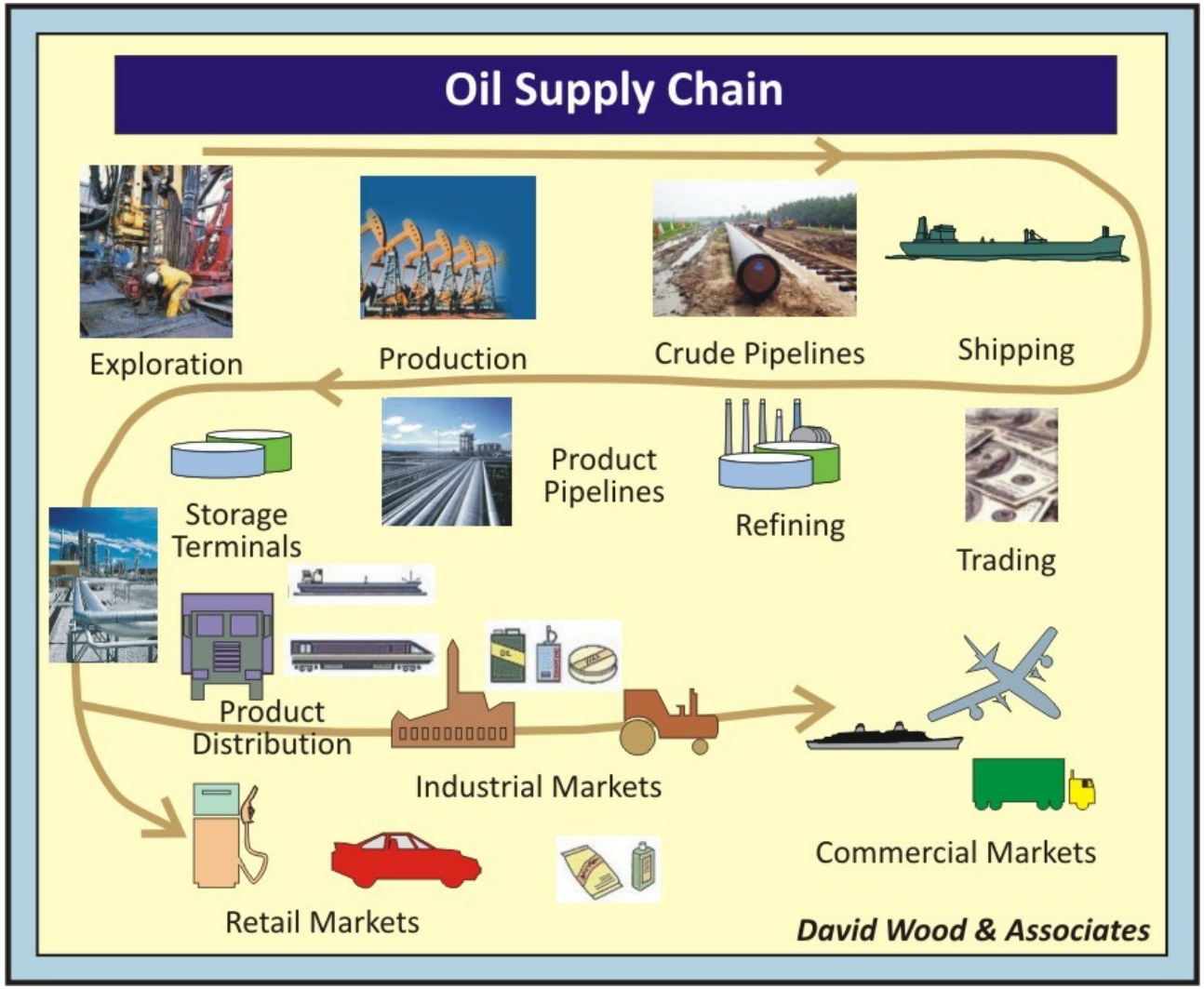
- Start date – same year as investment

- Peak production – 30% of reserves

- Time to peak – 0 years, Length of peak – 0 years

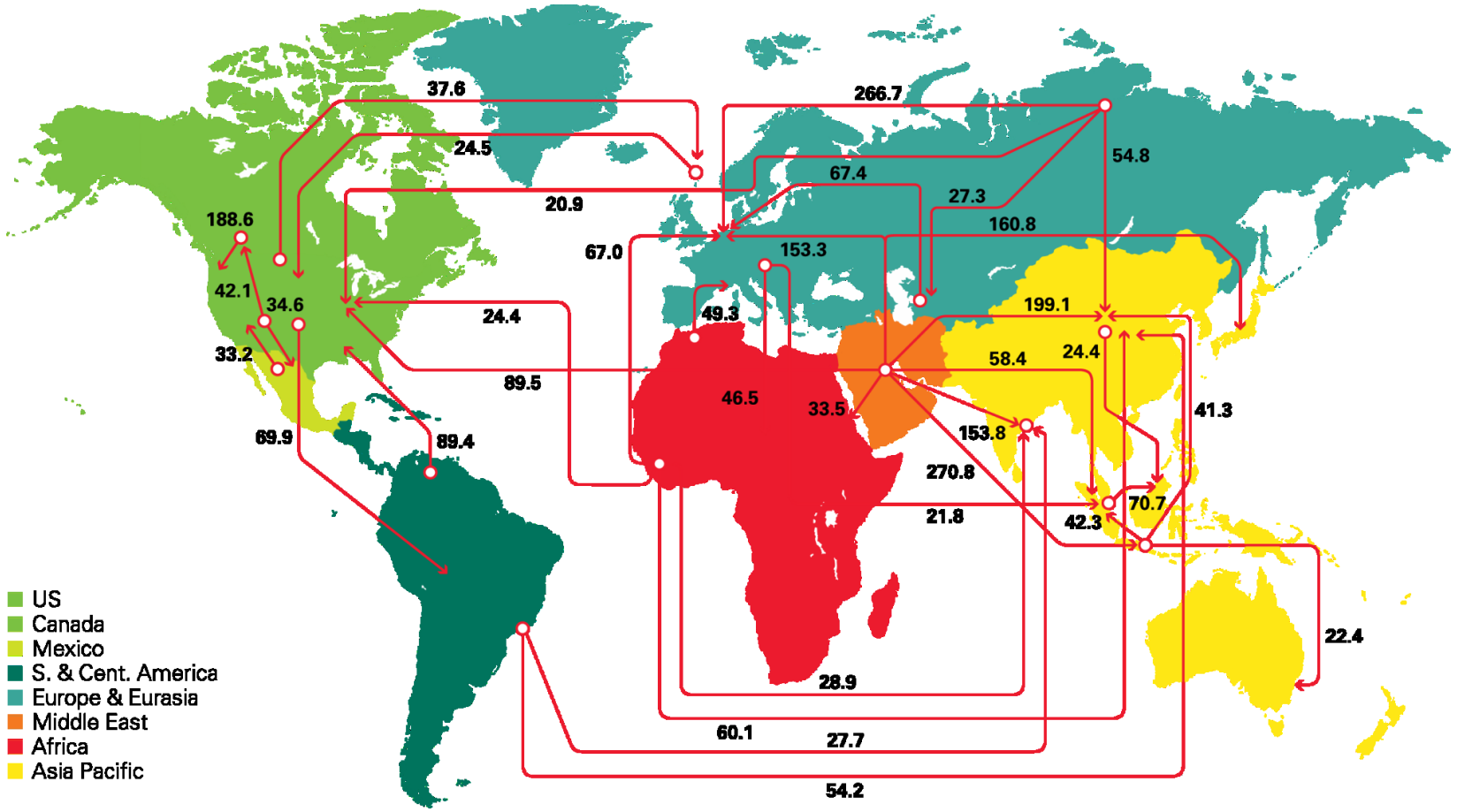
- Decline rates –
- Year 1 – 65%, Year 2 – 40%, Years 3-5 – 25%
- 3% per annum from Year 6

# Domestic supply chain




- We are concerned about well to refinery gate in domestic market

# Export supply routes

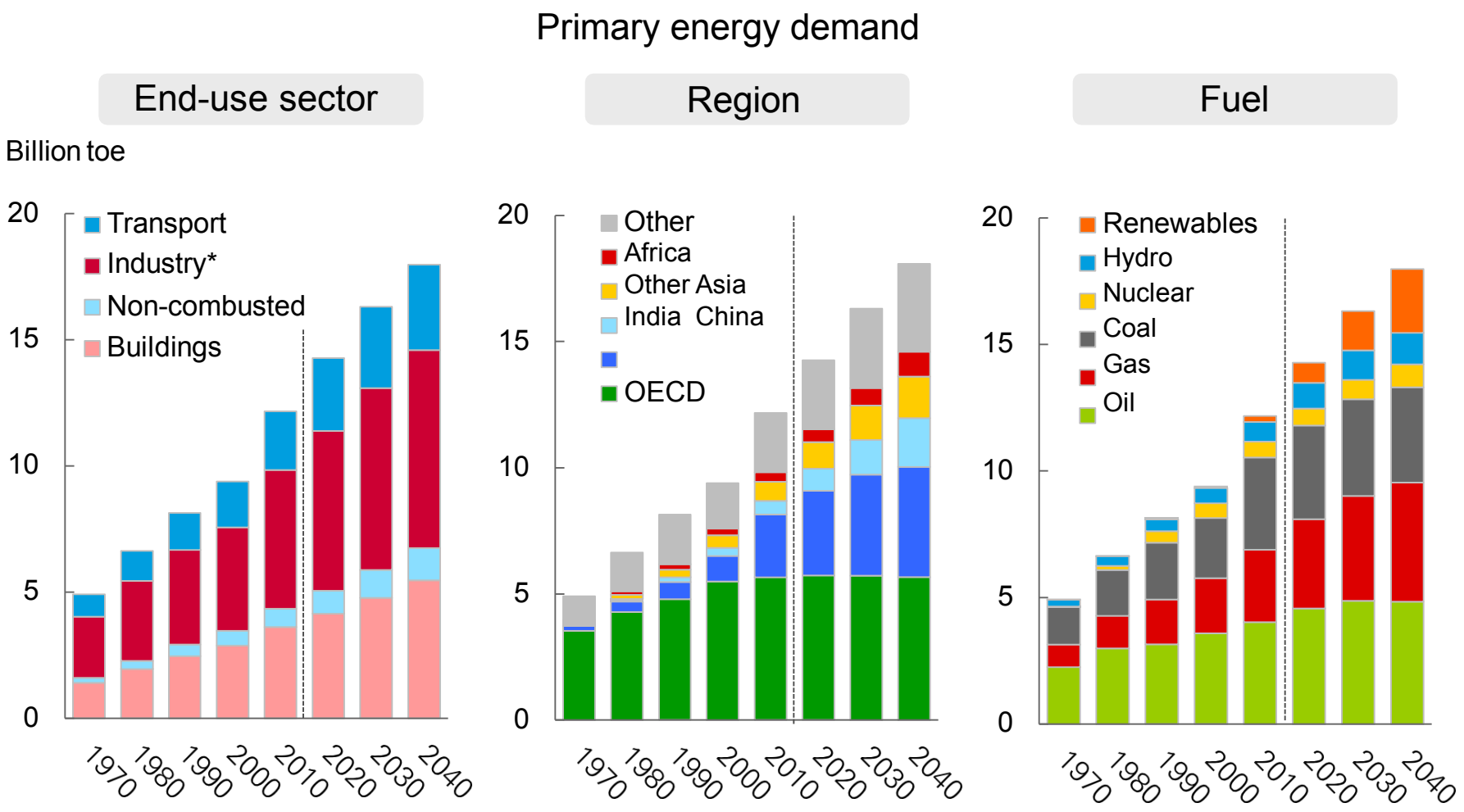



- Export price based on global markets
- Domestic price often lower due to subsidies / market constraints

# Some Scenario Planning

- We need to have some opinions of fuel prices for our cashflow model
- Future of oil and gas prices is critical to revenues
- Impact of changing energy economy is increasingly evident and needs to be discussed
- Strategic planning departments create a base case and various alternative outcomes around it
- The ultimate conclusion needs to be some price forecasts

# Energy transition is underway

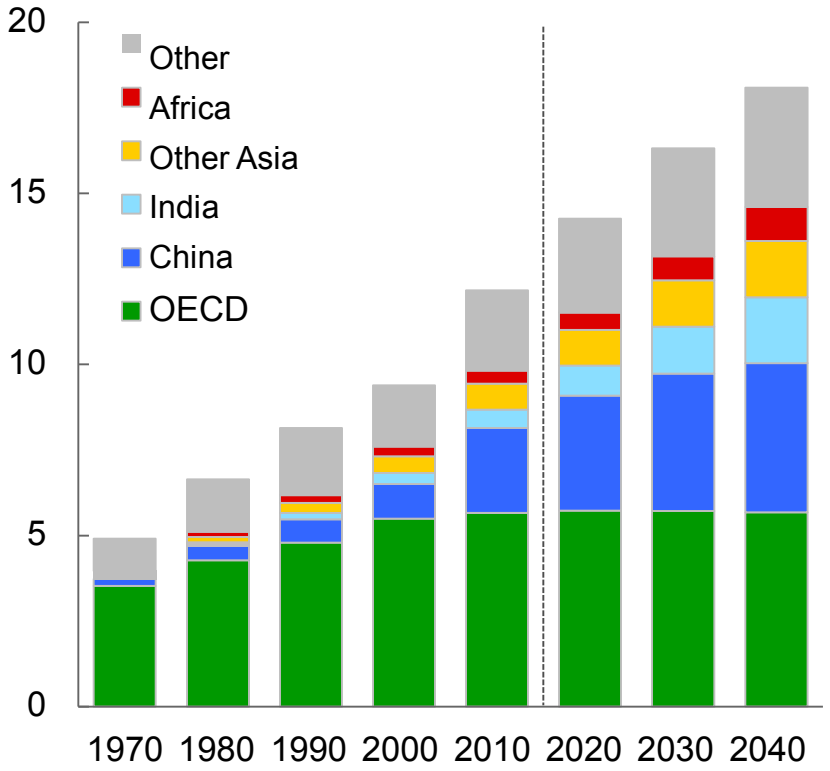



*Industry excludes non-combusted use of fuels

# Growth in energy demand is driven by increasing prosperity

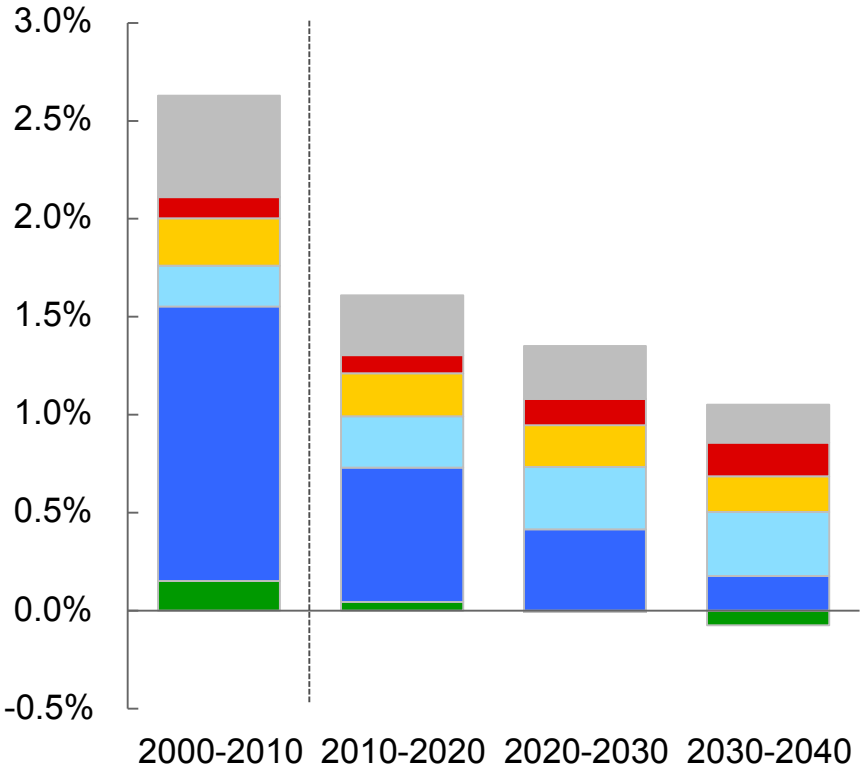
Primary energy consumption by region

Billion toe



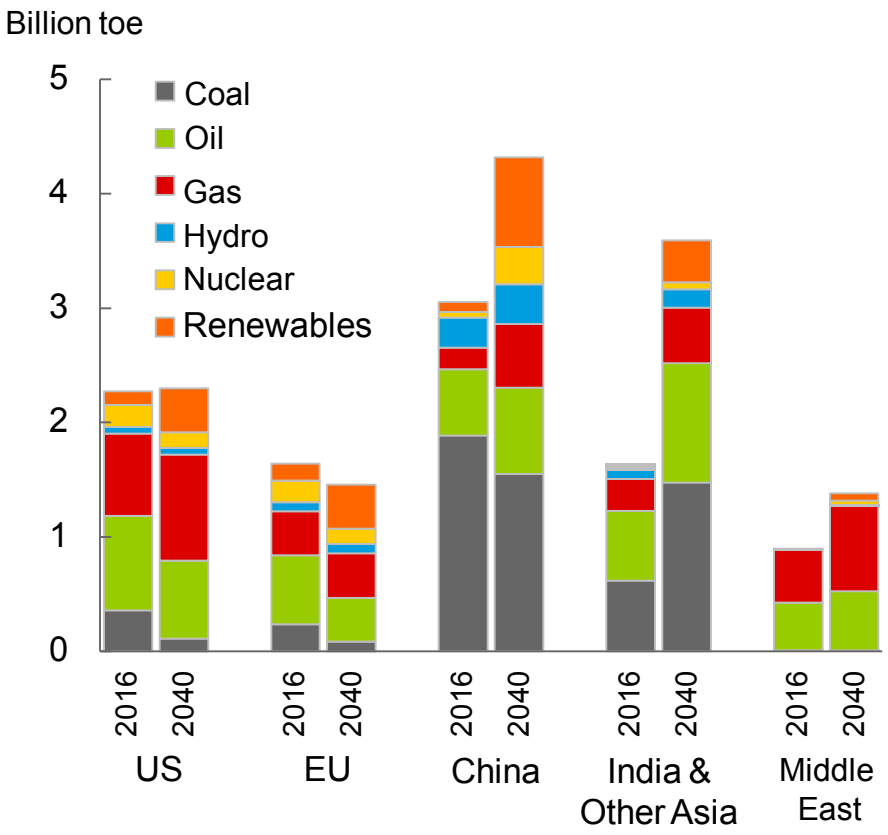

Primary energy growth and regional contributions

% per annum

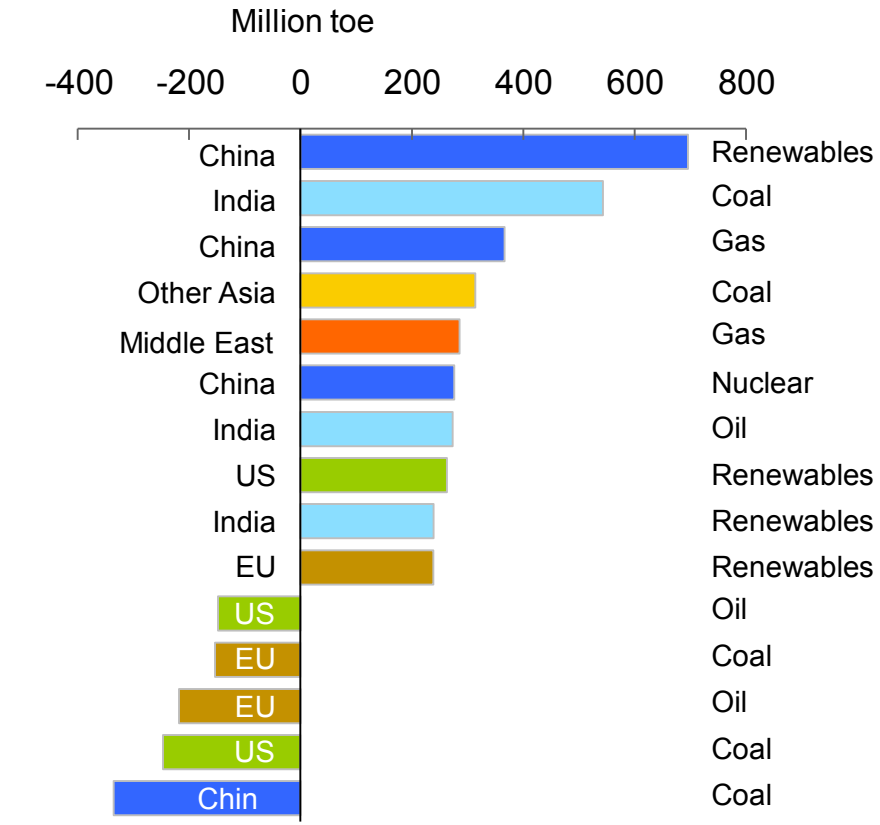


# Differences in the fuel mix across regions

Primary energy demand by fuel and region



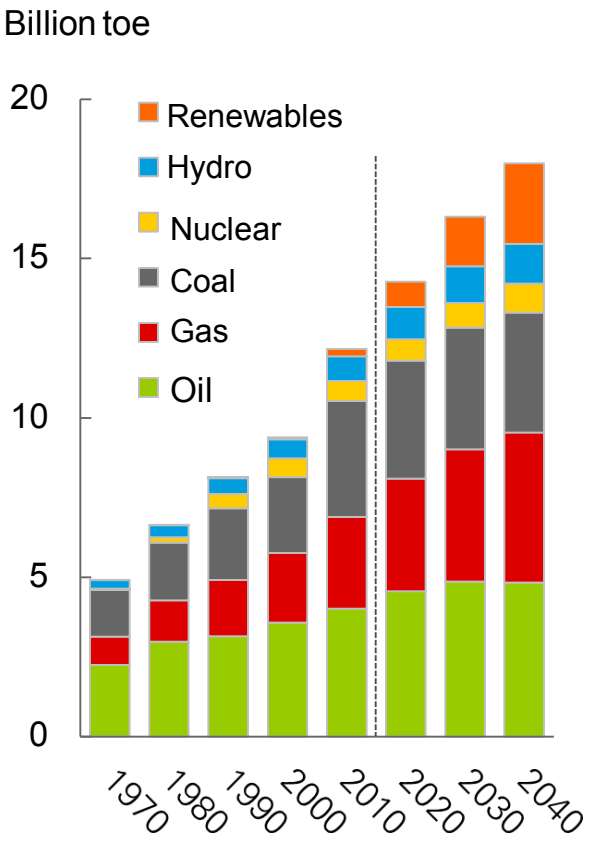

Changes 2016-2040† by fuel and region



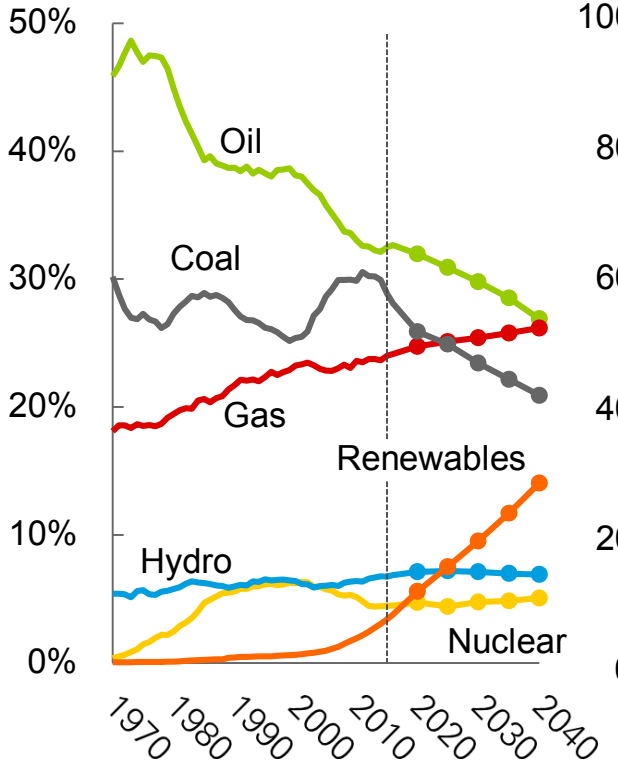

†Ten largest increases and five largest declines

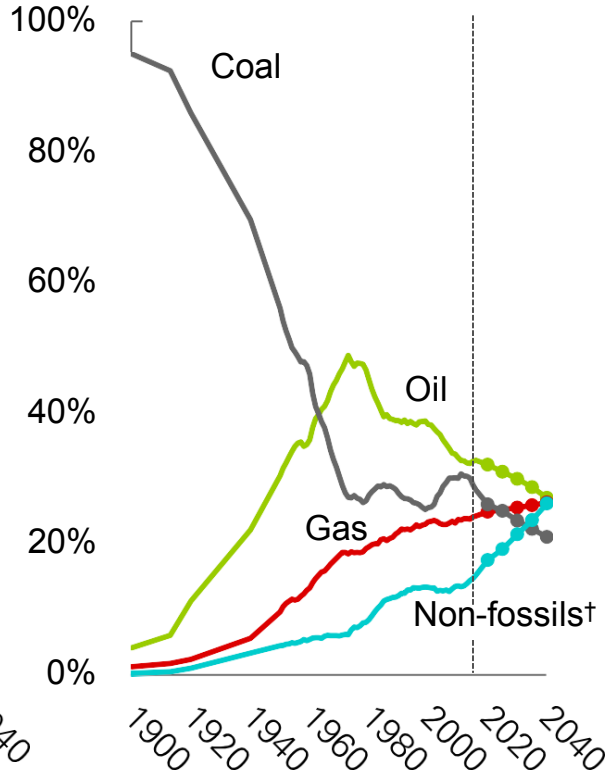
# The transition to a lower carbon fuel mix continues…

## Primary energy consumption by fuel




## Shares of primary energy

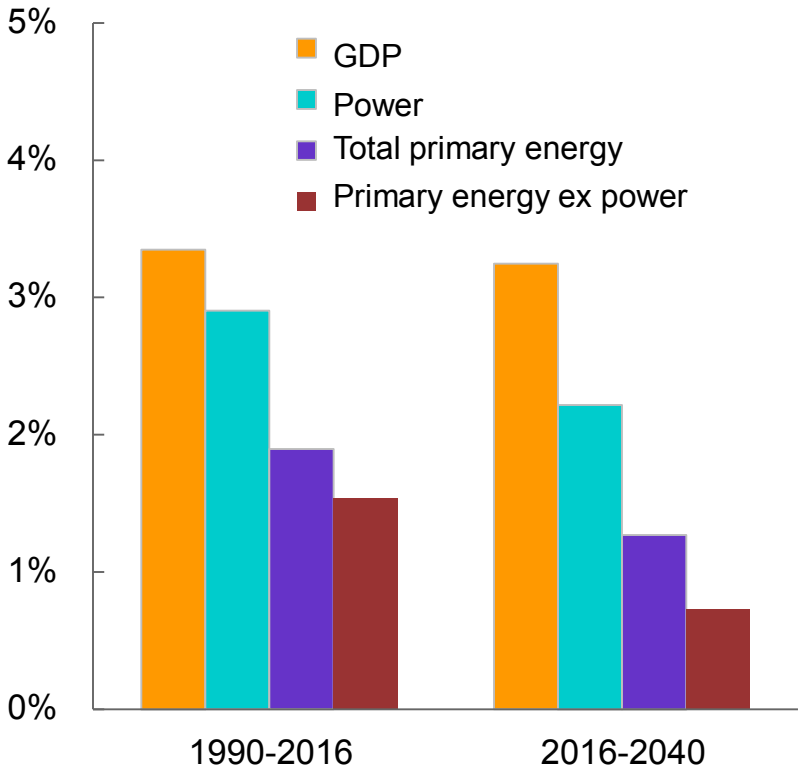


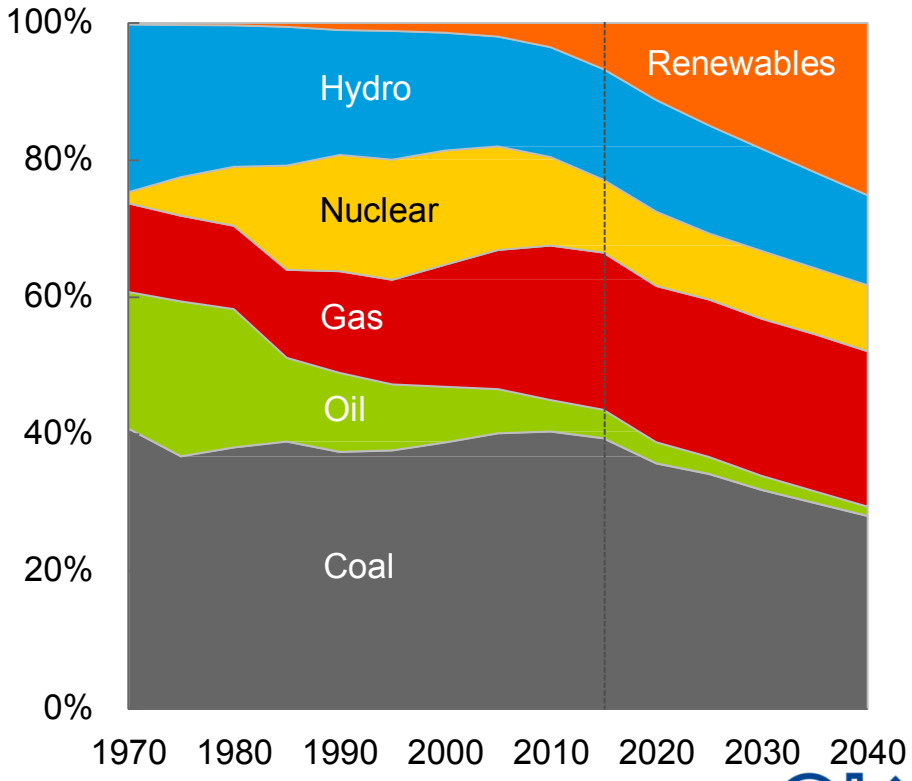

† Non-fossils includes renewables, nuclear and hydro

# The world continues to electrify…

Growth of GDP, power and primary energy
% per annum

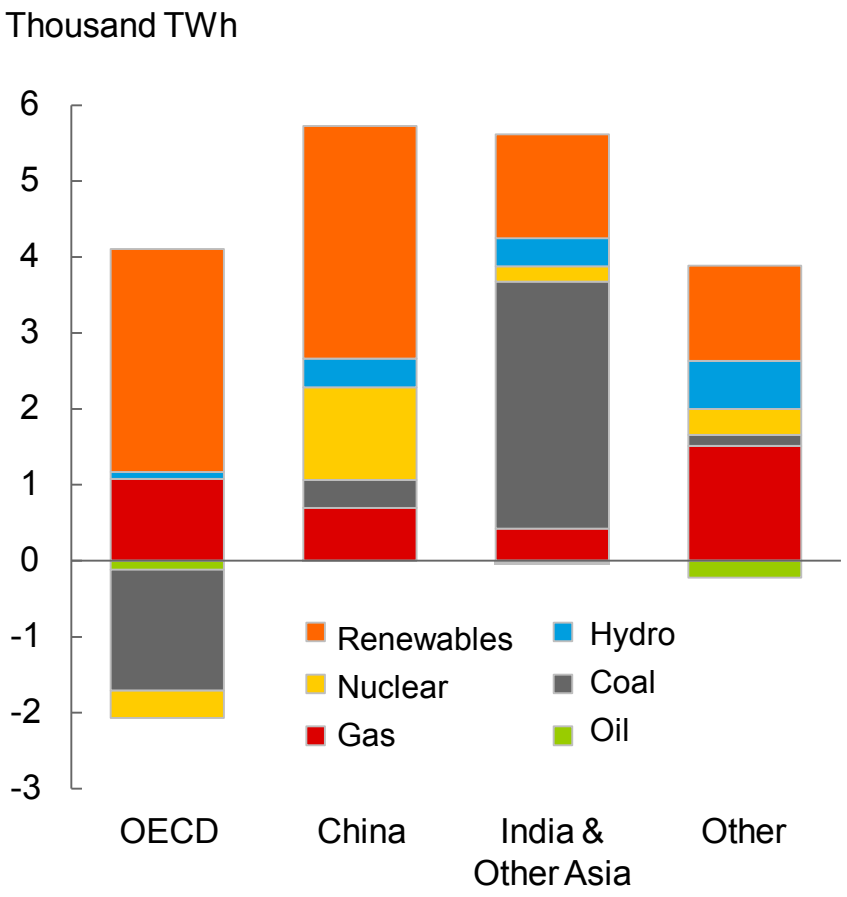



Shares of total power generation

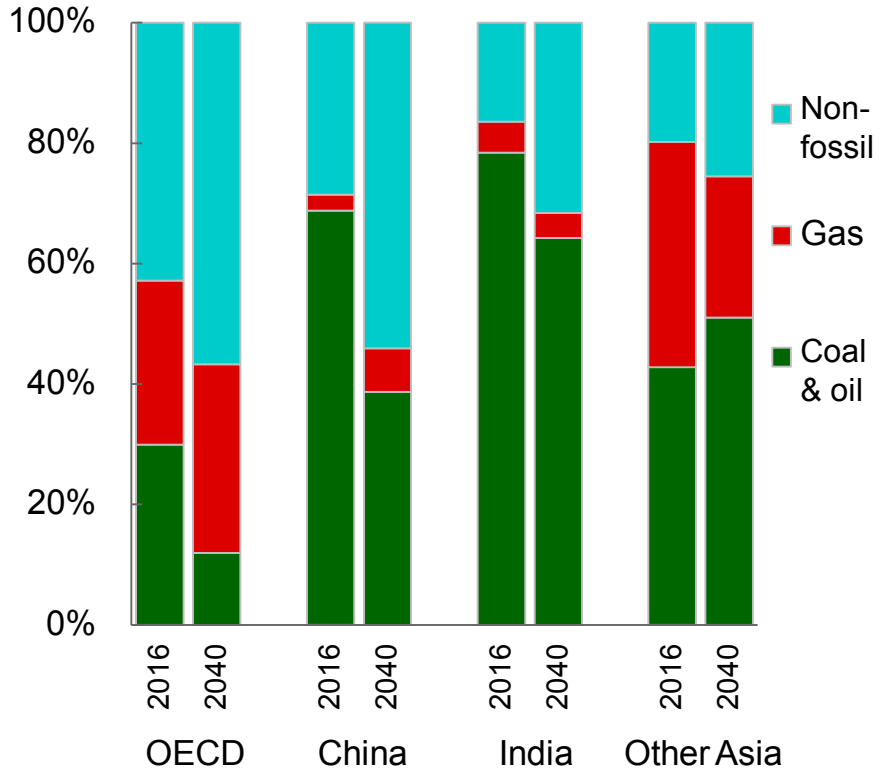


# The increasing share of renewables is led by China and OECD

Growth of power generation, 2016-2040

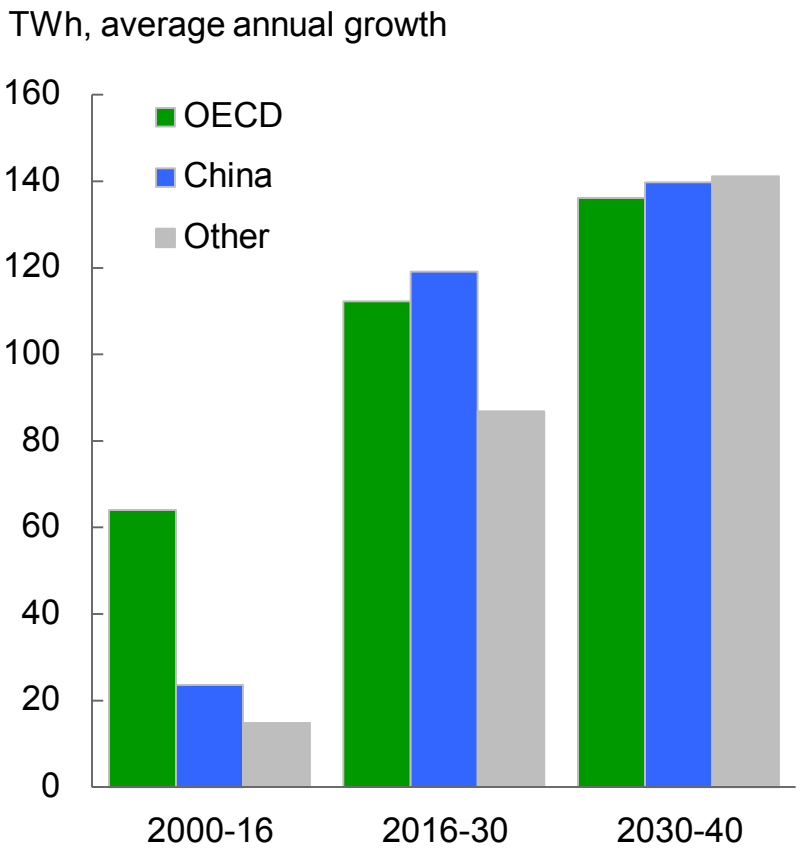



Shares of power generation, 2016 and 2040

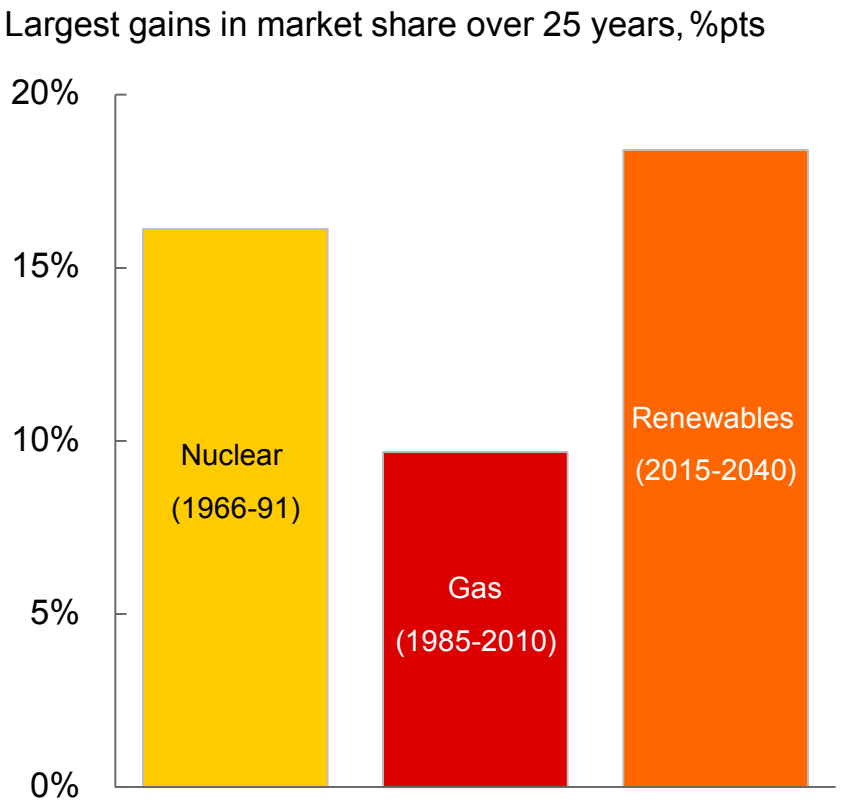


# Renewables are the largest source of energy growth

## Growth of renewable power

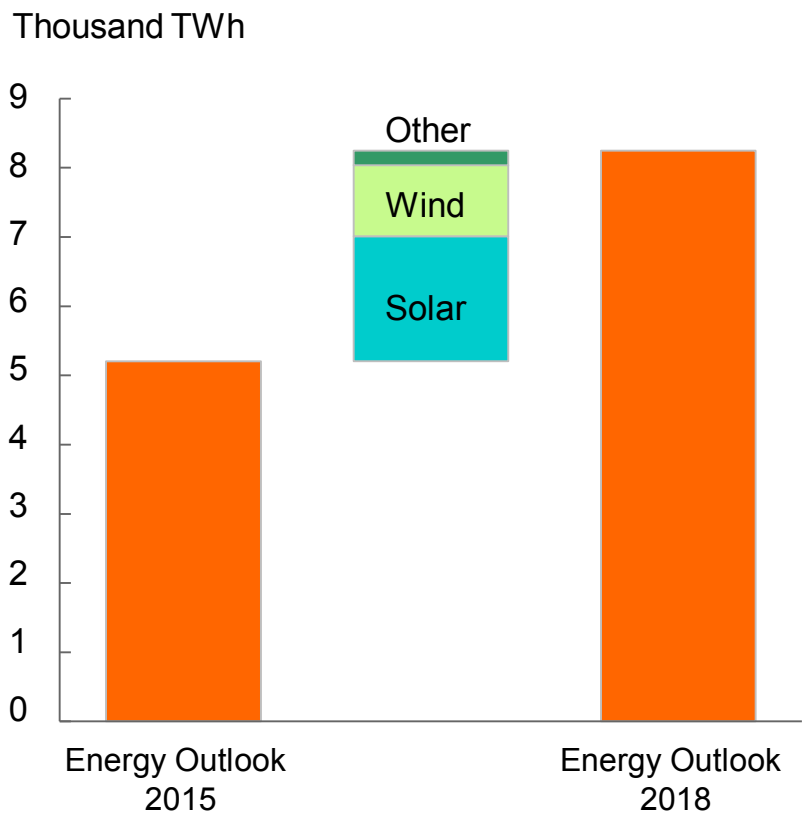



## Pace of power market penetration

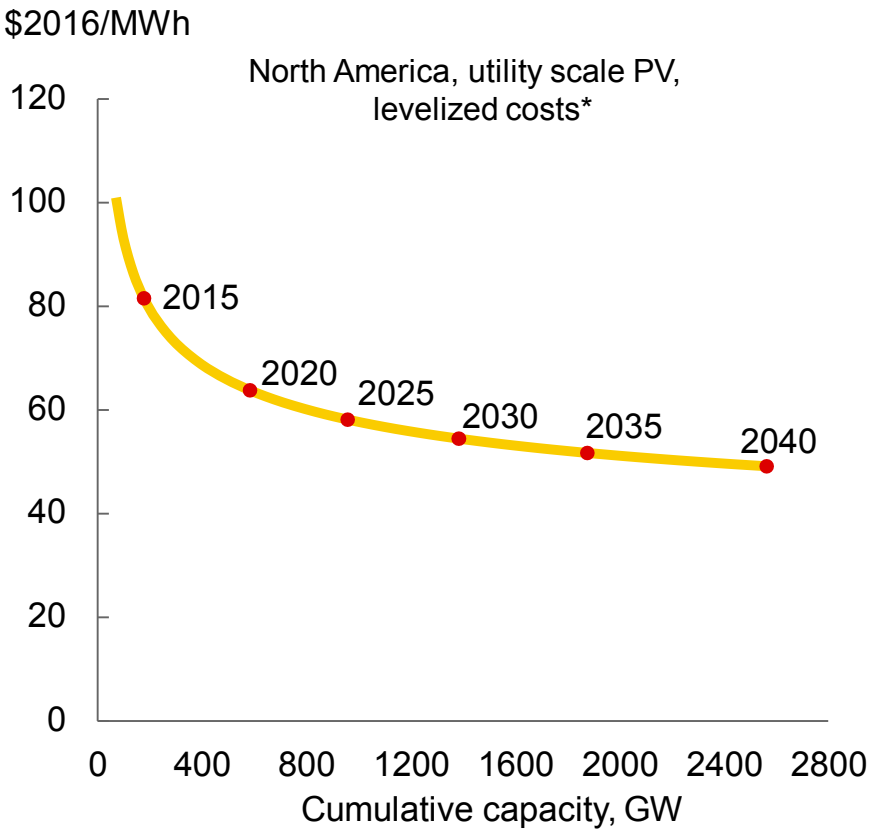


# The outlook for renewables has increased significantly

## Change to the projected level of renewable power in 2035



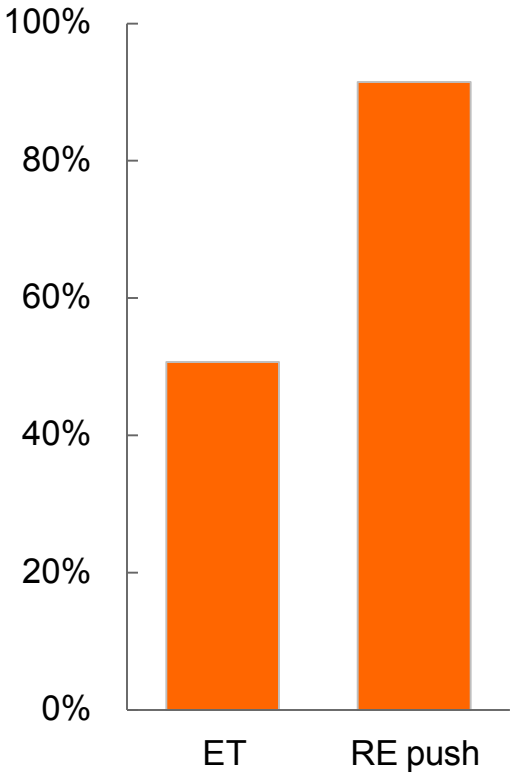

## Solar PV learning curve



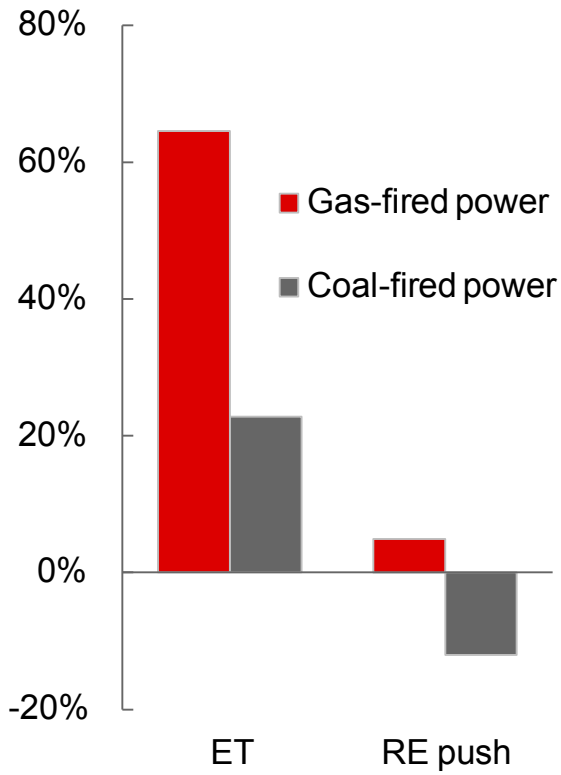

*Cost per MWh of building and operating a plant over its lifetime. Excludes subsidies, tariffs and the cost of grid integration.

# Alternative scenario: more sustained support for renewables

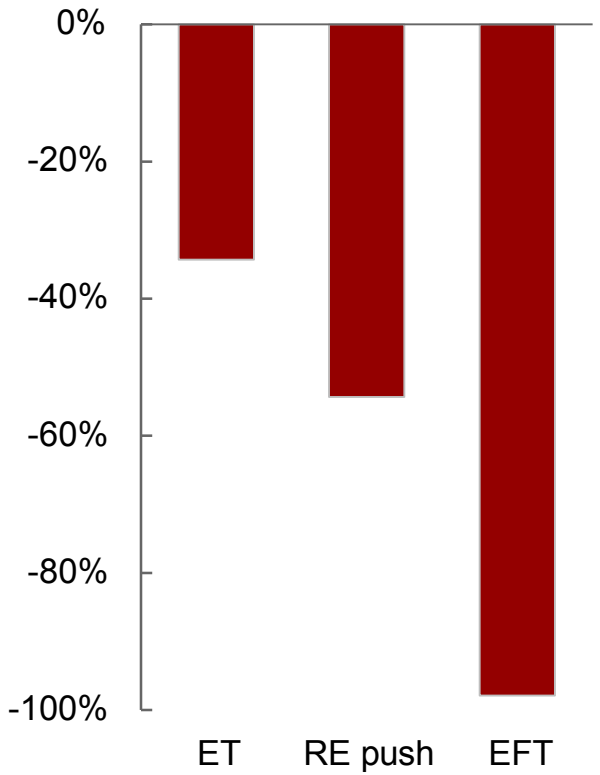
Renewables share of power growth, 2016-2040



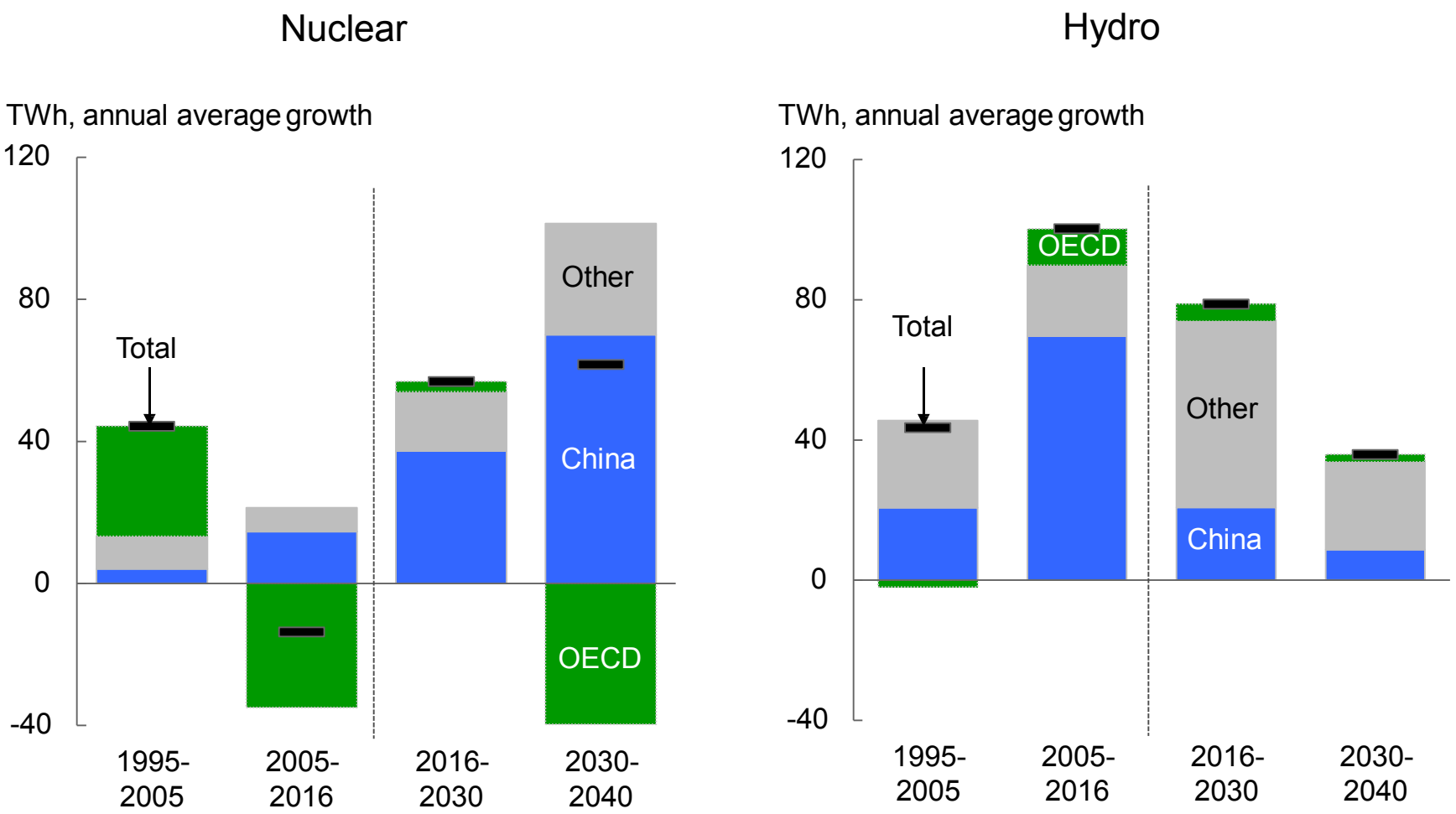

Change in gas and coal power output, 2016-2040




Change in carbon intensity of power, 2016-2040

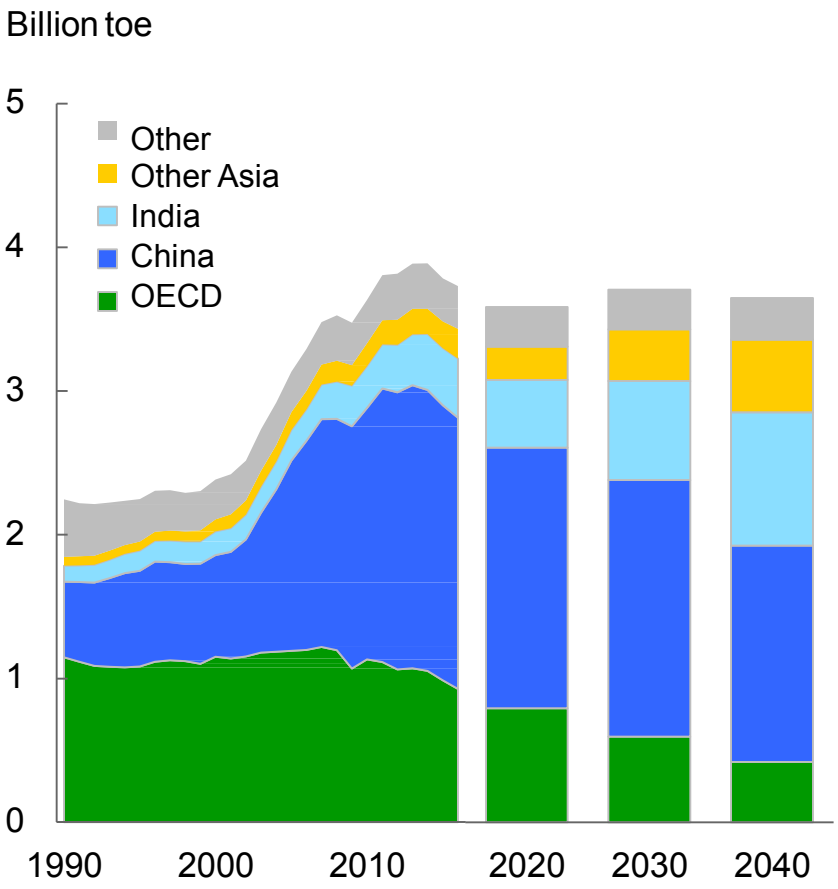


# Nuclear and hydro power output increases

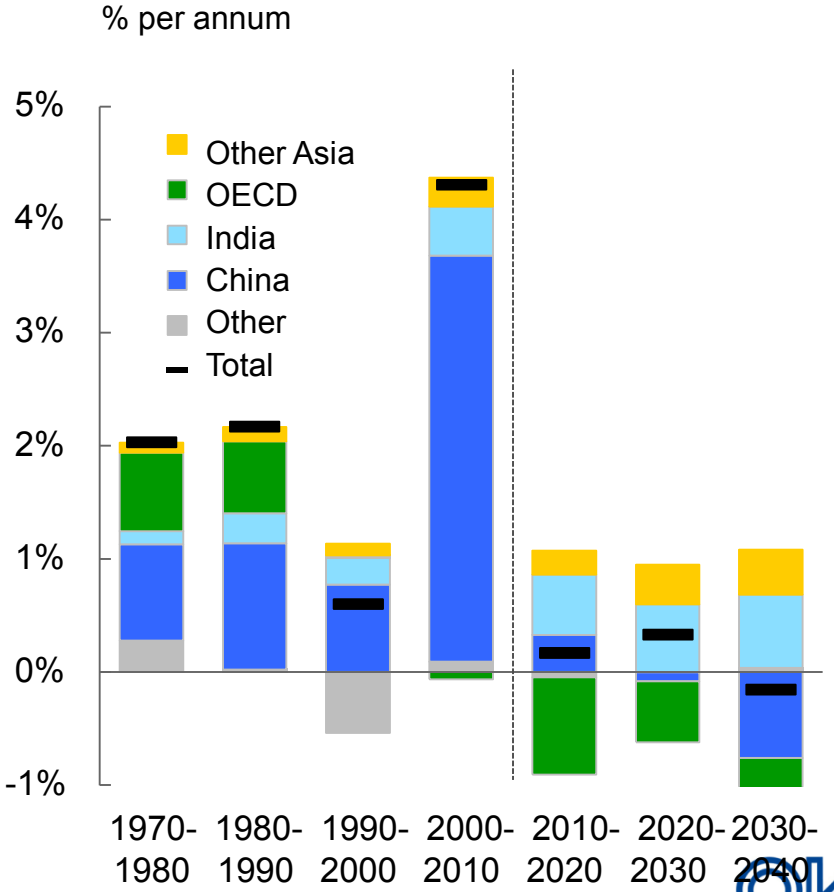


# Global coal demand flatlines, with falls in China and OECD

## Coal consumption by region

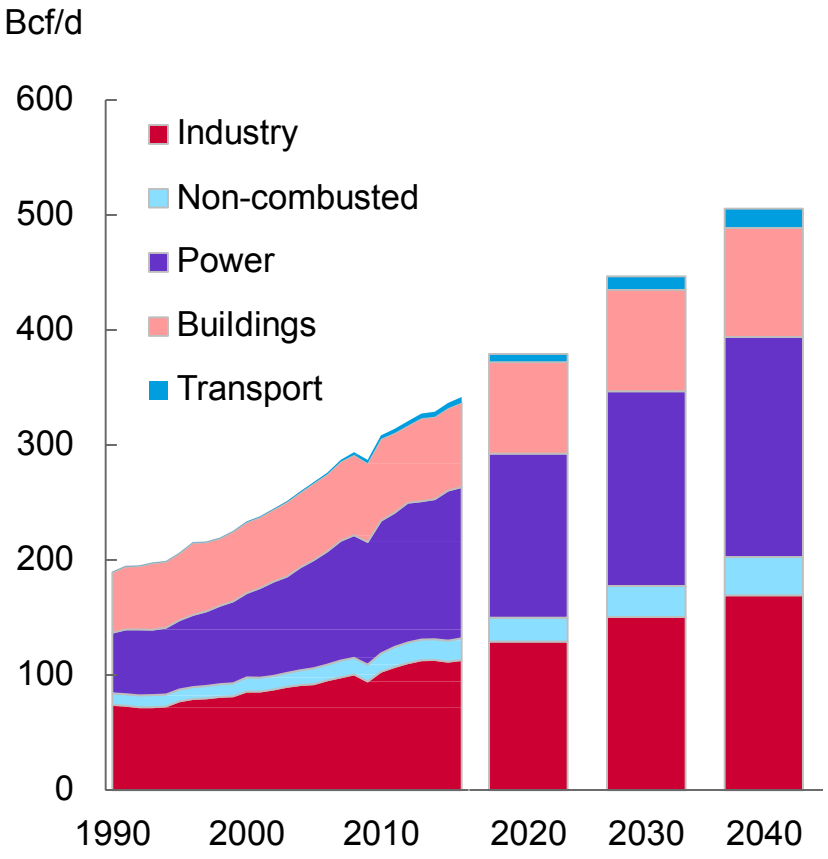



## Coal consumption growth and regional contributions

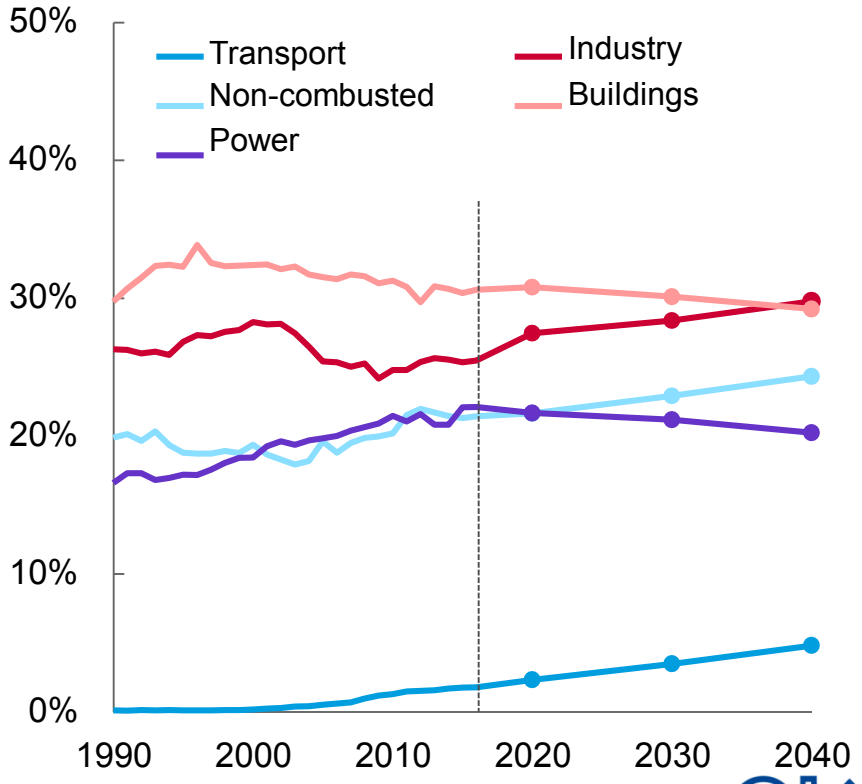


# Growth in natural gas demand…

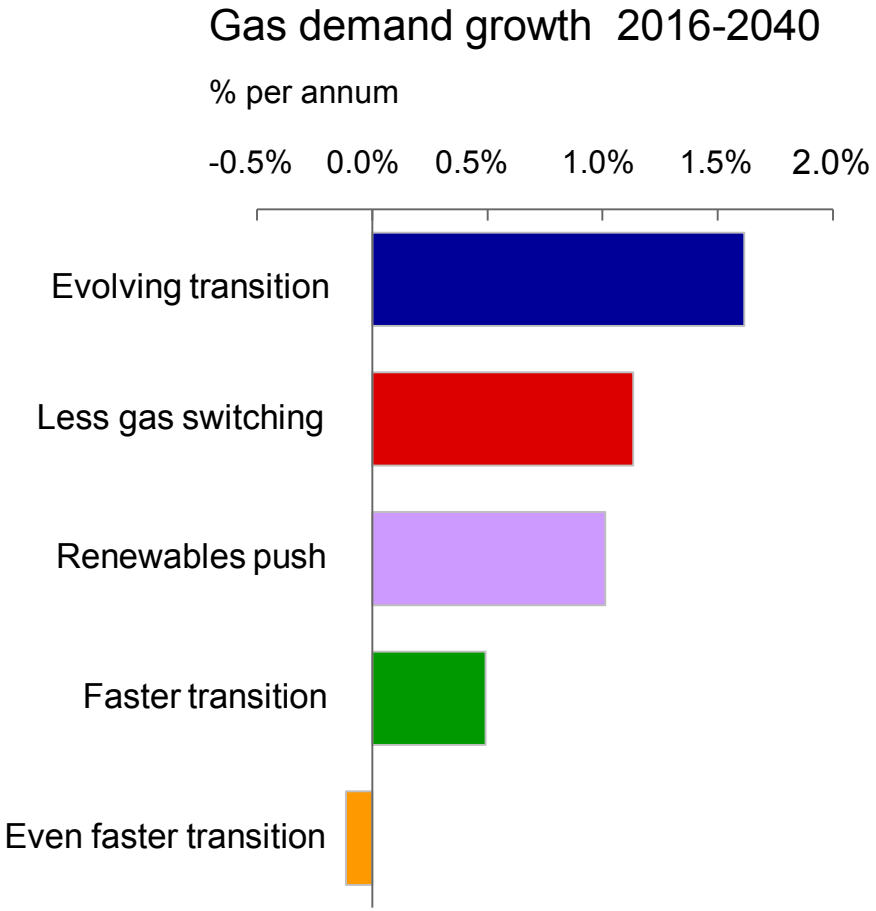
Gas consumption by sector

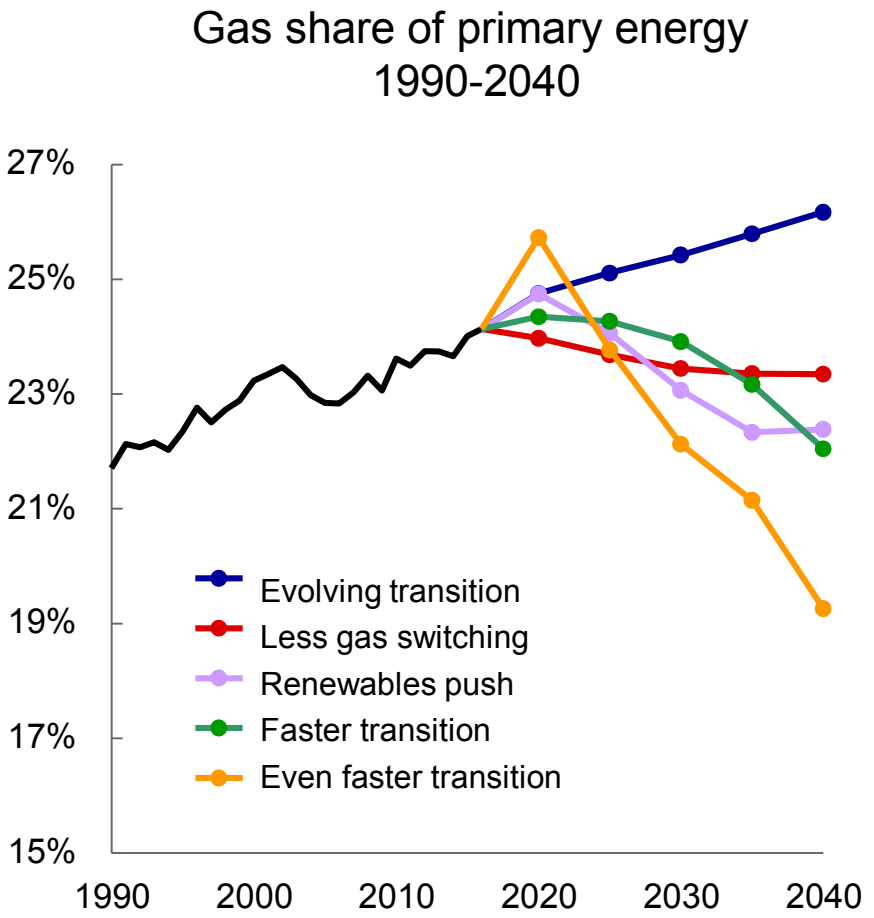



Gas share by sector



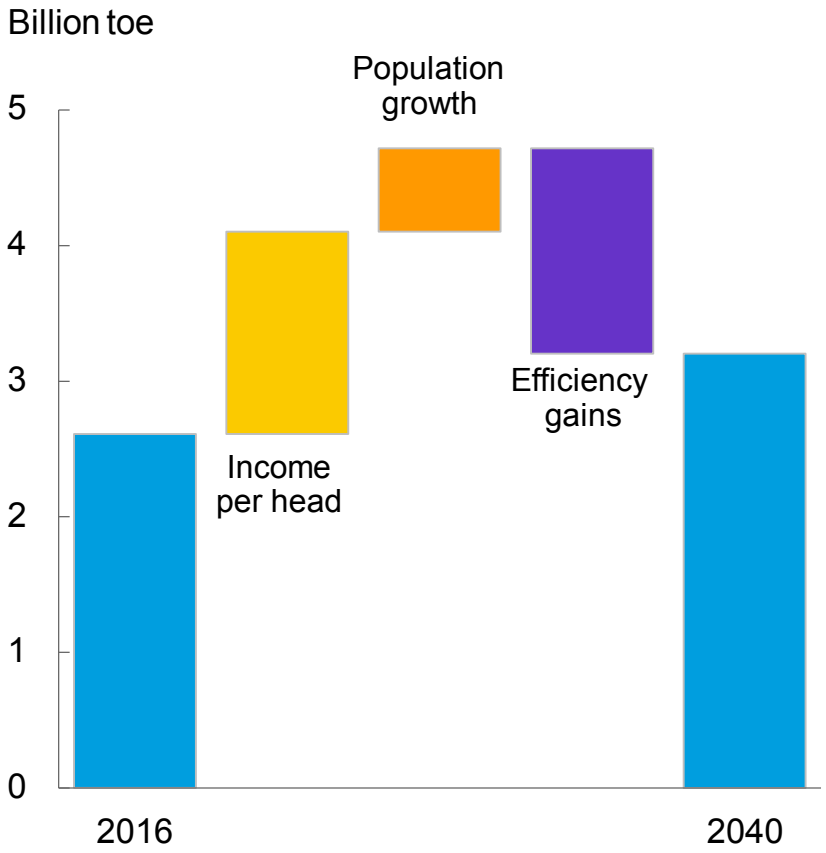
# Prospects for gas demand could be dampened



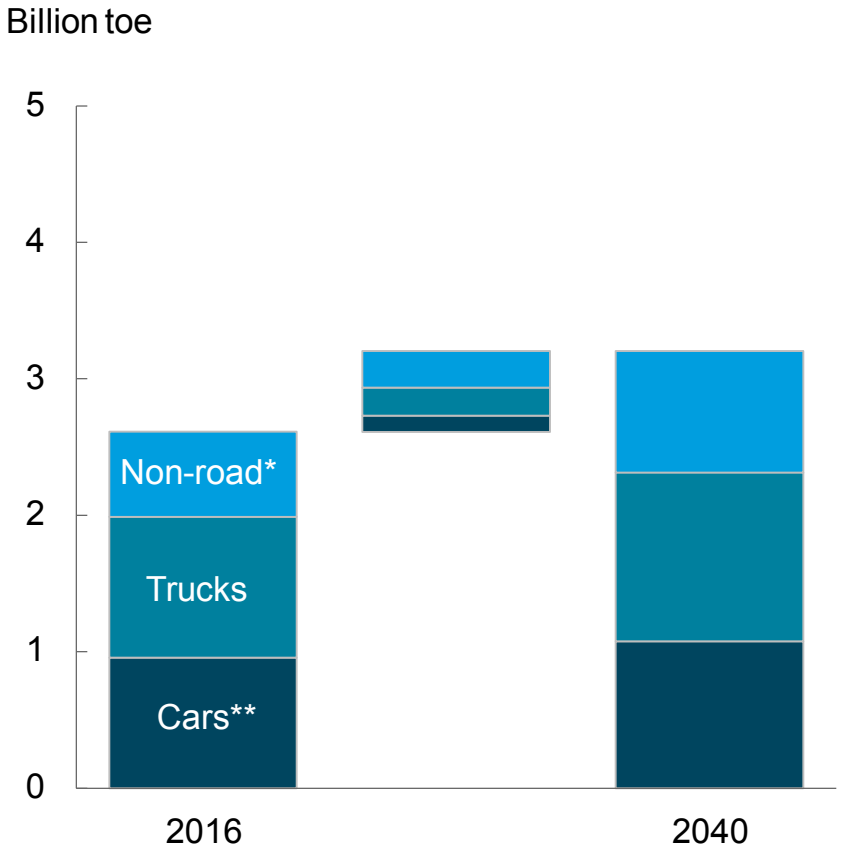



# Growth of fuels used in transport slows…

Contributions to transport energy consumption growth



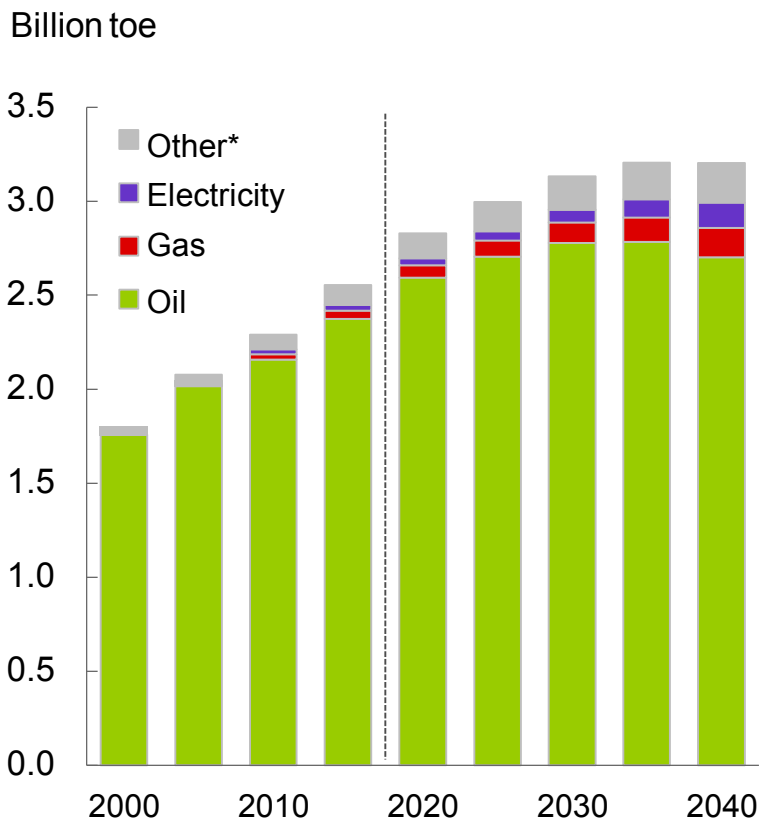

Transport energy consumption by mode



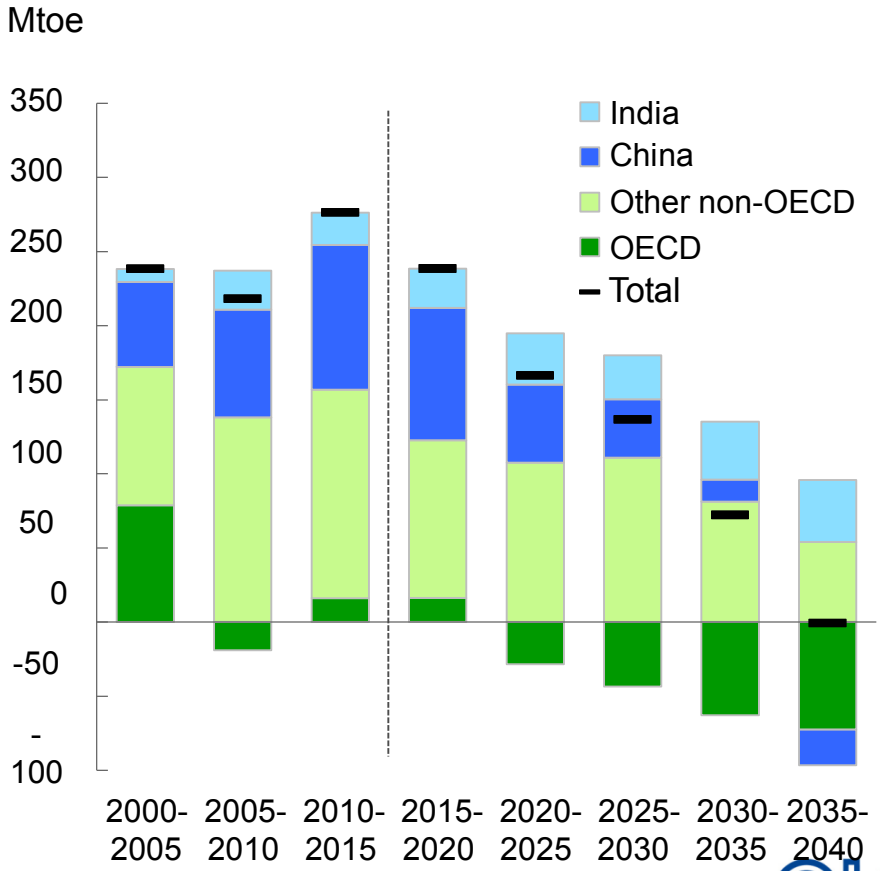

*Aviation, Marine and Rail
**Includes 2- and 3- wheelers

# Transport demand continues to be dominated by oil…

## Transport energy consumption by fuel type



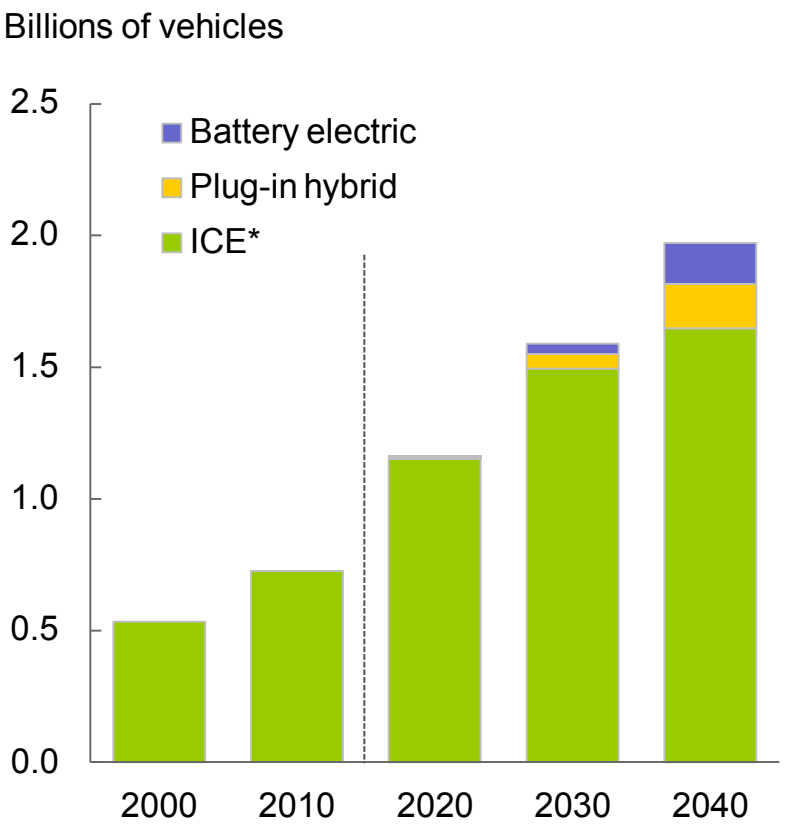

## Transport energy consumption growth by region



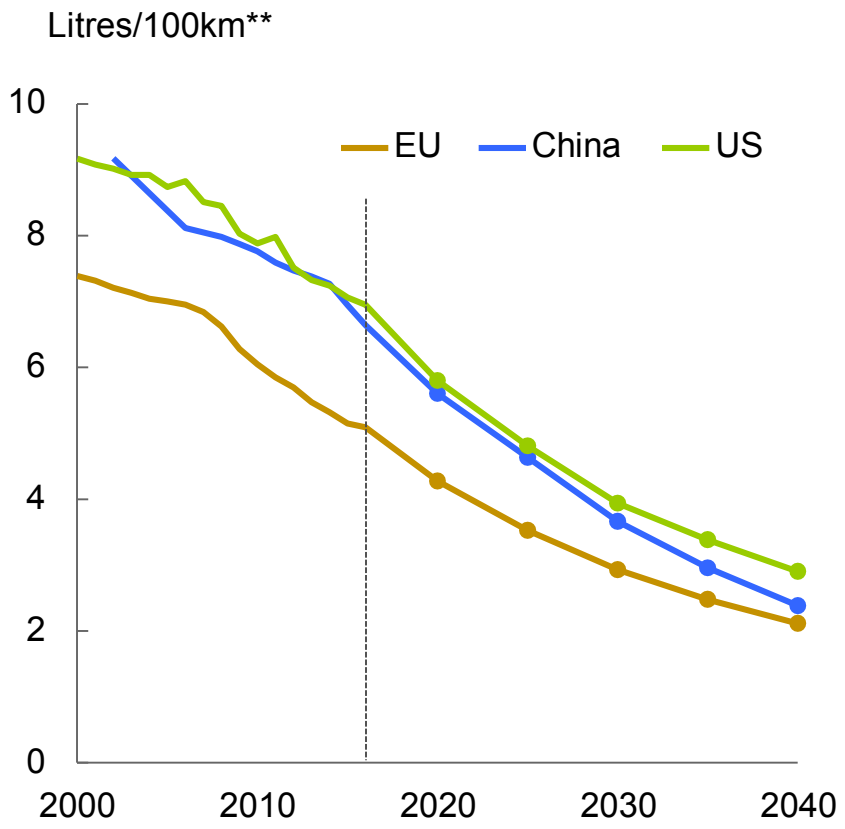

*Other includes biofuels, gas-to-liquids, coal-to-liquids, hydrogen

# The passenger car parc grows substantially...

## Passenger car parc by type



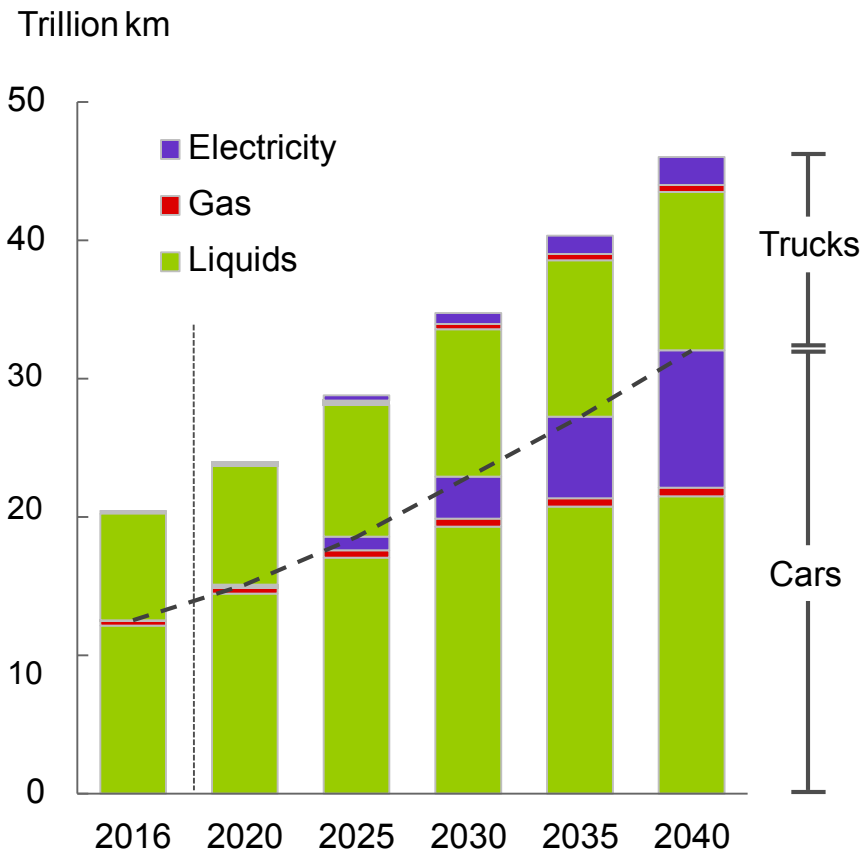

## Fuel economy of new cars



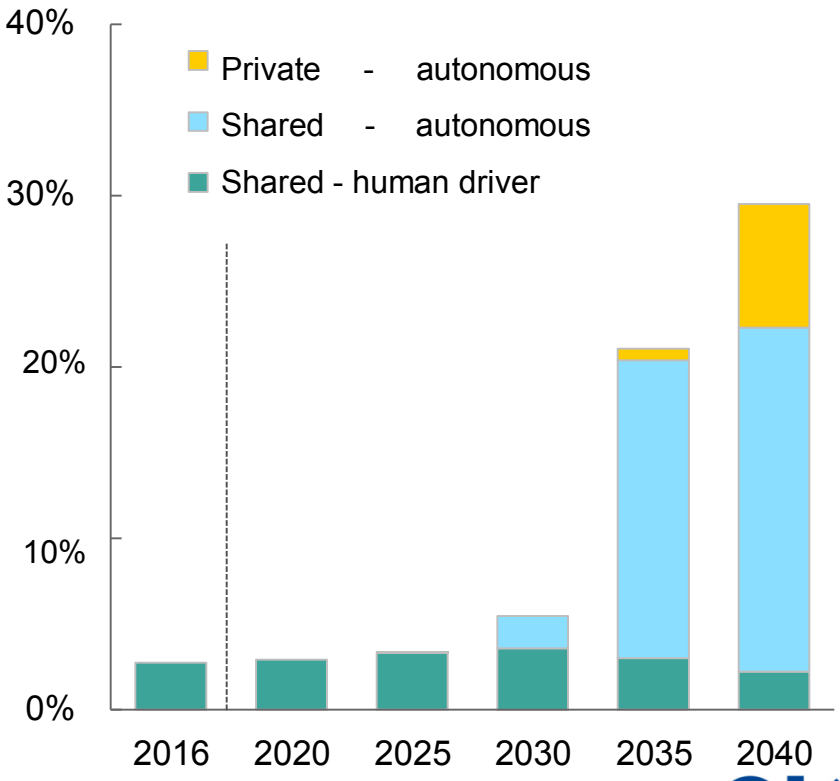

*ICE vehicles includes hybrid vehicles which do not plug into the power grid
**Based on the NEDC (New European Drive Cycle), gasoline fuel

# Road transport will be affected by the mobility revolution…

Vehicle kilometres (Vkm) by fuel type

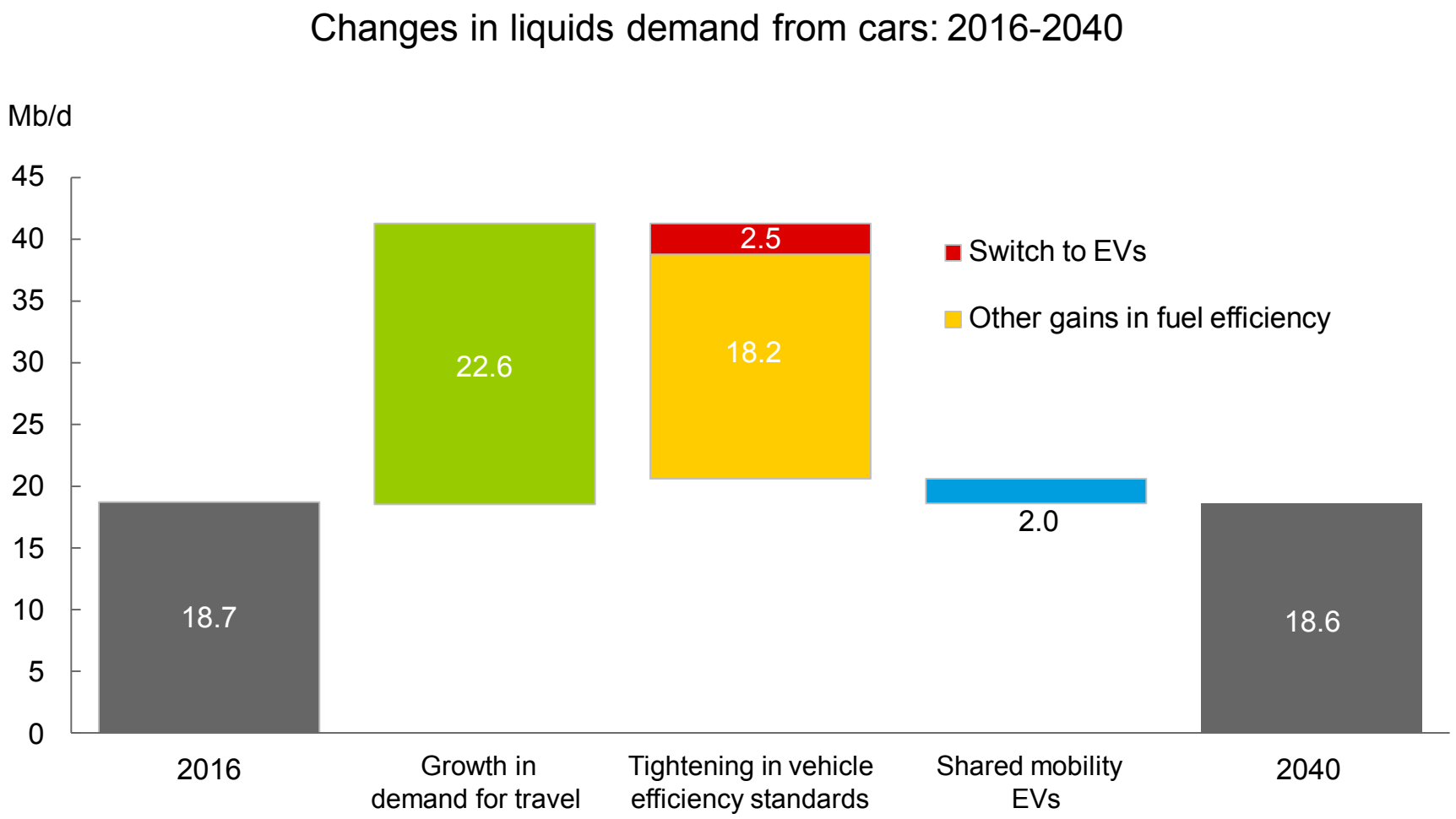



New mobility share of total Vkm

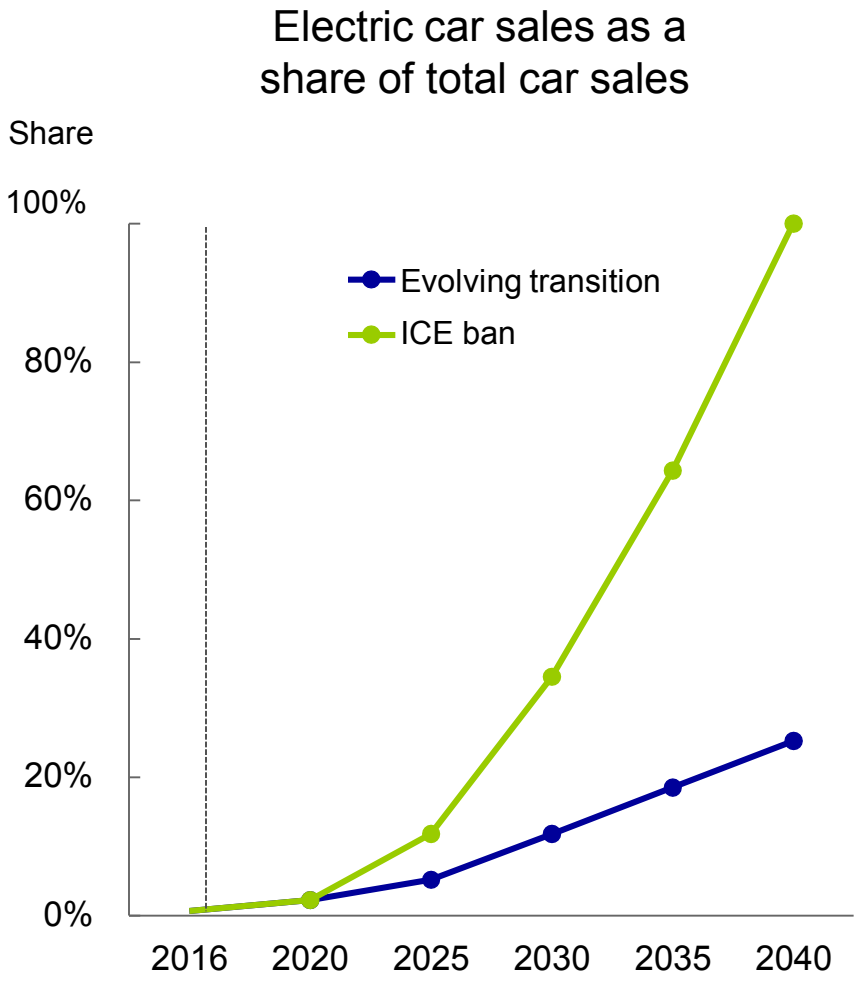


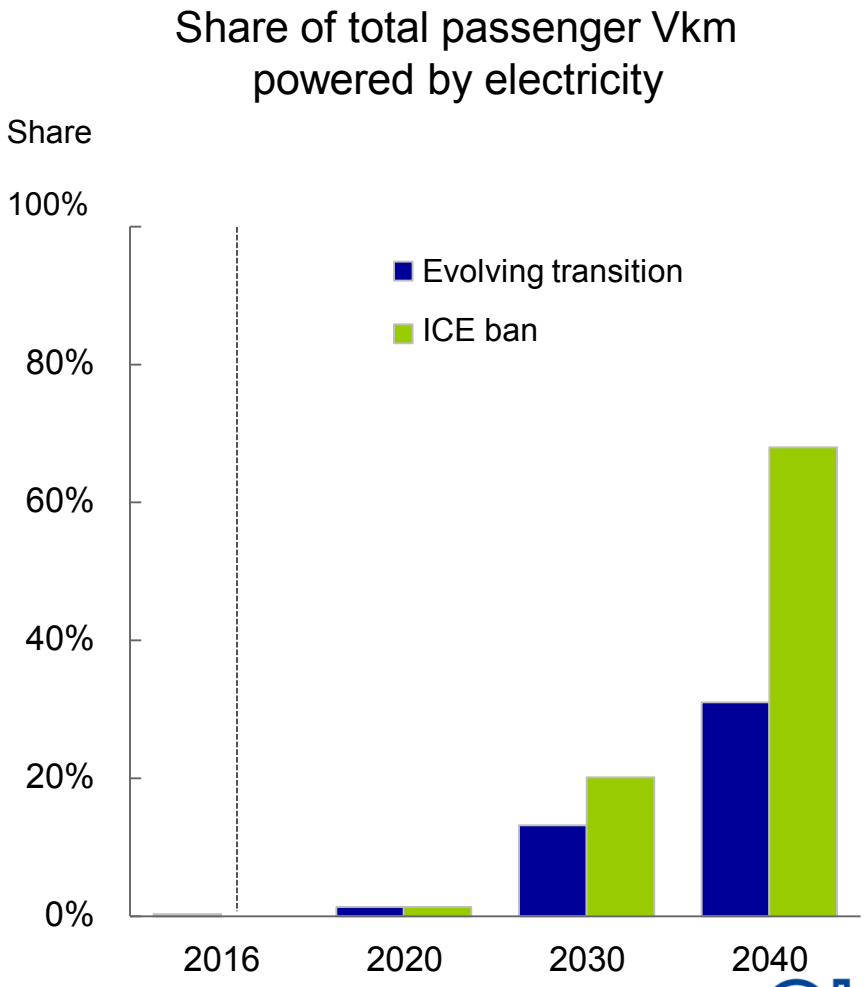

Cars excludes 2- and 3- wheelers

# Liquid fuel use in cars is broadly flat…



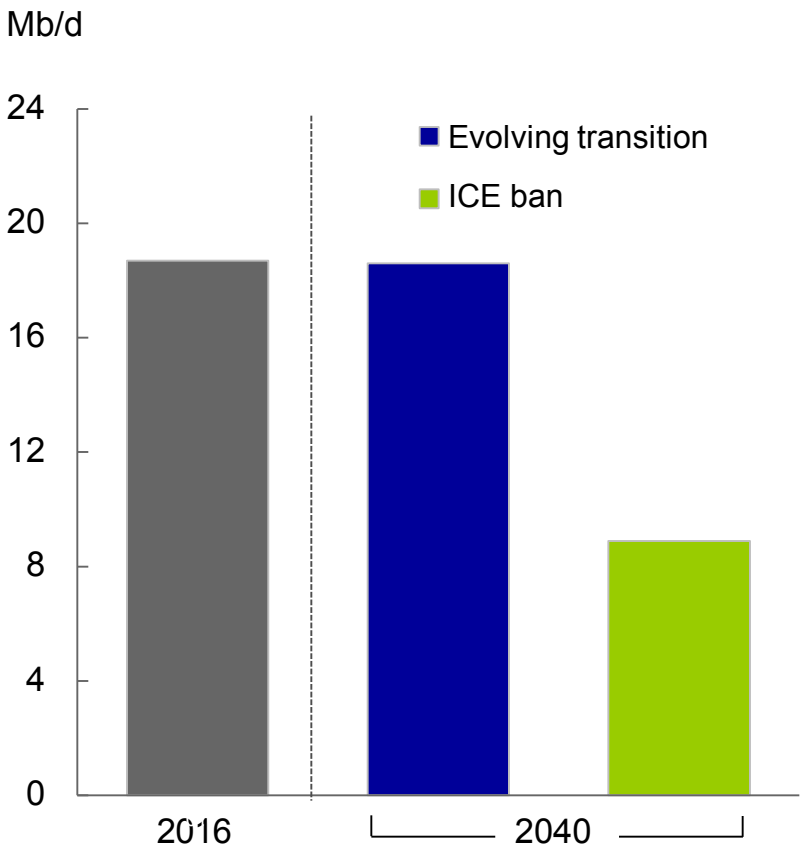
# Alternative scenario: impact of faster growth in electric cars…



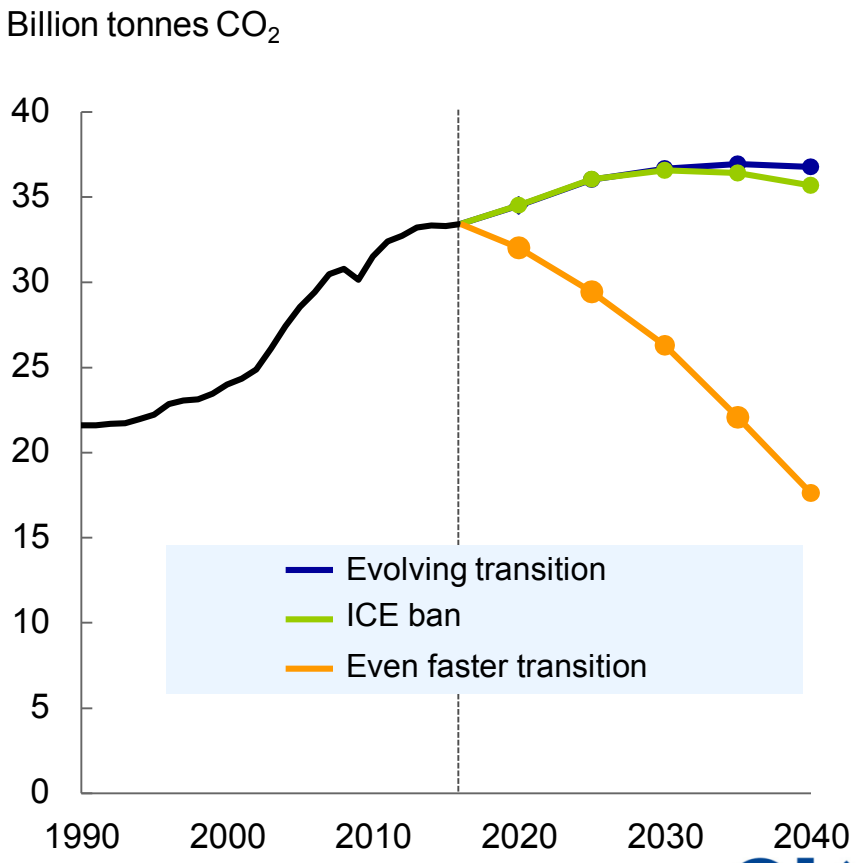



# The ICE ban has a limited impact on both liquid fuel demand

## Passenger cars liquids demand

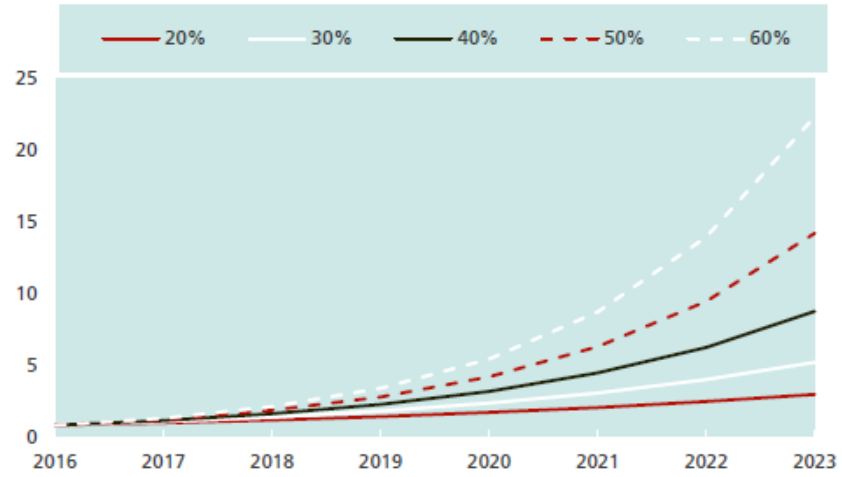



## Carbon emissions from energy



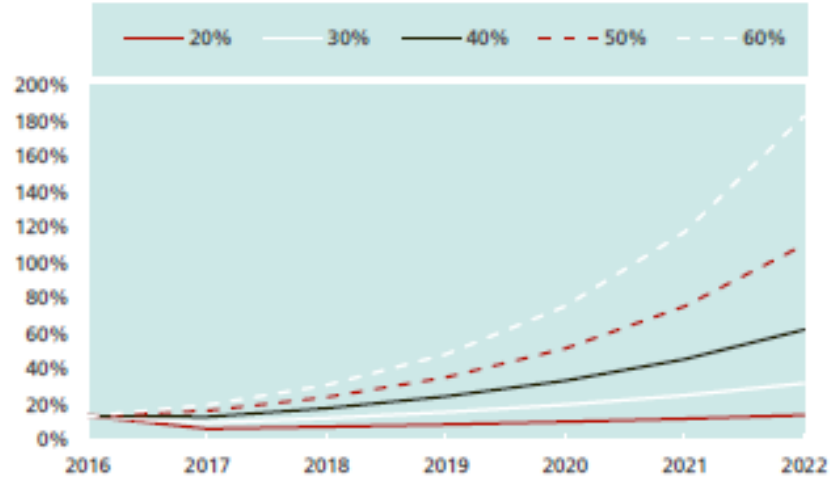
# EV impact on car sales growth

*Total EVs at different growth rates*




Source: TSRP estimates.

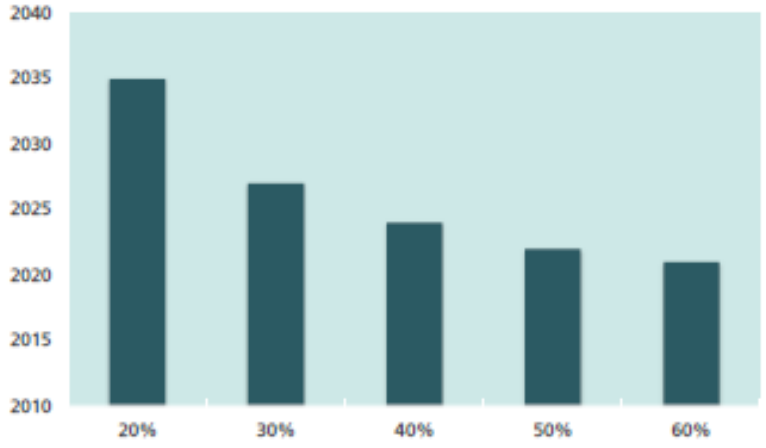
*Share of EVs in incremental growth*




Source: TSRP estimates

- A key argument for fossil fuels is when the tipping point for growth is reached
- Electric vehicles can provide a good example: at what point will EVs account for all incremental growth in car sales
- At a 60% growth rate it could be as early as 2020

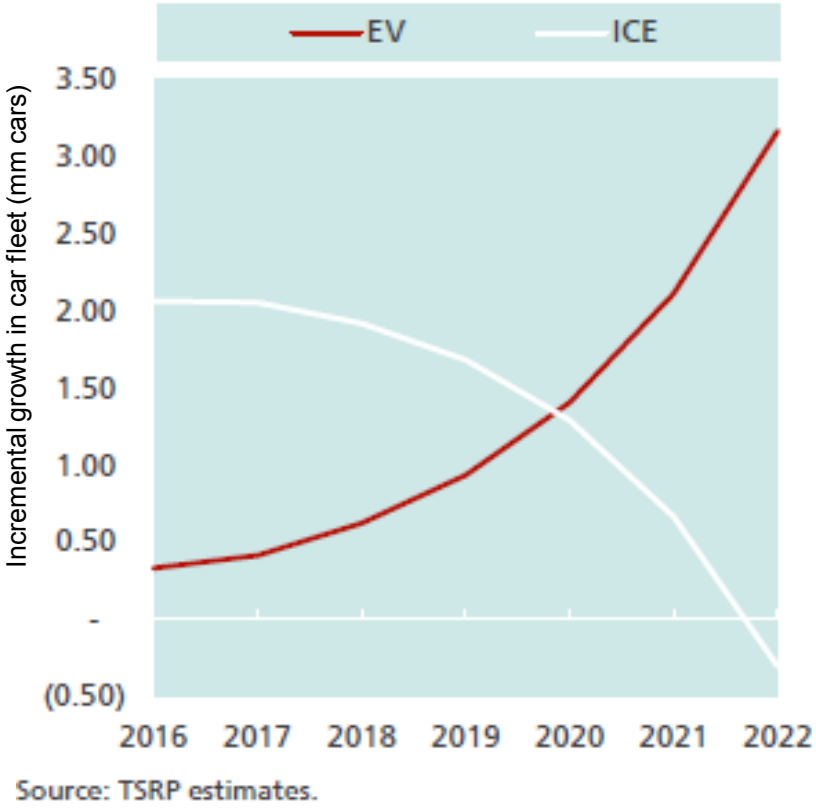
*Year of tipping point*



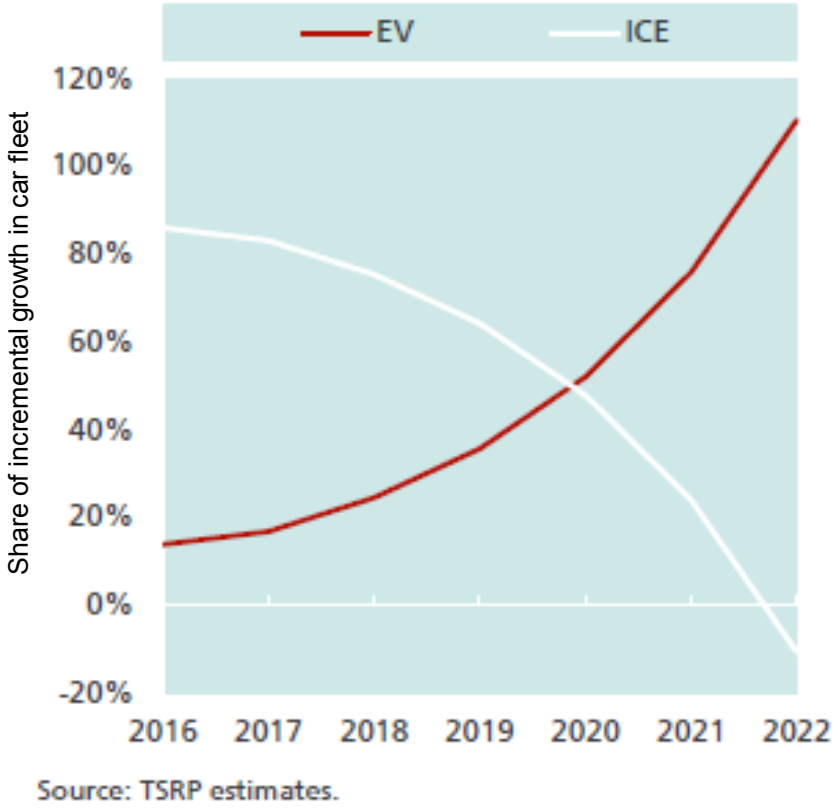

Source: TSRP estimates.

# If EVs grow at 50% per annum, car manufacturers and oil producers have some serious thinking to do

*The car market if EVs take off*




Source: TSRP estimates.

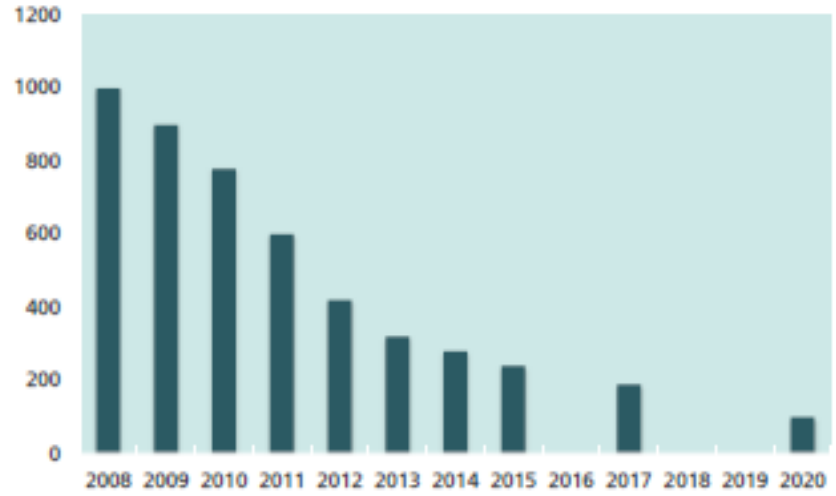



Source: TSRP estimates.

- Once the growth in ICE vehicles comes to a halt, vehicle manufacturers will accelerate production and development of EVs
- This will create an unstoppable momentum towards an electric world of transport

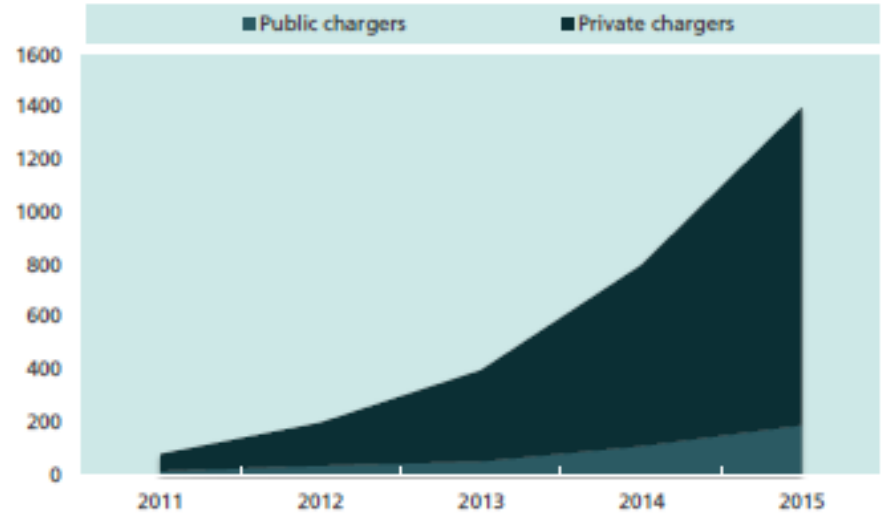
# Some infrastructure and technology issues

*Battery prices ($/kwh)*




Sources: US Department of Energy, Tesla.

*Charging stations worldwide ('000)*

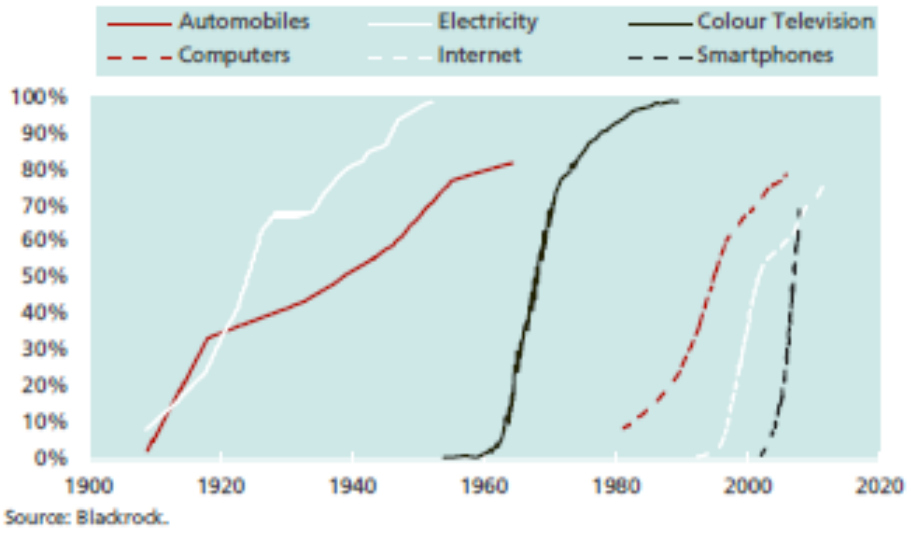



Source: IEA.

- Battery prices have been falling at 21% p.a. since 2008
- They could reach $100/kwh by 2020, at which point a car battery would cost around $6,000
- Charging infrastructure has also expanded rapidly, doubling every year since 2010
- Policy plays a key role – China has plans to build 5 million charging points by 2020

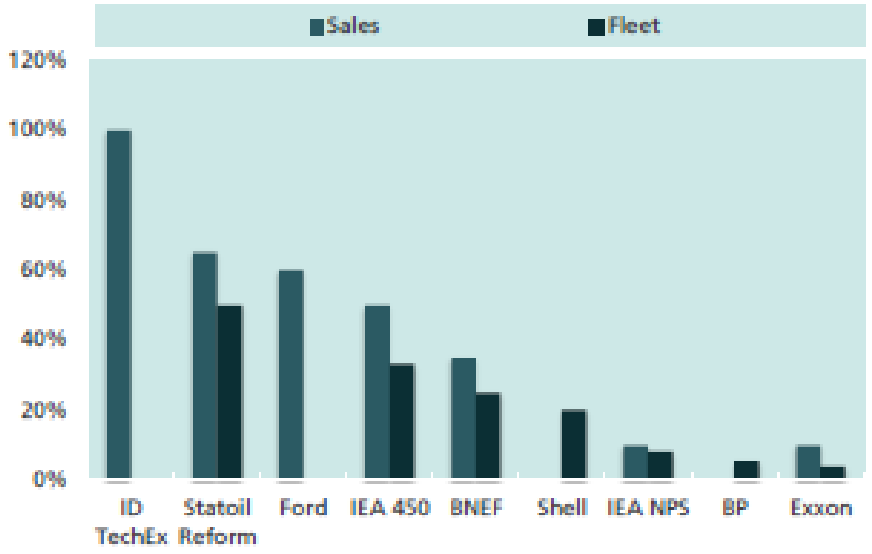
# Behavioural economics could suggest rapid growth

*US household penetration of new technologies*




Source: Blackrock.

*EV share of sales and fleet, end of period*

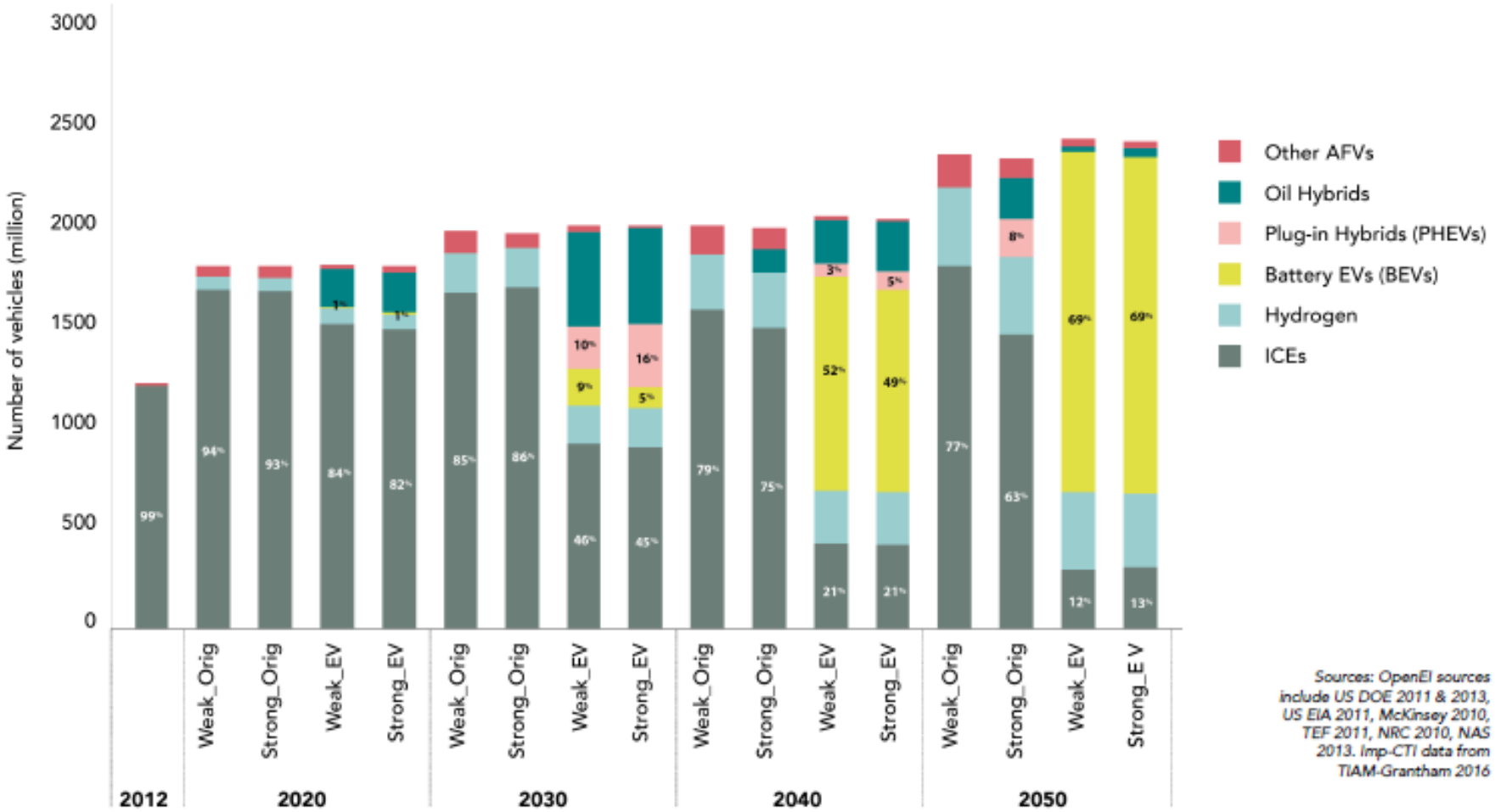



Sources: IDTechEx, Statoil, Ford, IEA, BNEF, Shell, BP, Exxon

- Consumer adoption will be vital to the success of electric vehicles
- If consumers start to think of EVs as an attractive and superior technology, then historical analogies suggest a rapid growth trajectory
- A key element in the decision will be cost, and the debate therefore centres on battery technology

# Optimistic longer term scenarios see dominance by EVs although the variations in outcome are wide

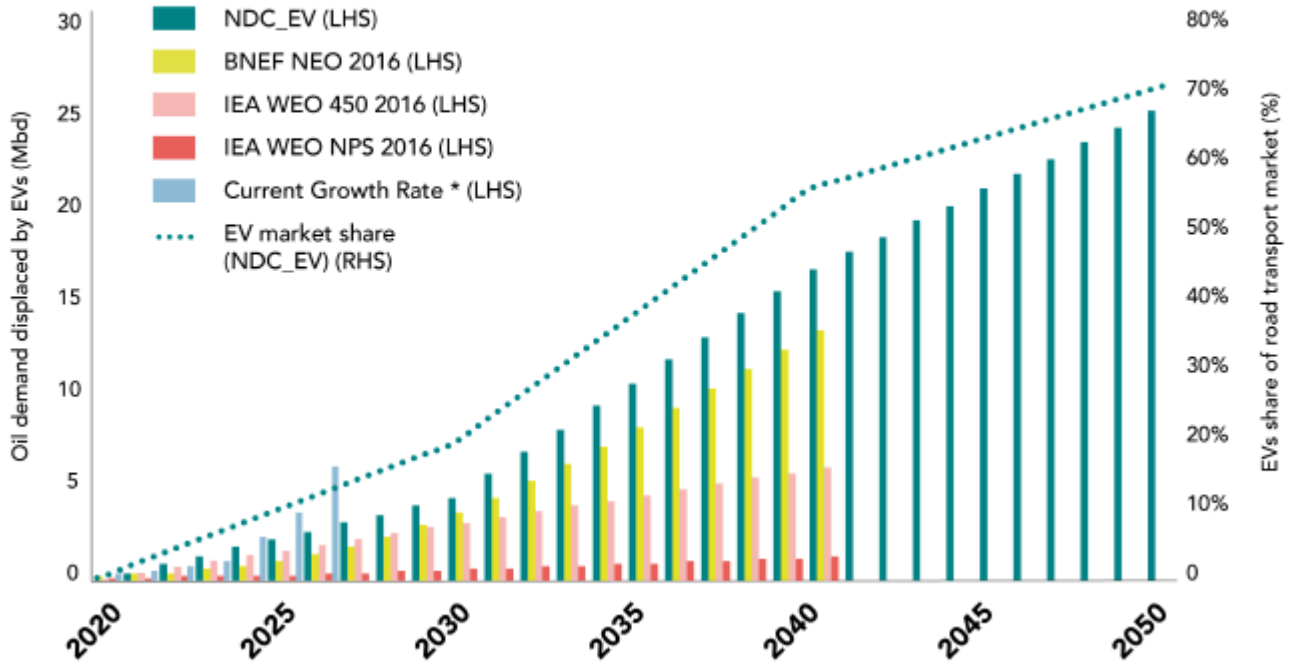
*Figure 9: The share of road transport met by different vehicle technologies under original and lower EV costs, and varying climate policy effort*[4]




*Sources: OpenEI sources include US DOE 2011 & 2013, US EIA 2011, McKinsey 2010, TEF 2011, NRC 2010, NAS 2013. Imp-CTI data from TIAM-Grantham 2016*

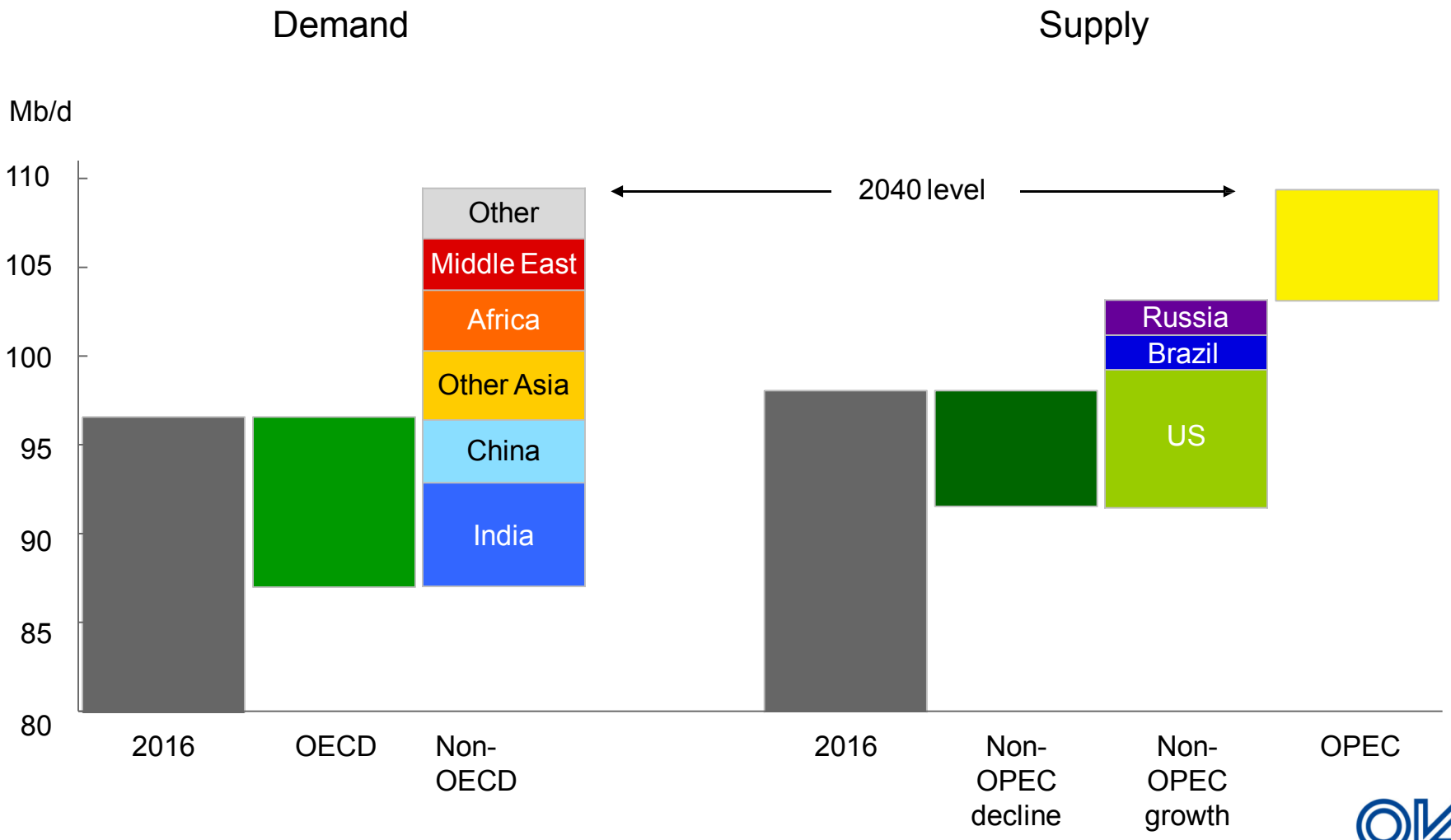
# The impact on oil demand could be very significant

*Figure 10: Comparing levels of oil demand displaced by EVs across institutional projections[4]*



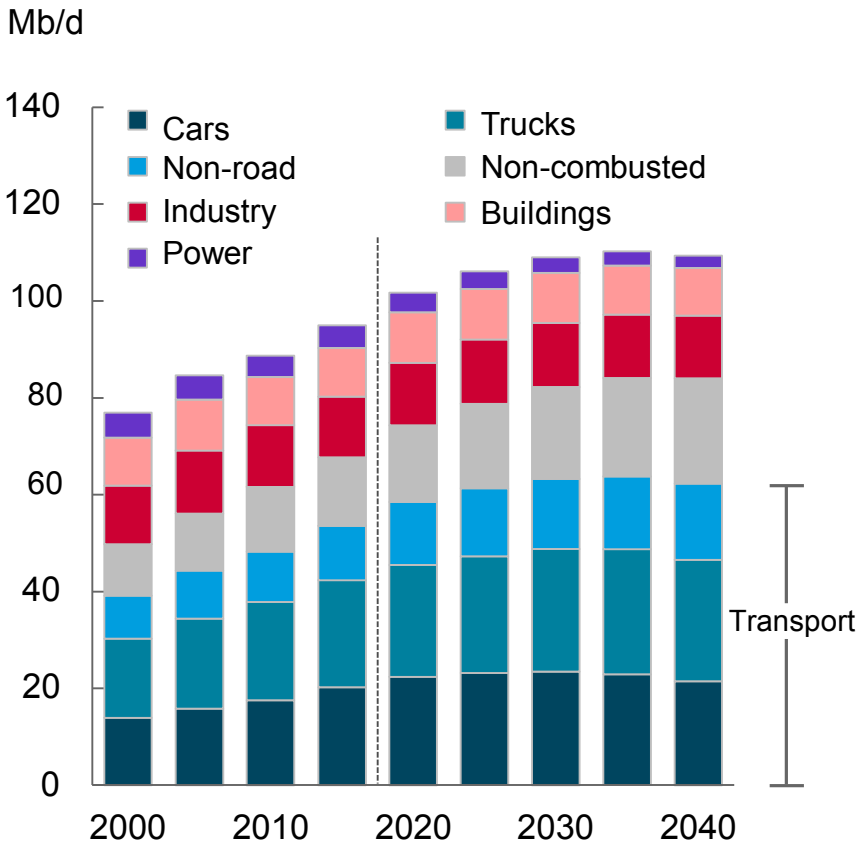

- A loss of even 5 million bpd would be huge, given that oil demand has historically grown by around 1mmpd per annum
- However, would a price collapse slow the switch away from oil?

# Growing demand for liquid fuels in emerging economies

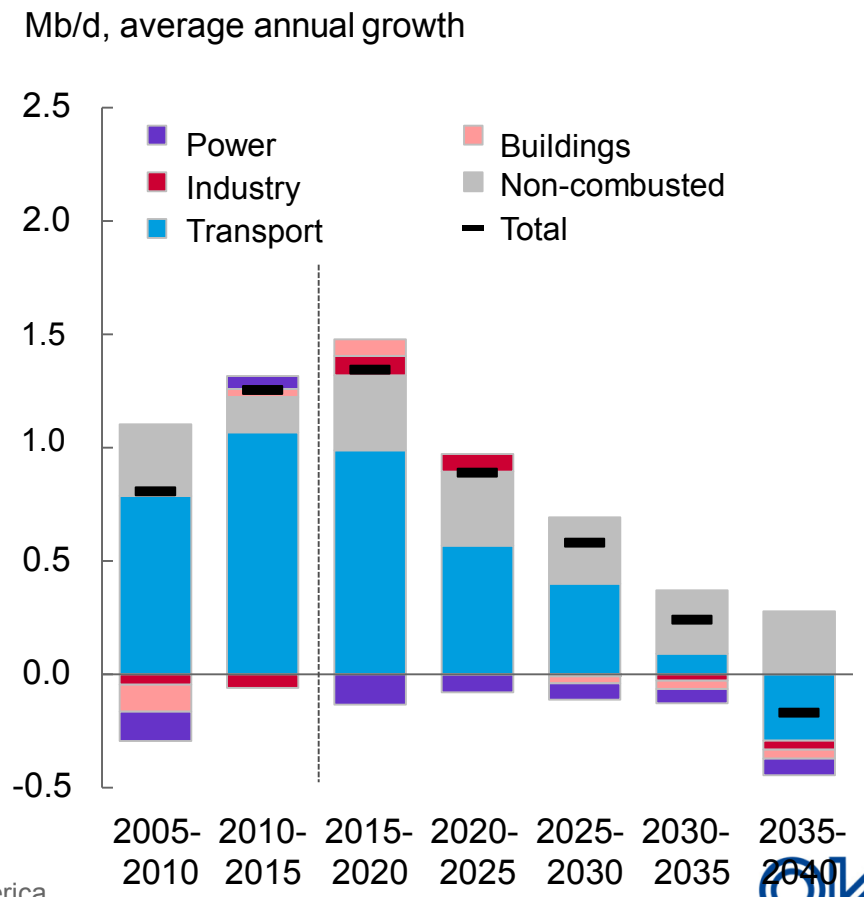


# Liquids demand grows materially over the period to 2040

## Liquids demand



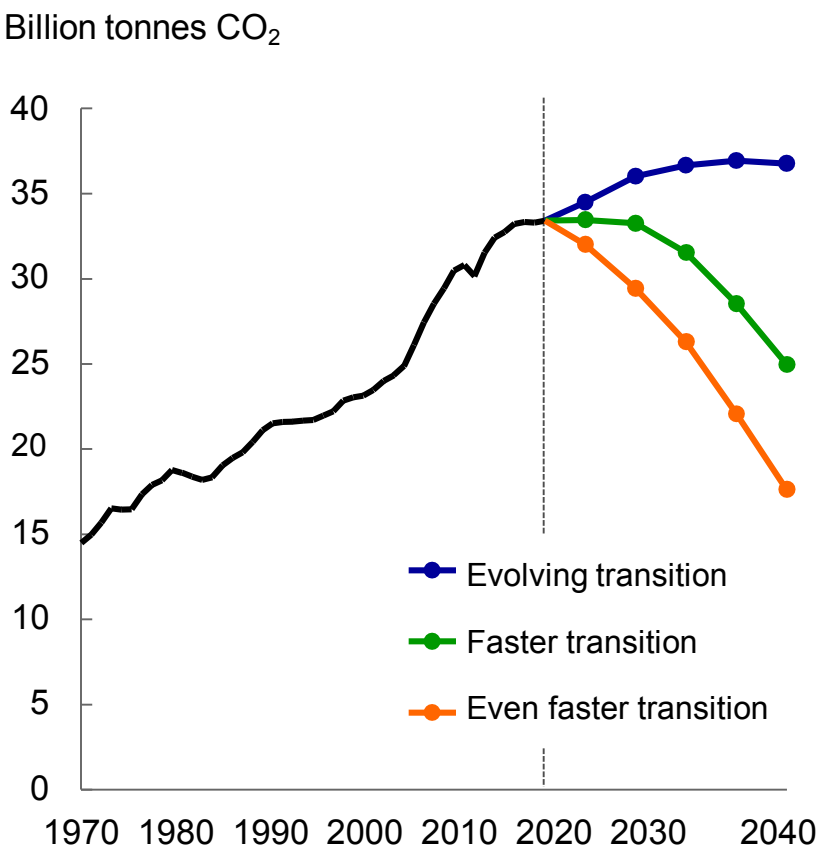

## Liquids demand growth



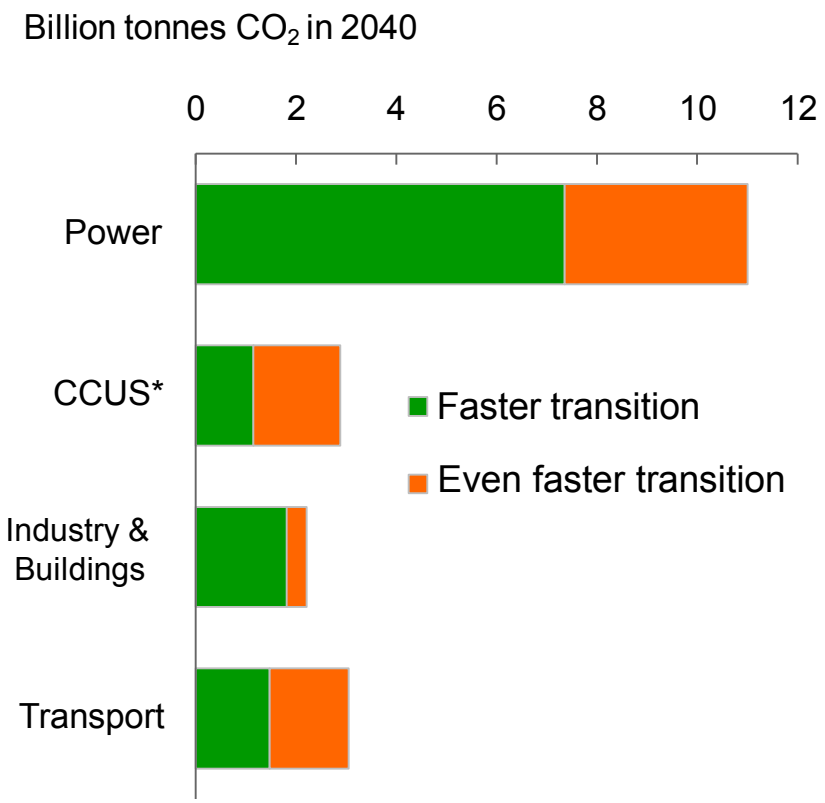

Cars include 2- and 3- wheelers. Trucks include most SUVs in North America. Non-road includes aviation, marine and rail

# Carbon emissions continue to grow in the ET scenario

## Carbon emissions



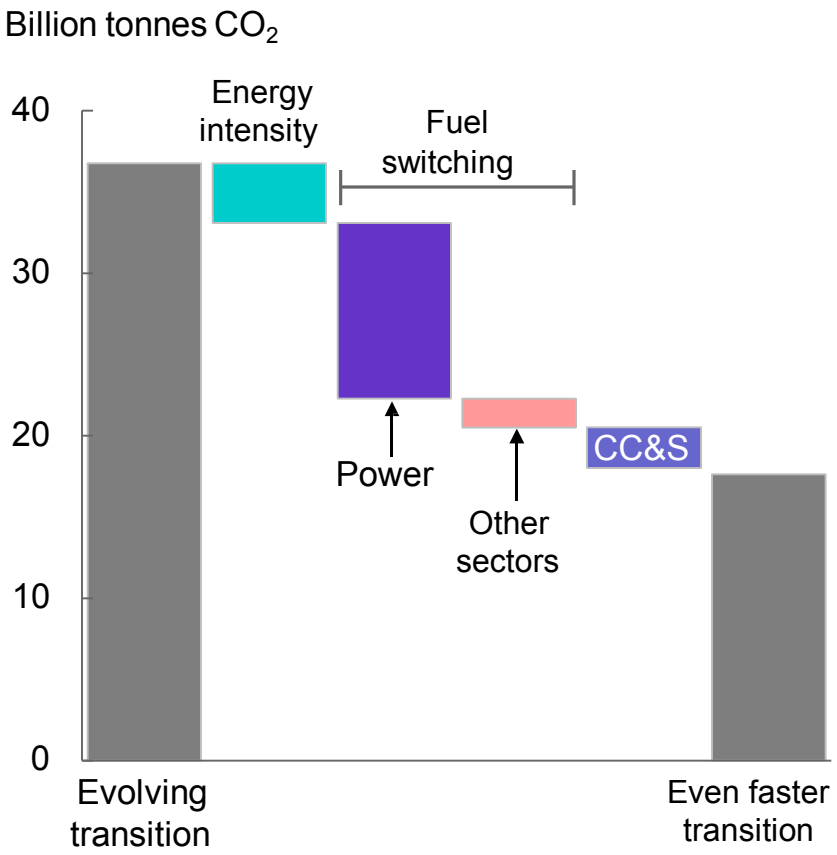

## Reductions versus ET scenario



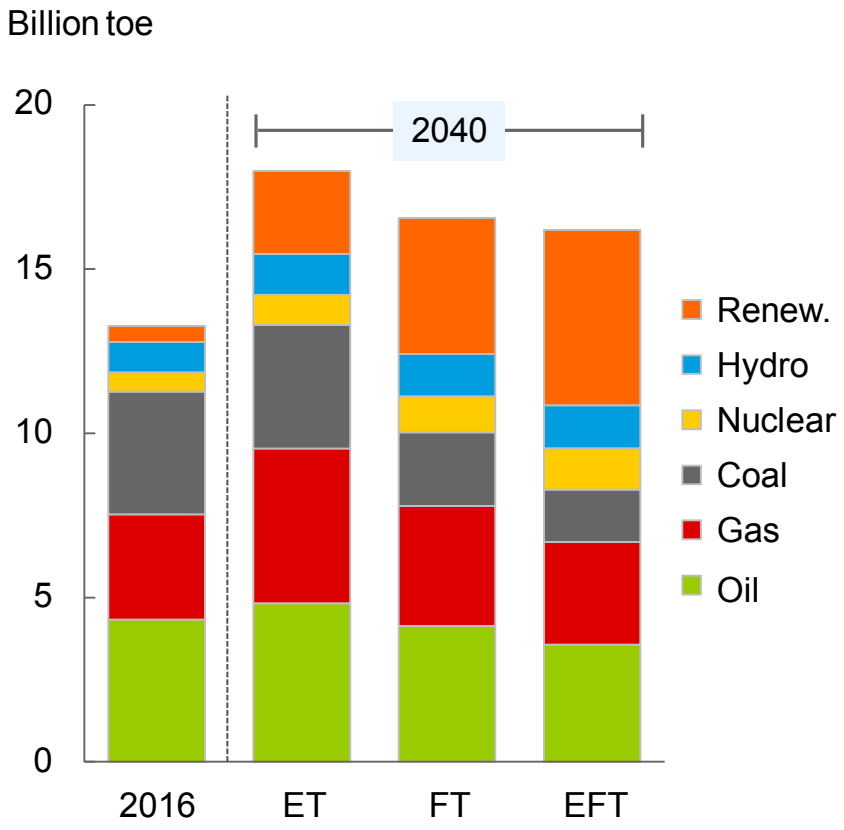

*Carbon capture use and storage

# Alternative scenario: impact on global energy system

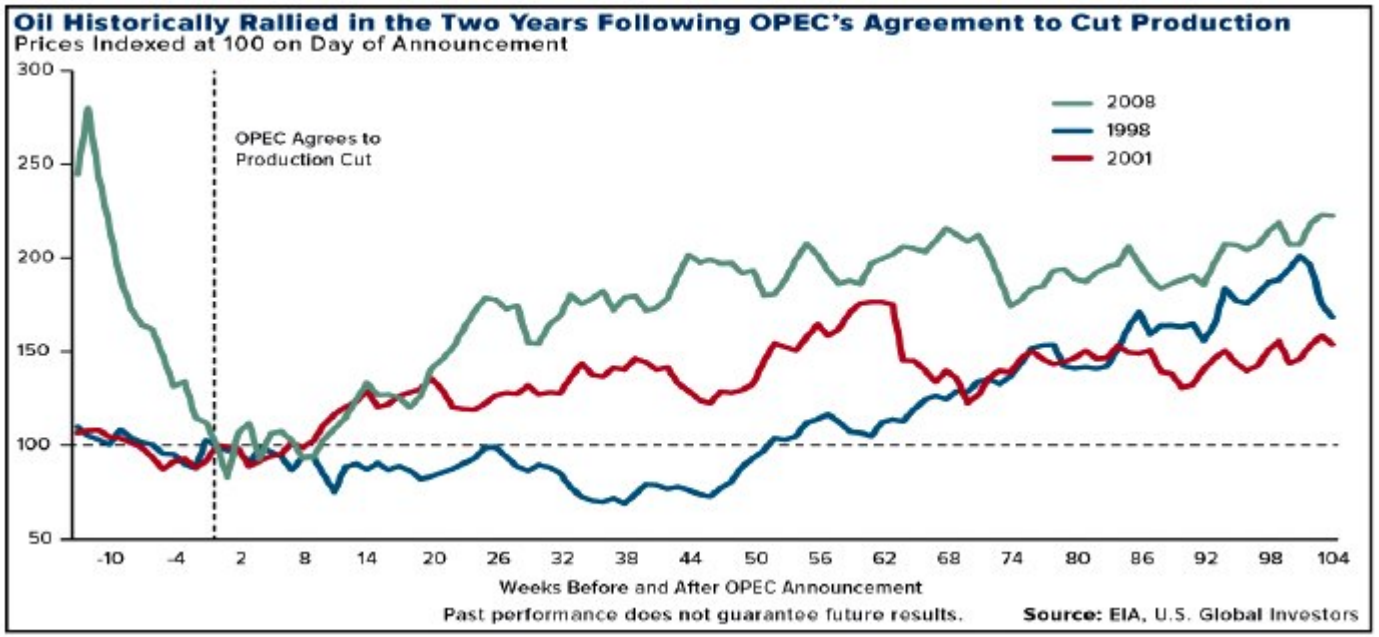
## Carbon emissions in 2040: EFT versus ET scenario




## Primary energy consumption by fuel

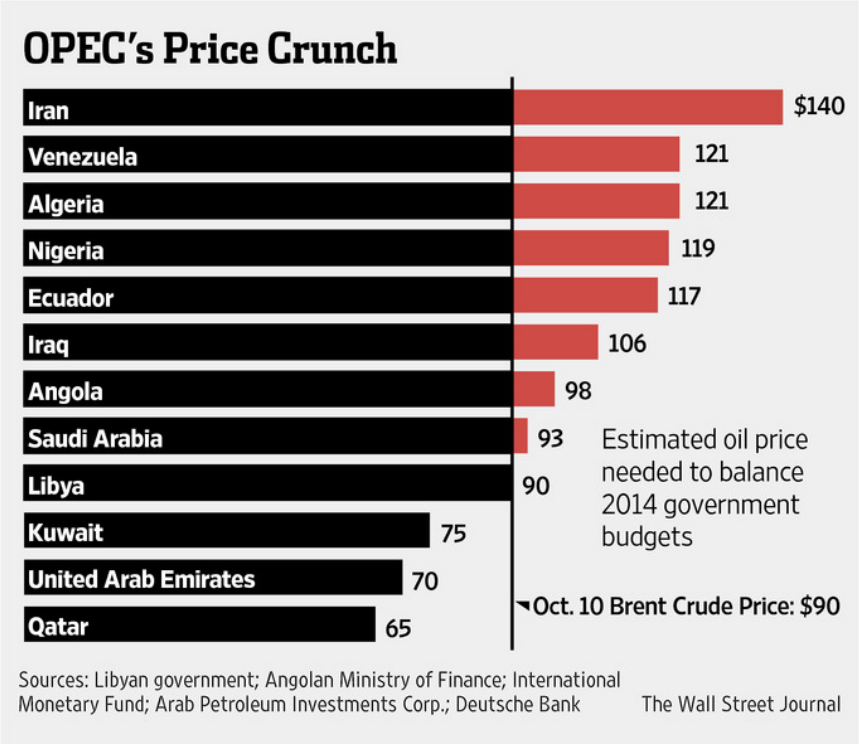


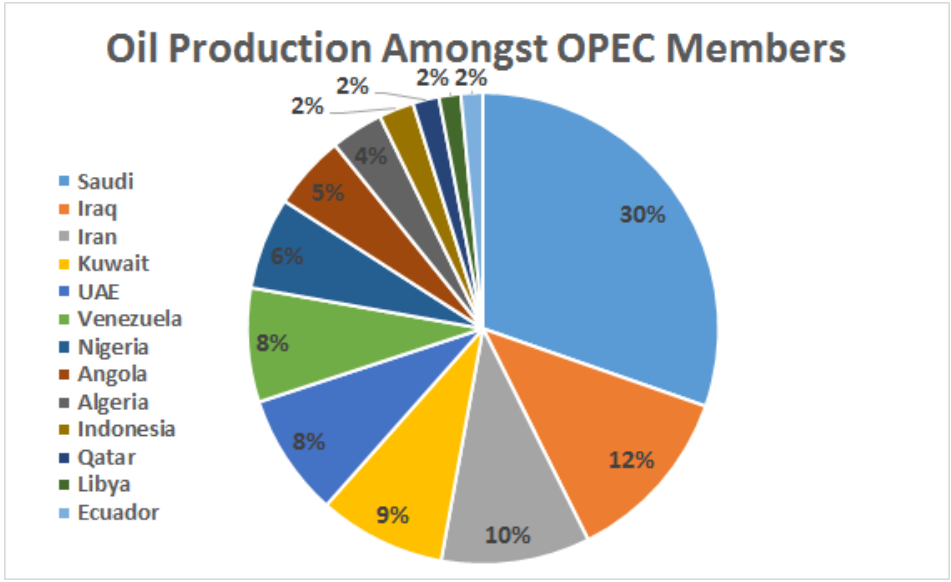
# Impact of OPEC




- OPEC accounts for around 40% of global oil production
- It tries to act as a cartel to control the oil price within an "acceptable" range
- Most recent cut was in November 2016 – price has risen from $45 per barrel to $70

# OPEC is a volatile organisation



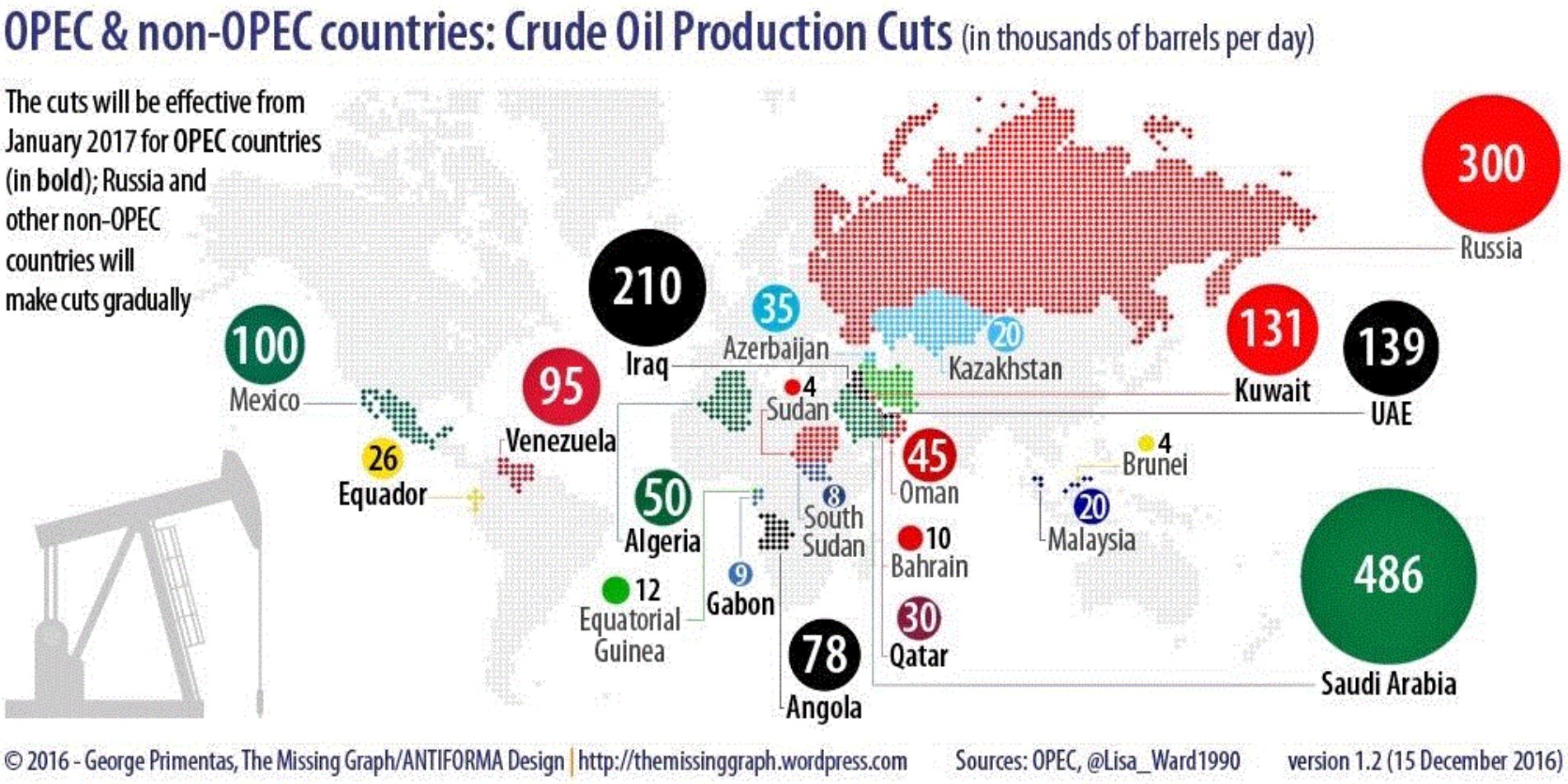




- The budgets of OPEC countries need high oil prices
- The politics of the Middle East provides a clear risk to oil production

# OPEC decisions about future oil production and oil prices are critical for new projects

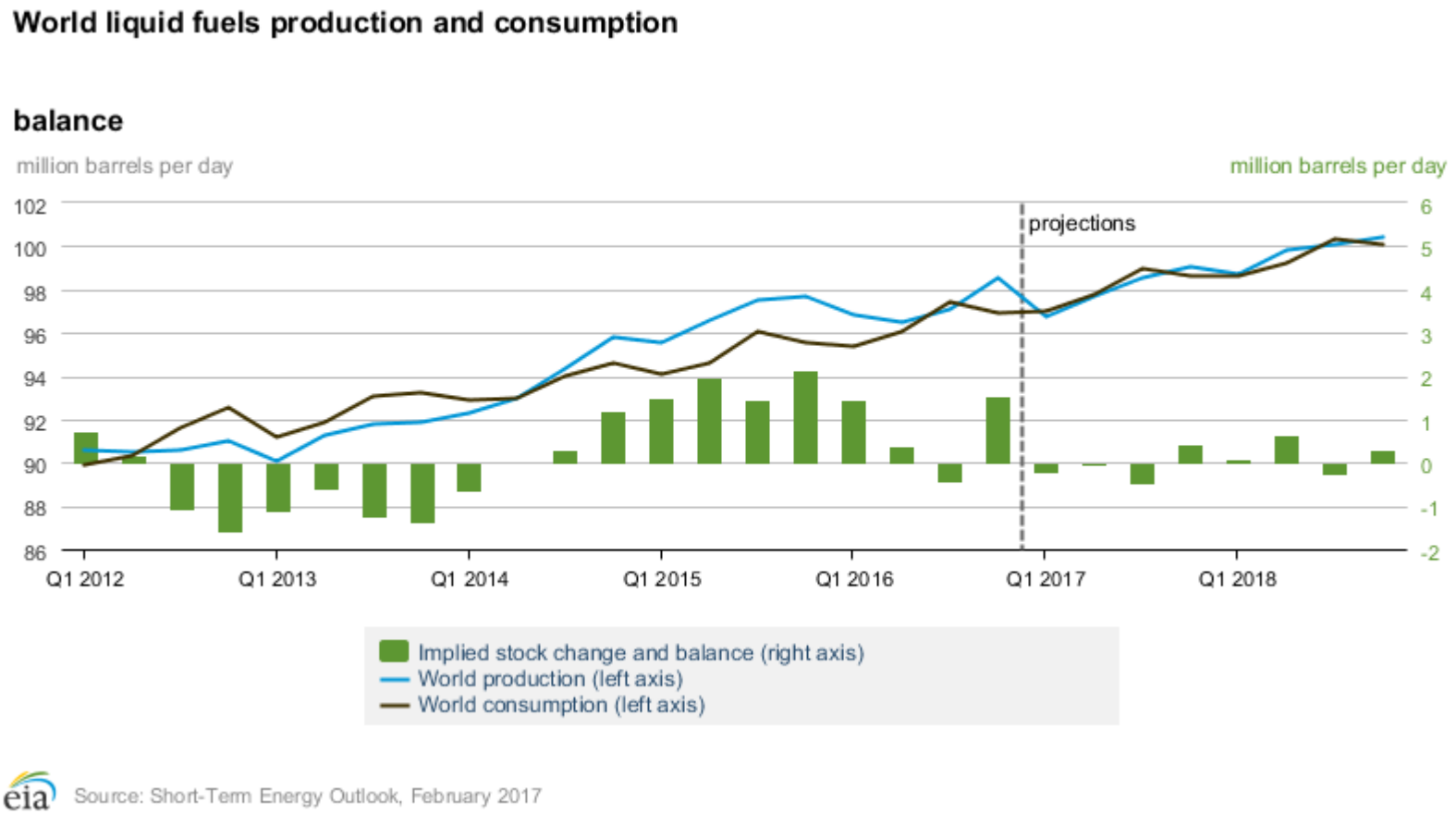
- Need to maximise oil revenues
- Historic strategy to preserve oil for future generations
- Now the question is whether there is a long-term future for oil?
- Largest reserve holders risk failing to monetise resources
- Low cost producers do not want to allow higher cost producers to take market share
- How to find the optimal balance?

# Current strategy – avoid very low oil prices by cutting production




- What happens next? An oil glut from US shale or an oil shortage due to lack of investment and growing demand?

# Short-term outlook is good




- Low prices have caused a surge in demand
- Production cuts have brought the oil market back into balance

# The Oil Price – A Volatile History


- Range over the past decade has been $140 to $25 per barrel
- Price has more than doubled in the past two years
- 10 year average is $79 per barrel, 5 year average is $68

# Let’s make an oil price forecast!

- Base case
- Upside case
- Downside case
- Disaster (worst) case
- Does the investment need to work in all of these scenarios?

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