THE OXFORD INSTITUTE FOR ENERGY STUDIES

A RECOGNIZED INDEPENDENT CENTRE OF THE UNIVERSITY OF OXFORD

UNIVERSITY OF OXFORD

Introduction to strategic decision-making in energy companies

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March 2023

Outline of the course

Overall objective – understand how senior management use economic models to make investment decisions

1. Refresher on key themes in the global energy market
2. Introduction to financial modelling as a management tool
    1. Understanding some key concepts
3. Modelling an oil and gas field – revenues and prices
4. Inputting the costs – capital expenditure
5. Operating costs and paying the government
6. A power plant – a buyer and seller of energy
7. Calculating a discounted cashflow
    1. Why is it important
    2. How is it used to make decisions
8. Testing the investment decisions: running some numbers under different assumptions
9. Answering your questions

Assessment

Overall objective – demonstrate understanding of cashflow models and output

1. Create a simple cashflow model, given set assumptions
2. Generate NPV and other results
3. Provide an analysis of simple scenarios
4. Compare two models and provide conclusions
5. Write up results in short review (one page)

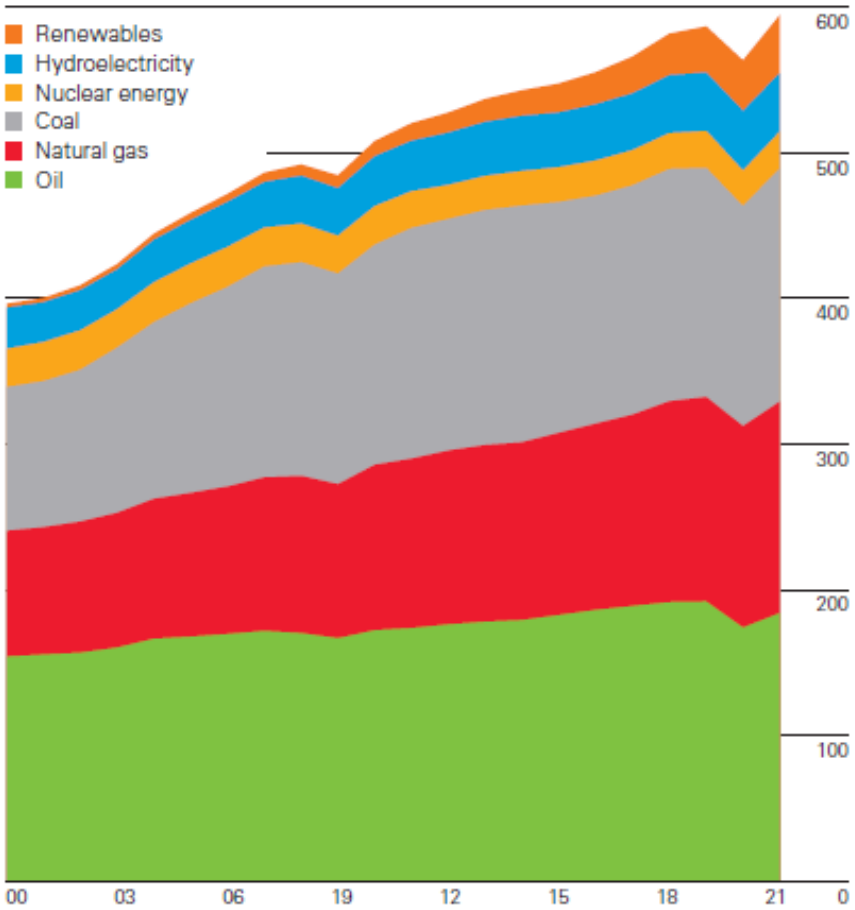
Key Questions for Company Management

- How much profit can I generate?
- How can I grow the business?
- Where can I grow the business?

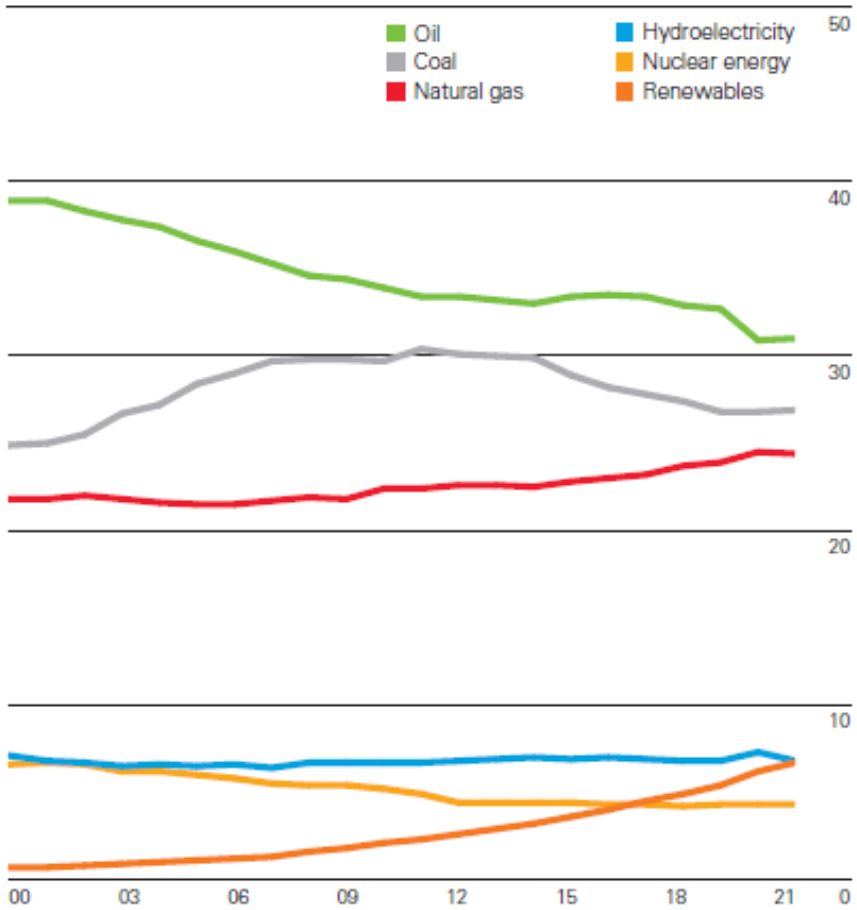
- What are my competitors doing?
- What rules must I abide by?
- What government support can I expect?
- What do my owners / shareholders want out of their investment?
- What are the long-term prospects for my industry?
- What is my business worth over the long-term?
- How do I stay competitive?
- How important is public opinion and how do I keep it on my side?

Primary energy consumption since 1990 (mmtoe)

World Consumption (Exajoules)

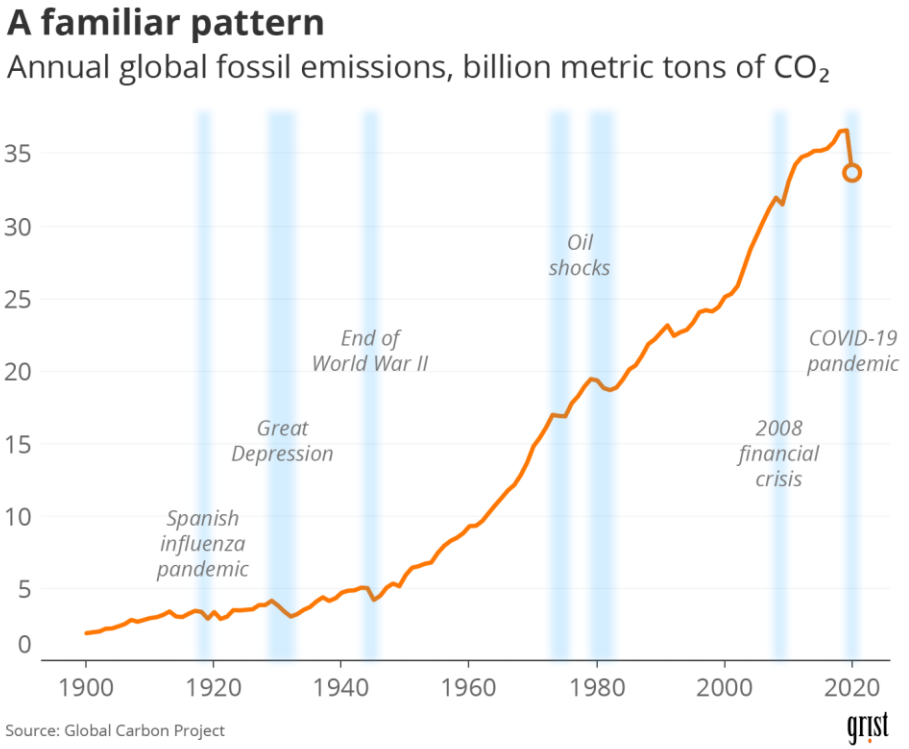


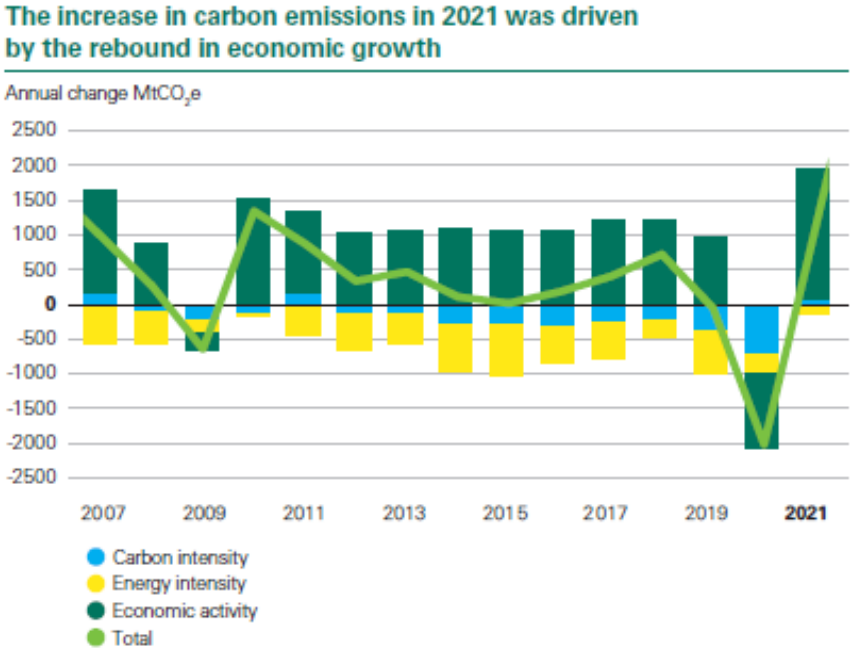
Share by Fuel (%)



- Overall energy demand has been growing by around 1% per annum
- The key primary fuels have been hydrocarbons, which account for 80%+ of total energy consumption
- Renewables are growing fast but from a very low base

CO2 emissions – will they ever peak?

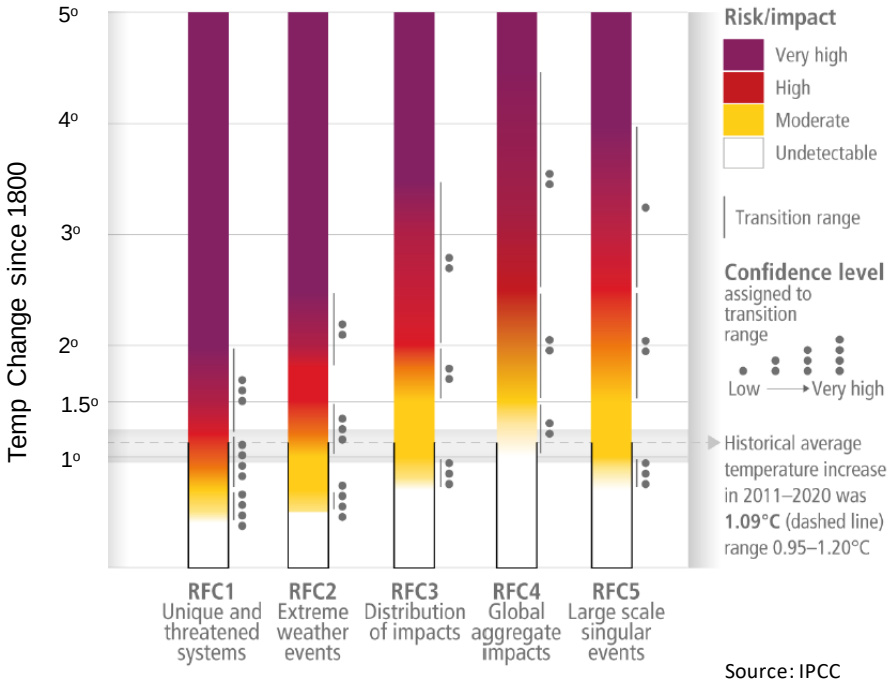




- Economic crises the main brake on carbon emissions (2008, 2014 2020)
- Otherwise the increase continues, led by China and India
- Decline in the USA driven by economics (coal to gas switch) not policy
- COVID rebound saw a 4.8% increase in emissions in 2021
- 2022 is looking equally bad thanks to reaction to Russia-Ukraine war

Key conclusions from the IPCC reports

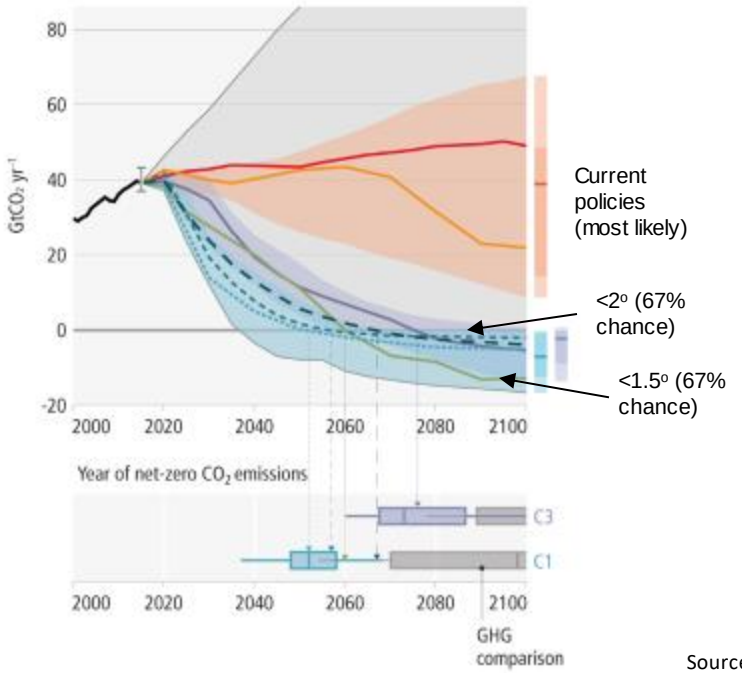
Working Group 2 – Impacts, Adaptation and Vulnerability



Source: IPCC

- Numerous risks to natural and human systems
- Most vulnerable already being affected and some changes are already irreversible
- Around 3.5 billion people living in vulnerable areas
- Big difference between the impact of 1.5° and 2.0°
- Adaptation is taking place but is very uneven

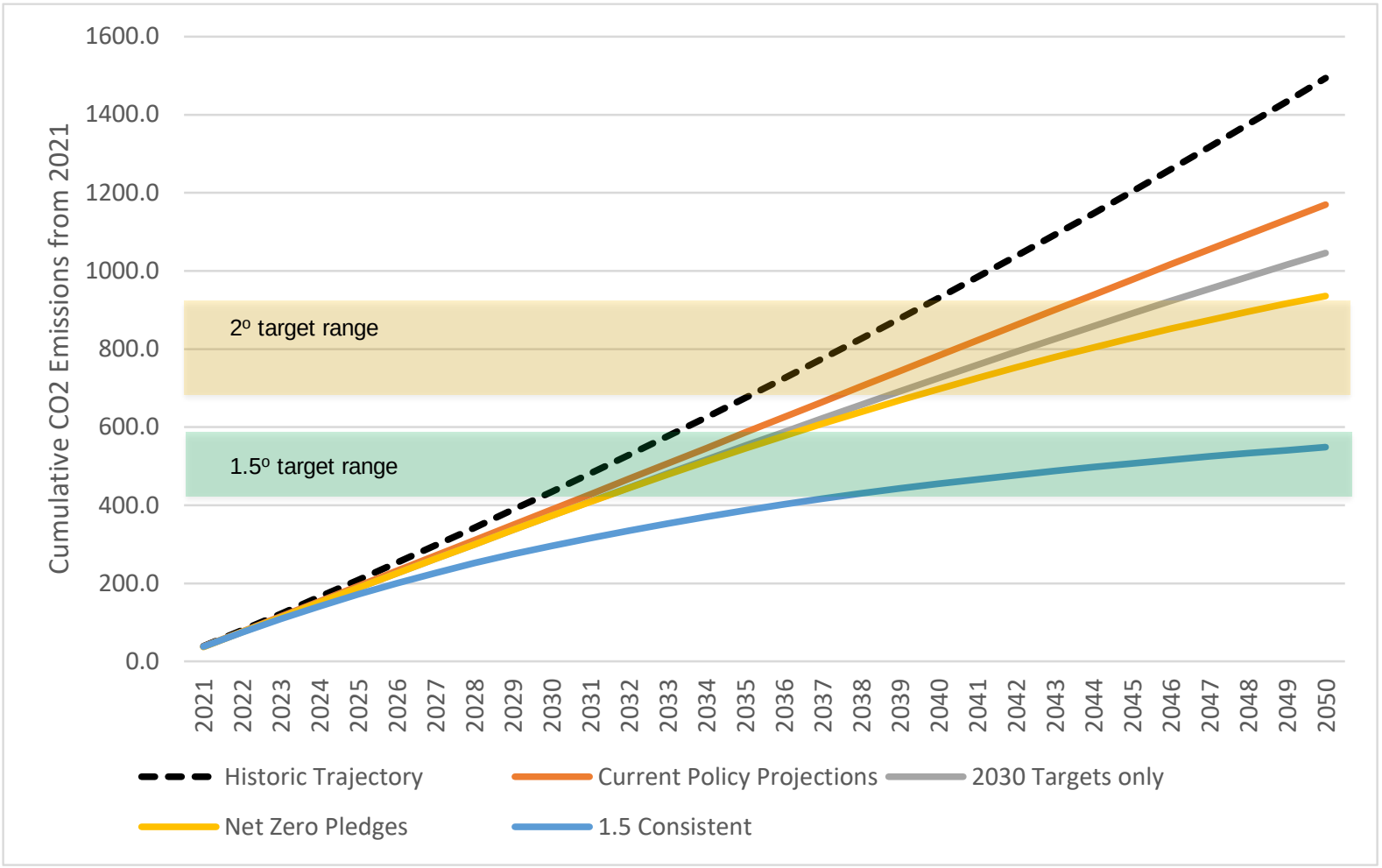
Working Group 3 – Mitigation of Climate Change



Source: IPCC

- Current policies and NDCs leave the world poised for an overshoot on emissions targets
- Numerous mitigation projects are underway and there is more potential but the pace of development is too slow
- Direct removal of carbon appears an inevitable necessity in the second half of the century

Overall conclusion – closer to using the carbon budget



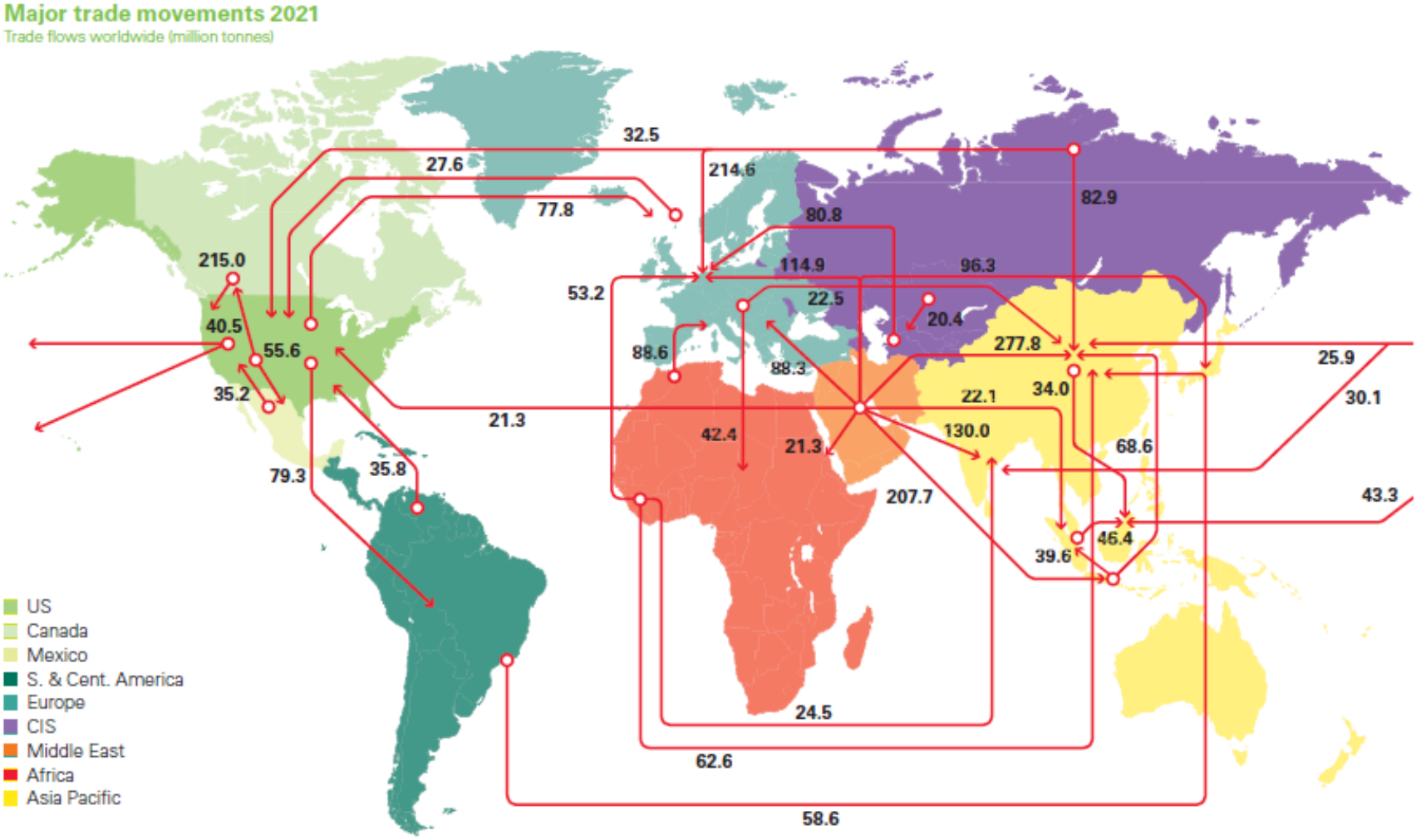
NB: Historic trajectory – 2021-2023 +4.8%, 2024 on +1.4%

Source: OIES, based on IPCC data

Key issues and challenges at COP27

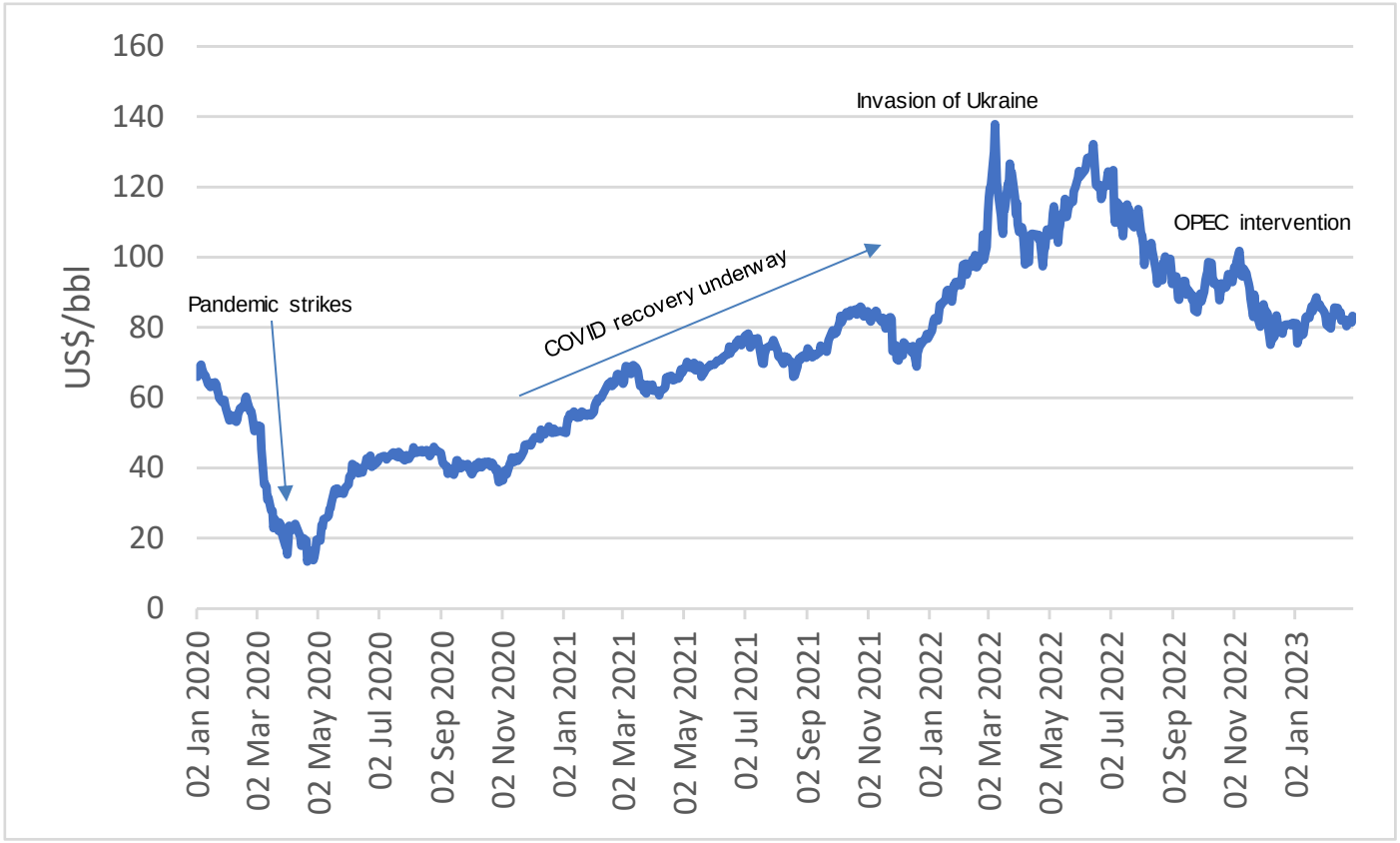
- Reaction to IPCC AR6 reports in Feb (Impacts and Vulnerability), March (Mitigation) and September (Synthesis)
  - Developing country reaction likely to be strong
- Ensuring an adequate review of the country NDCs
  - Will countries ratchet up again?
- US-China negotiations – will China engage in meaningful dialogue on environmental issues given geo-politics?
- What progress will be made with other multi-lateral pledges?
  - Important countries to sign methane and coal agreements
  - Further progress with zero emission vehicles needs government commitments on infrastructure
  - Deforestation – what impact of Brazilian elections?
- EU taxonomy – implications for nuclear and gas
- What will be the future role of hydrocarbons in the Developing World?
- Will $100 billion funding target be met and how will other financing negotiations proceed? Will there be a commitment to increase funding post 2025?
  - Mitigation and adaptation pledges plus loss & damage negotiations

Oil is a global commodity



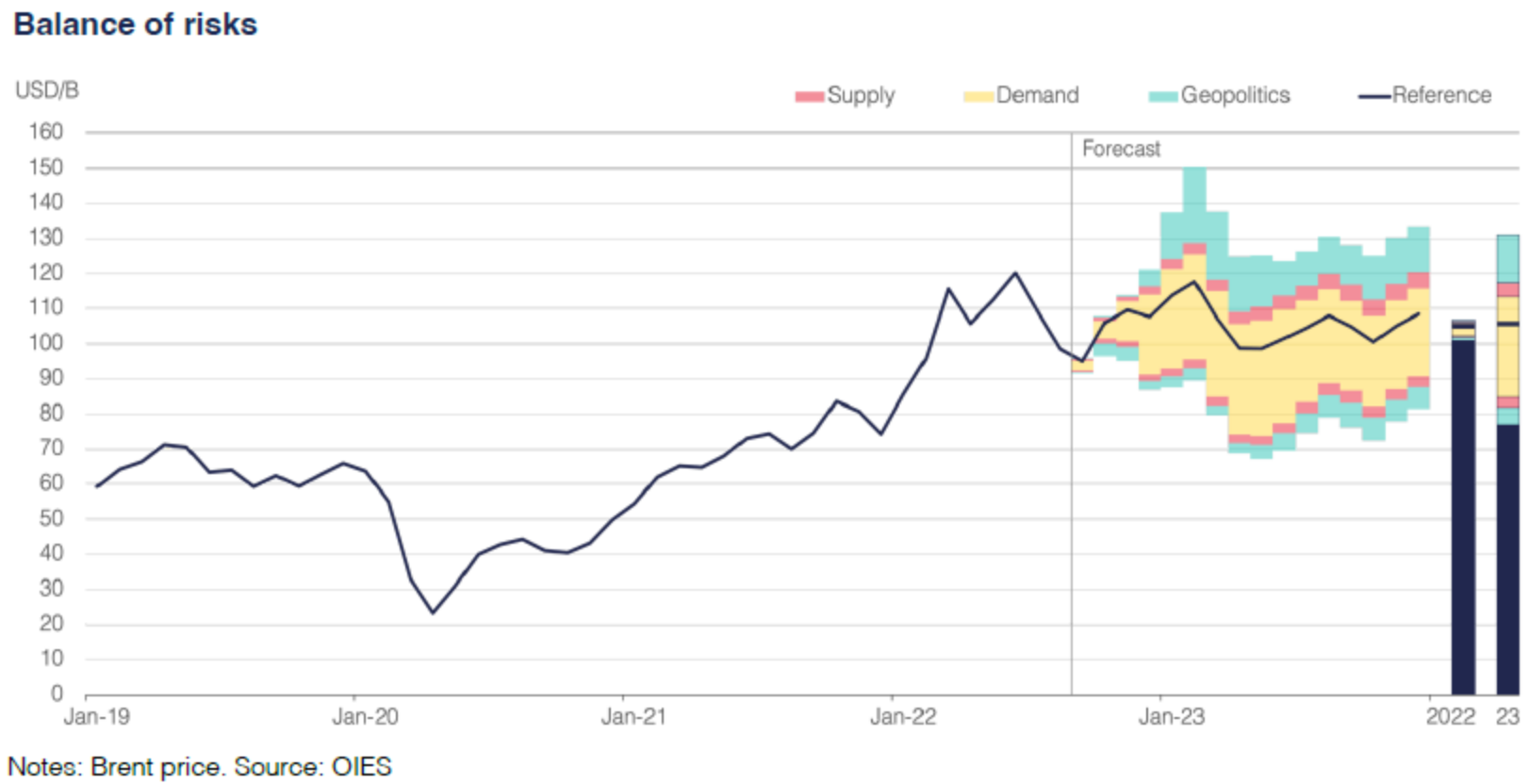
- Oil is traded in multiple directions across the globe
- Much of the trade originates from the Middle East and flows West and East
- Prices are set relative to a set of global benchmarks

The global oil price since Jan 2020



- Oil has been in a range from $15-$140 per barrel in the past 3 years
- Volatility driven by supply and demand but also by geopolitics
- Strength of US$ also having an impact in 2022/23

The global oil market – defining the key risks



- What are the key risk parameters?
- Supply – will Russian exports collapse? How will OPEC react?
- Demand – will there be a recession? What happens when China fully re-opens?
- Geopolitics – what does Russia do next? China-US relations?

We can't forget geopolitics – Russian energy relations have been critical in 2022/23

India

Europe

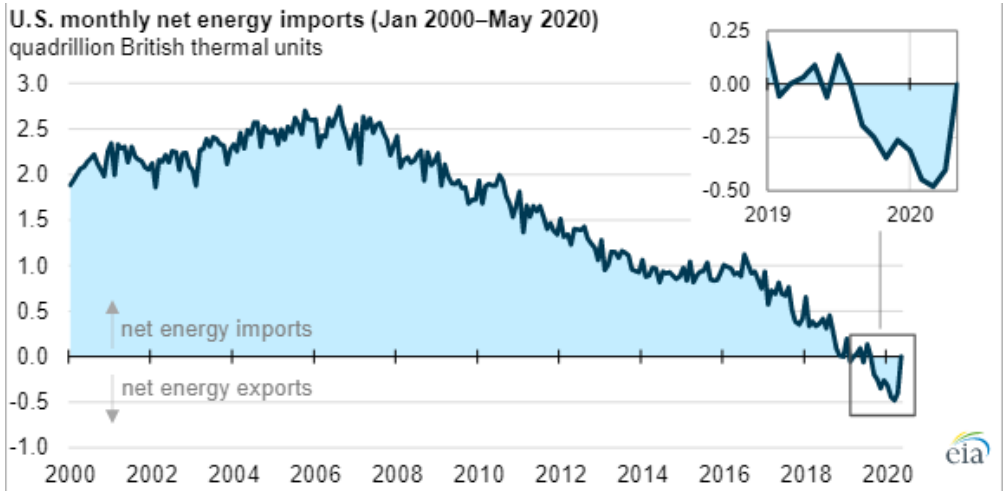
Saudi Arabia

China

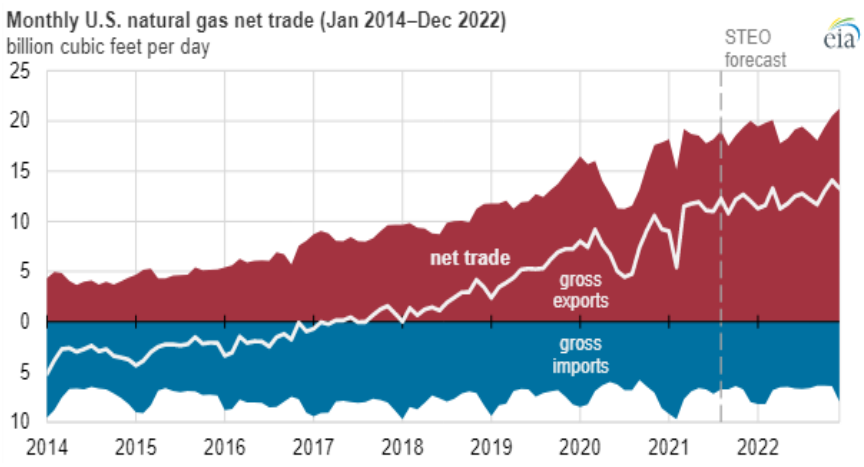
Turkey

The US has become energy independent thanks to shale oil and gas

US energy imports/exports



US natural gas trade balance



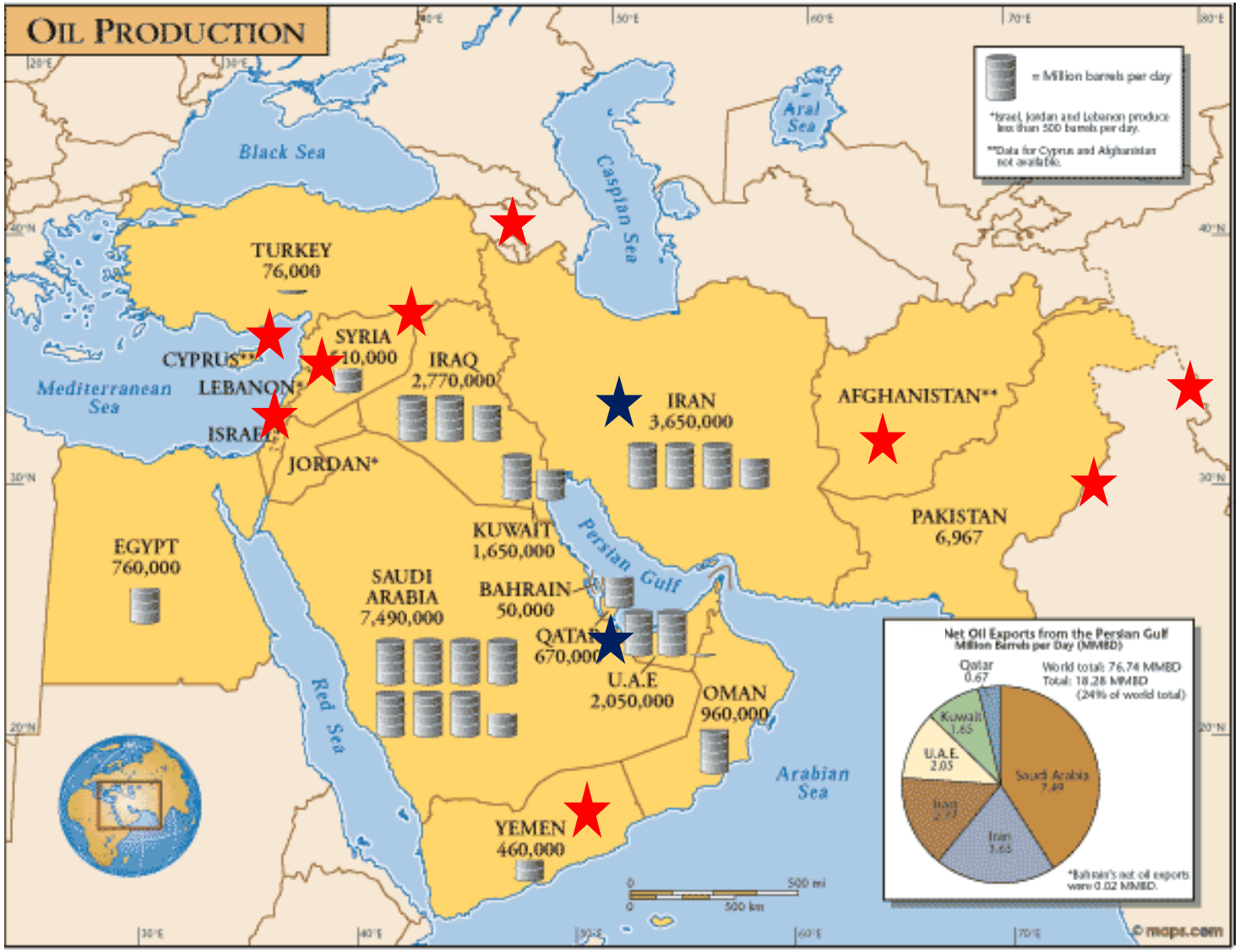
- The dramatic increase in shale oil and gas production has allowed the US to develop a net energy trade surplus
- Exports of gas via LNG have begun, and crude oil and products can also now be exported
- This has allowed the US government to shift its foreign policy and present itself as an energy ally to Europe and others

The Middle East remains synonymous with oil and conflict and appears to be conflicted between the US, Russia and China

Oil production in the Middle East

Sanctions

Conflict



China is becoming increasingly reliant on energy imports while relations with the US remain strained

China energy imports

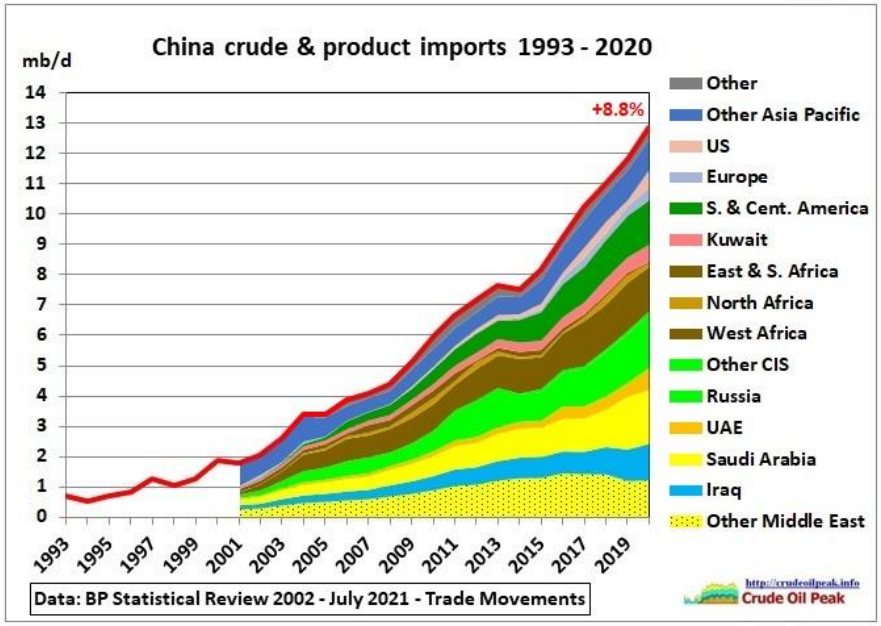
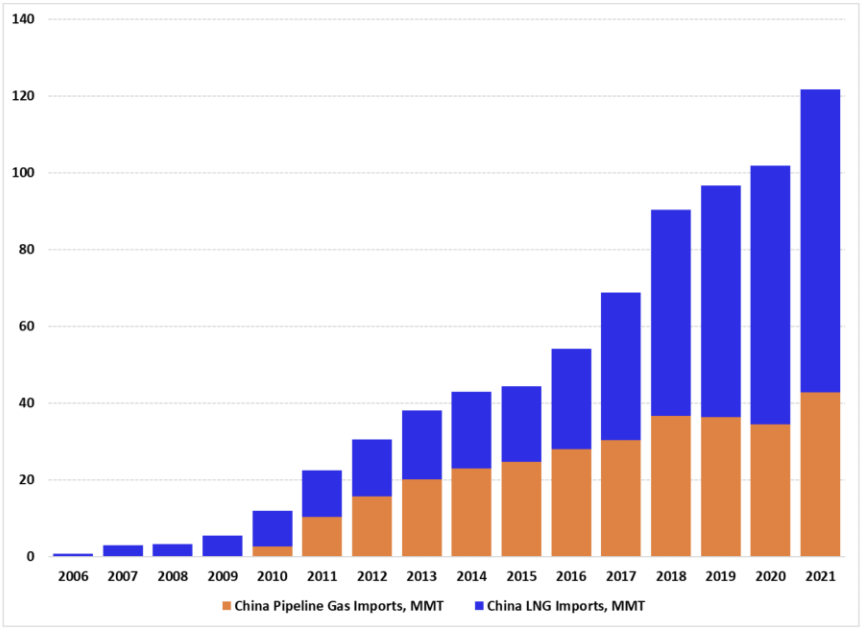


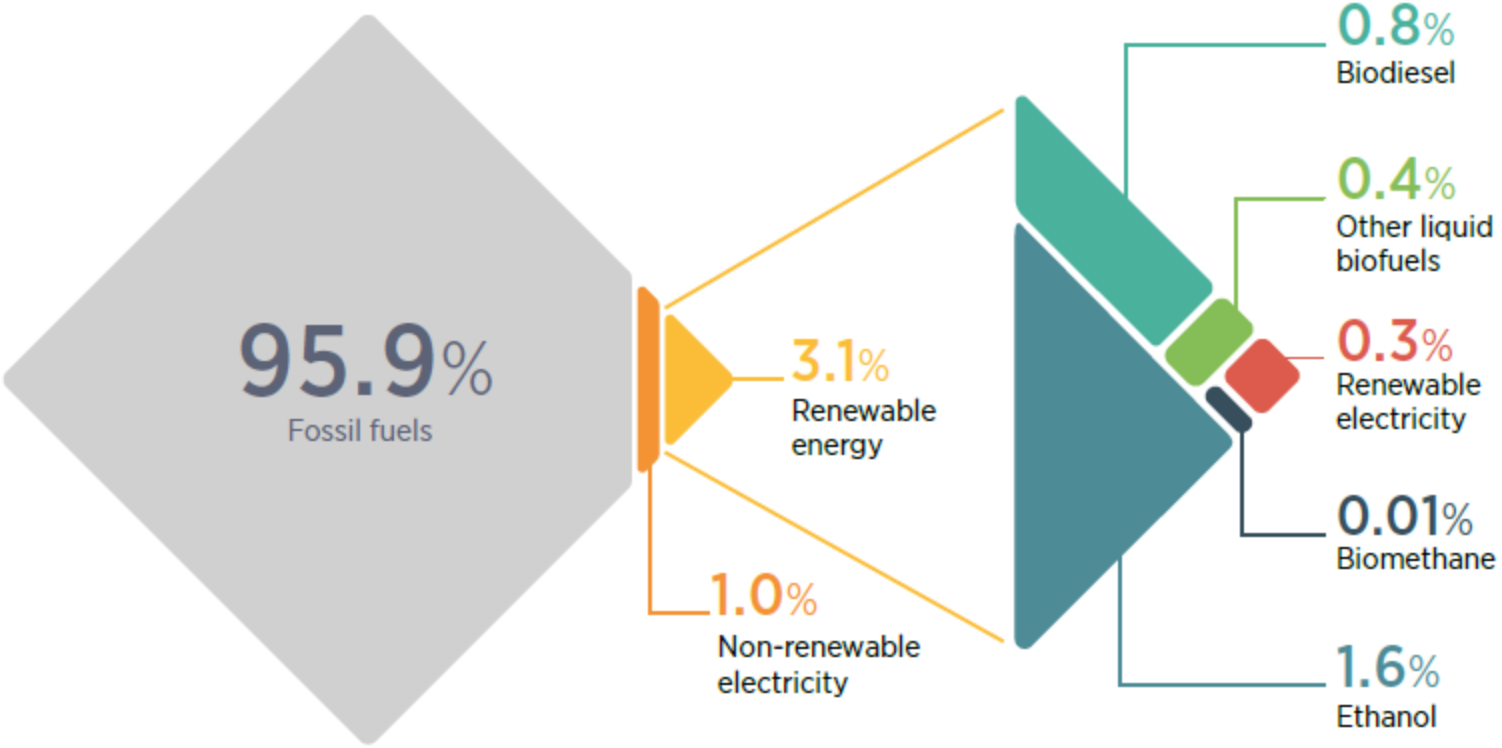
Exhibit 9: China Natural Gas Imports, 2006-2021 (Billion cubic meters)



Source: China General Customs Administration

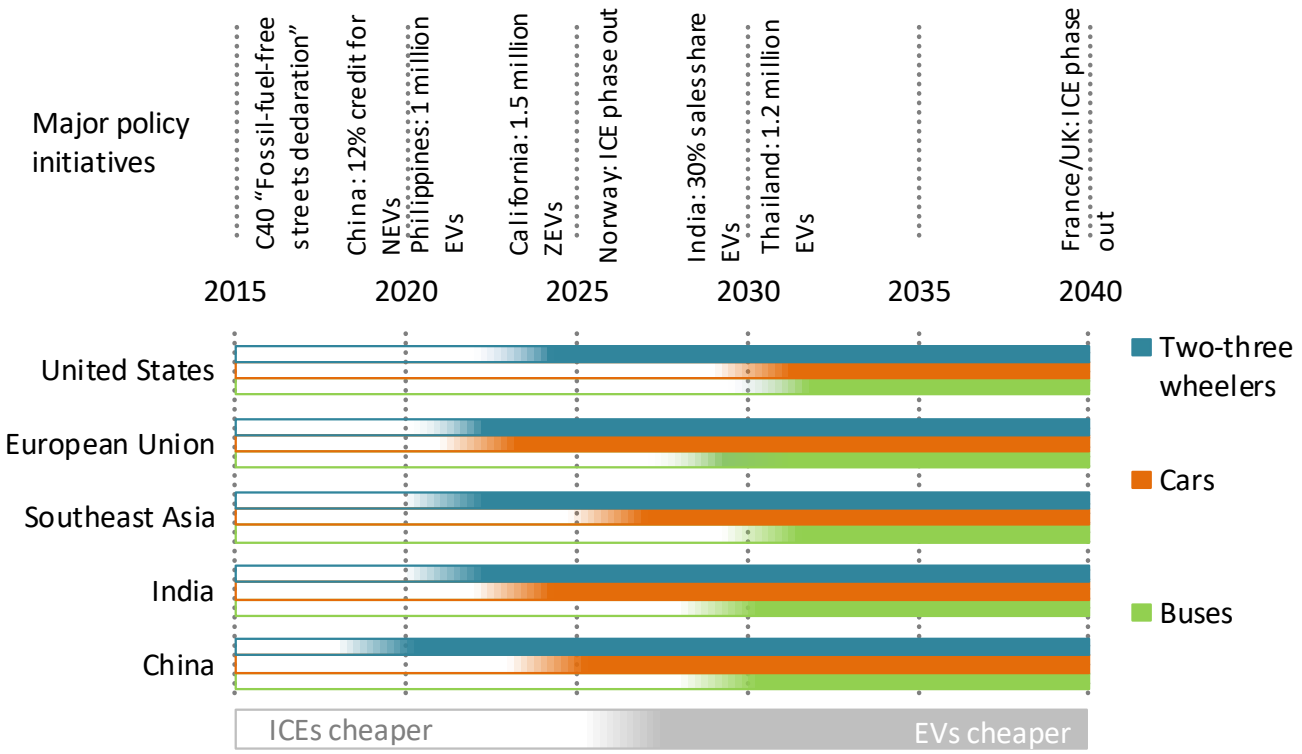
- As the US becomes energy independent so China is relying more on external sources
- This is a source of major concern in Beijing, especially as the US Pacific fleet is seen as a significant threat
- A significant amount of China's LNG comes from the US

Oil is predominantly a transport fuel so the future of this sector is critical to oil demand



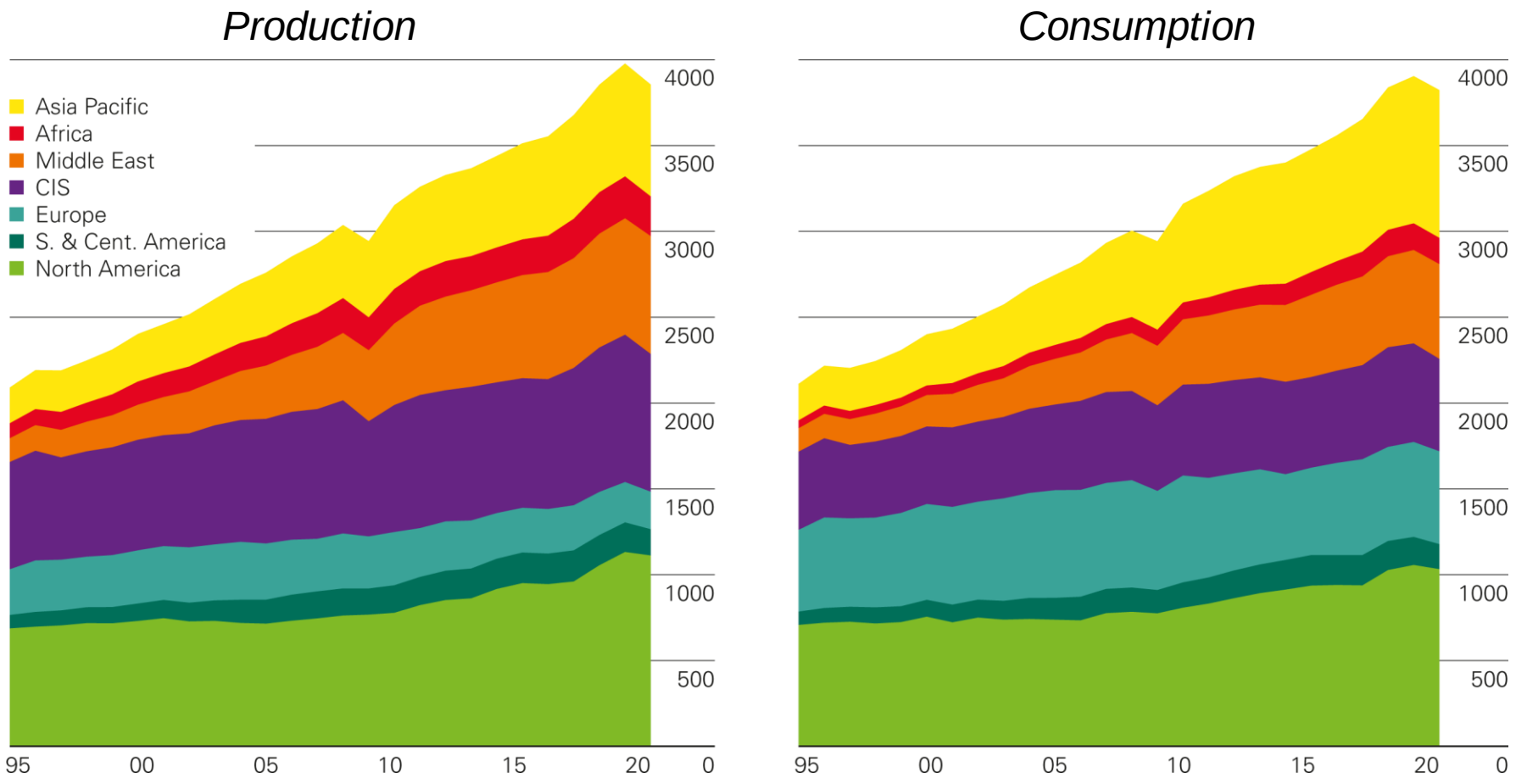
- Oil and liquid fuels dominate the transport sector because of their energy density
- However, the future of ICE cars in uncertain, especially in cities
- Many car manufacturers are now betting heavily on electric as the future
- What will be the pace of change and where?

Competitiveness of electric cars by region will undermine oil demand



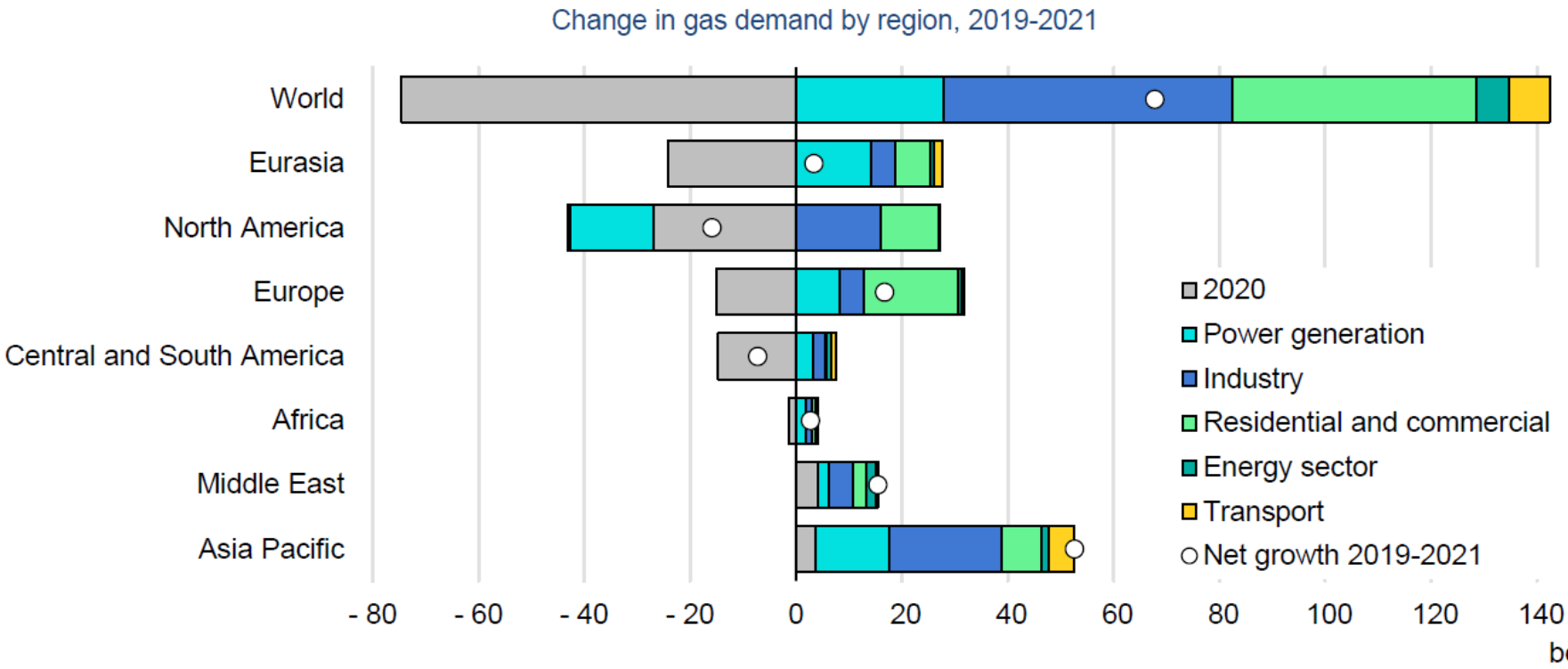
- Electric vehicle alternatives reach cost parity with ICEs at different times depending on region, based on total cost of ownership
- In Europe, India and China passenger vehicles could become competitive on cost by the mid-2020s
- Heavy vehicles are likely to take longer, and may be better served by a switch to bio-LNG or other renewable liquid fuels

Gas production and consumption by region (bcm)



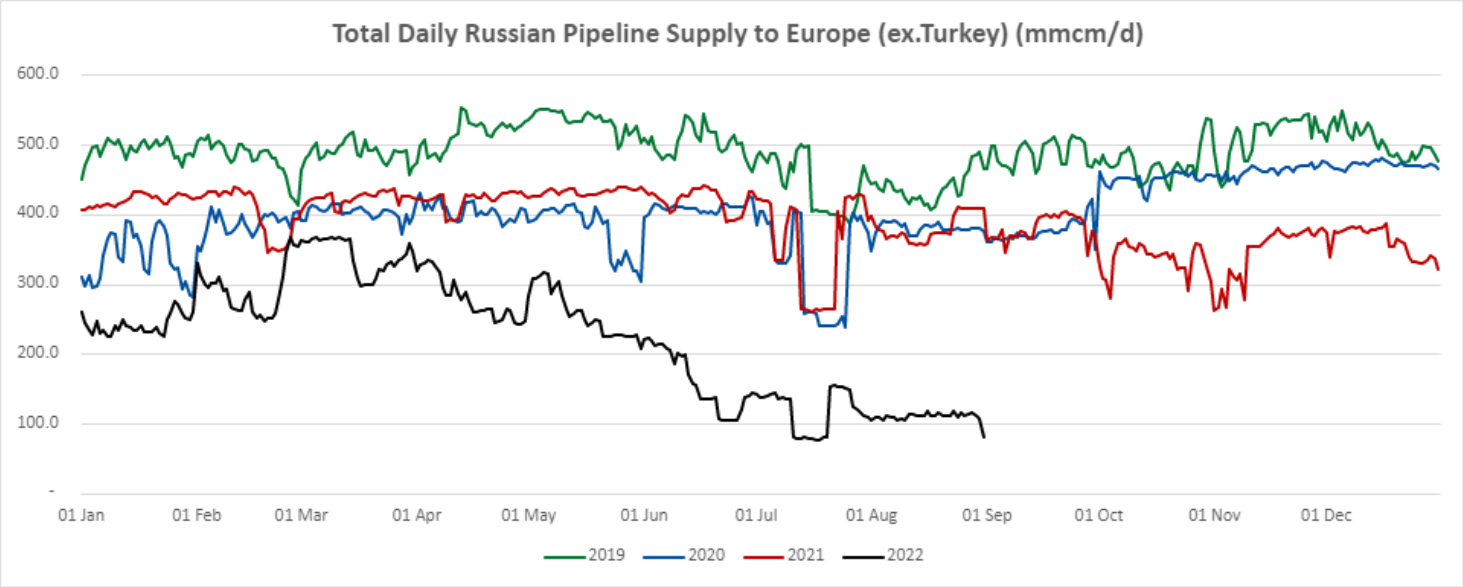
- Europe and North America have traditionally been the largest consumers of gas
- Major infrastructure in both regions facilitates indigenous production and imports
- Asia, the Middle East and Latin America are growing fast, however

2021 saw a strong rebound from 2020 collapse



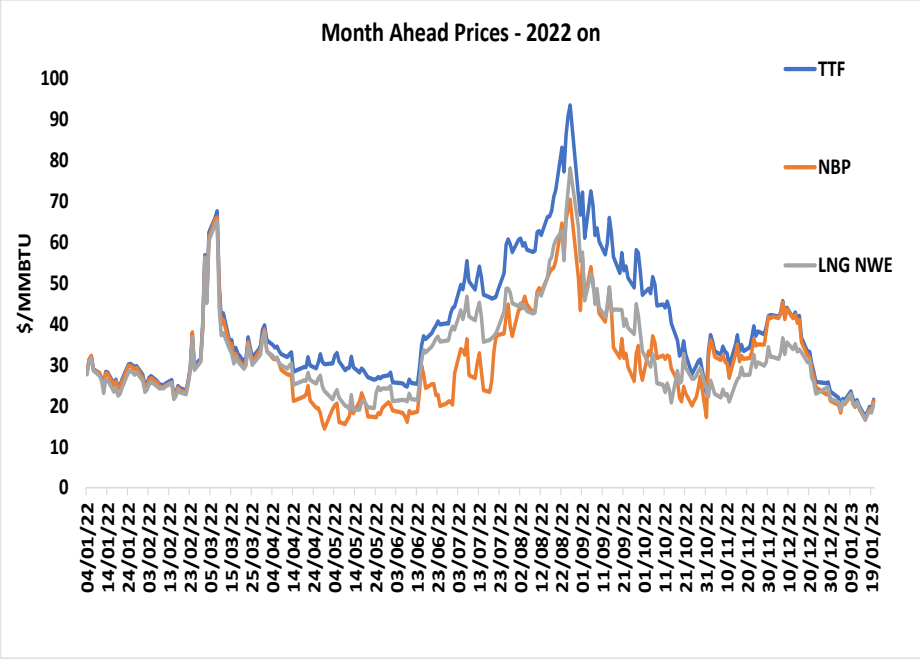
- Grey bar shows 2020 decline which amounted to c.-3% globally
- Coloured bars show recovery in 2021, led by industry and residential
- Cold weather at the start of 2021 provided a major boost to demand
- Growth being led by Asia, where there was also no decline in 2020

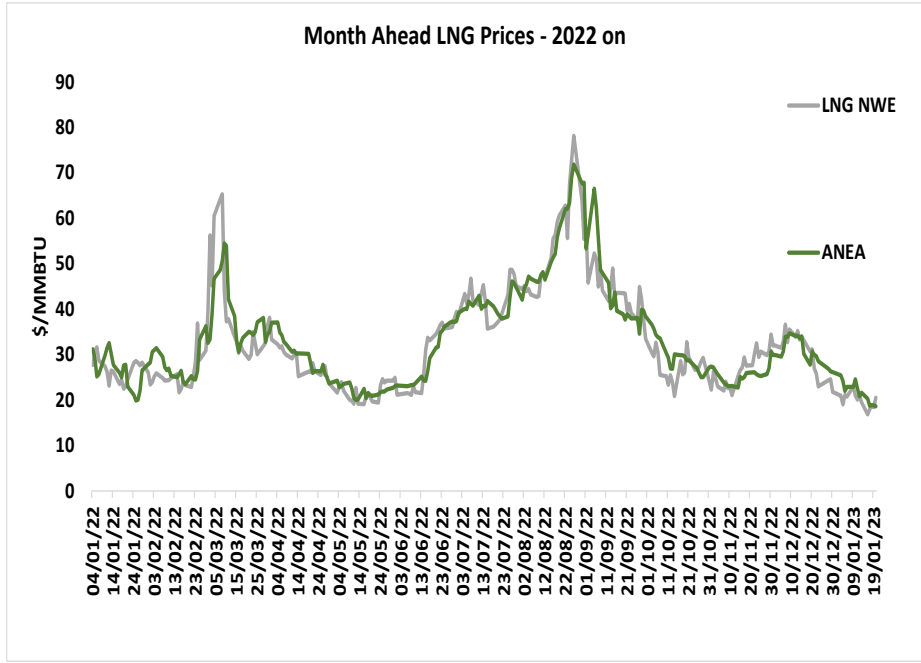
Russian gas export flows to Europe have declined sharply in 2022, putting global gas markets under pressure



- **Russian flows now at less than 15% of their peak in 2019 and around one quarter of the level seen in Q1 2022**
- **Nord Stream and Yamal Europe now at zero; one line via Ukraine and TurkStream remain at c. 76mmcm/d**
- **Russian supply to Europe in 2022 fell by 65bcm, and will decline again in 2023 to 28bcm**
- **Europe has lost around 25% of its total supply and has had to compete in the global LNG market for alternatives or reduce demand**

European Gas Prices have risen very sharply since the war started in Ukraine

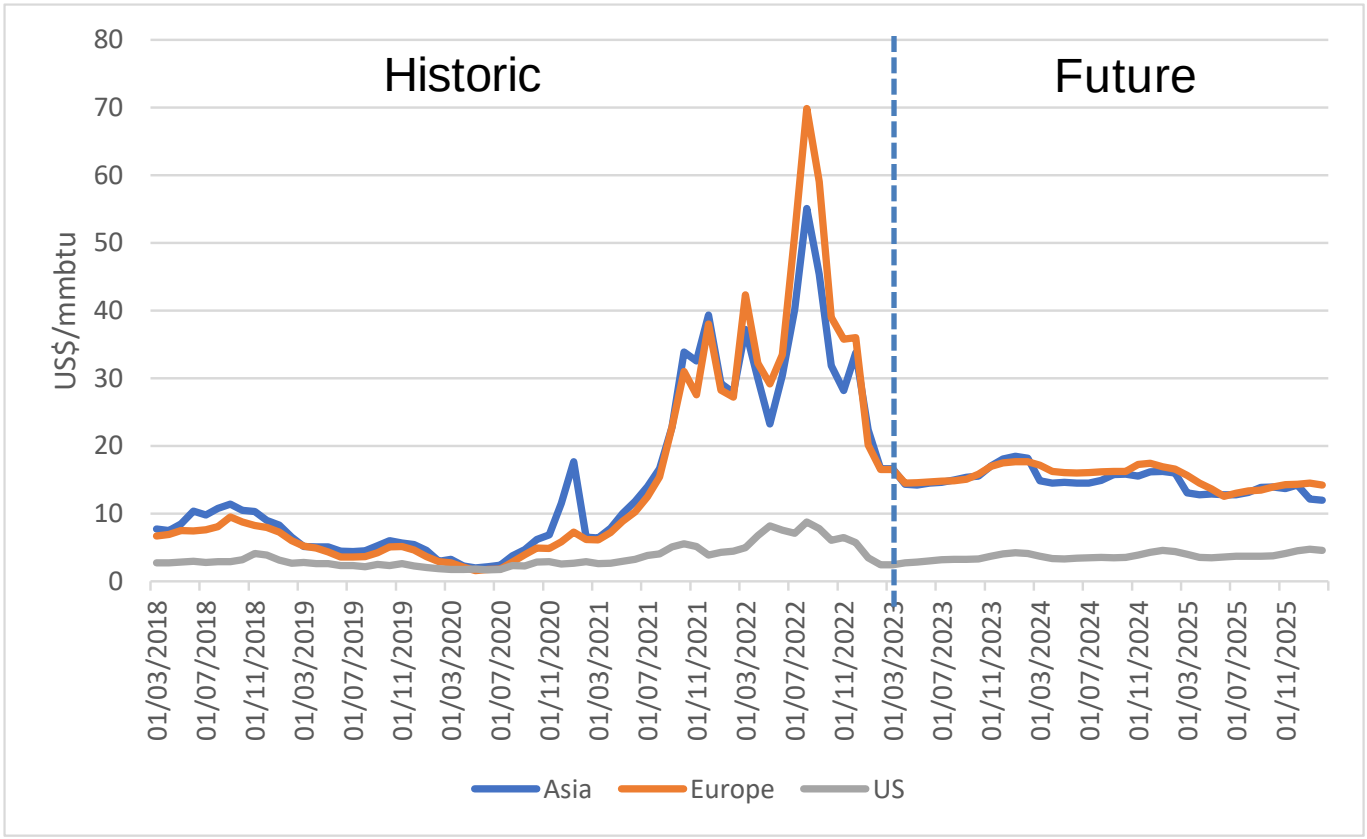




Source: Argus

- Run up in prices through 2021 as rising global demand met supply constraints, especially LNG
- 2022 has seen wild price volatility due to decrease in Russian supply to Europe and fears about the winter
- Prices have fallen recently due to full storage and warm weather
- A cold winter could still spark a crisis though, and the outlook for 2023/24 is difficult

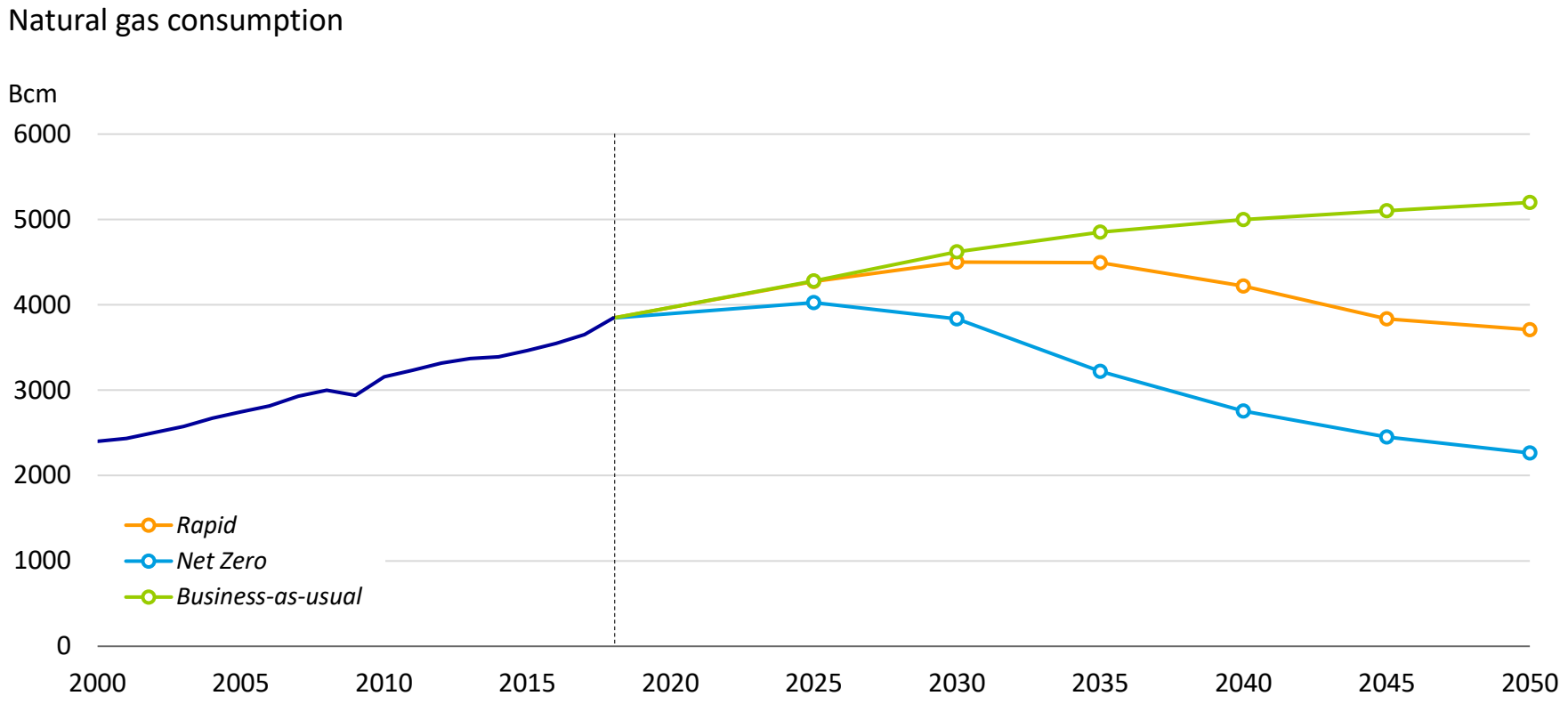
Forward price curves an interesting indicator of market perceptions



Source: Argus, CME, ICE

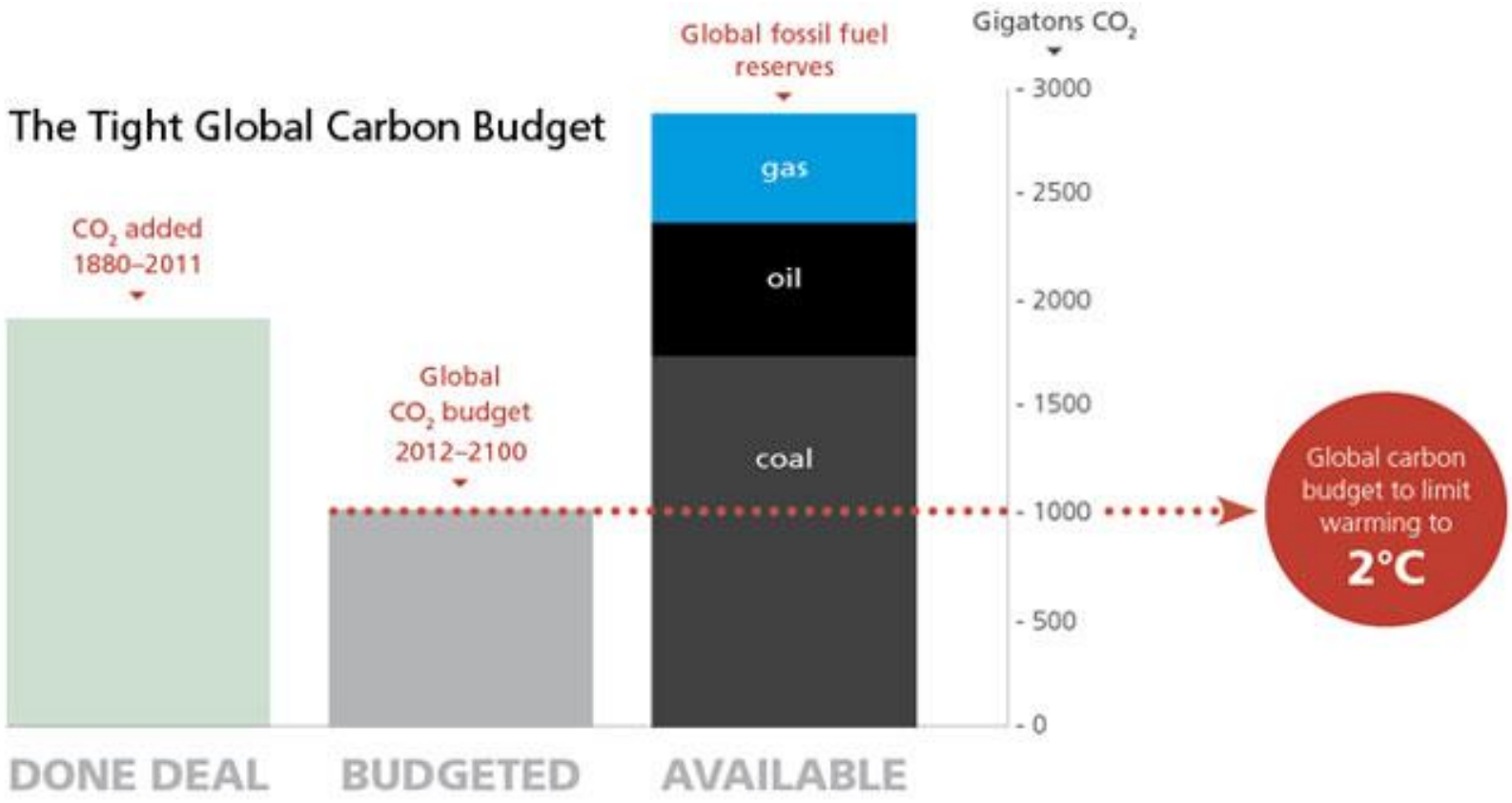
- Forward curve reflects the market expectation that Russian flows will not return soon
- Prices below historic highs due to warm weather and adequate LNG
- They remain double historic average though, and could spike on any supply disruption or demand spike

Long-term outlook for gas consumption is relatively positive, but high prices could change perceptions of gas in growth markets



- The outlook for gas is relatively positive compared to other hydrocarbons
- In Europe and the US there may be decline as decarbonisation strategies take priority, but growth is expected in Asia, the Middle East and Africa
- Net zero strategies present a threat, unless gas can offer a decarbonised alternative such as hydrogen

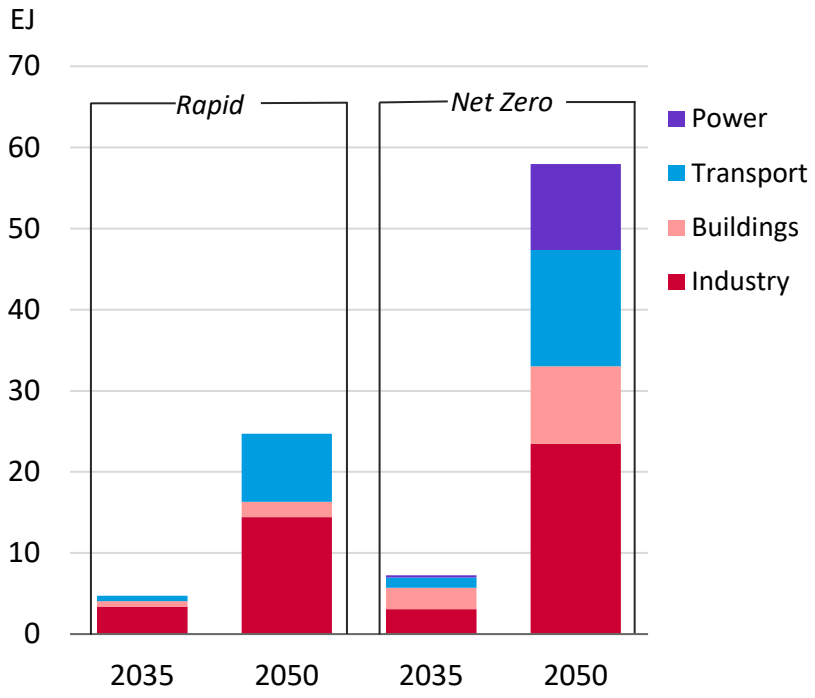
Looking at the global carbon budget, the race is on to produce fossil fuels while you can



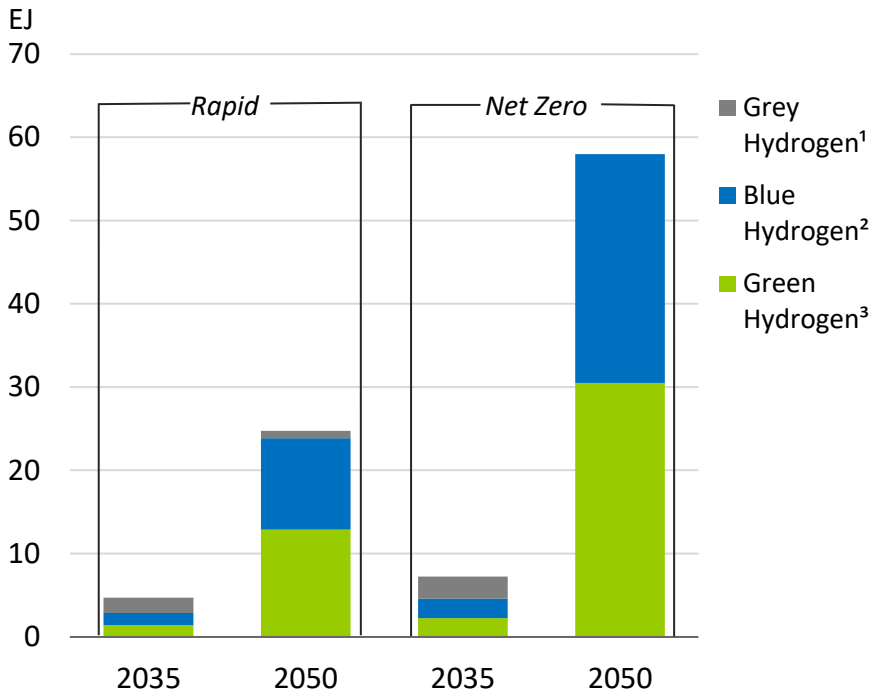
- This has vast political and commercial consequences, as countries and companies have to react to a fast changing energy economy
- The futures of Russia and the Middle East are closely bound up to the issue of whether this carbon budget will or can be enforced

Consumption and production of hydrogen

Hydrogen use by sector



Hydrogen production by type

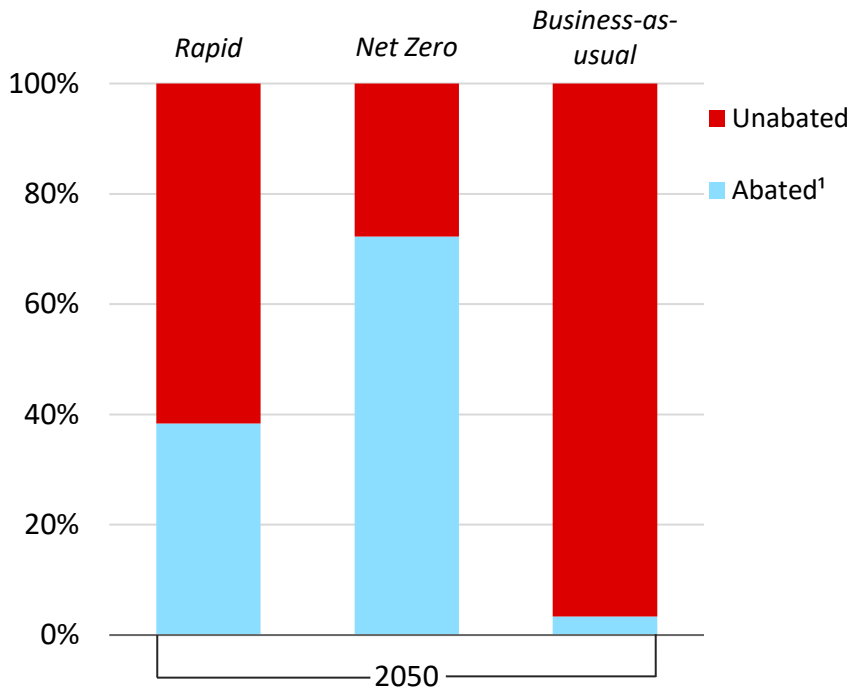


1) produced from natural gas (or coal), without CCUS.
2) produced from natural gas (or coal) with CCUS
3) made by electrolysis, using renewable power

- Hydrogen has become the new “buzz word” in Europe for promoting the energy transition away from natural gas
- Key question over the use of “blue” (low carbon) hydrogen or “green” renewable hydrogen
- We probably need both, although activists would prefer to avoid blue

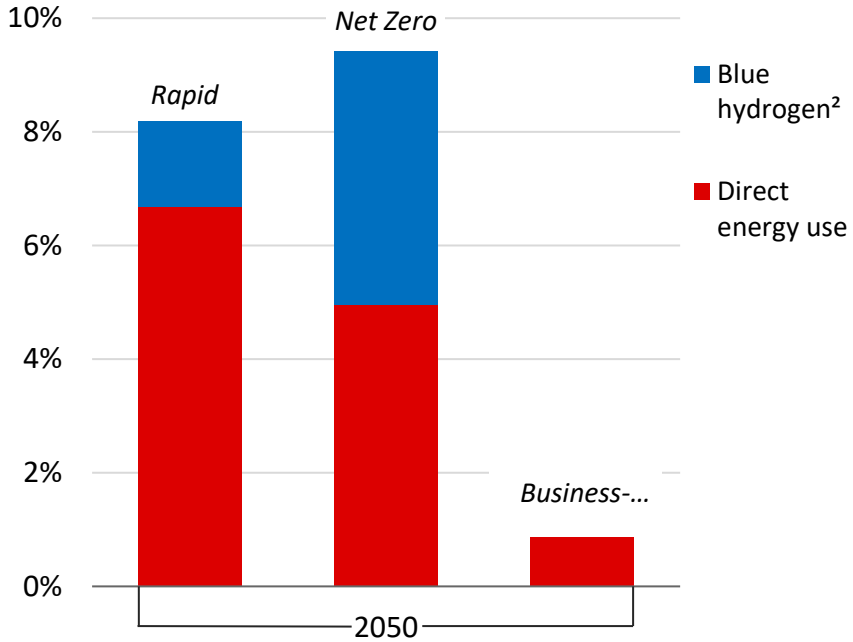
The changing role of gas in a decarbonised world

Share of natural gas abated[1] and unabated



1) Direct use of natural gas with CCUS plus natural gas as input to blue hydrogen

Natural gas with CCUS as a share of primary energy

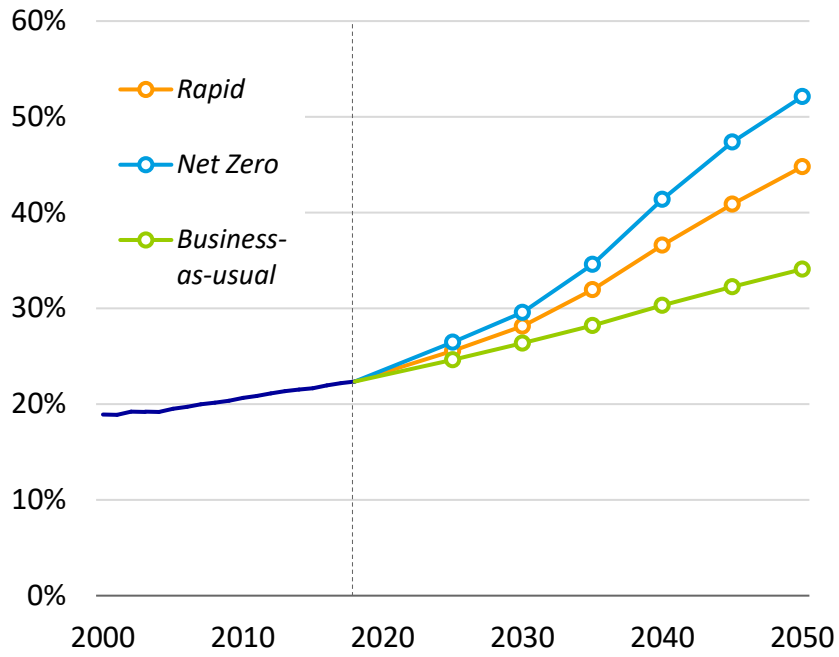


2) Blue hydrogen is extracted from natural gas (or coal), with the carbon dioxide by-product being captured via CCUS.

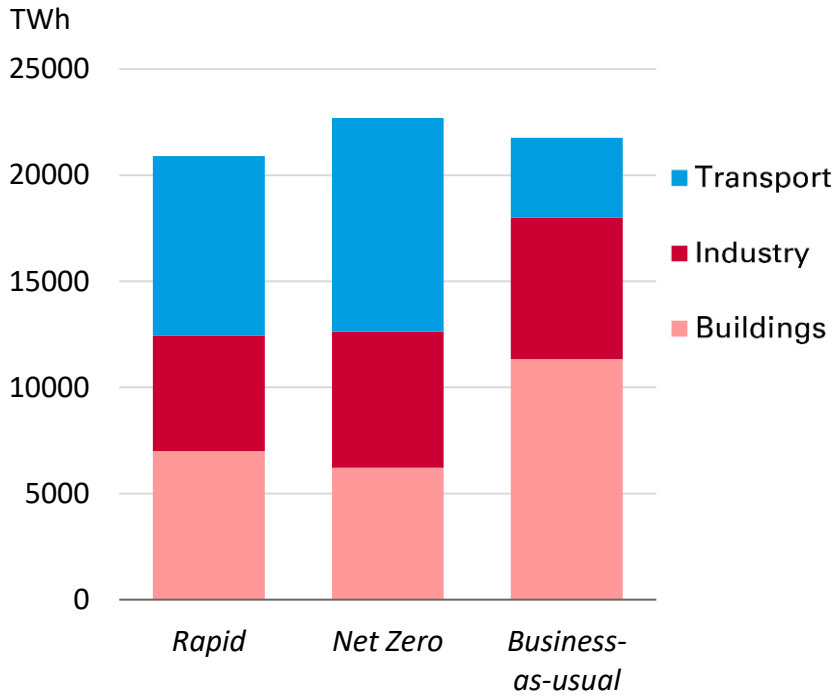
- In any case, the role of gas will have to change dramatically
- If we are going to meet target, use of “unabated” gas will have to fall significantly
- The use of carbon capture and storage will need to increase, although at the moment the cost is too high to make it economic

Electricity consumption is set to rise

Share of electricity in total final consumption

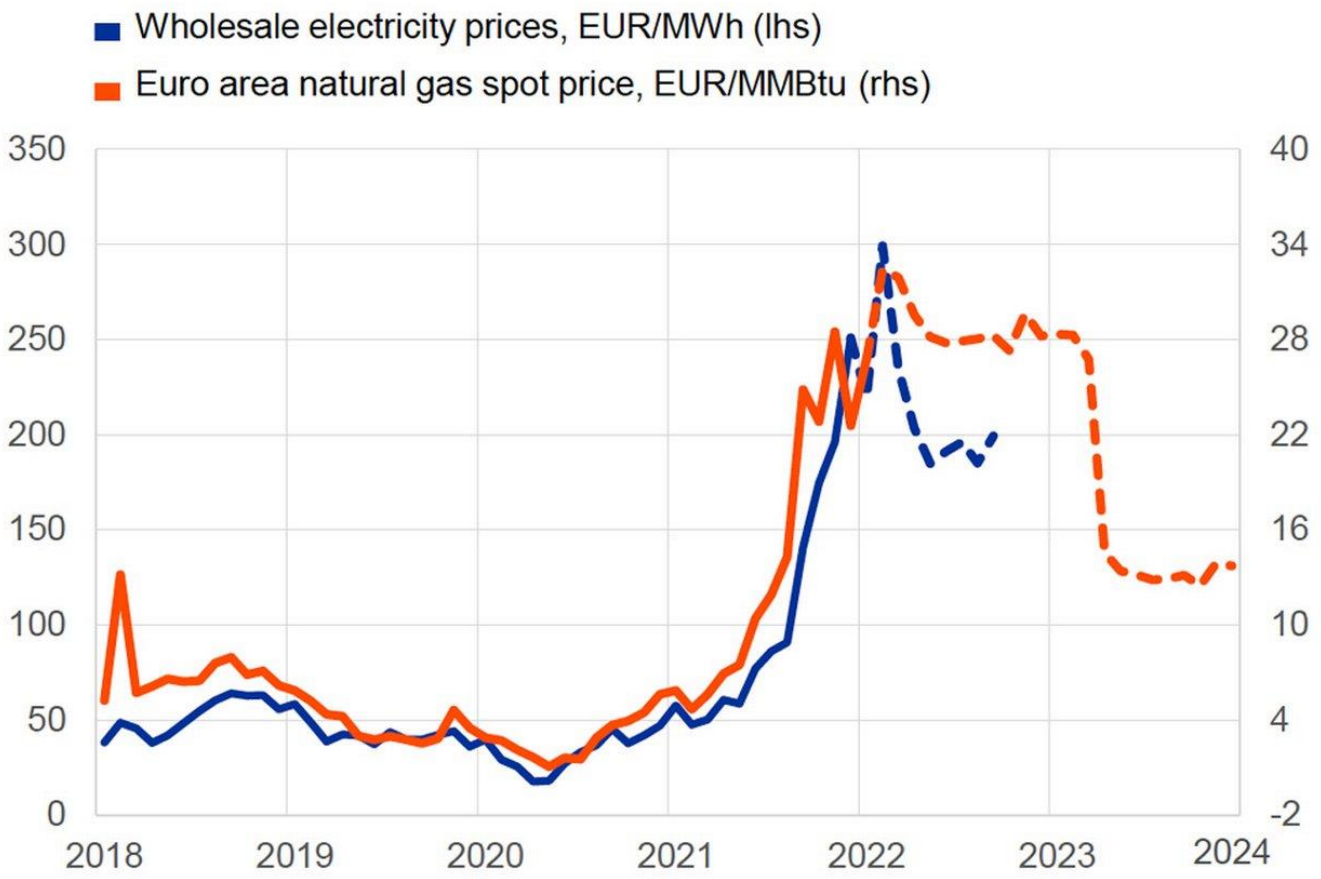


Change in electricity demand by sector, 2018-2050



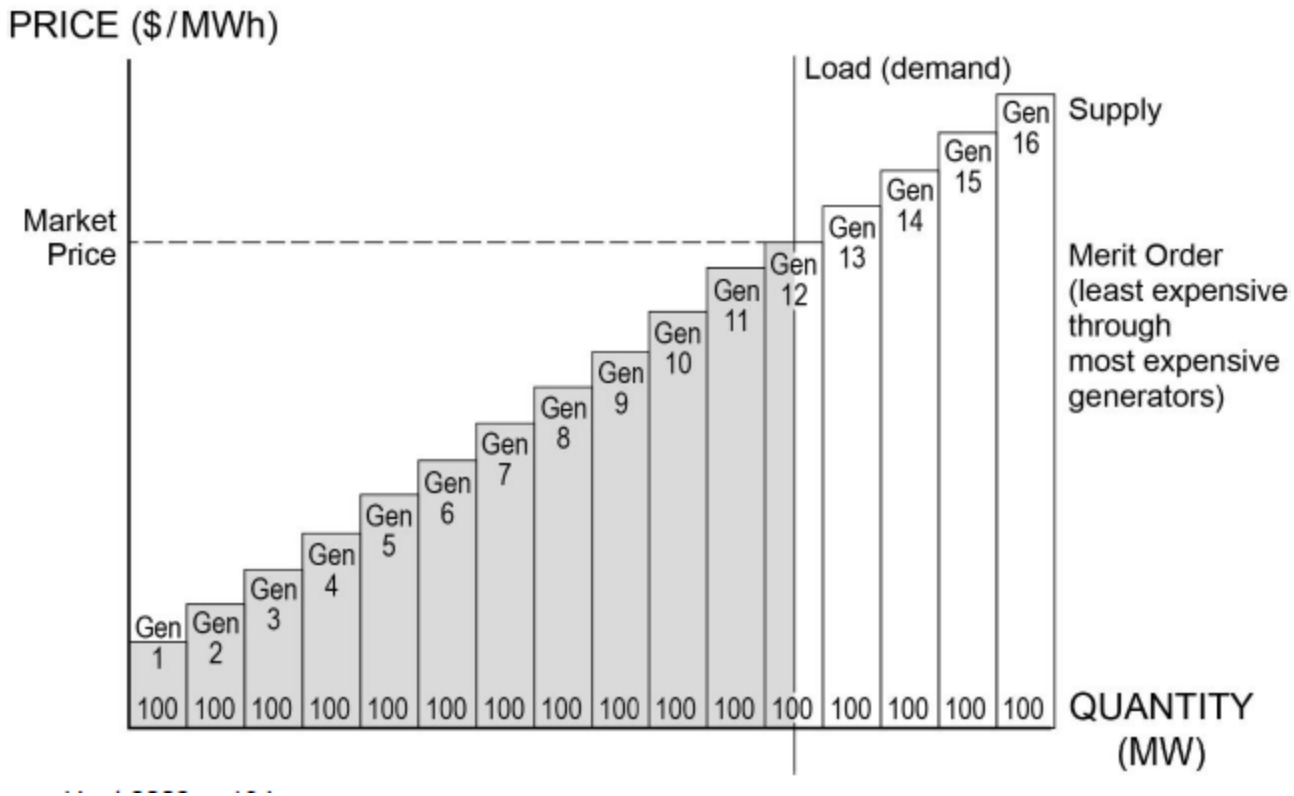
- Electricity demand is likely to rise as part of a decarbonisation strategy
- As a result, the focus of the energy economy will be on how power stations are fuelled, with the assumption that renewables will grow
- Key question for fossil fuels – how fast will the decline be?

In the short-term electricity prices have jumped due to the role of gas in the power sector



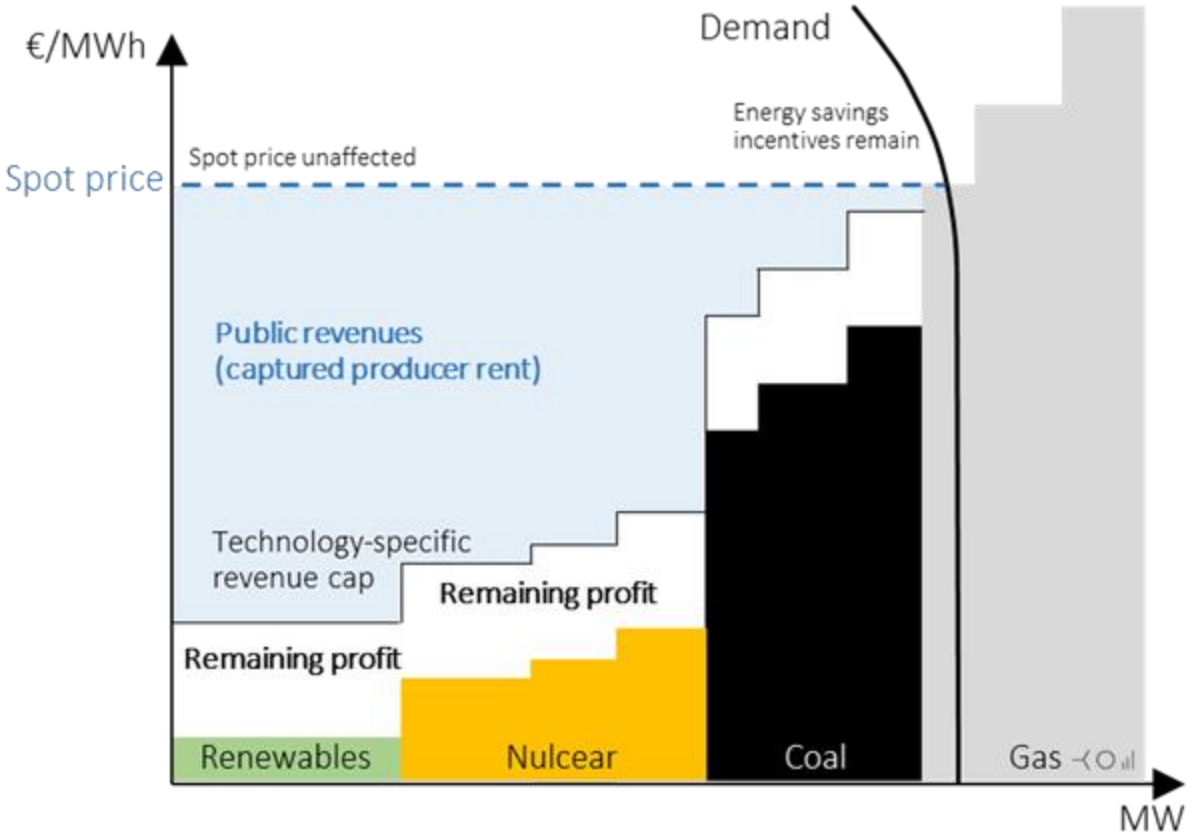
- Producers with a low marginal cost (mainly renewables) are making huge profits because the power price is driven by the high cost of marginal gas-fired production

Stylised merit order for power generation



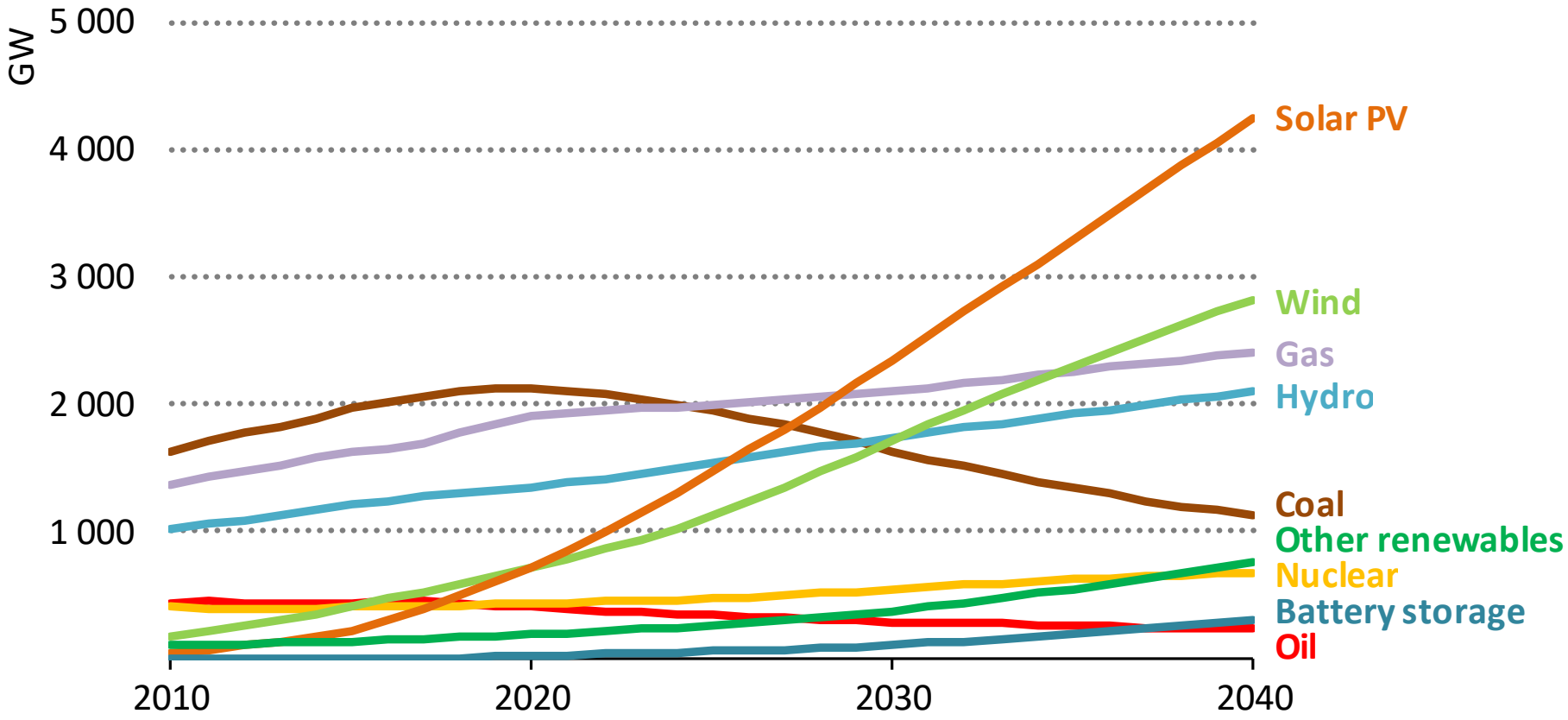
- Historically generating companies have competed on the basis of a merit order of generating costs
- The market price is set at the marginal price, which is paid to all power producers who are called upon to dispatch electricity

The EU wants to limit the profits earned by low cost producers



- Put a maximum price on electricity generated from low marginal cost sources
- Essentially, a fixed margin for all producers other than gas-fired power

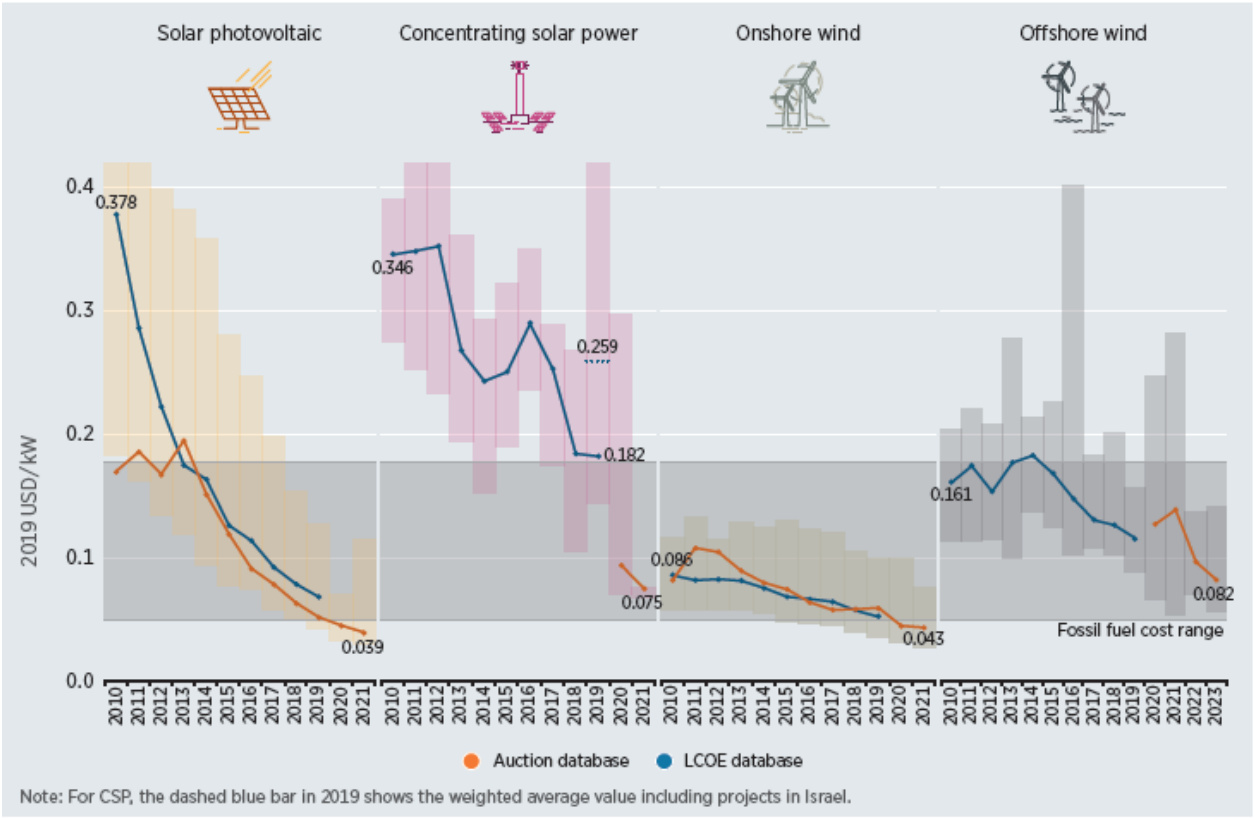
In a Net Zero world renewables will have a huge role to play – what will happen to other fuels for the power sector?



- Solar PV takes the lead in installed capacity before 2030; unabated coal capacity declines from 2020

The cost of renewables continues to fall

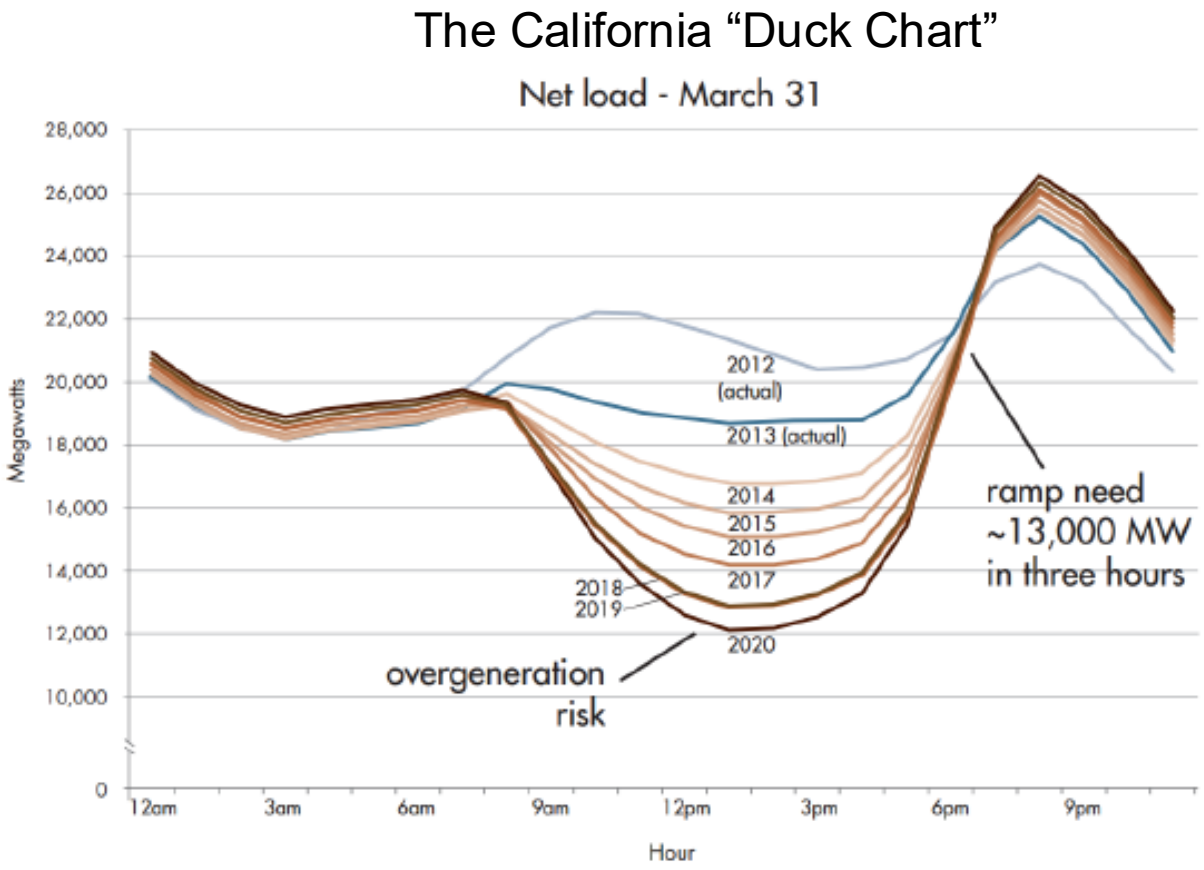
Figure ES.2 Global weighted average LCOE and Auction/PPA prices for CSP, onshore and offshore wind, and solar PV, 2010 to 2023



Note: The thick lines are the global weighted average LCOE, or auction values, by year. The grey bands that vary by year are cost/price range for the 5th and 95th percentiles of projects.. For the LCOE data, the real WACC is 7.5% for OECD countries and China, and 10% for the rest of the world. The band that crosses the entire chart represents the fossil fuel-fired power generation cost range.

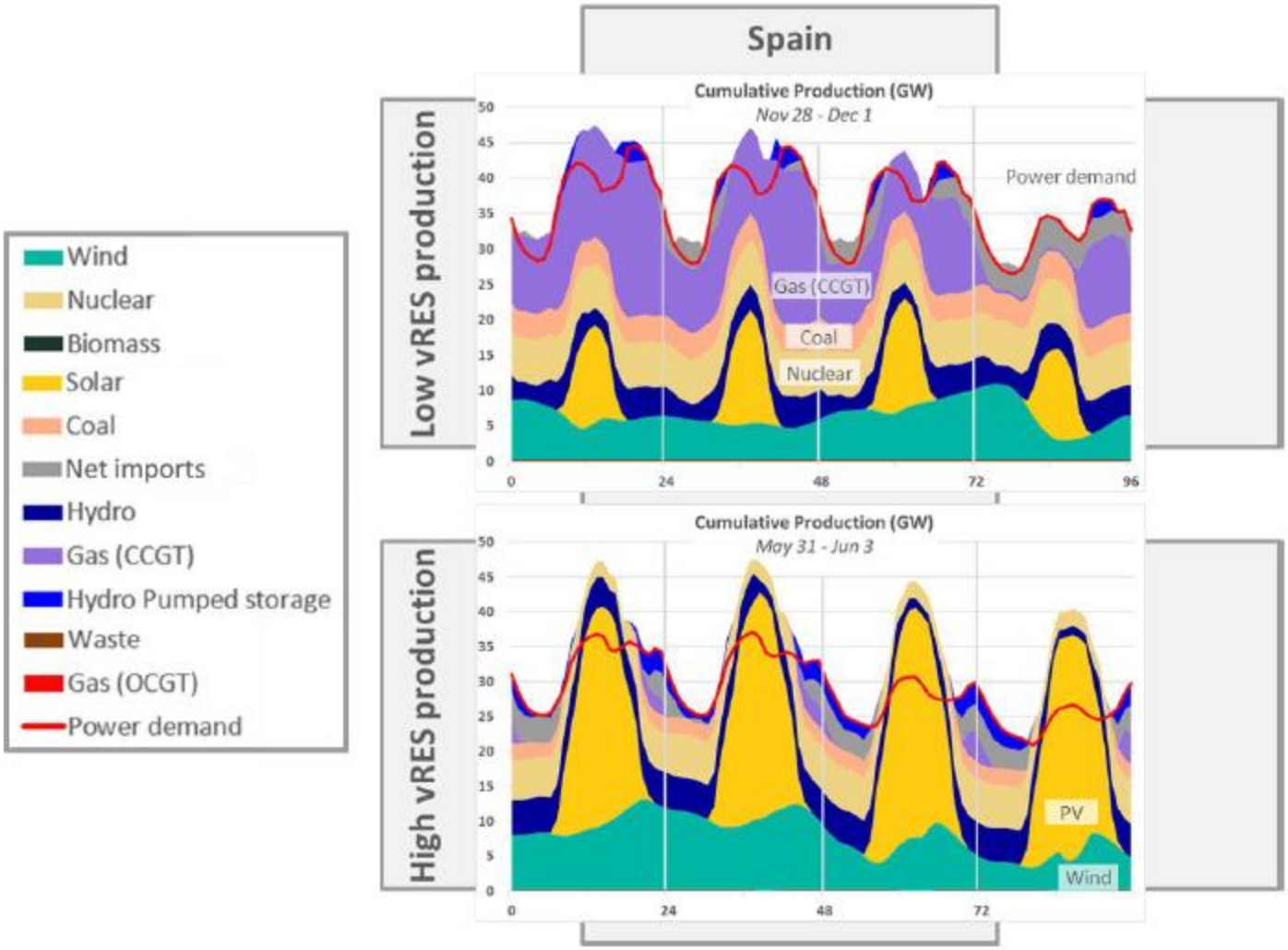
- The cost of renewable electricity bid into auctions is now well within the range of fossil-fuel electricity
- The cost does not include the cost of intermittency and back-up though

Renewables create over-generation risk



- Net load (total electricity demand less generation from wind and solar PV) varies dramatically according to weather, time of day and capacity available
- As renewable generation increases, so low point gets lower, increasing the risk of having too much base load capacity
- In a worst case scenario curtailment is required, undermining project economics

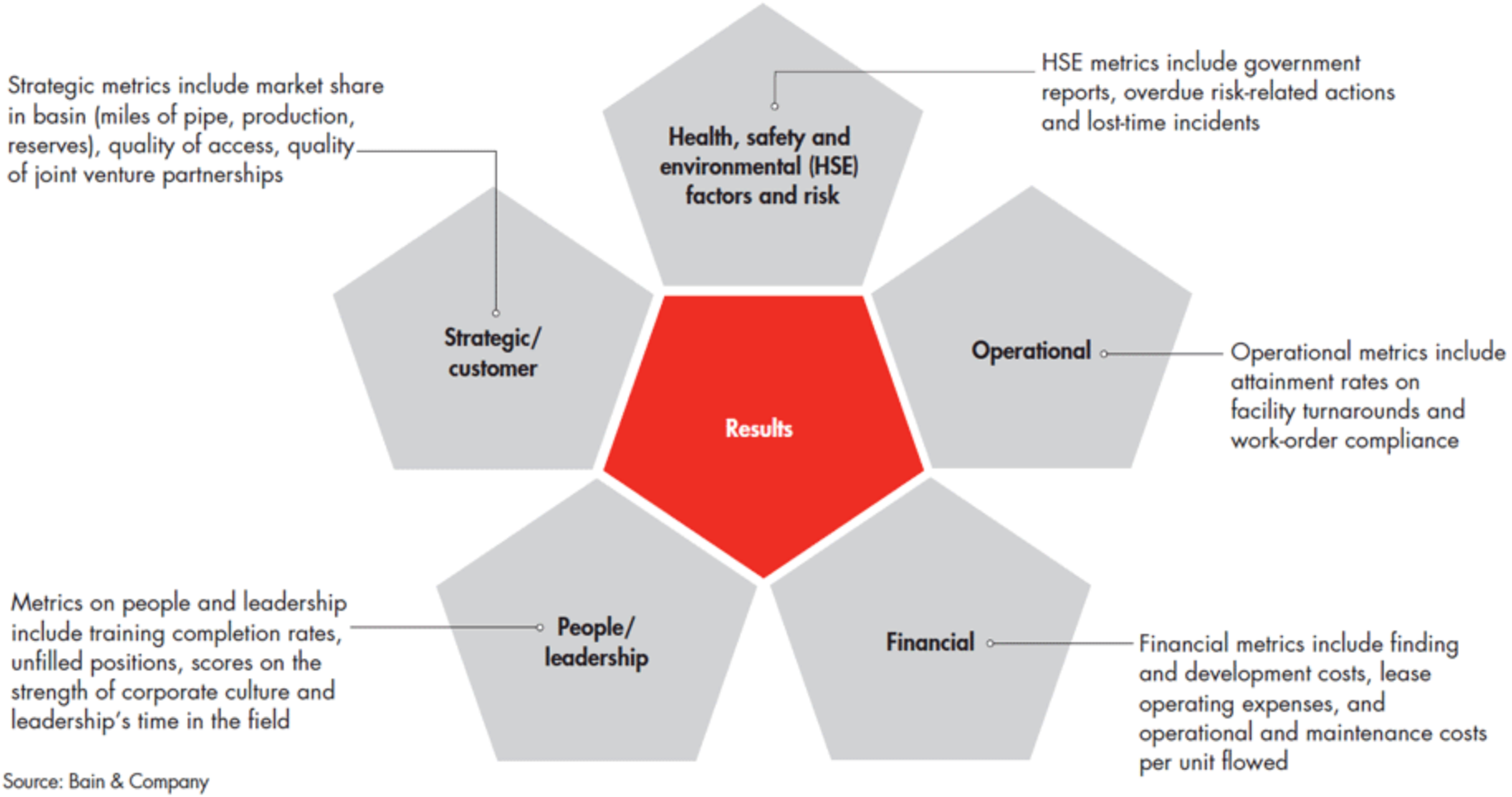
The impact of renewables on fuel inputs for power generation



- Dramatic difference in fossil fuel use between seasons
- What incentives are needed to keep a fossil fuel plant open?

Managements have a broad range of responsibities

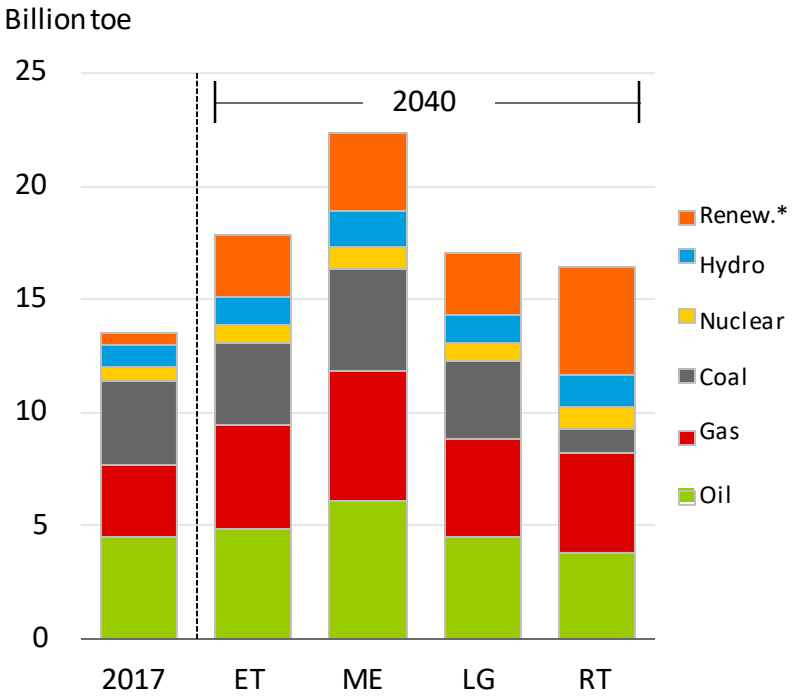
Figure 1: KPIs should provide a balanced view of the business to give a complete picture of a company's health and performance



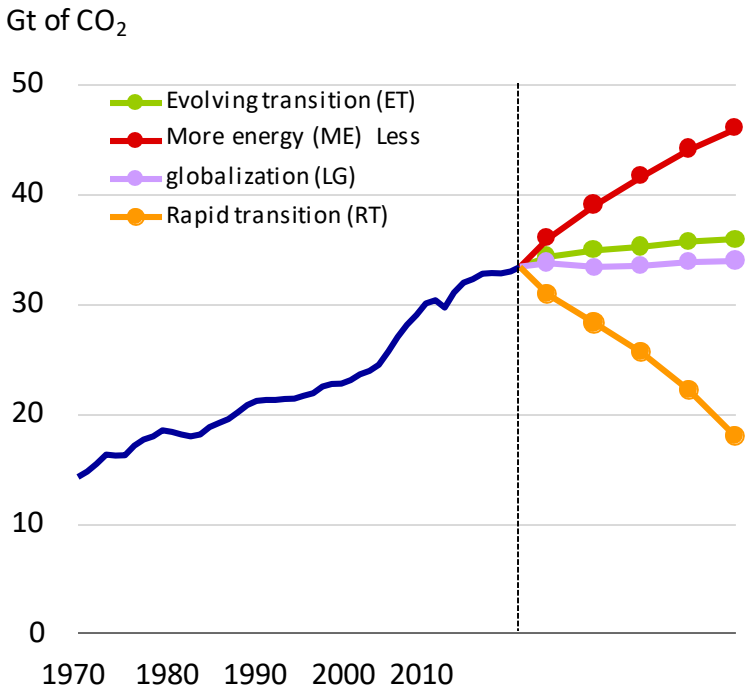
Source: Bain & Company

Which scenario are we heading for?

Primary energy consumption by fuel

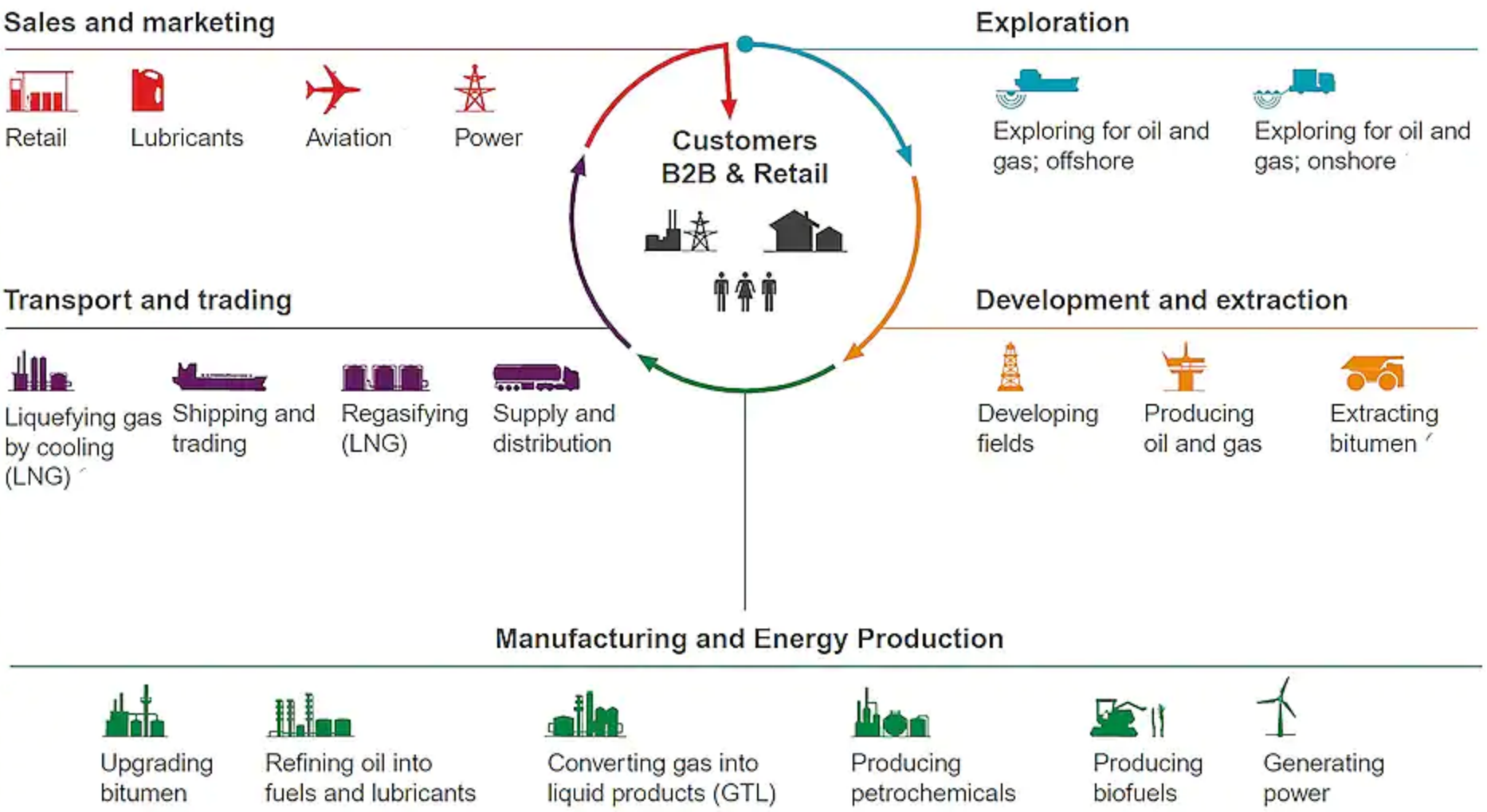


CO_2 emissions

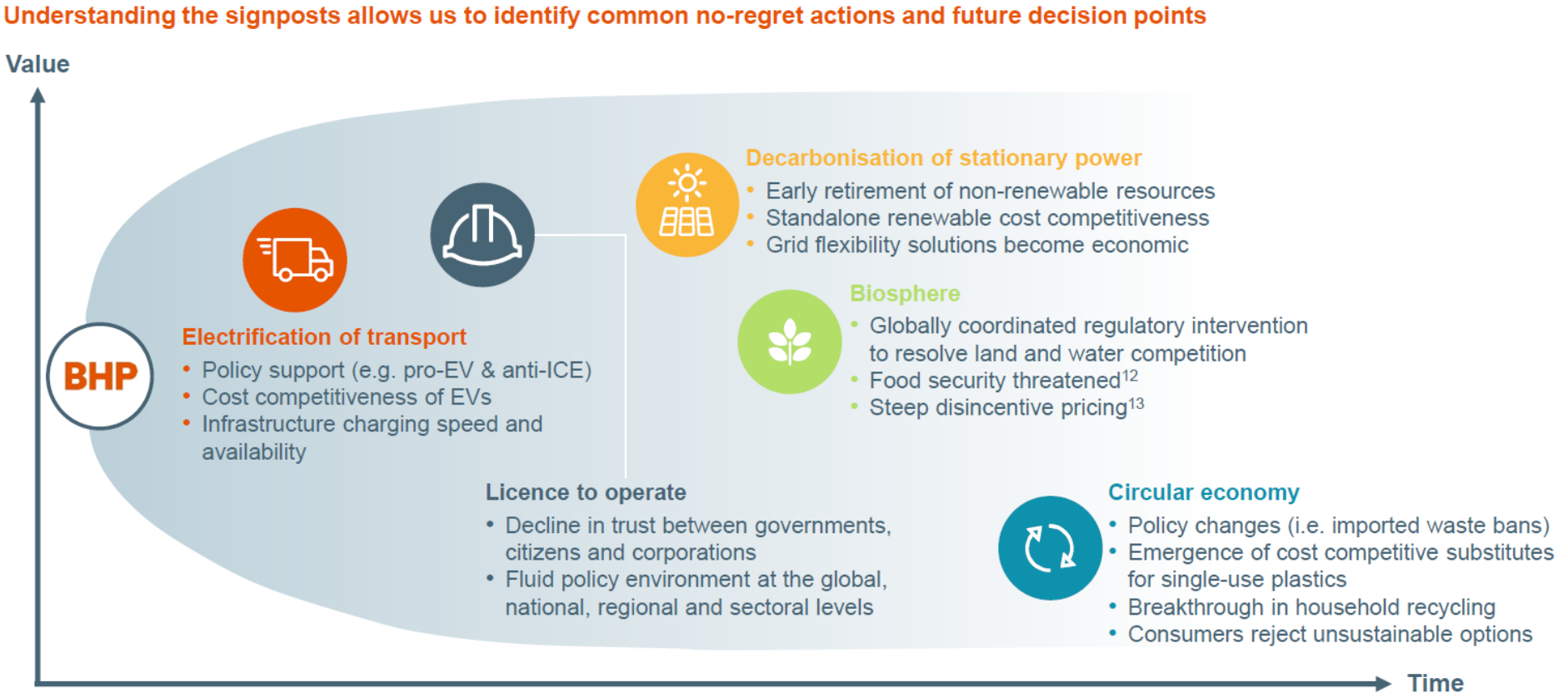


- What level of overall energy demand will there be?
- How much policy implementation will there be to achieve climate targets?
- What will the energy mix be?
- Many of these questions will be answered by politicians, not the market

Strategic thinking for the Energy Transtion



What are the key signposts to tell us which scenario we may be facing?

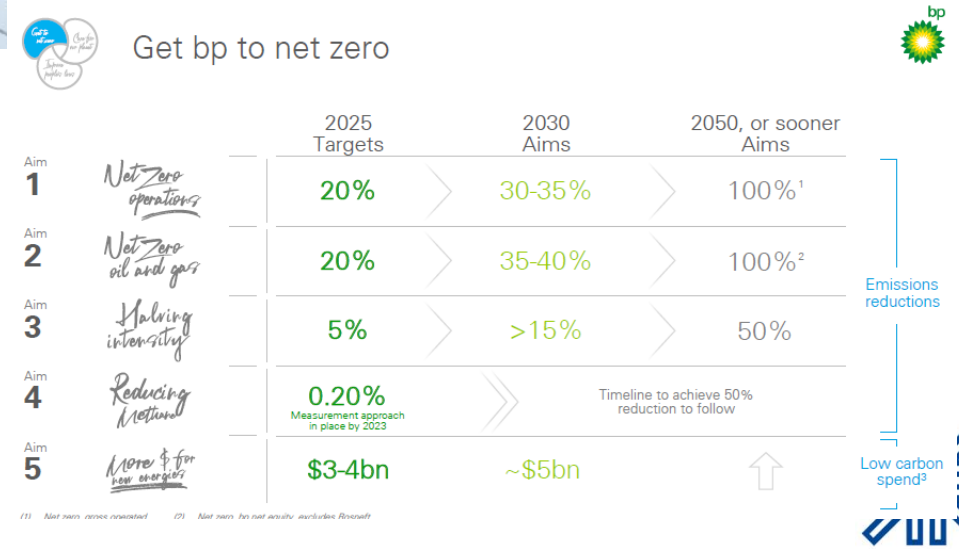


Note: Represents possible impact on our portfolio if no action is taken to mitigate against risks or seize opportunities. Themes are not mutually exclusive or exhaustive, outcomes from one theme could impact our view on severity, timeframes, or strategic considerations for other themes.

- Key differences in timescale and potential cost to the business
- For example, EVs are a relatively short-term risk to the oil business with a fairly significant impact

Net zero target now a major company objective for BP

- Sustainable development goals now a priority
- What will this do to investor returns?
- What are the priorities for key shareholders?



Equinor is slightly more nuanced – keep production growing while shifting business model

Key messages

Growing production, cash flow and returns

- Around 3% annual production growth 2019-2026
- Organic cash flow around USD 30 billion 2020-2023
- RoACE around 15% in 2023

Driving long term value creation, in line with the Paris Agreement

- Industry leading carbon efficiency
- Value driven growth in renewables
- Reducing net carbon intensity by at least 50%

Delivering competitive capital distribution

- Quarterly dividend of 27 cents per share
- Second tranche of share buyback around USD 675 million

- Equinor is rather between BP and Exxon – use current business to fund transition strategy
- Logical but could cause conflict of interest over capital allocation

The ExxonMobil View

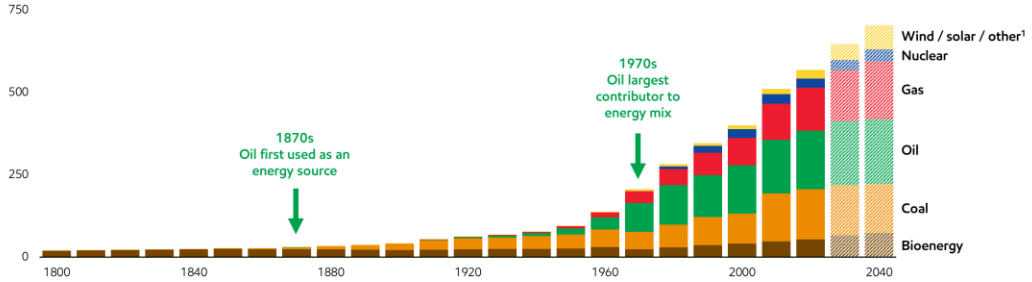
- The world is going to continue on a similar path
- Energy demand will rise and hydrocarbons will continue to have a vital role
- Change will be slow and incremental

ENERGY **EVOLUTION**

Scale and infrastructure requirements limit pace of energy transition

PRIMARY ENERGY DEMAND, IEA STATED POLICIES SCENARIO

Quadrillion BTUs



- Evolution of energy system will require time given scale, complexity, and society's needs
- Availability and affordability critical for wide-scale adoption

Source: 1800 -1960 from Smil; 1970 - 2000 from IEA and ExxonMobil analysis; 2010 - 2040 from IEA World Energy Outlook STEPS scenario

[1]Other includes geothermal and hydro

See supplemental information

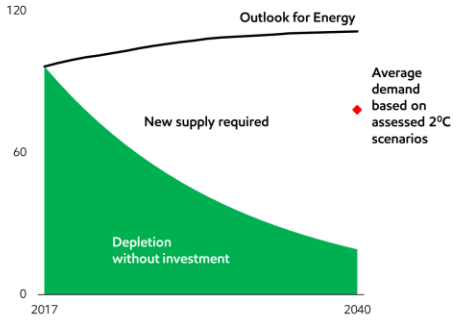
- Oil and gas demand are in natural decline from existing assets
- Demand still needs to be met, even if it does start to fall
- The most efficient and low cost companies can prosper

LIMITED ALTERNATIVES **SUPPORT INVESTMENTS**

Depletion drives level of investments

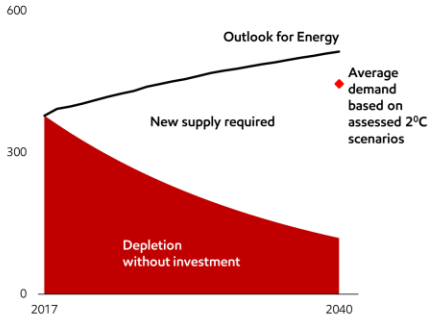
GLOBAL OIL SUPPLY AND DEMAND

Moebd



GLOBAL NATURAL GAS SUPPLY AND DEMAND

Bcfd



Source: 2019 ExxonMobil Outlook for Energy

- Significant new supplies needed across range of demand scenarios
- IEA estimates approximately $20 trillion[1] of oil and natural gas investment needed by 2040

[1] IEA 2019 World Energy Outlook – STEPS scenario

NOCs in Asia also see growth to fuel developing economies

ONGC: Growth Pursuits

- **Aggressive Investment in Upstream**
  - E&P expenditure of about ₹ 1,50,000 Crore in last 5 years
  - 10 Projects costing ₹ 13,000 Crore completed during FY'19
- **25 Projects under execution**
  - 18 Development and 7 Infrastructure Projects - Investment more than ₹ 83,000 Crore
  - Envisaged lifecycle Gains of 72 MMT (Oil) and 116 BCM (Gas)

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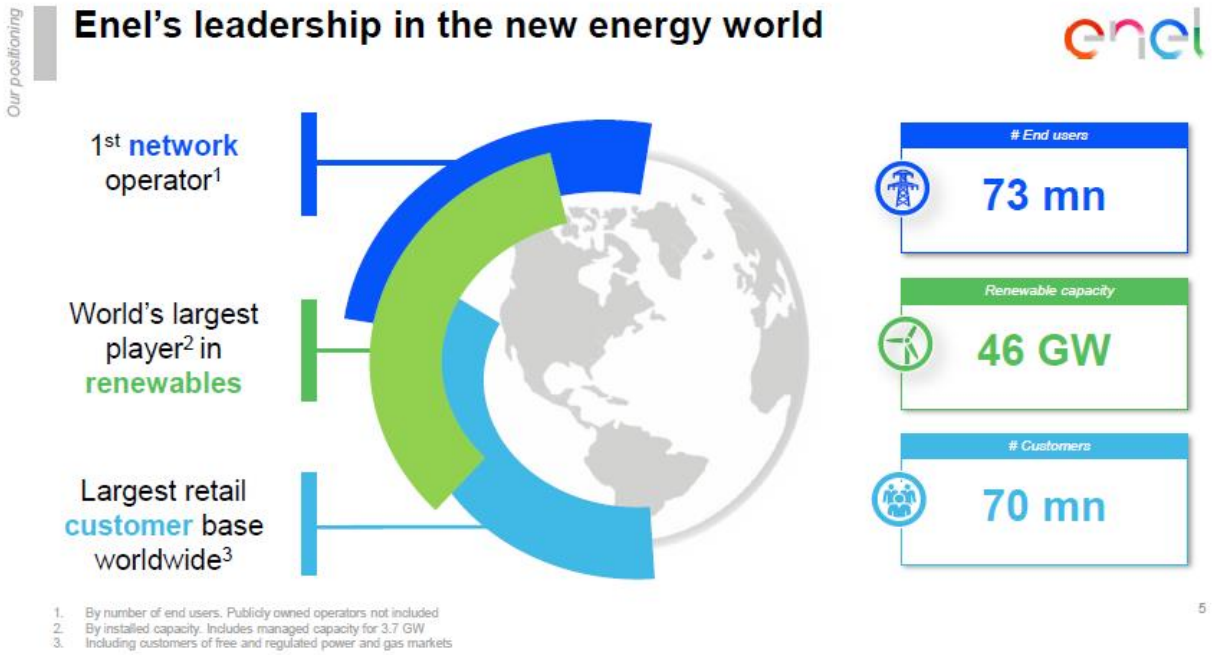
- India's ONGC is very keen to find new hydrocarbons to reduce the country's import bill and to supply growing domestic demand
- In addition, gas to replace coal and also improve the environment

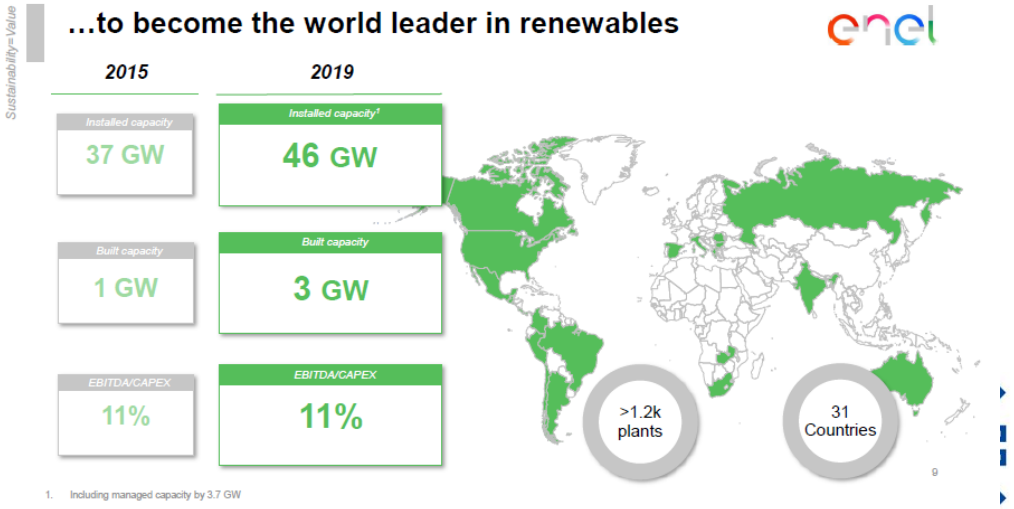
RWE is diversifying its asset base away from hydrocarbon-fired power

- RWE manages a significant part of Germany's lignite-fuelled power fleet
- However, it is gradually reducing its exposure and selling off nuclear assets
- Renewables becoming a the main focus of the business, but trading activity is also growing in order to offset volatility and intermittency risks

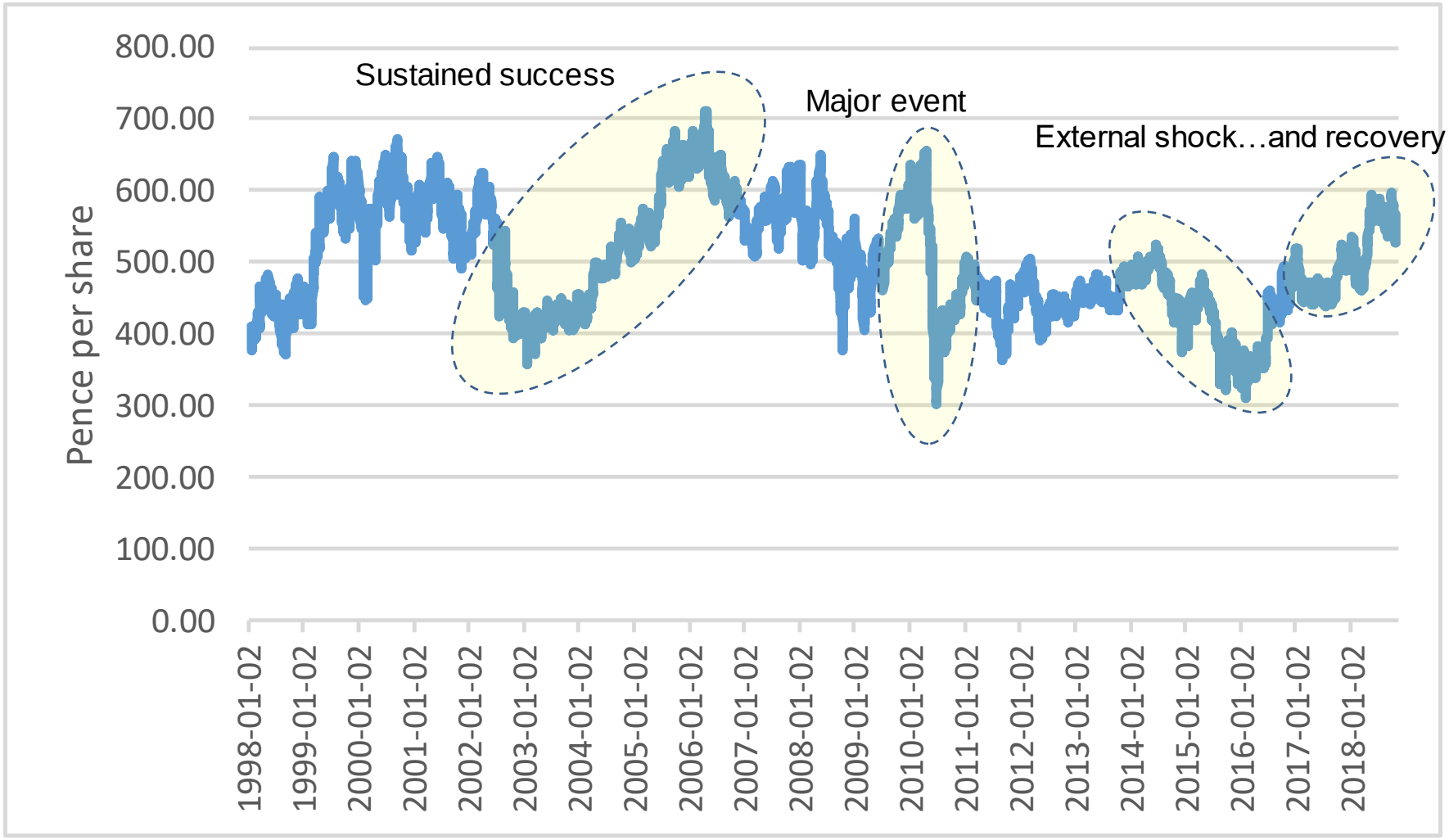
ENEL, Italy's main power company, has committed to leadership in renewable power



- Global renewables business model
- Operates across the electricity value chain
- Rapid increase in capacity and output

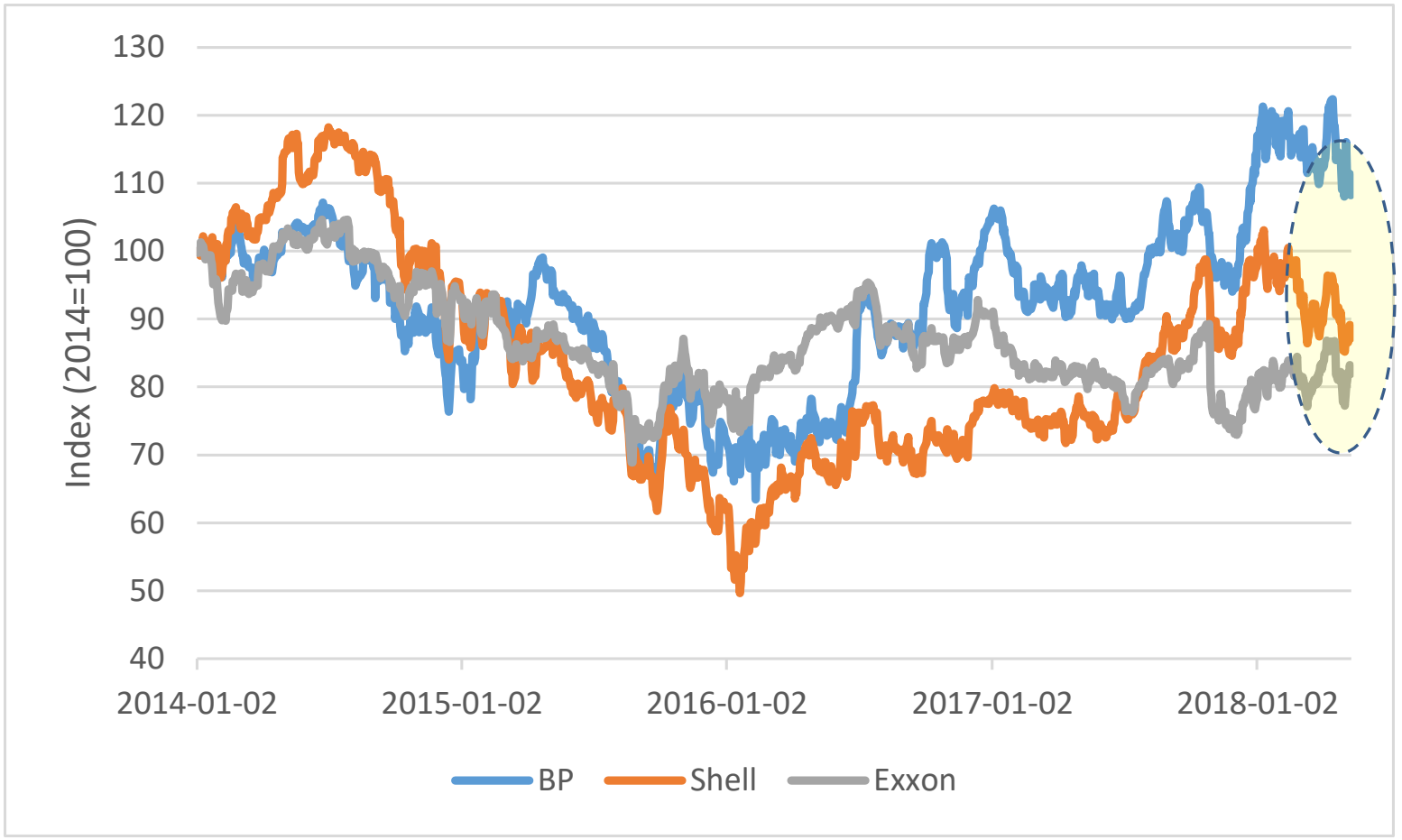


Key Management Driver = The Share Price



- Management incentives often driven by the share price as one key objective

Share price relative to Peer Group



- In the shorter term, BP has outperformed its major European and US competitors
- BP has been in recovery mode, but the final settlement of US court action has provided a boost

Credit Agencies and Banks also have to be convinced

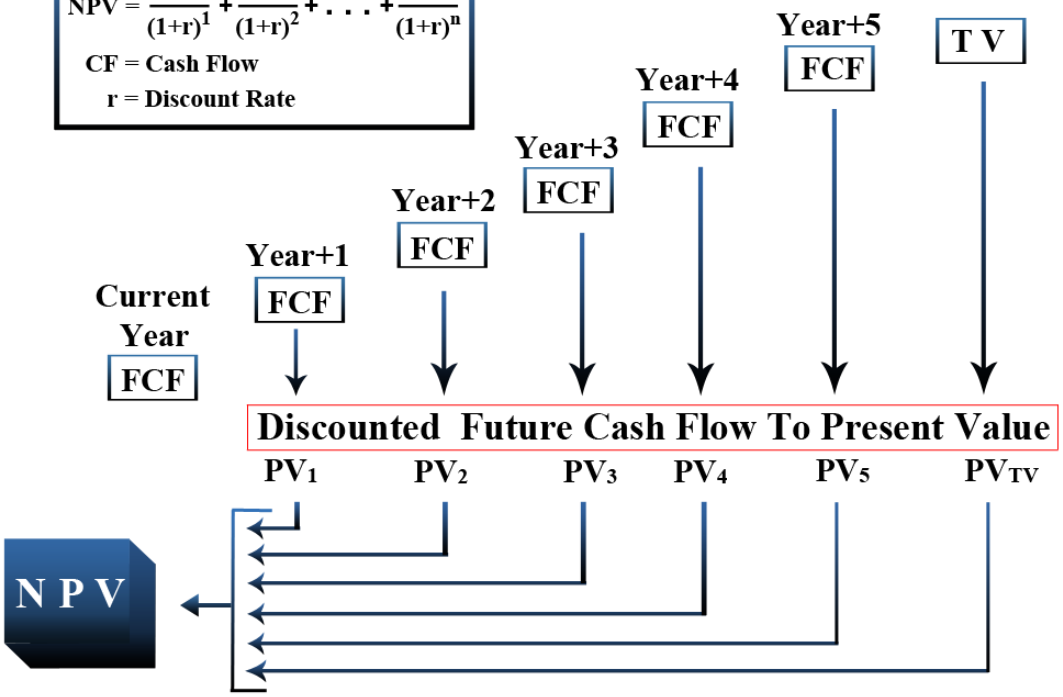
- Any project has to pass the scrutiny of banks who may be involved in financing it or lending to the company as a whole
- Credit Agencies can influence the cost of debt, and will also test the robustness of a company and its investments

The DCF Calculation as a foundation

$$NPV = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_n}{(1+r)^n}$$

CF = Cash Flow

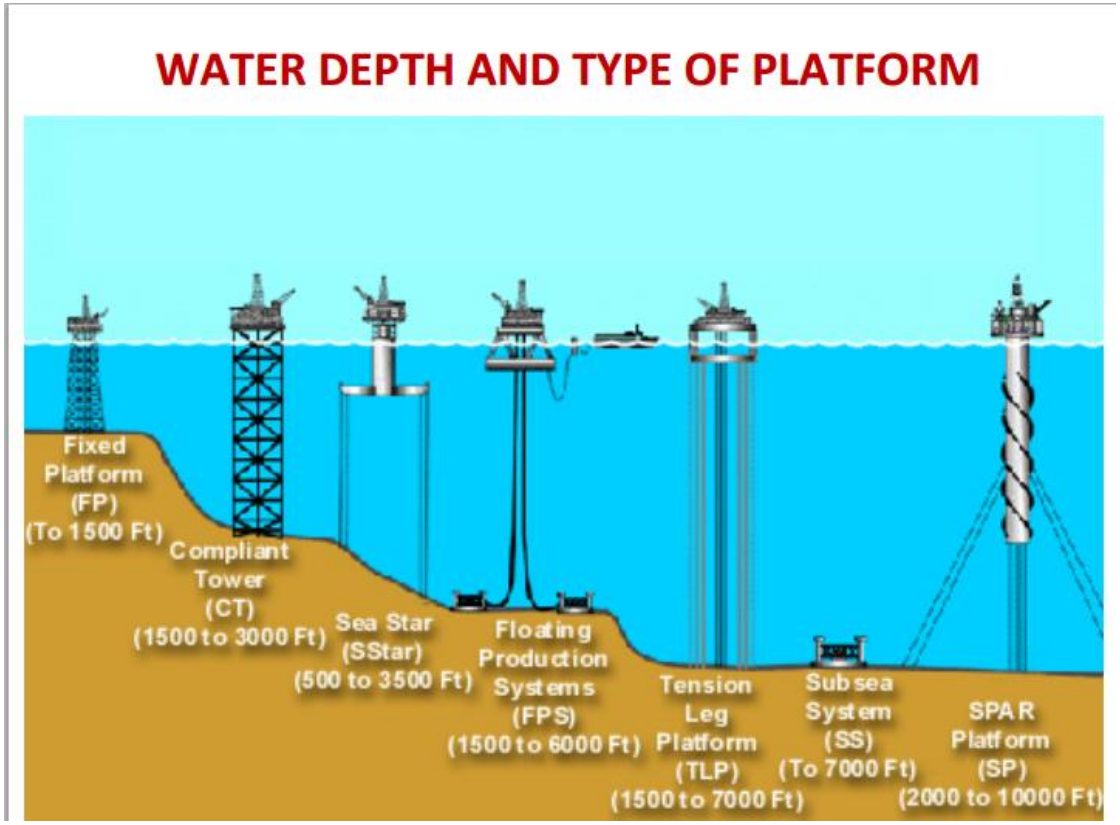
r = Discount Rate



- Management thought process is encapsulated in the DCF model
  - Key assumptions include price, cost, tax, long-term outlook, short-term cashflow and the value of money
- Management must ensure at all times that the combined value of their assets remains NPV positive, and should aim to maximise the return on their assets

What is the management thought process?

Development of an oil discovery



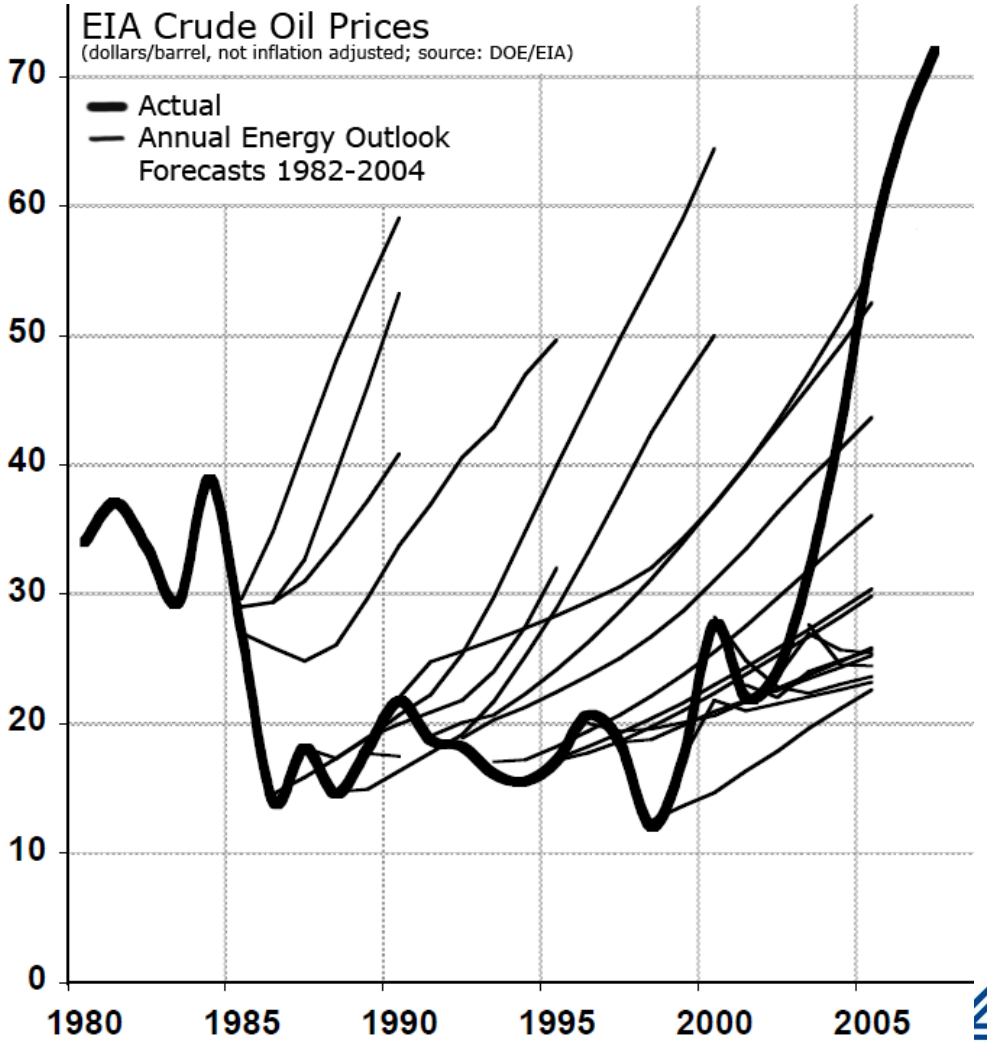
Key Issues

- Size of discovery
- Location / access to infrastructure
- Tax regime
- Local content requirement
- Development cost
- Net present value
- Future oil price expectation
- Future oil demand expectation
- Local politics
- Legal and institutional framework
- Type of financing
- Partner credit-worthiness
- Time to cost recovery
- Breakeven oil price

Oil price forecasting – an imprecise art largely based on optimism

- Consensus is normally that prices will rise from current levels
- Companies plan using a "worst case" scenario assumption – any project must be viable at "US$xx/bbl
- Scenario planning attempts to create alternative outcomes
- Safest assumption is that the consensus will always be wrong

Various US oil price forecasts



Topics of interest

- Impact of new technology
- Cost inflation/deflation and the oil price
- Changing tax regimes
- Political risk
- Partner risk
- Oil companies and their local responsibilities
- Health and Safety
- Shareholder responsibilities
- Corporate and social responsibility
- Oil spill risk
- Electric and gas-fuelled cars

What is the management thought process?

Development of a gas field

Key Issues

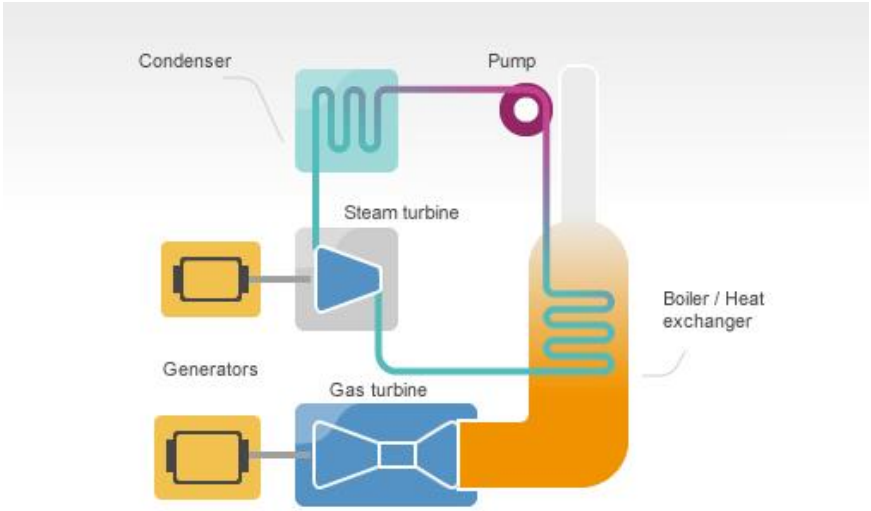
- Access to market
- Export technology
- Total cost
- Outlook for medium and long-term gas demand
- Outlook for coal demand and price
- Competing sources of gas supply
- Breakeven gas price
- Associated liquids
- Length of sales contract available
- Price formation mechanism
- Securing finance
- HSE issues

Topics of interest

- Is the gas market becoming like the oil market
- Is gas the cleanest fossil fuel?
- Will methane demand be displaced by other forms of gas?
- Can CCUS be developed in time?
- The impact of Russia on security of supply concerns
- Shale gas – a good or bad thing?
- Can anywhere else replicate US shale gas success?
- Pipeline gas versus LNG – which to choose?
- Domestic versus export markets
- Subsidised prices

What is the management thought process?

Construction of a fossil fuel power station



Key Issues

- Economics of project
- Pricing mechanisms
- Likely plant utilisation
- Availability of government support
- Security of supply for fuel input
- Expected cost of fuel input
- Availability of renewable energy at zero marginal cost
  - Domestic
  - Imported
- Grid infrastructure requirements
- Country plan for power generation mix to 2050
- Possible carbon capture technology
- Development of off-grid power sources

Topics of interest

- Biogas as an alternative power source
- Carbon capture and storage – will it ever be viable?
- Coal versus gas power – the energy trilemma
- Is gas-fired power the ideal back-up for renewables?

Carbon capture and storage

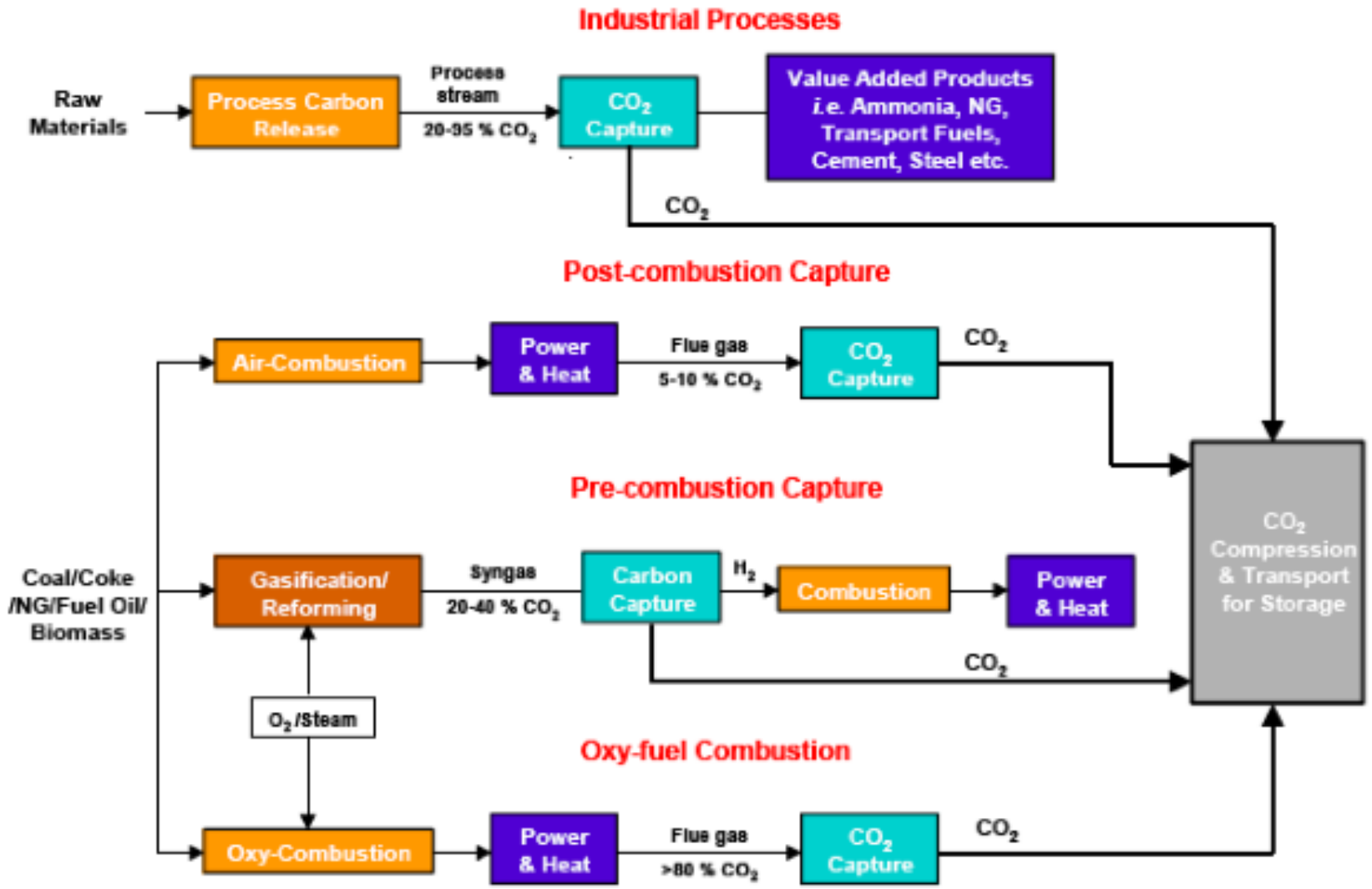
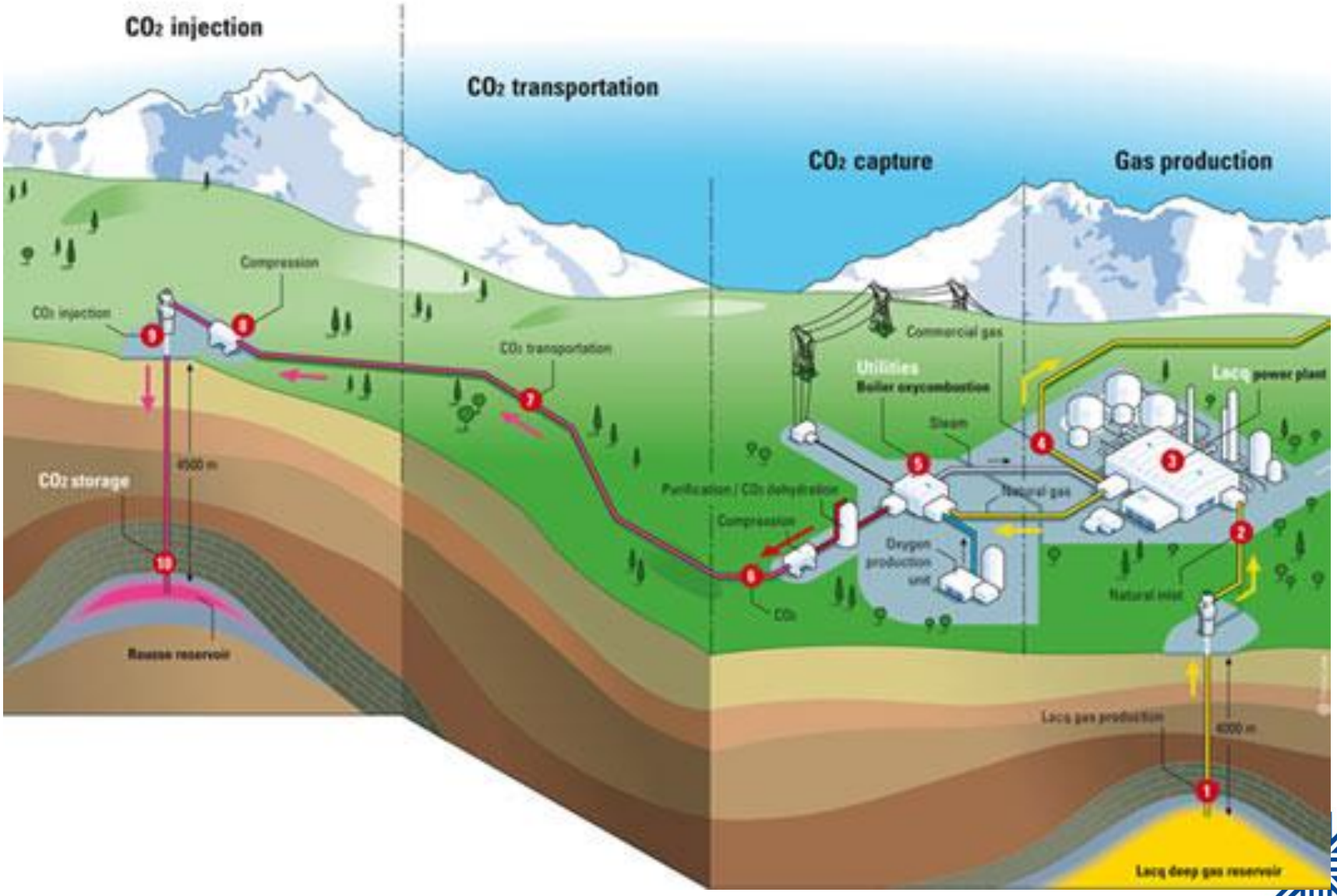


Figure 3: Technology CO_2 capture pathways in fossil fuel conversion and industrial processes (Courtesy of Gupta and Pearson, NRCan)

Carbon capture and storage



What is the management thought process?

Major truck fleet owner or shipping magnate

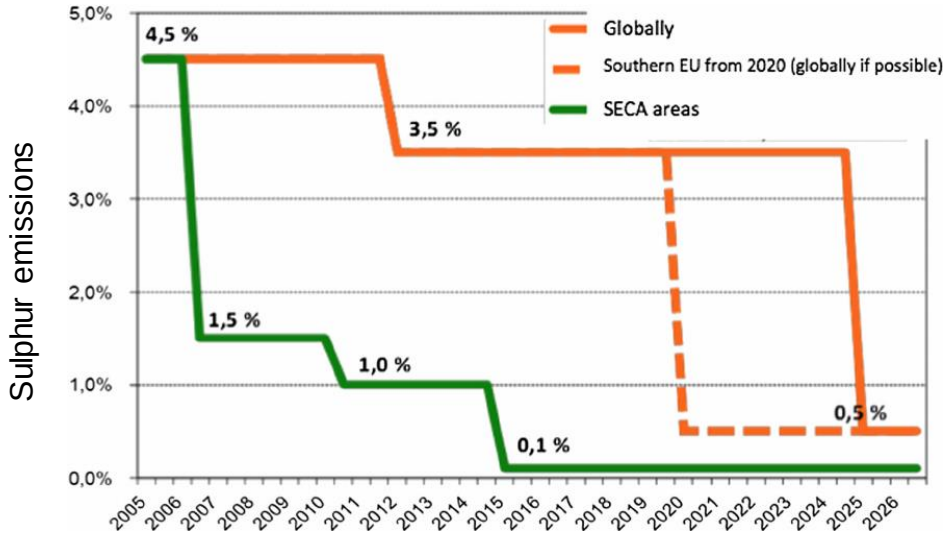
Key Issues

- Relative fuel prices (short and long-term)
- Distance driven before re-fill / re-charge
- Environmental legislation
- Customer demands (public opinion)
- Cost of changing technology
- Re-fuelling infrastructure
- Commitment of truck/car/ship manufacturers
- Longer term technology advances
- Competitor activity (what is everyone else doing?)
- Social responsibility

Topics of interest

- Maritime shipping emissions legislation (IMO)
- Power of engines (LNG trucks versus electric vehicles)
- Trucking fleets with own infrastructure and standard routes
- Commitment of vehicle manufacturers – when does the market demand change
- Battery technology a key constraint
- Fuel efficiency versus change in fuel
- Impact of lower oil prices – reduces incentive to change
- Status quo effect – no-one ever got fired for choosing IBM

IMO Worldmap for ECA's (Emission Control Areas)



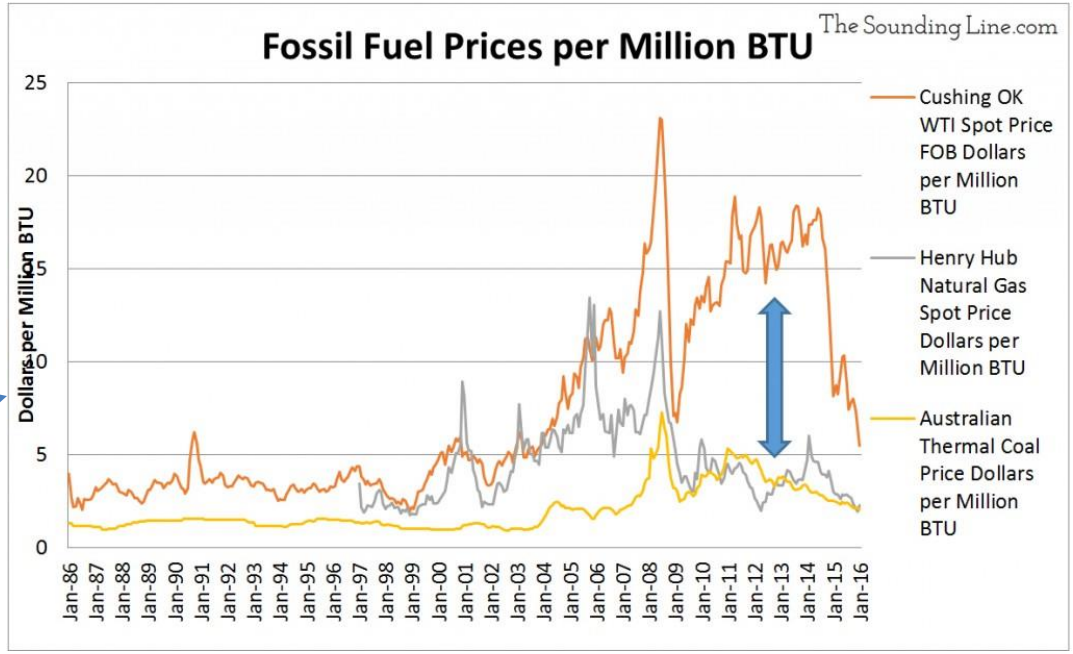
LOWER GREENHOUSE GAS EMISSIONS

	Extraction	Processing	Transportation and storage	Emissions at end use	Total life cycle
Natural gas (LNG)	94 g/km	25 g/km	55 g/km	842 g/km	1016 g/km
Diesel	148 g/km	132 g/km	6 g/km	1079 g/km	1365 g/km

Based on Natural Resources Canada's GHGenius model, version 3.15.
Assumes use of Westport Innovations 15 litre HD engine system.

The environmental case is relatively clear….

…but is only of interest to companies if the oil and gas price differential is wide



What is the management thought process?

Construction or maintenance of a gas pipeline

Key Issues

- Sources of throughput
- Long-term future of fuel
- Payback timescale
- Government support (regulated prices)
- Alternative uses for pipeline
- Security of gas producing company
- Security of gas buyer
- Availability of finance
- Cost of dismantling asset

Topics of interest

- Alternative uses for gas pipelines
  - Hydrogen (electrolysis or methane conversion)
  - Biogas (local grids)
  - CO2 (if CCS works)
- Pipeline networks are major national assets with strategic implications
- Pipeline tariffs may rise if the assets useful life shortens
  - Need to recover cost sooner

Conclusions

- The Energy Trilemma – Price versus Environmental Impact versus Security of Supply
- Economics normally trumps everything else
- Uncertainty creates a disincentive to invest, which creates its own security of supply risks
- Government support beyond renewables is almost inevitable – what does this say for free markets?
- As fossil fuels near the end-game, declining prices will affect energy companies but will also affect consumer choices
- Government revenues will also be significantly affected, with potential serious geo-political impacts
- Shareholders of energy companies have some interesting choices to make – what returns do they want from their investments?
- Renewables are causing huge disruption to the global energy economy – they are necessary to reduce global warming, but have potential security of supply implications