ENERGY MARKET SCENARIOS OF OIL AND GAS COMPANIES

An analysis of the climate strategies and long term scenarios of 14 international oil and gas companies

MAIN REPORT

On behalf of the Swedish National Pension Fund, AP7

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Foreword

A global transformation of society is necessary to deal with climate change. To have a chance of succeeding, robust policies are needed at both national and international level. A large part of the work, however, will need to be done by the business community.

For investors, the transformation of society means both opportunities and risks. During this change some industries will prosper, and others will be disadvantaged. This, in turn, will affect the performance of investor portfolios. The greater risk is that the transition is too slow and insufficient. In this case, the entire global economy will be impacted.

AP7 has concluded that our most important contribution to the transition is as active owners. In the short term, we can persuade companies to increase transparency and thereby the market's ability to price climate risks in an efficient manner. In the longer term, we can increase the adaptation to a new low-carbon economy by engaging in the development of business strategy in critical industries and companies.

This study is an in-depth analysis of some of the largest players in one of the crucial industries in the transition – oil and gas companies. A key aspect of the study, both from a business perspective and from a sustainability perspective, is climate scenarios.

Since the introduction of TCFD's (Task Force on Climate-related Financial Disclosures) framework, scenario analysis has come into focus. If companies analyse and publish climate scenarios that they use in their strategic planning, the market will be able to assess and evaluate the company's climate-related risks more easily. One of the report's conclusions, is that the scenarios can look very different, even though the conditions should be relatively similar. This reduces the value of the scenarios for investors and for companies themselves.

The report proposes a set of metrics that companies can report against in preparing their scenarios. Adopting these criteria would increase the reliability and comparability of companies' business and climate strategies.

We believe this report can make a valuable contribution to the discussion on robust reporting of climate scenarios, and to a speedier transition of companies that play a key role in managing climate change.

Richard Gröttheim, CEO AP7

Executive Summary (1) - observations

In this project we have undertaken a detailed comparison of the climate strategies of the world's major oil and gas companies and assessed the reasons for their different approaches to the energy transition. From this analysis we draw five main conclusions:

1. ***International Oil Companies (IOCs) that embrace the energy transition and set ambitious climate strategies, do so because their forecasts of the oil market indicate this to be a logical, long term strategy***. This is driven by a deeper understanding of the factors affecting the future energy system than those with less developed climate strategies.

2. ***Climate leading IOCs see greater potential for oil demand to be eroded and prices to remain low, than the laggards do***. They see this being caused by a combination of climate policies and the continued downward pressure on the cost of low carbon technologies.

3. ***Climate leading IOCs have marginally higher extraction costs than the laggards, but not sufficiently high to explain their greater pivot to low carbon energy technologies***. Climate leading IOCs have adopted more rapid energy transition strategies because of their view of risks to the oil market, not because they have significantly different cost bases.

4. ***IOC climate laggards*** tend not to look as far into the future at the climate leaders (projections can stop at 2040 rather than 2050) and compliance with the Paris Agreement can be interpreted as a 2^0C warming goal, rather than 1.5^0C goal. Both these factors can have material outcomes for projecting global oil demand.

5. ***IOCs differ significantly in their compliance with the Taskforce on Climate Related Disclosures (TCFD)***. Climate leaders are generally compliant with TCFD disclosure recommendations (BP, Shell, Repsol, Total), whilst tail-enders are least compliant (eg Marathon, Occidental, Suncor, Rosneft, Lukoil, Petrobras).

Alignment of IOCs Scenario Disclosures with TCFD Recommendations

TCFD Recommendation	BP	Shell	Repsol	Total	Marathon Oil	Chevron	Conoco Phillips	Exxon	Occidental	Suncor	Rosneft	Lukoil	Petrobras	PetroChina
Scenarios Analysis	✓	✓	✓	✓		(✓)	✓	✓	(✓)					(✓)
Transition (2C) Pathway	✓	✓	✓	✓		✓	(✓)	✓	✓					(✓)
Assumptions Disclosed	✓	✓		✓			(✓)	✓						
Material Timeframes	✓	✓		✓			✓							(✓)
Scenario Resilience Assessment	✓	✓	✓	✓		✓			✓					
Key Business Drivers Analysed	✓	✓	✓	✓		(✓)		✓	(✓)					(✓)
Up-to-date Scenarios	✓	✓		✓		✓	✓	✓	(✓)					(✓)
Compliant with TCFD recomm's	✓	✓	✓	✓		(✓)	(✓)	(✓)	(✓)					(✓)

(✓) indicates partial compliance with criteria – either limited in scope or incomplete information

Executive Summary (2) - recommendations

The central recommendation from this analysis is that IOCs need to reveal their projections of the energy system on a consistent basis and disclose the assumptions they use. In many respects this means ensuring compliance with the TCFD. However, compliance with the TCFD is not sufficient to encourage IOCs to adopt more ambitious climate strategies. The main purpose of the TCFD is for investors to understand the risks faced by companies under future climate mitigation scenarios.

For IOCs to change their strategies they need to create meaningful, long term, low emission scenarios and believe that they are likely to occur. Asking an IOC to assess their business against an extreme emissions scenario that the firm believes has little chance of happening is unlikely to alter the firm's business strategy. IOCs with less ambitious climate strategies, need to believe there is a significant chance that demand for oil will decline – as the leaders do. This comes from a deeper understanding of the factors driving changes in the energy markets.

More comprehensive disclosure around companies' understanding of the future energy system will help inform investors the risks companies face, but will also help companies learn from each other. Specifically we recommend that IOCs expand their disclosures beyond the minimum guidance provided by the TCFD:

1. ***All projections are made at least to 2050.*** Currently some projections only extend as far as 2040.

2. ***Projections need to include three scenarios:***

   (i) *Business as Usual* – Also sometimes referred to as a Reference scenario, or Stated Policies (IEA). This shows how energy and oil demand will change without any further policy interventions or step changes in technology.

   (ii) *The central scenario the company strategy is based on* – This is likely to be the "base case" for business planning purposes, incorporating the company's central view on oil demand and prices, where this can be disclosed.

   (iii) *A 1.5^{0}C trajectory* – this is the most extreme impact scenario and arguably the least likely. However, it provides a worst-case scenario for IOCs in terms of oil demand.

3. **For the three scenarios IOCs should provide disclosures against the following 12 metrics.** These metrics will allow more direct comparison of oil company visions of the future and how their businesses will be affected by future changes in the world energy system.

Executive Summary (3) – proposed scenario disclosure criteria

Criteria	Sector / metric	Comments
Energy demand (mtoe)	Total primary energy demand	Firms should make clear how they treat traditional biomass and measure the primary equivalent of nuclear, hydro and electricity from renewable sources.
Oil demand (Mbpd and mboe/yr)	Total oil demand	Include all forms of oil use, splits by fuel type to be provided separately (see below). Provide industry reference metric of mbpd and mtoe/yr
Oil demand by fuel type (Mbpd and mboe/yr)	Fossil oil	Fossil oil demand (includes crude from conventional and tight oil, NGLs, GTLs and coal to liquids.
	Biofuels	Future demand for biofuels used for combustion, ie exclude bio-products used in plastics.
Oil demand by use (Mbpd and mboe/yr	Power	Split by fossil and biofuels
	Industry	Split by fossil and biofuels
	Buildings	Split by fossil and biofuels
	Non-combusted	Amount of oil used in plastics – split by fossil and biofuels where necessary. Show where cumulative plastics end up. Quantity of plastics (i) recycled (ii) thermal destroyed (with/without energy recovery) (iii) landfill (iv) uncollected on land or in sea.
	Transport	Split by cars/trucks and fossil/biofuels
	Transport - aviation	Split by fossil and biofuels
	Transport – sea & rail	Split by fossil and biofuels
Gas demand (MMbtu or mboe/yr)	Total gas demand	Total gas demand for all uses
	Power	Reciprocating engines, OCGT and CCGT
	Industry	All forms of gas used in industry
	Buildings	Gas used for heating
	Transport	CNG and related vehicle gas use
	Non-combusted	For use a feedstock
	Hydrogen	In use for combustion purposes but not as a chemical feedstock
Electricity use	Total electricity demand (EJ)	Electricity generated from all sources as delivered energy
	Electricity share of total final energy demand (%)	This shows how rapidly the world is moving towards electrification. Note final energy demand, not primary energy demand.
Renewable energy	Total renewable energy output (EJ)	Measured as delivered energy.
	Wind and solar output (EJ)	Measured as delivered energy
	Biomass (EJ)	Biomass and biofuels. NB: excludes traditional biomass.
	Geothermal (EJ)	Measured as delivered energy
	Renewable as % final energy demand (%)	Final energy demand measured as EJ
Costs	LCOE of wind power ($/MWh)	Onshore wind - Standardise calculations for 30% load factor Offshore wind – standardise calculations for 50% load factor
	LCOE of solar PV power ($/MWh)	Standard calculations for 10%, 20% and 30% load factor
	Cost of vehicle ownership ($ per km driven)	Also show cost of vehicle purchase. Standardise assumptions for mid-size family car – 10,000 miles/yr, 10 year life time, price of electricity $50/MWh.
	Battery price ($/MWh)	Price of battery packs for vehicle use and power storage.
Electric vehicles	Number of EV Sales / % of total new vehicle sales	Include number of “light vehicles” and “e-motorcyles”.
	% of car fleet	% of light vehicles and e-motorcyles in operation
CCUS	Volume of CCUS capacity in place (MtCO2/yr)	Separate out EOR and new CCS
	LCOE of CCUS ($/tCO2)	
Nature based sequestration (MtCO2/yr)	REDD+, restoration, soil & Other	Show annual carbon sequestration rates for land use categories
GHG emissions (MtCO2e/yr)	CO2, methane.	Total annual CO2e emissions from fuel combustion and methane emissions. Separate methane emissions from oil & gas and other sources.

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SECTION 1. INTRODUCTION AND CONTEXT

Introduction

This report has been prepared by Trove Research for the Swedish National Pension Fund AP7 to examine the climate strategies of the world's major international oil and gas companies (IOCs) and provide recommendations for further climate-focussed engagement with the oil and gas industry.

The investor community is already actively engaged with the oil & gas sector, both directly and through collective initiatives such as the Climate Action 100 (CA100+) and International Investor Group on Climate Change (IIGCC). Climate research organisations such as the Transition Pathway Initiative (TPI) and Carbon Tracker have also been monitoring the sector and provide analyses of company climate performance.

In 2019 and early 2020 many of these initiatives focussed on encouraging the IOCs to do more to limit their emissions as none of the companies emission projections were remotely on track with the 1.5^0C or even 2^0C pathways. However, throughout 2020 a number of IOCs have made pledges that are more consistent with these pathways with commitments of Net Zero emissions by 2050 – depending on the scope of coverage.

The purpose of this report is to build on these other investor-led climate initiatives in the light on these recent IOC climate commitments taking a uniquely business perspective. Specifically, this report covers three main topics:

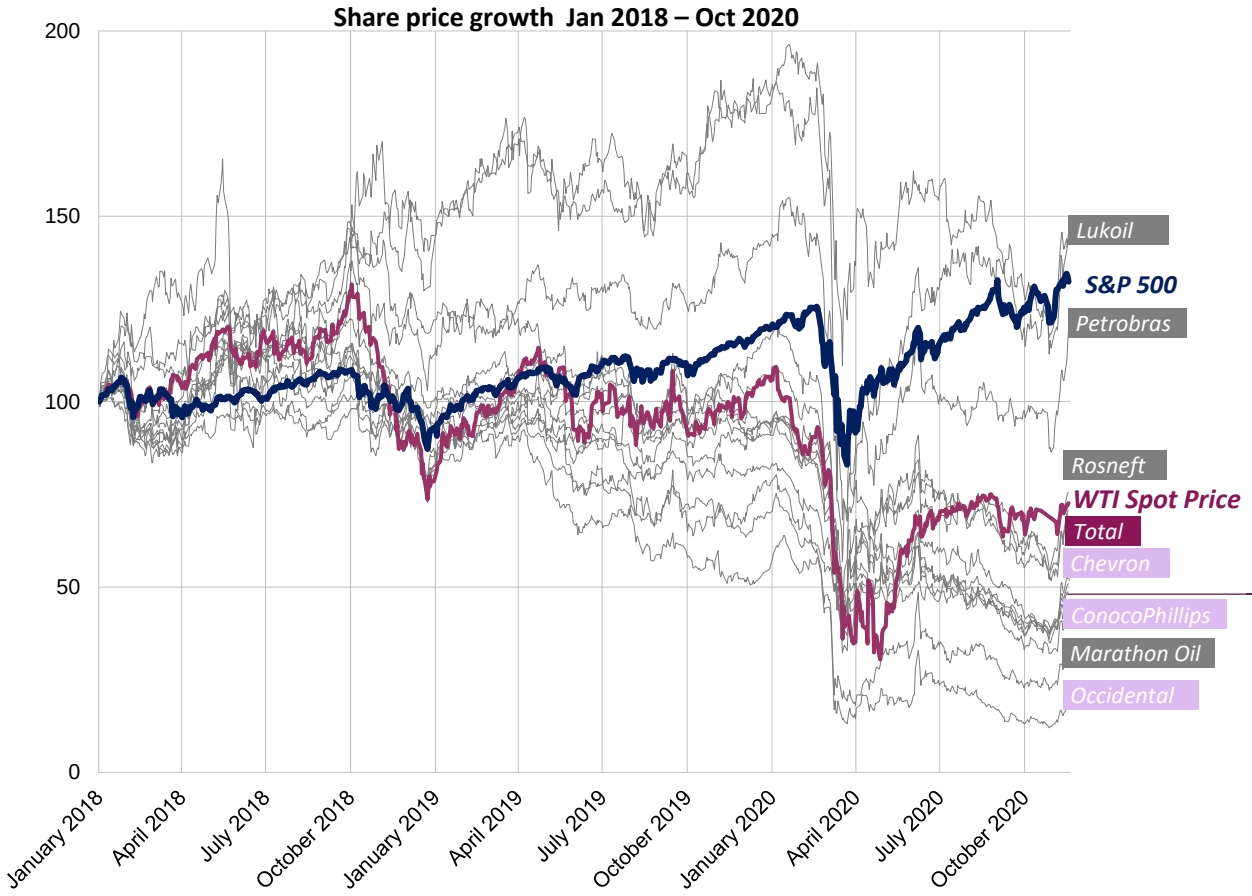
1. We firstly examine the differences between climate leading and laggard firms and the business reasons for those differences, highlighting inconsistencies and inadequacies in IOC strategies. We then rank firms based on an assessment of 14 climate criteria across three main areas: policy disclosure, emissions targets and investments in low carbon technologies. These are used to identify climate "Leaders", "Slipstreamers" and "Laggards". "Slipstreamers" are firms that appear to be moving in the right direction with positive statements, but have yet to reveal detailed plans and make significant financial commitments to low carbon technologies.
2. We then look at the relationship between the degree of climate ambition and how each firm sees the future of the oil market, breaking down the core assumptions in their forecasts. These assumptions are critical to forming each company's strategy, and when compared with each other reveal outlying views. These can then be used to challenge the firm's vision of the future and how it will respond to ensure shareholders long term interests are served. In this section we also examine the extent to which IOC climate strategies are influenced by their cost base, on the premise that firms with higher costs of extraction will be more inclined to pivot towards low carbon technologies.
3. Finally we show how oil and gas is used across the economy. This highlights which areas of oil and gas demand are most at risk of demand decline as the world transitions to a less carbon energy system and reduces its reliance on single use plastics.

In this report we use the term IOC (International Oil and Gas Companies) to refer to large oil and gas companies with publicly traded shares. Most, but not all of these have substantial international activities. Suncor and Marathon, for example, are largely North America-based, and Lukoil and Rosneft Russia-based. The term IOC is used in other reports to refer to Integrated Oil and Gas Companies with upstream and downstream operations.

Share Price Performance of IOCs

The need for the oil industry to develop climate strategies is not just to support global climate change mitigation efforts. They need to address long standing issues of financial performance. IOCs have underperformed the S&P 500 for several years. Although oil prices have fallen in this period, the majority of IOCs have performed worse than the crude price index.

Since 2018 every IOC, except Lukoil, has underperformed the S&P500 with the median firm losing around 50% of its stock value. Over this period the S&P increased by over 30%. Part of this was due the decline in crude prices, but most IOCs have performed worse than the WTI spot price. Margins have been squeezed as the cost base required to support oil and gas production is still too high.



The three firms that have performed better than the WTI index are Lukoil, Petrobras and Rosneft.

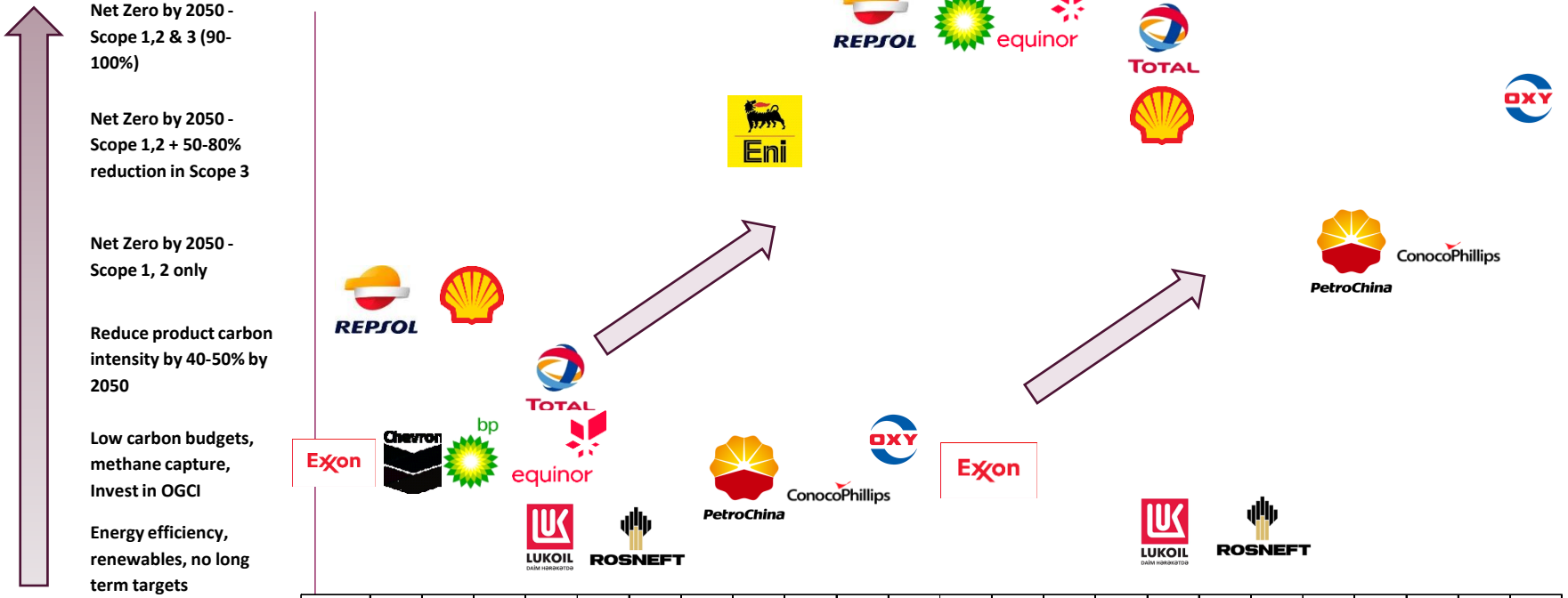
Of those that have underperformed relative to WTI, the US IOCs have, on average, performed worse than their EU counter-parts. Stocks prices of Marathon and Occidental have lost the greatest value.

There are many reasons for individual stock price changes, and it is beyond the scope of this study to assess the reasons behind each firm. However, history and theory show that firms with more diversified revenue models perform better in volatile markets. US IOCs have the less diversified businesses, being heavily invested in conventional and unconventional oil production with lower shares of revenue from low carbon technologies.

Recent changes in international oil company climate commitments

IOC climate commitments have changed significantly in 2020. Prior to 2020 oil & gas climate strategies' were limited to three areas: investment in low carbon technologies, methane capture and the Oil & Gas Climate Initiative (OGCI). Over the course of 2020 European IOCs started to introduce long term emission reduction targets covering not only scope 1 and 2, but also scope 3. US and Russian firms' position have changed little since 2019.

Increasing climate ambition



2020 targets		
Total	May-20	Net Zero from worldwide operations by 2050 or sooner (scope 1+2), production and energy products used by its customers in Europe2 by 2050 or sooner (scope 1+2+3). 60% or more reduction in the average carbon intensity of energy products used worldwide by Total customers by 2050
ENI	Sep-19	Net Zero for scope 1 and 2 for all activities by 2040. Net Lifecycle emissions scope, 1,2 and 3 reduction of 80% by 2050 (from 2018)
Repsol	Dec-19	Net Zero target by 2050 released in 2019 to cover 95% of emissions by use of its products (ie scope 3)
Shell	Apr-20	reduce our global NCF by around 30% by 2035, and by around 65% by 2050, in step with society
BP	Mar-19	$530m total budget for low carbon investments
Equinor	Feb-20	reduce net carbon intensity by at least 50% by 2050 takes into account scope 1, 2 and 3 emissions,

SECTION 2. METHOD AND APPROACH

Study scope

The scope of this analysis a comparison of 14 International Oil Companies. These have been selected to give a coverage across Europe, North America, Brazil, Russia and China. We have not included state owned oil companies as these stocks are not held by institutional investors. The companies are: BP, Shell, Repsol, Total, Marathon, Chevron, Conoco, Exxon, Occidental, Suncor, Rosneft, Lukoil, Petrobras and Petrochina.

We then asses each company's approach to climate change and the energy transition in three areas: Policy Disclosure, Emissions Targets and Investments in Low Carbon Technologies. Each area is broken down into individual criteria as shown below, using 14 criteria in total. Scores have been made against each criteria and weighted to provide overall climate strategy rankings.

Climate strategy assessment criteria

1. Policy disclosure

Climate Change Mitigation Strategy
Paris Statement
OGCI Member

2. Emissions targets

Net Operational Emissions (Scope 1 & 2)
Net Product Emissions (Scope 3)
Operational Emissions Intensity
Methane Intensity
Flaring Commitments
Timeframe(s)

3. Investment in low carbon technologies

Nature Based Solutions (NBS)
Carbon Capture (Use) & Storage (CCUS)
Cleantech VC/R&D
Low-carbon Energy
Renewables in Own Supply

Scoring & weighting

Leaders

IOCs that have made significant climate commitments and transitioning their businesses. Supported by visible changes in investment strategy.

Slipstreamers

IOCs that appear to be moving in the right direction with positive statements, but have yet to reveal detailed plans or make significant financial commitments to low carbon technologies.

Tail-enders

IOCs that have minimal disclosures on climate commitments and emissions targets, and have made few investments in low carbon technologies .

Company comparison – ranking methodology

We have developed the following framework to score and weight each company's position. The scoring used, while subjective, reflects materiality of a commitment to climate change action. A detailed methodology and rationale for individual weights can be found in the appendix

Category	Criteria	Company Score	Metric Weighting	Category Weighting
Policy Disclosures	Climate Change Mitigation Strategy	0 (no commitment), 1 (some commitment) or 2 (strong commitment)	5%	10%
	Paris Statement	0,1 or 2	2.5%	
	OGCI Member	0,1 or 2	2.5%	
Emission Targets	Net Operational Emissions (Scope 1 & 2)	0,1 or 2	12.5%	50%
	Net Product Emissions (Scope 3)	0,1 or 2	15%	
	Operational Emissions Intensity	0,1 or 2	7.5%	
	Methane Intensity	0,1 or 2	5%	
	Flaring Commitments	0,1 or 2	5%	
	Timeframe(s)	0,1 or 2	5%	
Low-Carbon Investment	NBS	0,1 or 2	5%	40%
	CC(U)S	0,1 or 2	10%	
	Cleantech VC/R&D	0,1 or 2	10%	
	Low-carbon Energy	0,1 or 2	10%	
	Renewables in Own Supply	0,1 or 2	5%	
		Total	*100%*	

Company categorization:

Category	*Score*
Leader	31 - 40
Slip-streamer	16 - 30
Tail-ender	0 - 15

SECTION 3. COMPARISON OF IOC CLIMATE STRATEGIES

Company comparison summary

The table below summarises the strategies of each IOC against our 14 criteria. European firms have taken a clear lead on climate strategies, all of them setting long term emissions targets. Petrobras and Petrochina have also set emissions targets. Whilst many non-European IOCs support the Paris Agreement and make modest commitments to controlling emissions, they do not believe oil demand will be materially affected in the medium to long term.

Region	Europe				North America						Other			
Company	BP	Shell	Repsol	Total	Marathon	Chevron	ConocoPhillips	Exxon	Occidental	Suncor	Rosneft	Lukoil	Petrobras	PetroChina
1. Policy Disclosures														
Climate Change Mitigation Strategy	■	■	■	■		■	■	■	■	■	■	▢	■	■
Paris Statement	■	■	■	■	■	■	■	■	■	■	■	■	■	■
OGCI Member	■	■	■	■		■		■	■				■	■
2. Emissions Targets														
Net Operational Emissions (Scope 1 & 2)	■	■	■	■		▢	■		■		▢		▢	■
Net Product Emissions (Scope 3)	■	■	■	■					■					
Operational Emissions Intensity	■	■	■	■		▢	▢	▢	▢	▢	▢		▢	▢
Methane Intensity	■	▢	▢	▢		▢	■	▢	▢		▢	■	▢	▢
Flaring Commitments	■	■	■	■		■	■	■	■		■	■	■	
Timeframe(s)	■	■	■	■		▢	■	▢	■	▢	▢			▢
3. Low Carbon Investments														
NBS	▢	■		■									▢	▢
CCUS	■	■		■	▢	▢	▢	▢	▢				▢	▢
Cleantech VC/R&D	■	■	■	■		■		▢	■	■				
Low-carbon Energy	■	■	■	■				▢	▢	▢	▢	▢		■
Renewables in Own Supply				▢		■			▢				▢	■

■ = Strongest commitment ▢ = Some commitment = No commitment

Note: company positions as of 10 November 2020

Policy Disclosures

Almost all companies do address Paris Agreement and 2°C warming goal, though with varying alignment. Just over half of companies have a climate change mitigation strategy, i.e. concerted and stated aims of emissions reductions, with actionable targets, to mitigate climate change.

Region	Europe				North America						Other			
Company	BP	Shell	Repsol	Total	Marathon	Chevron	ConocoPhillips	Exxon	Occidental	Suncor	Rosneft	Lukoil	Petrobras	PetroChina

1. Policy Disclosures

Climate Change Mitigation Strategy	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Paris Statement	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OGCI Member	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No	No	No	Yes	Yes

- OGCI Membership – the OGCI has set targets for its member companies for methane-intensity reductions (<0.25% by 2030) and flaring, aiming to eliminate routine flaring by 2030.
- However while most companies do acknowledge the Paris Agreement and associated temperature increase limit publicly, commitments and conviction in operations diverge starkly. For example, Exxon, while publicly acknowledging climate change science and global warming implications, as well as 'alignment' to a 2°C target, has spent considerable resources combatting "#Exxonknew"

Emission Commitments

The leaders have substantially more rigorous emission commitments, characterised by scope 3 emissions targets. The less ambitious firms limit their commitments to energy efficiency improvements and flaring and methane intensity reductions, as set out by OGCI targets and APG capture.

Region	Europe				North America						Other			
Company	BP	Shell	Repsol	Total	Marathon	Chevron	ConocoPhillips	Exxon	Occidental	Suncor	Rosneft	Lukoil	Petrobras	PetroChina
2. Emissions Targets														
Net Operational Emissions (Scope 1 & 2)	Net zero	Net zero	Net zero	Net zero	No target	2-5% reduction (vs 2016)	Net zero	No target	Net zero (by 2040)	No target	20 MtCO2e avoidance	No target	Zero growth by 2025	Near net zero
Net Product Emissions (Scope 3)	Net zero	Net zero	Net zero	Net zero	No target	No target	No target	No target	Net zero	No target	No target	No target	No target	No target
Operational Emissions Intensity	60% reduction (45-50% by 2030)	65% by 2050 (30% by 2035)	100% (40% by 2040)	60%	No explicit target - aiming for yr-on-yr reduction	Upstream reductions of 40% for oil, 26% for gas	35-45% reduction by 2030	Upstream reduction of 15-20%	20% reduction by 2025	30% reduction	30% reduction	No target	32% reduction in E&P and 16% in refining by 2025	25% reduction in CO2-intensity of 2020 profit vs 2015
Methane Intensity	<0.1%	<0.2%	<0.2%	<0.2%	No target	53% reduction	<0.1% by 2025	40-50% reduction	<0.25% (OGCI, 2025)	No target	<0.25%	<0.15%	30-50% reduction by 2025	<0.25% by 2025 (OGCI target)
Flaring Commitments	0 by 2030	0 by 2030	0 by 2030	0 by 2030	No target	0 by 2030	0 by 2025	0 by 2030	0 by 2030	No target	0 by 2030	0 by 2030	0 by 2030	None
Timeframe(s)	2050 (2030 interim)	2060 (2030 interim)	2050 (interim targets)	2050 (interim targets)	N/a	2028	2050 (2030 interim)	2025	2050 (2025 & 2040 interim)	2030	2035	N/a	Varied	2050

Low carbon investments

As well as leading on emission commitments, European firms have committed more capital to investing in low carbon technologies. Eg BP is pledging to spend $5bn per year in clean energy investments by 2030 (33% of invested capital), compared to $500m in 2019. Shell has committed $1-$2bn per year from 2020 to 2030.

Region	Europe				North America						Other			
Company	BP	Shell	Repsol	Total	Marathon	Chevron	ConocoPhillips	Exxon	Occidental	Suncor	Rosneft	Lukoil	Petrobras	PetroChina
3. Low Carbon Investments														
NBS	NCS Alliance	$200m/yr	None	$100m/yr	None	None	None	None	None	None	None	None	15 projects - 850ktCO2 captured	Green area of 286km^2 developed
CCUS	North Endurance Partnership (1) OGCI Fund	North Endurance Partnership (1) OGCI Fund	None	North Endurance Partnership (1) OGCI Fund	1 MtCO2/yr in Alberta oil sands	$1bn into CCS projects	259 ktCO2 purchased in 2019 for CO2-EOR	40% of global captured CO2 share	Store ~20 MtCO2/yr from 14 plants 2.6 Bcf/d for CO2-EOR (5)	None	None	None	40 MtCO2 used for CO2-EOR by 2025	1.5 MtCO2e sequestered in pilot CCUS pant
Cleantech VC/R&D	bp ventures - technology VC arm	Shell New Energies Shell Ventures	Repsol Technology Labs (3)	40% of R&D to decarbonisation	None	$100m to own low-carbon tech fund	None	Algal biofuel - 10,000 b/d by 2025	Oxy Low Carbon Ventures	$200m/yr for low-carbon tech VC fund	None	None	None	None
Low-carbon Energy	$5bn/yr by 2030 for low-carbon energy (2)	$1-2bn per year (2020-2030)	50% of energy from low-carbon sources by 2025	35GW solar and wind portfolio by 2025 (4)	None	None	None	Biodiesel investments	NET Power - CCS-based gas power company	2.4 GW low-carbon portfolio	7% of 2020-22 CAPEX for clean gas	>97% of APG used in 2019 for EOR	None	$0.4-0.7 bn/yr between 2020-25, US$1.5 billion/yr thereafter (6)
Renewables in Own Supply	None	None	None	Clean energy for EU operations by 2050	None	~600MW portfolio to power operations	None	None	16 MW solar plant to power CO2-EOR	None	None	None	16 MW renewables in portfolio	~50% of upstream energy to go green

1. Expected to sequester around 17 MtCO2/yr by 2030, while Humber Net Zero will add a further 17 MtCO2
2. BP - 33% of invested capital by 2030
3. Largest private R&D facility in Spain, focussing on hydrogen, CCUS, biofuels, heat recovery and other research
4. Total - $1.7 billion per year investment, around 10% of total invested capital
5. Occidental - 40-50% newly sourced CO2, 50-60% recycled from wells. Store around 18 MtCO2/yr from 35 projects
6. PetroChina to invest in geothermal, solar, wind and hydrogen. 1-2% of invested capital through 2025

Note on nature-based solutions. These feature minimally in IOCs plans. As such, the $200m and $100m per year committed by Shell and Total to re-/afforestation projects stand out considerably. PetroChina has thus far planted over 2m trees as part of environmental rehabilitation extension from past resource sites, but these three remain the only instances of NBS development.

Summary ranking of company climate position

Companies were scored for each category of their climate commitments, and then categorised as Leaders, Slip-Streamers and Tail-Enders on the basis of their overall score.

Region	Europe				North America						Other			
Company	BP	Shell	Repsol	Total	Marathon	Chevron	ConocoPhillips	Exxon	Occidental	Suncor	Rosneft	Lukoil	Petrobras	PetroChina
1. Policy Disclosures														
Climate Change Mitigation Strategy	2	2	2	2	0	2	2	2	2	2	2	1	2	2
Paris Statement	2	2	2	2	2	2	2	2	2	2	2	2	2	2
OGCI Member	2	2	2	2	1	2	1	2	2	1	1	1	2	2
2. Emissions Targets														
Net Operational Emissions (Scope 1 & 2)	2	2	2	2	0	1	2	0	2	0	1	0	1	2
Net Product Emissions (Scope 3)	2	2	2	2	0	0	0	0	2	0	0	0	0	0
Operational Emissions Intensity	2	2	2	2	0	0	0	0	0	0	0	0	0	0
Methane Intensity	2	1	1	1	0	0	2	1	1	0	1	2	1	1
Flaring Commitments	2	2	2	2	0	2	2	2	2	0	2	2	2	0
Timeframe(s)	2	2	2	2	0	1	2	1	2	1	1	0	0	1
3. Low Carbon Investments														
NBS	1	2	0	2	0	0	0	0	0	0	0	0	1	1
CCUS	2	2	0	2	1	1	1	1	1	0	0	0	1	1
Cleantech VC/R&D	2	2	2	2	0	2	0	1	2	2	0	0	0	0
Low-carbon Energy	2	2	2	2	0	0	0	1	1	1	1	*1*	0	2
Renewables in Own Supply	0	0	0	1	0	2	0	0	1	0	0	0	2	2
Weighted scores:	37	37	31	38	3	18	17	15	30	11	12	8	15	21

SECTION 4. SCENARIO DISCLOSURES

IOC energy scenarios - overview

Future expectations of oil and gas demand are central to oil companies' strategic planning. This section examines and compares companies' published views on the role of oil and gas in the future mix under different scenarios.

Availability

Of the 14 companies investigated, only 5 publish their own scenario projections (BP, Shell, Total, ConocoPhillips and Exxon Mobil), while a further 3 base their strategy on the International Energy Agency's World Energy Outlook (IEA WEO). Two of these are outdated by at least a year (Repsol uses IEA WEO 2017, Occidental uses IEA WEO 2019).

PetroChina does publish an energy outlook, however it relates exclusively to China's energy demand and supply, and as published by the state-owned China National Petroleum Corporation, reflects government policy, rather than expectations of energy balances. Marathon Oil, Suncor, Petrobras, Lukoil and Rosneft meanwhile do not publish any energy forecasts, nor do they allude to any independent, third-party resources they may use.

Timelines

Timelines also differ between outlooks. Of the 5 published scenarios, Exxon's extends only to 2040, as do the IEA's outlooks, while BP, Shell, Total and ConocoPhillips run out to 2050 (with Shell out to 2100). This is of particular importance to oil and gas demand peaks - ConocoPhillips expects oil demand to peak in 2050, while Exxon and the IEA forecast maximum demand to occur around 2040. Placing cut-offs at peak demand, thereby ignoring the reduction, and its pace, skews long-run growth projections and financial feasibility of continued production levels.

Scenarios

All outlooks contain a business-as-usual (BAU) case, as well as a rapid decarbonization pathway (Exxon reports a summary of external low-carbon models), in-line with emissions requirements for 1.5/2^{o}C pathways. Since emissions levels in these are externally prescriptive, the comparisons are made between the BAU cases stated by the companies, where considerable divergence in future energy supply and demand expectations arise.

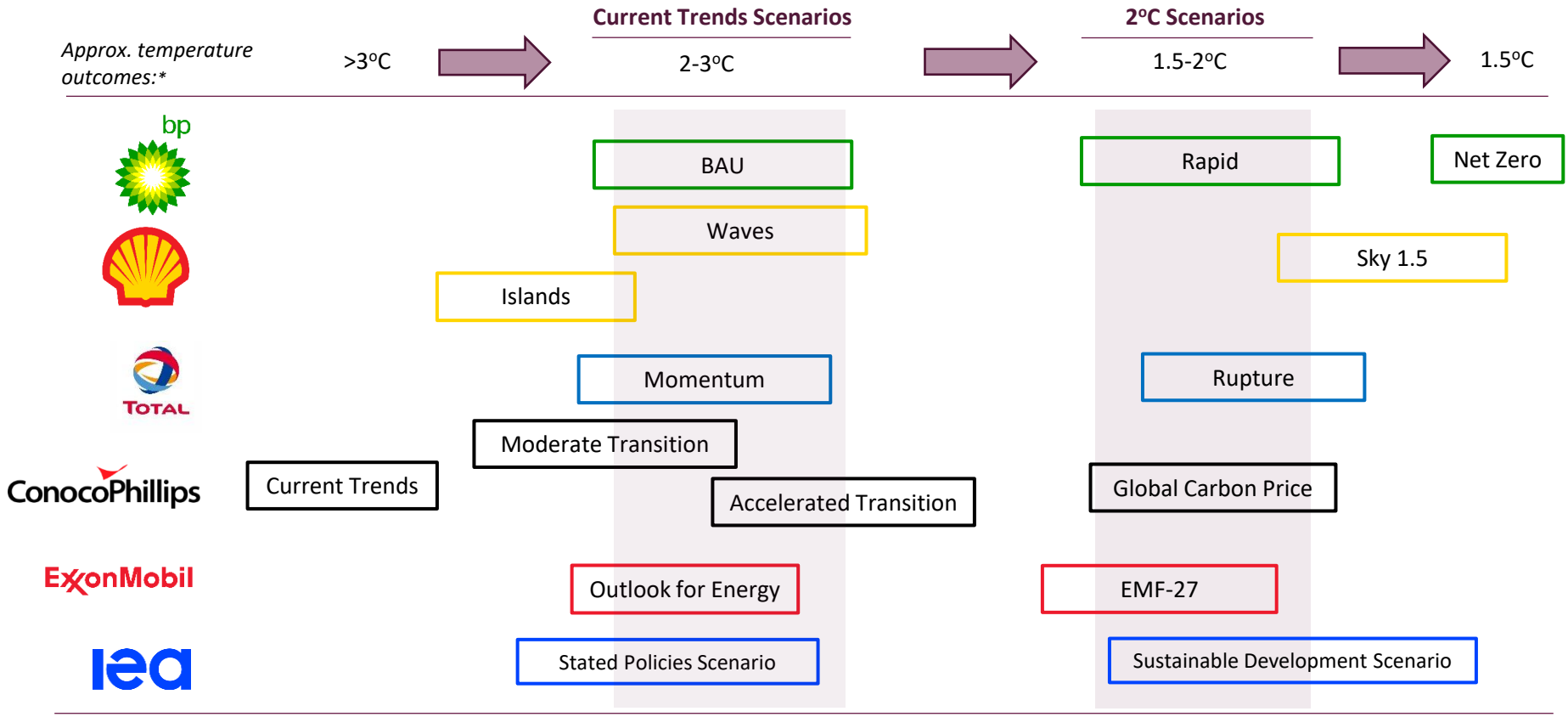
Granularity

The forecasts are not equally granular, both in breadth and depth of reporting. With regards to breadth, not all outlooks report the same metrics, with several reporting substantially fewer parameters, e.g. ConocoPhillips does not report expected share of EVs in total fleet or electricity share of total final consumption. Secondly, interim values are not always reported alongside end-year expectations. Given growth factors are not linear over time, functional form plays an important role in determining penetration growth rates of EVs, renewable energy and other factors which affect oil and gas demand.

Forecast Scenarios - summary

Most companies have developed several scenarios, all with varying input assumptions, metrics and reporting parameters. This complicates a comparison of scenario forecasts, particularly of scenarios which describe continuation of 'current trends'. Generally however it is possible to categorise scenarios into two areas : "Current Trends" and "2 Degrees".

Current trends are characterized by the policy commitments to emissions reductions in line with countries' Paris NDCs, the rate of renewable energy growth seen over the past decade, rapid electrification and growth of natural gas and its displacement of coal. This reflects the trend of climate policy, economic shifts and consumption patterns seen over the past 10 years. *2 Degrees* scenarios show changes in the energy system consistent with achieving the upper range of the Paris Agreement targets, ie 2 degrees.



* Ranges of temperature increases were estimated from correspondence of scenario energy-sector CO_2 emissions in end-years and development over time to probabilistic temperature outcomes modelled in the Fourth National Climate Assessment (Fawcett et al., 2016)

Scenario Comparison Matrix

Based on their alignment in describing future states defined by current trends and 2°C drivers, the following scenarios were compared across companies.

Company / *Scenarios*	BP	Shell	Total	ConocoPhillips	Exxon Mobil
Current Trends Scenario	**BAU**	**Waves**	**Momentum**	**Moderate Transition**	**Energy Outlook**
Cut-off Year	2050	2100	2050	2050	2040
Temperature Target	~2-3°C	~2.3°C	~2-3°C	>3.5°C	~3.5°C
Energy Demand (EJ)	725	901	720	835	713
Coal, Oil and Gas Share	66%	58%	70%	74%	75%
2°C Scenario	**Rapid**	**Sky 1.5**	**Rupture**	**Global Carbon Price**	***EMF27**
Cut-off Year	2050	2100	2050	2050	*2040*
Temperature Target	<2°C (NZ by 2070)	1.5°C (NZ by 2057)	1.5-1.7°C	2°C	2°C
Energy Demand (EJ)	625	828	634	547	N/a
Coal, Oil and Gas Share	40%	45%	25%	40%	N/a

** Exxon does not forecast a low-emission scenario, instead using Energy Modelling Forum 27 models (Stanford study) from 2014*

Omitted scenarios

Current trends. Given the 'current trends' criteria described, ConocoPhillips' *Current Trends* scenario is excluded. The low relative growth in renewables, marginal carbon pricing policies and oil demand of >125 Mb/d by 2050 are not in line with expectations given recent trends. Its *Moderate Transition* scenario is compared instead. Furthermore, both Shell's *Waves* and *Islands* depict higher emissions outcomes and continuation of some current trends. However, *Islands* is characterized by isolationist rebuilding and economic recovery post-Covid, and the most fragmented, deteriorating approach to climate change mitigation out of Shell's scenarios; *Waves*, while prioritizing economic recovery post-Covid as well, sees global efforts towards curbing emissions rebound later and is chosen to represent current trends.

2°C scenarios are those which aim for GHG emissions in line with a high likelihood of not exceeding 2°C of warming, requiring net-zero briefly before 2100. Shell's *Sky 1.5*, BP's *Rapid* and Total's *Rupture* scenarios, though stated as well-below 2°C aligned, do not see net-zero emissions by 2050 (earliest by 2057), therefore "well-below 2°C" scenarios are considered in the 2°C comparison category

IOC energy forecasts

There is a strong link between the sophistication of an IOCs (disclosed) energy demand modelling and its climate strategy – the more detailed and longer term the analysis, and the more information is disclosed, the greater the pivot to low carbon technologies.

Current Trends Scenarios

	Region	Europe				North America						Other			
	Company	BP	Shell	Repsol	Total	Marathon Oil	Chevron	ConocoPhillips	Exxon	Occidental	Suncor	Rosneft	Lukoil	Petrobras	PetroChina
	Scenario	BAU	Waves	STEPS	Momentum		RCP8.5	Moderate transition	Outlook for Energy	STEPS					
Metric	Source	Own scenarios	Own scenarios	IEA WEO 2017	Own scenarios	None published	IPCC AR5	Own scenarios	Own scenarios	IEA WEO 2019	None published	None published	None published	None published	China Outlook 2019
Year	2030	✓	✓	*✓	✓		*✓	✓	✓	*✓					
	2040	✓	✓	*✓	✓		*✓	✓	✓	*✓					
	2050	✓	✓		✓			✓							
1. Global energy demand		✓	✓		(✓)			(✓)	✓						
2. Total oil demand		✓	✓		✓			(✓)	(✓)						
3. Total gas demand		✓	✓		✓			(✓)	(✓)						
4. Liquid fuel demand in transport		✓			✓			(✓)	✓						
5. Oil demand in petrochemicals		✓			✓				✓						
6. Electricity share of total final energy consumption		✓	✓		✓				(✓)						
7. Renewable share of total primary energy		✓	✓		(✓)			(✓)	✓						
8. Levelised cost of electricity for wind, solar		✓													
9. Levelised cost of vehicle ownership: EV vs ICE		(✓)													
10. EV share of transport fleet		✓	✓		✓			(✓)	(✓)						

(✓) indicates metric is reported but only final-year value is given

*✓ indicates external/third-party scenario used

Note - comparison methodology

For holistic comparison across companies' forecasts, where data was missing this was interpolated. If a company had produced a forecast for the given metric but for a different period, a constant growth rate was assumed and the given given data point scaled to time periods by its compounded constant average annualized growth rate. Where no data points across time periods were given for a metric, an average of other companies' forecasts was used.

IOC energy forecasts

There is a strong link between the sophistication of an IOCs (disclosed) energy demand modelling and its climate strategy – the more detailed and longer term the analysis, and the more information is disclosed, the greater the pivot to low carbon technologies.

2°C Scenarios

	Region	Europe				North America						Other			
	Company	BP	Shell	Repsol	Total	Marathon Oil	Chevron	ConocoPhillips	Exxon	Occidental	Suncor	Rosneft	Lukoil	Petrobras	PetroChina
	Scenario	Rapid	Sky 1.5	SDS	Rupture		SDS	Global Carbon Price	EMF-27	SDS					
Metric	Source	Own scenarios	Own scenarios	IEA WEO 2017	Own scenarios	None published	IEA WEO 2020	Own scenarios	Third-party	IEA WEO 2019	None published	None published	None published	None published	China Outlook 2019
Year	2030	✓	✓	*✓	✓		*✓	✓	✓	*✓					
	2040	✓	✓	*✓	✓		*✓	✓	✓	*✓					
	2050	✓	✓		✓			✓							
1. Global energy demand		✓	✓		(✓)			(✓)	✓						
2. Total oil demand		✓	✓		(✓)			(✓)	(✓)						
3. Total gas demand		✓	✓		(✓)			(✓)	(✓)						
4. Liquid fuel demand in transport		✓	✓		(✓)			(✓)	✓						
5. Oil demand in petrochemicals		✓			(✓)										
6. Electricity share of total final energy consumption		✓	✓		(✓)										
7. Renewable share of total primary energy		✓	✓					(✓)	✓						
8. Levelised cost of electricity for wind, solar		✓													
9. Levelised cost of vehicle ownership: EV vs ICE		(✓)													
10. EV share of transport fleet		✓			✓			(✓)							

(✓) indicates metric is reported but only final-year value is given

*✓ indicates external/third-party scenario used

Note - comparison methodology

For holistic comparison across companies' forecasts, where data was missing this was interpolated. If a company had produced a forecast for the given metric but for a different period, a constant growth rate was assumed and the given given data point scaled to time periods by its compounded constant average annualized growth rate. Where no data points across time periods were given for a metric, an average of other companies' forecasts was used.

SECTION 5. IOC COMPLIANCE WITH THE TCFD

IOC scenarios and TCFD

The Taskforce for Climate-Related Financial Disclosure has developed recommendations for scenario analysis to assess climate change impacts on firms' financial and strategic planning. We have assessed the compliance with the TCFD recommendations for each IOC reviewed in this study. Only four comply with the recommendations, and these are climate leaders. The remaining firms have limited compliance.

TCFD Recommendations

Scenarios – companies should consider:

- **A set of scenarios,** both favourable and unfavourable in their future outcomes to business operations, not just singular scenarios.
- The set should **include a transition scenario, such as a 2°C or below scenario**, as well as at least one other reference scenario which is jurisdictionally-relevant, e.g. one which targets NDC/some mitigation outcome, or a suite of scenarios such as the IPCC's RCPs.

Disclosure – key assumptions and pathways should be disclosed so analytical approach and limitations of forecasts can be understood.

- **Input parameters/assumptions should be disclosed**, such as technological response, timings and potential costs, variation in parameters across geography, markets and time.
- **Timeframes** of climate risks and their materiality to operations under different scenarios
- **Resilience** of the company's finances and strategy under various scenarios, including transition scenario, are assessed.

Application – the more material and significant a company's exposure to climate risks, the more rigorous analysis should be.

- **Comprehensive, including quantitative**, if relevant, scenarios should be developed, particularly **considering key drivers** which affect the business.
- **External scenarios may be used** where in-house modelling capacities aren't yet fully developed, and quantitative approaches are first developed, though, particularly in the case of IOCs, these **should be the most current iterations**.

Alignment of IOCs Scenario Disclosures with TCFD Recommendations:

TCFD Recommendation	BP	Shell	Repsol	Total	Marathon Oil	Chevron	Conoco Phillips	Exxon	Occidental	Suncor	Rosneft	Lukoil	Petrobras	PetroChina
Scenarios Analysis	✓	✓	✓	✓		(✓)	✓	✓	(✓)					(✓)
Transition (2C) Pathway	✓	✓	✓	✓		✓	(✓)	✓	✓					(✓)
Assumptions Disclosed	✓	✓		✓			(✓)	✓						
Material Timeframes	✓	✓		✓			✓							(✓)
Scenario Resilience Assessment	✓	✓	✓	✓		✓			✓					
Key Business Drivers Analysed	✓	✓	✓	✓		(✓)		✓	(✓)					(✓)
Up-to-date Scenarios	✓	✓		✓		✓	✓	✓	(✓)					(✓)
Compliant with TCFD recomm's	✓	✓	✓	✓		(✓)	(✓)	(✓)	(✓)					(✓)

(✓) indicates partial compliance with criteria – either limited in scope or incomplete information

SECTION 6. IOC COSTS OF EXTRACTION

Cost of oil and gas production of IOCs

IOCs' strategies and production decisions are decided as much by expectations of future oil demand and pricing as by current production costs and financially feasible resource access. We therefore also consider metrics for operating and capital costs of oil and gas production within the sample.

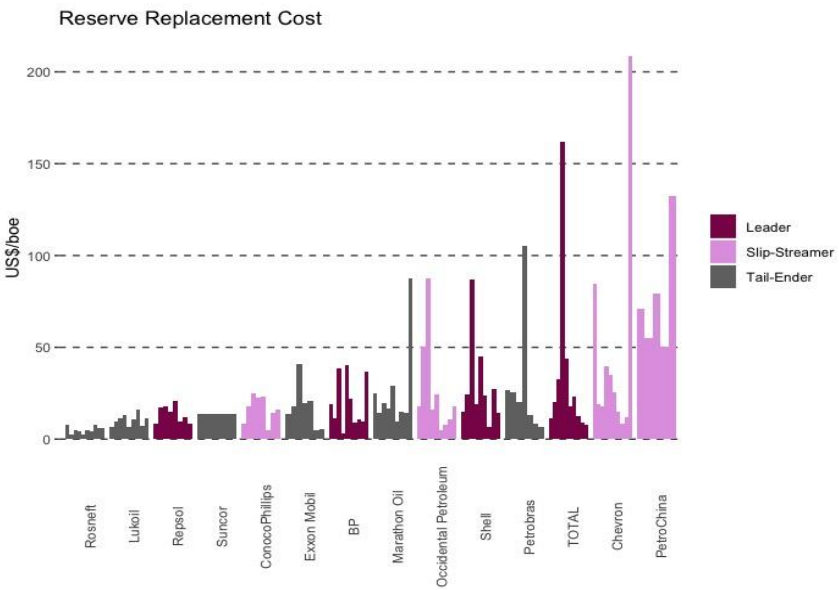
The divergent strategies amongst IOCs fundamentally determine future output levels of oil and gas. Traditional operations of O&G companies revolved around reducing operating costs to increase margins and finding cheap new reserves to ensure continued growth as current reserves are depleted. However, oil price volatility and cost-competitiveness of clean energy sources over the past decade has disrupted the operational status quo. While companies such as ExxonMobil have amassed vast capital expenditures on relatively small amounts of reserves, the US shale revolution has seen low capital costs drive profitability while oil prices remained above higher-than-average marginal extraction costs of shale resources. The oil price collapses of 2015, which saw some US$ 4 billion in P7P oil reserves written-off, and 2020 have called into question the long-term financial resilience of the oil industry. Central to continuing operations are the costs at which companies can extract oil and gas, and their resilience to commodity price fluctuations.

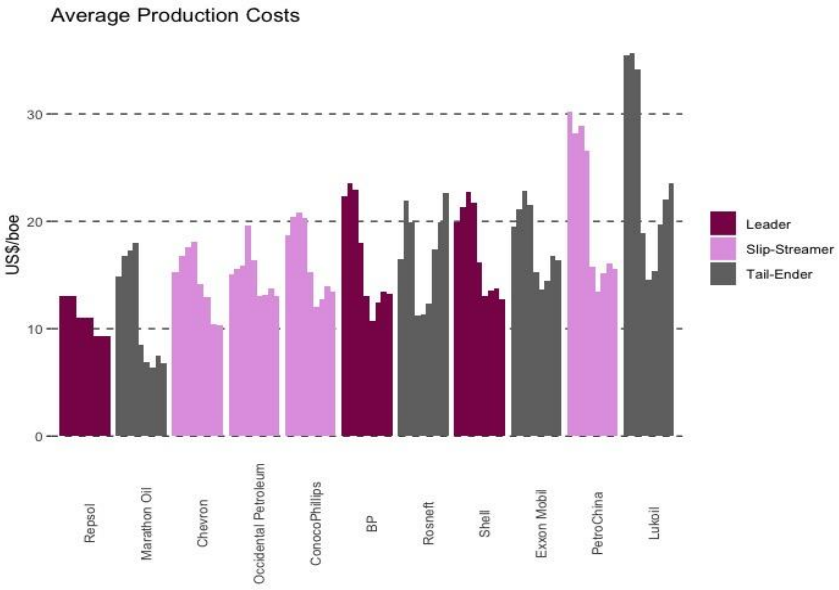
To assess whether cost considerations are driving the divergence in IOC climate strategies, and by extension their extraction and production planning, we consider two metrics which look at the capital and operating costs of production:

- **Reserve replacement costs** (RRC). This proxies for the capital costs of oil and gas production by calculating how much it costs a company to replace the existing reserves it uses in production, on a barrel of oil equivalent basis.
- **Average production cost**. This is a measure of the operating expenses of an IOC, calculating the barrel of oil equivalent cost of production and taxes associated with a firm's level of output.

To provide a holistic overview of the total cost per barrel of oil equivalent, both of producing and replacing it, the metrics are then combined. A weak correlation between stronger climate commitment and higher combined cost is identified, however it is by no means strong enough to be considered the main driver of strategy over the next decades.

Cost of oil and gas production of IOCs





Reserve Replacement Cost

Reserve replacement cost (RRC) is calculated by dividing the sum cost of proven reserve acquisitions, exploration and development by proven reserve additions, revisions, purchases in place and improved recovery.

The metric indicates the cost of new reserves added, with resources incurring higher capital expenditures, e.g. non-OPEC onshore drilling, incurring substantially higher RRCs than low-capex projects, such as shale gas wells.

RRC is subject to considerable variance, given its sensitivity to reserve revisions in particular. The oil price crash of 2015, for example, led to $4bn of oil reserves being revised down from proven and probable, resulting in negative RRCs for several companies. For meaningfulness of results, 2015 was excluded from calculations and figure 3.9 . Nonetheless, we see the impacts of high opportunity costs of field development, driven by expensive capital investments and low reserve additions which have characterised the oil industry in the past 5 years

Average Production Cost

This is calculated as the sum of total oil and gas production costs and production taxes, divided by total oil equivalent production. Production costs include current portion of ARO liabilities.

While RRC proxies capex in the O&G industry, average production costs indicate companies' operating expenditures. Production costs, not being subject to reserve revisions, are much less varied within companies from year-to-year, and also the between company spread is considerably smaller. However, the impact of the 2015 oil price crash can similarly be observed in the substantial drop in production costs for fall companies, rebounding considerably less so for leaders than for laggards

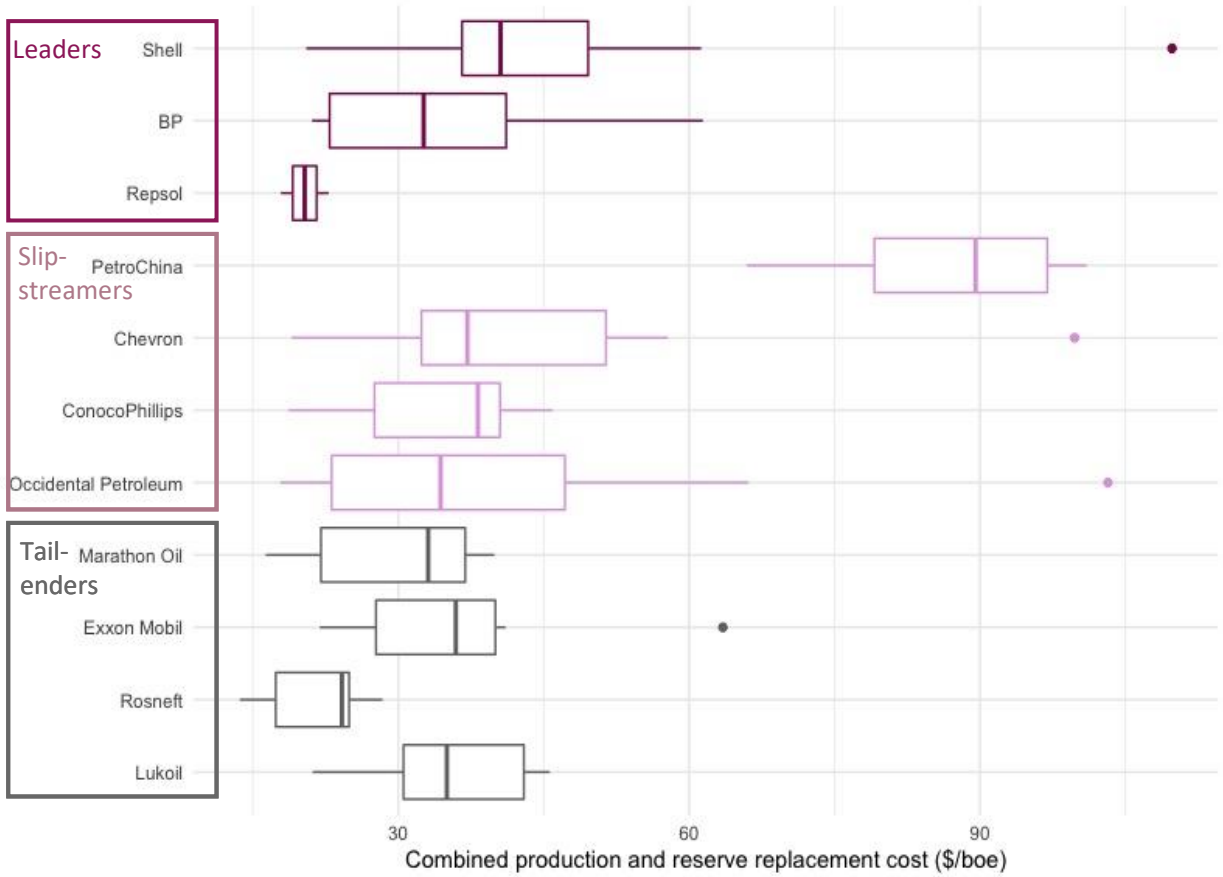
Cost of oil and gas production

This analysis shows that there is little correlation between the production costs and reserve replacement costs and IOC climate change commitments. This suggests that the climate Leaders in the oil and gas industry are driven by their views on the future of the oil market rather than increasingly high costs of extraction and production.

This chart shows the average cost of extracting oil and gas for each firm, combined with the cost to replace extracted barrels, between 2010 and 2020. It comprises the sum of Reserve Replacement Cost and average Operating Costs [(1)].

The central, vertical line within each square represents mean, with lines to the left and right the lower and upper quartiles, respectively. The horizontal lines extend to show the range of costs, and dots represent extreme values, which are interpreted as outliers given RRC's sensitivity to reserve revisions which can result in meaningless values.

On average, combined costs lie mostly between $30-$40/boe. While tail-enders as a group show a slightly lower spread in costs, the differences are not large enough to concretely indicate climate strategy is driven by financial considerations



1. Marathon Oil is excluded from the sample as it had RRCs lower than -$500/boe for several years, as are Total and Petrobras due to missing data on production taxes and costs

SECTION 7. OBSERVATIONS & RECOMMENDATIONS

Observations & recommendations

In this project we have undertaken a detailed comparison of the climate strategies of the world's major oil and gas companies and assessed the reasons for their different approaches to the energy transition. From this analysis we draw five main conclusions:

Observations

1. ***IOCs that embrace the energy transition and set ambitious climate strategies also have forecasts of the oil market that indicate this to be a logical, long-term strategy.***
2. ***Climate leading IOCs see greater potential for oil demand to be eroded and prices to remain low, than the laggards do***. They see this being caused by a combination of climate policies and the continued downward pressure on the cost of low carbon technologies.
3. ***Climate leading IOCs have marginally higher extraction costs than the laggards, but not sufficiently high to explain their greater pivot to low carbon energy technologies***. Climate leading IOCs have adopted more rapid energy transition strategies because of their view of risks to the oil market, not because they have significantly different cost bases.
4. ***IOC climate laggards*** tend not to look as far into the future at the climate leaders (projections can stop at 2040 rather than 2050) and compliance with the Paris Agreement can be interpreted as a 2^0C warming goal, rather than 1.5^0C goal. Both these factors can have material outcomes for projecting global oil demand.
5. ***IOCs differ significantly in their compliance with the Taskforce on Climate Related Disclosures (TCFD)***. Climate leaders are generally compliant with TCFD disclosure recommendations (BP, Shell, Repsol, Total), whilst tail-enders are least compliant (eg Marathon, Suncor, Rosneft, Lukoil, Petrobras).

Alignment of IOCs Scenario Disclosures with TCFD Recommendations

TCFD Recommendation	BP	Shell	Repsol	Total	Marathon Oil	Chevron	Conoco Phillips	Exxon	Occidental	Suncor	Rosneft	Lukoil	Petrobras	PetroChina
Scenarios Analysis	✓	✓	✓	✓		(✓)	✓	✓	(✓)					(✓)
Transition (2C) Pathway	✓	✓	✓	✓		✓	(✓)	✓	✓					(✓)
Assumptions Disclosed	✓	✓		✓			(✓)	✓						
Material Timeframes	✓	✓		✓			✓							(✓)
Scenario Resilience Assessment	✓	✓	✓	✓		✓			✓					
Key Business Drivers Analysed	✓	✓	✓	✓		(✓)		✓	(✓)					(✓)
Up-to-date Scenarios	✓	✓		✓		✓	✓	✓	(✓)					(✓)
Compliant with TCFD recomm's	✓	✓	✓	✓		(✓)	(✓)	(✓)	(✓)					(✓)

(✓) indicates partial compliance with criteria – either limited in scope or incomplete information

Observations & recommendations

The central recommendation from this analysis is that IOCs need to reveal their projections of the energy system on a consistent basis and disclose the assumptions they use. In many respects this means ensuring compliance with the TCFD. However, compliance with the TCFD is not sufficient to encourage IOCs to adopt more ambitious climate strategies. The main purpose of the TCFD is for investors to understand the risks faced by companies under future climate mitigation scenarios.

For IOCs to change their strategies they need to create meaningful, long term, low emission scenarios and believe that they are likely to occur. Asking an IOC to assess their business against an extreme emissions scenario that the firm believes has little chance of happening is unlikely to alter the firm's business strategy. IOCs with less ambitious climate strategies, need to believe there is a significant chance that demand for oil will decline – as the leaders do. This comes from a deeper understanding of the factors driving changes in the energy markets.

More comprehensive disclosure around companies' understanding of the future energy system will help inform investors the risks companies face, but will also help companies learn from each other. Specifically we recommend that IOCs expand their disclosures beyond the minimum guidance provided by the TCFD:

1. ***All projections are made at least to 2050.*** Currently some projections only extend as far as 2040.
2. ***Projections need to include three scenarios:***
   - *(i) Business as Usual* – Also sometimes referred to as a Reference scenario, or Stated Policies (IEA). This shows how energy and oil demand will change without any further policy interventions or step changes in technology.
   - *(ii) The central scenario the company strategy is based on* – This is likely to be the "base case" for business planning purposes, incorporating the company's central view on oil demand and prices, where this can be disclosed.
   - *(iii) A 1.5^{0}C trajectory* – this is the most extreme impact scenario and arguably the least likely. However, it provides a worst-case scenario for IOCs in terms of oil demand.
3. ***Within each projection IOCs should show their assumptions for 10 key inputs.*** These are important, as they show where and how IOC market projections differ. With this information investors are able to understand where deficiencies in market understanding may lie, and challenge companies on their forecasts and appropriateness of their business models.

For the three scenarios IOCs should provide disclosures against the following 12 metrics. These metrics will allow more direct comparison of oil company visions of the future and how their businesses will be affected by future changes in the world energy system.

Observations & recommendations

Criteria	Sector / metric	Comments
Energy demand (mtoe)	Total primary energy demand	Firms should make clear how they treat traditional biomass and measure the primary equivalent of nuclear, hydro and electricity from renewable sources.
Oil demand (Mbpd and mboe/yr)	Total oil demand	Include all forms of oil use, splits by fuel type to be provided separately (see below). Provide industry reference metric of mbpd and mtoe/yr
Oil demand by fuel type (Mbpd and mboe/yr)	Fossil oil	Fossil oil demand (includes crude from conventional and tight oil, NGLs, GTLs and coal to liquids.
	Biofuels	Future demand for biofuels used for combustion, ie exclude bio-products used in plastics.
Oil demand by use (Mbpd and mboe/yr	Power	Split by fossil and biofuels
	Industry	Split by fossil and biofuels
	Buildings	Split by fossil and biofuels
	Non-combusted	Amount of oil used in plastics – split by fossil and biofuels where necessary. Show where cumulative plastics end up. Quantity of plastics (i) recycled (ii) thermal destroyed (with/without energy recovery) (iii) landfill (iv) uncollected on land or in sea.
	Transport	Split by cars/trucks and fossil/biofuels
	Transport - aviation	Split by fossil and biofuels
	Transport – sea & rail	Split by fossil and biofuels
Gas demand (MMbtu or mboe/yr)	Total gas demand	Total gas demand for all uses
	Power	Reciprocating engines, OCGT and CCGT
	Industry	All forms of gas used in industry
	Buildings	Gas used for heating
	Transport	CNG and related vehicle gas use
	Non-combusted	For use a feedstock
	Hydrogen	In use for combustion purposes but not as a chemical feedstock
Electricity use	Total electricity demand (EJ)	Electricity generated from all sources as delivered energy
	Electricity share of total final energy demand (%)	This shows how rapidly the world is moving towards electrification. Note final energy demand, not primary energy demand.
Renewable energy	Total renewable energy output (EJ)	Measured as delivered energy.
	Wind and solar output (EJ)	Measured as delivered energy
	Biomass (EJ)	Biomass and biofuels. NB: excludes traditional biomass.
	Geothermal (EJ)	Measured as delivered energy
	Renewable as % final energy demand (%)	Final energy demand measured as EJ
Costs	LCOE of wind power ($/MWh)	Onshore wind - Standardise calculations for 30% load factor Offshore wind – standardise calculations for 50% load factor
	LCOE of solar PV power ($/MWh)	Standard calculations for 10%, 20% and 30% load factor
	Cost of vehicle ownership ($ per km driven)	Also show cost of vehicle purchase. Standardise assumptions for mid-size family car – 10,000 miles/yr, 10 year life time, price of electricity $50/MWh.
	Battery price ($/MWh)	Price of battery packs for vehicle use and power storage.
Electric vehicles	Number of EV Sales / % of total new vehicle sales	Include number of “light vehicles” and “e-motorcyles”.
	% of car fleet	% of light vehicles and e-motorcyles in operation
CCUS	Volume of CCUS capacity in place (MtCO2/yr)	Separate out EOR and new CCS
	LCOE of CCUS ($/tCO2)	
Nature based sequestration (MtCO2/yr)	REDD+, restoration, soil & Other	Show annual carbon sequestration rates for land use categories
GHG emissions (MtCO2e/yr)	CO2, methane.	Total annual CO2e emissions from fuel combustion and methane emissions. Separate methane emissions from oil & gas and other sources.

APPENDICES

A1. EXPLANATION OF IOC ENERGY SCENARIOS

A2. SCORING AND WEIGHTING OF IOC ENERGY SCENARIOS

A3. DETAILED COMPARISON OF IOC ENERGY SCENARIOS

A1. EXPLANATION OF IOC ENERGY SCENARIOS

IOC energy scenarios

An overview is provided here of the different scenarios of the five IOCs which publicize their use and summary findings.

bp	***Business-as-usual*** – This scenario assumes a continuation of regulatory, political, economic and social preference trends seen in recent past. Some progress in curbing GHG emissions is made, with energy emissions peaking in mid-2020s, but reductions are slow, with 2050 emissions still some 30 $GtCO_2$, in large part due to weaker policy initiatives, such as low carbon pricing, resulting in a 67% fossil fuel-share of primary energy consumption by 2050. ***Rapid*** – Involves strong and coordinated policy approaches and sector-specific measures such as technology and infrastructure development. Fossil fuels provide less than 40% of primary energy demand, predominantly from gas, and CCS is widely deployed, resulting in a 70% reduction in energy-emissions by 2050, in line with limiting temperature increase to 2°C by 2100. ***Net Zero*** – Assumes the policy responses of *Rapid* are reinforced by substantial shifts in social preferences and behaviour. Circular and sharing economies become widespread, with societal drivers complimenting policy drivers for even stronger GHG abatement, with renewables providing >60% of energy demand and energy emissions by 2050 are less than 10% of current levels, with the remaining share offset through negative emission solutions, limiting global warming to 1.5°C.

	Waves – After Covid-19, the impetus is to repair and rebound economic wealth and growth, seeking a return to normality. Governments' economic strategies are predominantly self-interested, and while high-level economic indicators rebound strongly, underlying wealth and income inequalities abound. From an energy perspective, Fossil fuels provide ~58% of primary energy by 2050. Net-zero emissions from energy are achieved by 2100, leading to ~2.3°C global temperature increase. ***Islands*** – Self-sufficiency and reliance in the post-Covid rebuild are prioritized, with securitization of resources and energy dependence leading strategy objectives. Isolationist policies lead to fragmented and disparate growth outcomes, with richer countries outperforming less developed countries and those reliant on energy imports. Net zero is not achieved by 2100. ***Sky* 1.5**– Global health recovery after the pandemic gives way to focus on recovering environmental health. Effective government policy drives economic and industrial collaboration, inducing rapid electrification in all end-use sectors, with renewables providing >50% of primary energy demand by 2050. The energy sector reaches net-zero by around 2057.

IOC energy scenarios

TOTAL	***Momentum*** – Assumes a Green Deal is reached in Europe, committing to net-zero emissions, but other countries actions are in pursuit of their nationally-determined contributions (NDCs). Proven technologies are widely deployed, with solar and wind yearly capacity additions doubling to 200 GW/yr (compared to 2010), 40% of plastics being recycled and single-use plastics (SUPs) banned in Europe and China by 2040. CCS abatement reaches around 2Gt/yr, or 6% of emissions. ***Rupture*** – Sees global commitment to achieving net-zero emissions, with public policies and technological breakthroughs facilitating aggressive scaling of new technologies such as hydrogen, CCS and synthetic fuels. Renewable capacity additions are fivefold higher than 2010 levels (500 GW/yr), single-use plastic are banned worldwide by 2040, and CCS capacity reaches 7.5GtCO_2/yr, around 50% of emissions, with remaining emissions offset through nature-based solutions.
ConocoPhillips	***Current trends*** – Assumes government cooperation and policy remains uncoordinated. OECD region carbon prices rise to \$30/tCO_2 by 2030, and non-OECD countries do not implement any pricing, even by 2050. Oil demand grows by almost 30%, and gas by 75%, with fossil fuels comprising 75% of global energy demand by 2050. ***Moderate transition*** – Government policy, particularly carbon pricing, sees moderate advances, with higher OECD carbon prices, as well as Chinese and non-OECD schemes introduced. However, oil production grows steadily, benefitting from technological improvements to extraction, and power generation drives strong gas growth. Fossil fuels still constitute 75% of primary energy demand by 2050, with energy emissions stabilizing at current levels by then. ***Accelerated transition*** – While regulation and policies are widely and aggressively implemented to curb GHG emissions, fossil fuel production and consumption, consumer preferences and private sector-driven technological advances play a substantial role in decarbonization. Oil demand peaks by 2025, while gas peaks in 2045. Energy storage improvements allow larger shares of renewables in energy, with fossil fuels providing 68% of primary energy demand by 2050. ***Global carbon price*** – Mass technological breakthroughs, unprecedented global cooperation and policy regulation, and societal shifts greatly reduce fossil fuel consumption and emissions. Efficiency improvements reduce total energy demand by 5%, with 55% provided by non-fossil fuel sources, by 2050. Energy related emissions are less than a third of current levels by 2050, corresponding to a ~2°C temperature increase.

IOC energy scenarios

ExxonMobil	***Outlook for energy*** – Sees global energy demand driven by increasing household income globally, leading to primary energy demand rising by 20% by 2040, driven primarily by non-OECD growth. Natural gas sees the strongest growth of any energy source and oil also continues to grow, remaining the worlds foremost energy source by share of primary demand. Policy responses and strategic planning is expected to develop at the same pace as recently, reducing emissions in line with countries' NDCs, yet a 2^{o}C-limit on global warming will not be achieved. Represents Exxon's expectation of future emissions and abatement effort. ***EMF-27**** - Exxon uses average growth rates of external models calibrated for 2^{o}C limits to global warming. Natural gas is still expected to grow, while on aggregate oil declines out to 2040, though by less than natural declining rate from existing production sites. Together they still constitute 40% of primary energy demand by 2040, remaining crucial to energy systems across all compared models.

*EMF-27 - Energy Modelling Forum 27, a model-intercomparison project of 13 integrated assessment models, conducted at Stanford University in 2014.

A2. SCORING AND RANKING OF IOC ENERGY SCENARIOS

IOC climate strategy scoring and ranking

The following slides show the detailed assessment of individual company climate strategies.

1. Policy Disclosures

Disclosures were given the lowest weighting out of the three commitment groups. While policy disclosures, particularly direct addressal of climate change risks to business and positions on the Paris statement are widespread across the sample of companies, policy disclosures and statements by themselves are only as strong as the emissions targets and low carbon investments which they encompass. Hence, lower weighting is given to the disclosures and statements made by companies than the targets themselves.

		Commitment		
Measure	*Weighting rationale*	**Strong**	**Some**	**None**
Climate Change Strategy	Formal action outlined by the company to address climate change risks, both transitional and physical, are given a higher weighting due to material significance for company strategy and shareholder valuation	**2**	**1**	**0**
Paris Statement	Statements on Article 6 of the Paris Agreement are to a large degree spurred by reputational considerations and in the sample by no means influence the strength of climate change mitigation, hence are given a lower weighting	**1**	**0**	**0**
OGCI Member	OGCI membership, while entailing hard targets is given a lower weighting as the entailing targets are scored in the emissions targets section below, as well as weakness of targets themselves compared to those set independently by more aggressively abating firms	**1**	**0**	**0**

IOC climate strategy scoring and ranking

2. Emissions Targets

For substantial reduction in emissions and alignment with low-carbon economic growth, O&G companies will need to rapidly scale-up their investments into low-carbon solutions. These range from negative emission technologies, such as CCUS, and nature-based solutions to renewable energy supply and clean technologies. To avoid the transition risks and shareholder aversion under increasingly stringent regulatory and shifting energy environments, investments into low-carbon solutions will be central to financial resilience and growth, and thus has the highest weighting after emission targets

		Commitment score		
Measure	*Weighting rationale*	**Strongest**	**Some**	**None**
Scope 1 & 2	Setting absolute operational emissions targets directly impacts the second-highest emissions source in the oil and gas value chain - from operations - i.e. scope 1 and 2 emissions, and is given the second highest weighting in the emissions category	**5**	**2**	**0**
Scope 3	End-use emissions from consumption of marketed products represent the overwhelming share of oil and gas-related GHG emissions. Across the companies, ca. 87% of total emissions were scope 3, hence efforts to reduce this were given the highest weighting	**6**	**4**	**0**
Operational Emissions Intensity	Relative operational emission intensity targets were much more common than absolute targets, reflecting less aggressive abatement necessary to reduce emissions on a per-energy-unit basis than an absolute level, if output and production is expected to grow. Since relative emissions intensity do not preclude overall growth in absolute emissions, they were thus assigned a lower weighting	**3**	**2**	**0**
Methane Intensity	Methane's global warming potential over 100 year is ca. 21 times that of CO2, however on a CO2-equivalent basis, methane emissions represented around 7% of total operational emissions. Given the share of contribution to total emissions, it was thus assigned a lower weighting than targets aimed at total GHG emissions or intensity	**2**	**1**	**0**
Flaring Commitments	Emissions from flaring represent roughly 6% of total emissions from oil and gas operations worldwide. While a considerable source of emissions, reducing flaring and/or re-using flared gases can be addressed to a large extent through infrastructural and best technology practices in project planning stages, at low-cost, and with potential financial incentives, e.g. revenue from associated petroleum gases (APG) captured	**2**	**1**	**0**
Timeframe(s)	Although emissions targets themselves determine most of the ultimate abatement, the timeframes for them matter for two reasons. Firstly, consistent interim targets avoid short to medium-term inaction in the hope of backloading opportunities later on. Secondly, they permit assessment of companies' alignments with emission budgets in low-carbon scenarios, e.g. those required by the Paris Agreement.	**2**	**1**	**0**

IOC climate strategy scoring and ranking

3. Low Carbon Investments

For substantial reduction in emissions and alignment with low-carbon economic growth, O&G companies will need to rapidly scale-up their investments into low-carbon solutions. These range from negative emission technologies, such as CCUS, and nature-based solutions to renewable energy supply and clean technologies. To avoid the transition risks and shareholder aversion under increasingly stringent regulatory and shifting energy environments, investments into low-carbon solutions will be central to financial resilience and growth, and thus has the highest weighting after emission targets

		Commitment score		
Measure	*Weighting rationale*	**Strongest**	**Some**	**None**
NBS	Nature-based solutions, primarily re-/afforestation, have been adopted by several firms and can simultaneously offset emissions, and reduce rising environmental rehabilitation costs of operations. However, the financial incentives, as well as their abatement potential given current land use, lowers their efficacy compared to other low-carbon solutions, and are thus weighted lower within the category	**2**	**1**	**0**
CC(U)S	Carbon capture, use and storage (CCUS), is expected to play a central role in achieving negative emissions required for 1.5 and 2C temperature targets, particularly with permanent sequestration. Currently, all CCUS in the O&G industry is operated for CO2-enhanced oil recovery (CO2-EOR), which more than halves the sequestration potential when accounting for carbon content of extracted oil, spurred by large tax credits primarily in the US.	**4**	**2**	**0**
Cleantech VC/R&D	Dedicated facilities for development of clean technologies, both through R&D and corporate venture capital play an important role in reudcing emissions by helping green technologies mature and decrease in cost, as well developing technologies which reduce emissions in O&G operations, and are thus given a high weighting in the category	**4**	**2**	**0**
Low-carbon Energy	Low-carbon energy, encompassing primarily natural gas and renewable energies, are at the centre of O&G companies' repositioning of business models. O&G companies' expertise in developing and financing large energy infrastructure, make them primed to play a leading part in developing the >$3 trillion of renewable infrastructure required by 2050.	**4**	**2**	**0**
Renewables in Own Supply	Companies have also taken steps to reduce operational emissions by supplying own energy use from renewable sources. While encouraging, the share of displaced emissions is still a relatively small fraction of overall emissions, and hence is given a lower weighting	**2**	**1**	**0**

IOC climate strategy scoring and ranking

	Strength of Climate Commitment		
	Leader	Slip-stream	Tail-end
1. Policy Disclosures			
Climate Change Mitigation Strategy	The company has formulated strategy and implemented tangible measures which address climate change by reducing emissions from production and/or consumption of oil and gas products	Company has acknowledged climate change as an inssue in strategy formulation, and is taking steps to quantify and monitor environmental of operations, but no hard targets for reduction of emissions have been set. Excludes efficiency-driven targets such as recycling of flared gases	No attempt in corporate strategy to address climate change, monitor emissions, or set reduction targets for the purpose of reducing environmental impact
Paris Statement	Explicit or implicit acknowledgement of the Paris Agreement's Article 6, pledging to limit emissions to ensure no more than 2ºC of warming, as well as expression of support towards the aim	Acknowledgement of Paris Agreement's Article 6, but no explicit expression of support	No mention of the Paris Agreement, Article 6, or any other pledge to limit global warming to 2ºC or below
OGCI Member	Company is a member of the Oil and Gas Climate Initiative	N/A	Company is not a member of the OGCI
2. Emissions Targets			
Net Operational Emissions (Scope 1 & 2)	Indicates the company has set a net zero target for emissions resulting from operations (Scope 1 and 2)	Company has set a target for reduction of absolute operational emissions, but not net zero	Company has set no target for reduction of emissions from operations
Net Product Emissions (Scope 3)	Company has set a target to reduce emissions from consumption of its products, both through direct offsetting of associated lifecycle emissions and reducing carbon-intensity of output, e.g. through changing mix of energy supplied	Company has set a target to reduce the carbon intensity of marketed products through shifting mix of products sold. No commitment made regarding emissions from use of products sold	Company has made no commitments regarding emissions associated with the use of its products
Operational Emissions Intensity	Inidcates the company has pledged operational emissions intensity, i.e. the relative emissions associated with a standard unit of energy output (MJ), **reduction of >50%**	Company has pledged operational emissions intensity, i.e. the relative emissions associated with a standard unit of energy output (MJ), **reduction of 1-50%**	No commitment has been made by the company to reduce the relative emissions intensity of its operations, per unit of energy output (MJ)
Methane Intensity	Explicit methane-intensity (% of total natural gas production) target of **<0.2%** targetted within 10 years	Methane-intensity target set for **<0.25%** (OGCI target) within ten years. This can be explicit or implicit, e.g. through strategic aim of capturing all APG from crude manufacture	No explicit methane intensity reduction target set or implicit reductions expected from other strategic goals
Flaring Commitments	Company has committed to **0 routine flaring by 2030**	Company has pledged to **reduce flaring by >20%**	No commitment has been made to reduce flaring, or commitment is **<20% reduction**
Timeframe(s)	Long-term target set as well as interim, progress-status checks	Only long-term or single target date set	No explicit target set
3. Low Carbon Investments			
NBS	Company has spent **>$100m on re-/afforestation** to promote development of land as carbon sinks	Company has financed re-/afforestation as part of capital decomissioning and environmental rehabilitation	No re-/afforestation committed
CC(U)S	Company has developed, financed, contributed to or marketed CCS technology for the purpose of permanently sequestering carbon/CO2	Company has developed CCUS for the purpose of CO2-enhanced oil recovery	No CCS/CCUS technology developed
Cleantech VC/R&D	Dedicated segment or subsidiary has been set-up or acquired for the purposes of developing cleantech, low-carbon technologies and energy efficiency R&D	Cleantech and low-carbon R&D being pursued by the company, but as part of existing operations	No cleantech/low-carbon R&D or VC efforts
Low-carbon Energy	Investments of over **$1bn/yr or 10% of invested capital** pledged towards renewable energies in supply mix by 2030	Development of low-carbon gas supply through APG capture, CCS/CCUS or other technologies	No low-carbon energy sanctioned or planned to be developed
Renewables in Own Supply	**>250MW or >40% of energy consumption** supplied by renewables	Some renewable energy developed or PPA-leased to meet own-consumption energy demand	No renewable energy in production

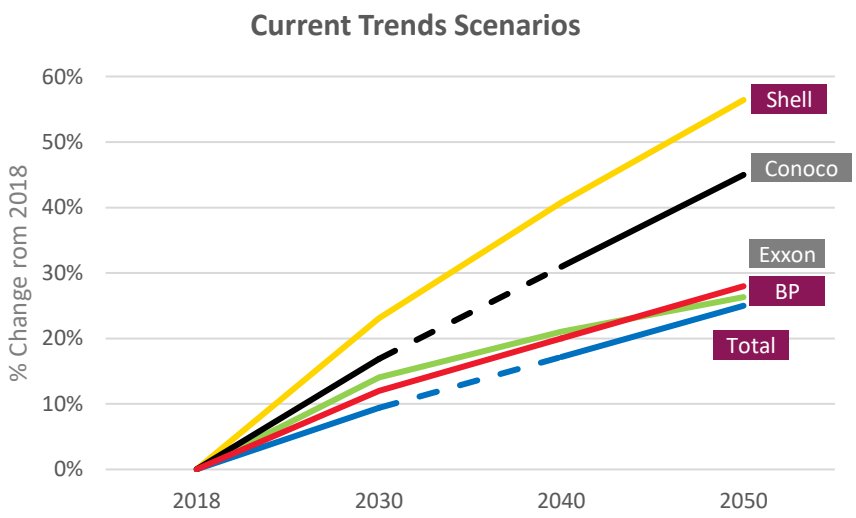
A3. COMPARISON OF IOC ENERGY SCENARIOS

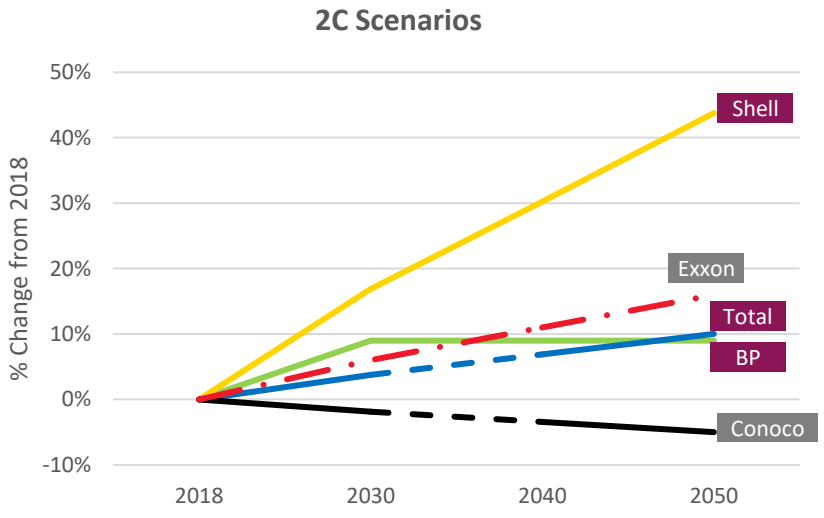
Scenario Comparison - Global Energy Demand Growth

While all IOC outlooks expect global energy demand to grow, the growth rates vary substantially. There is however little relationship between the global energy demand forecasts of climate leaders and laggards.

Under Current Trends, ConocoPhillips expects world energy demand to increase rapidly, forecasting a 45% growth by 2050. Shell (a climate leader) sees an even higher rate of energy growth, growing by just over 55%. Exxon and BP's forecasts are nearly identical to 2040, while Total sees slightly slower energy demand growth. Differences in total energy consumption are largely driven by forecasts of global population and GDP which do not differ significantly between firms, using historical relationships between these variables and energy consumption. The main differences are due to expectations of energy efficiency.

Under the more aggressive 2^0C scenario Shell's projection stands out as significantly higher than the rest, and even higher than its projection in the Current Trends scenario. This is because under a lower emissions pathway, Shell sees a growing need for electrification



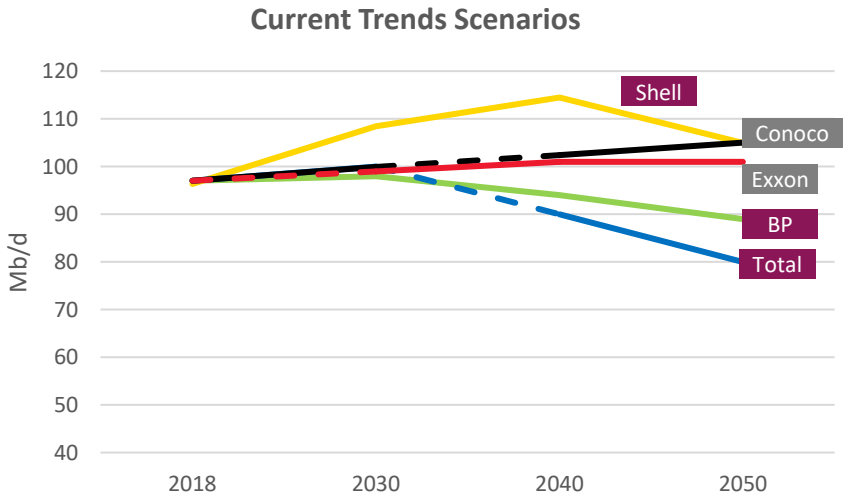


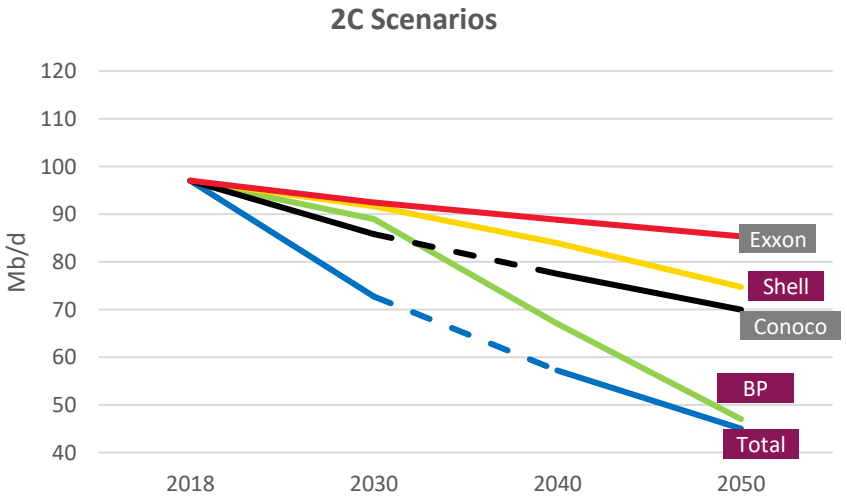
Scenario Comparison - Expected Oil Demand

There is a significant difference in the forecasts of future world oil demand by European and US IOCs, with European firms seeing a decline and US firms seeing growth or stable demand. This difference drives much of the companies' business models.

European IOCs show a consistent reduction in global oil demand with steepening declines between 2040 and 20505 (BP, Shell and Total) in current trend scenarios. US companies however see continued growth, with Exxon expecting peak oil demand in 2040 and ConocoPhillips continuing through 2050. ConocoPhillips' expectations appear anomalous amongst the other forecasts, showing not only growth, but substantially so to 105 Mb/d by 2050, a 25 Mb/d range in expectations.

The 2°C scenarios show an even larger range of expectations of over 30 Mb/d between Total and BP, around 45 Mb/d, and Shell and ConocoPhillips which expect around 75 Mb/d.





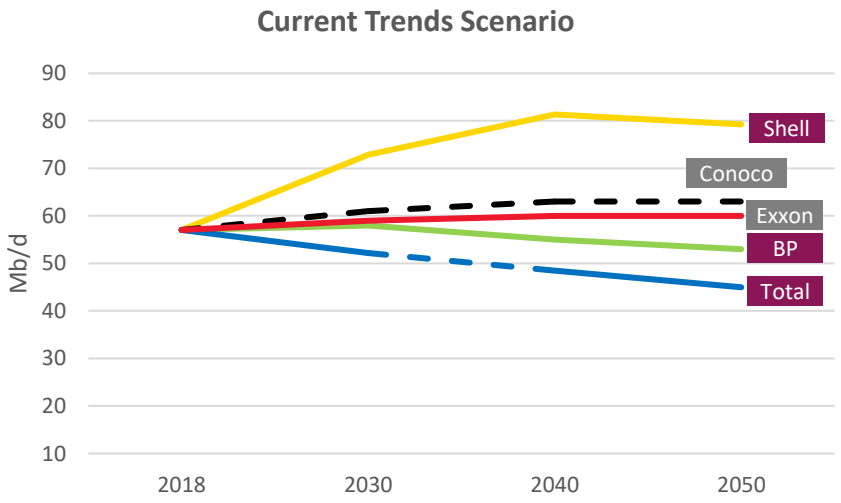
Scenario Comparison - Transportation Fuel Demand

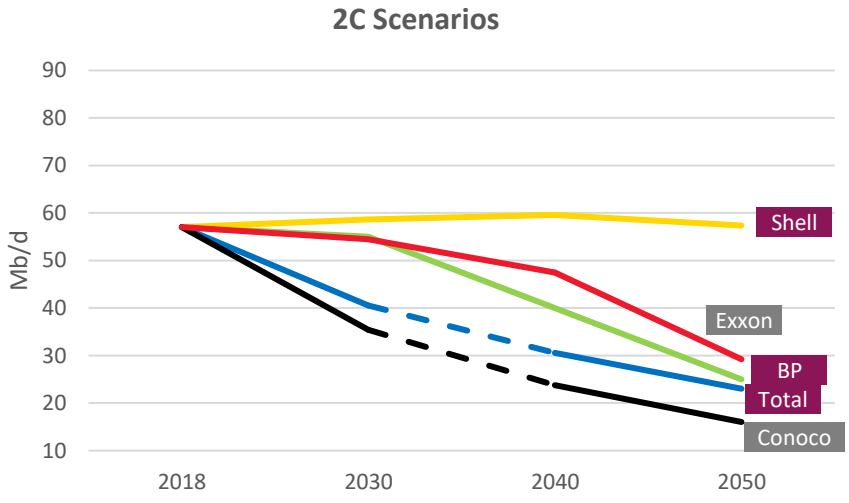
European IOCs have considerably lower expectations of future transport fuel demand than ConocoPhillips and Exxon. This is due to more aggressive expectations for EVs, given higher gas prices, advances in EV and hydrogen technologies and other supportive mechanisms. Transportation is the single largest source of demand affecting overall global oil demand in forecasts.

Reducing demand from EU IOCs is primarily driven by three factors:

- improved fuel efficiency of internal combustion engines (ICEs)
- increased penetration of electric vehicles (EVs)
- public transport/ride-sharing share increases.

As with total oil demand, European IOCs are considerably lower than ConocoPhillips and Exxon, driven by more aggressive expectations for EVs, given higher gas prices, EV subsidies and other policies prevalent in Europe. US IOCs expect passenger vehicle demand reductions to be more than offset by light and heavy-goods vehicles.



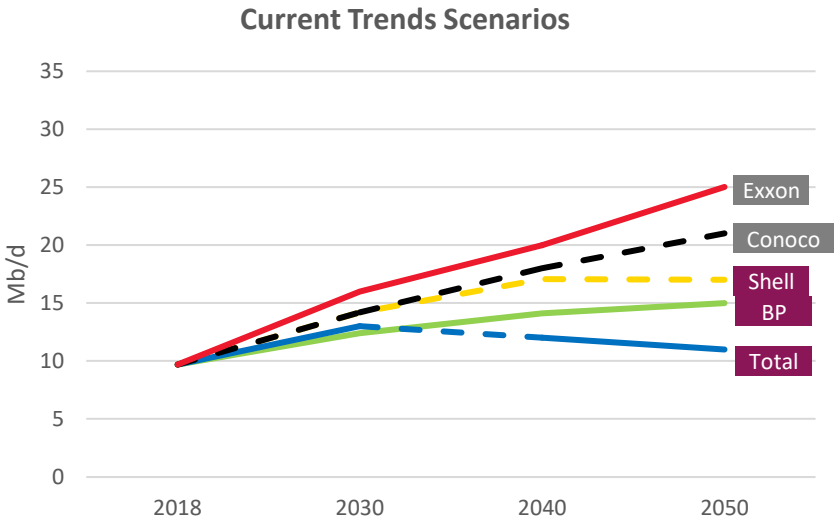


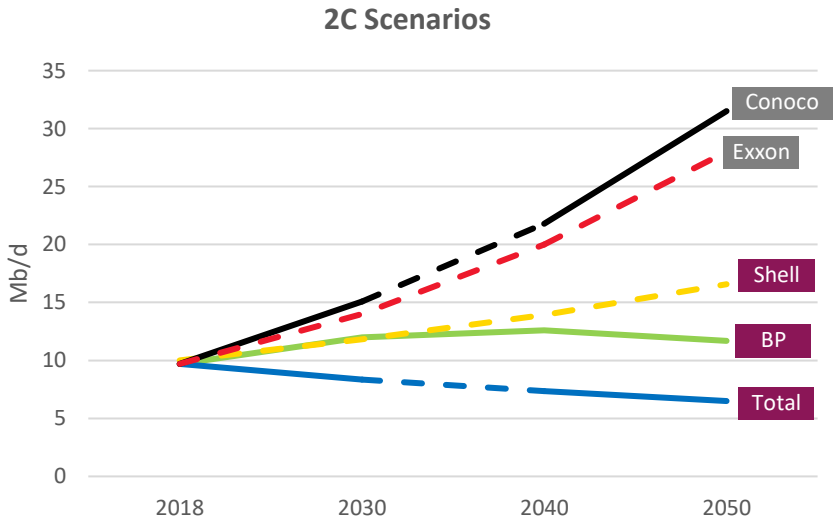
Scenario Comparison - Petrochemicals Demand

Petrochemicals account for around 20% of world oil demand and all IOCs, except for Total, expect an increase in oil demand from this sector. Exxon's view of future demand from this sector is significantly higher their European counterparts. Chevron produces no breakdown of demand for this use of oil.

All companies, except for Total expect an increase in oil demand from this sector. Total's reduction is partly due to expectations on single-use plastic bans, higher recycling rates and bioplastic uptake displacing oil demand. Under current trends, Exxon has the highest forecast for petrochemical growth, at 20 Mb/d in 2040, almost double current levels.

However, ConocoPhillips' projections for its 2°C scenario are the largest by far out of all forecasts. It's petrochemicals expectations help to explain why its low transport fuel demand growth doesn't impact total oil demand as strongly as for other companies. Petrochemicals remain particularly important to forecast, given volatility induced by refinery over-supply and massive capital outlays by O&G majors in recent years into petrochemicals to attempt to hedge against transport fuel demand reductions.



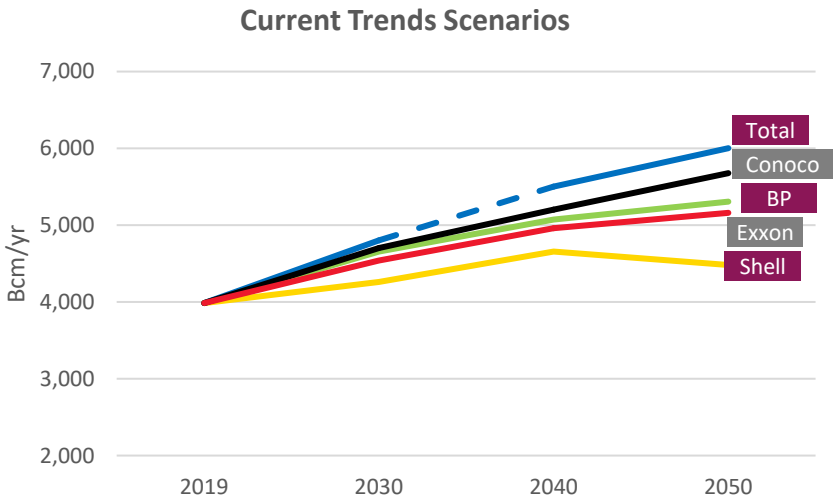


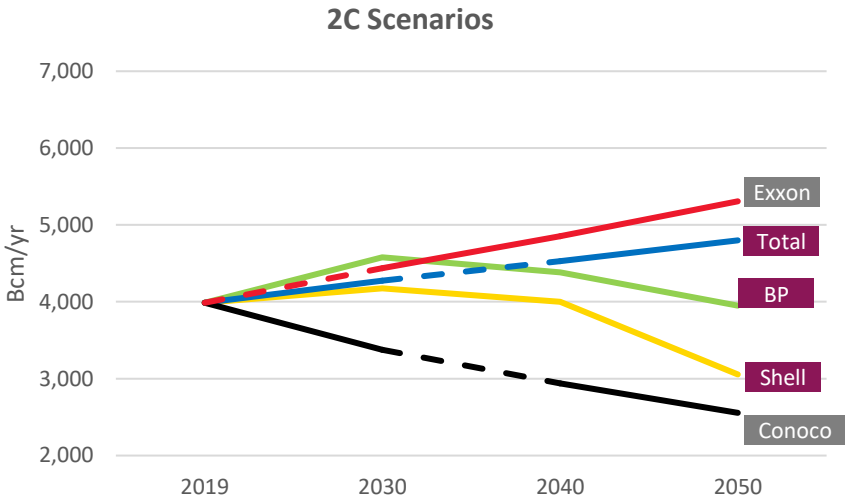
Scenario Comparison - Expected Gas Demand

All IOCs expect continued growth in global gas demand under continuation of current trends, though only the Americans do under 2°C scenarios. Though it's expected to play a pivotal role as a transition fuel to renewable-dominated landscapes, it is scenario-dependant on factors such as CCS scale, renewables roll-out, and aggressiveness of decarbonisation.

Global gas demand expectations are the most consistent in terms of growth trends in the current trends scenario, ranging from around 5,200 to 6,800 Bcm/yr. By contrast, in the 2°C scenarios a larger range of 2,500 to around 5,000 Bcm/yr by 2050 is seen.

Under current trends, and Total under its 2°C scenario, IOCs expect gas to grow continuously between 2020 and 2050 - as natural gas is expected to play a key role in the energy transition displacing dirtier forms of energy – notably coal and biomass. Substitution for oil and coal reductions in power and industry, as well as future combination with carbon capture and storage (CCS) technologies thus ensure resilient, continued growth for natural gas.





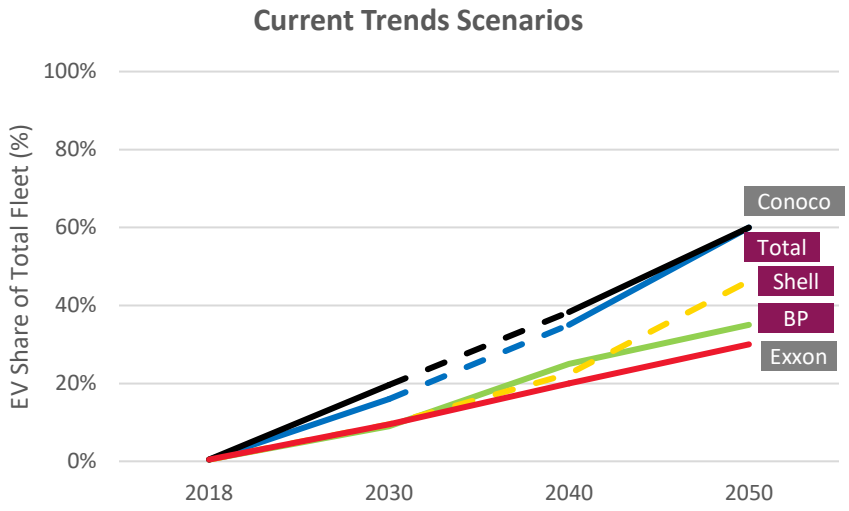
Scenario Comparison - Electric Vehicle Penetration

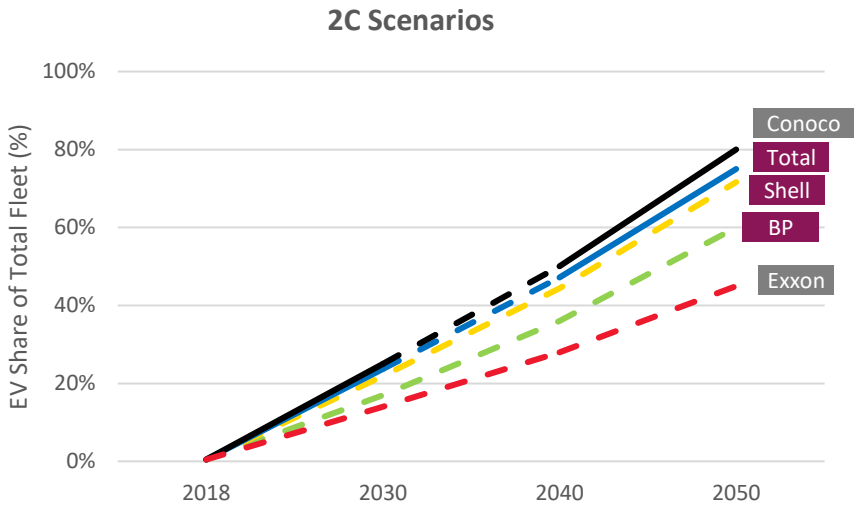
Assumptions on EV penetration are a key driver of expectations of future oil demand. ConocoPhillips's EV shares in 2050 are broadly in line with BP, Shell and Total, while Exxon's are slightly lower than other forecasts (in 2040).

Expectations of the future growth in electric vehicles is a key driver of oil demand in transportation. While currently representing less than 0.5% of the global fleet, EV penetration is expected to rise considerably given decreasing technology costs and public policy (such as future bans on ICE vehicle sales in several developed countries and subsidies towards EV purchases).

However the aggressiveness of EV penetration varies considerably between companies nearer 2050. Total, for example, expects over 60% EV share of fleet by 2050, BP estimates this to be around 35%, though 2030 estimates all lie around 8% mark. ConocoPhillips's EV shares in 2050 are broadly in line with BP, Shell and Total.

The forecasts of 2050 EV penetration under 2°C are much more closely aligned, however, between 75-83%, concurrent with stronger growth rates of electrification of those forecasts, necessary to sustain widespread electrification of passenger road transport.



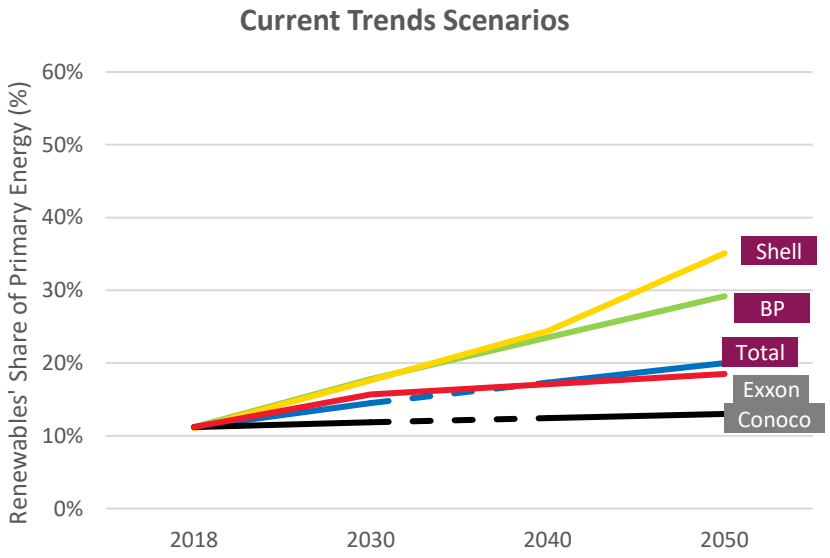


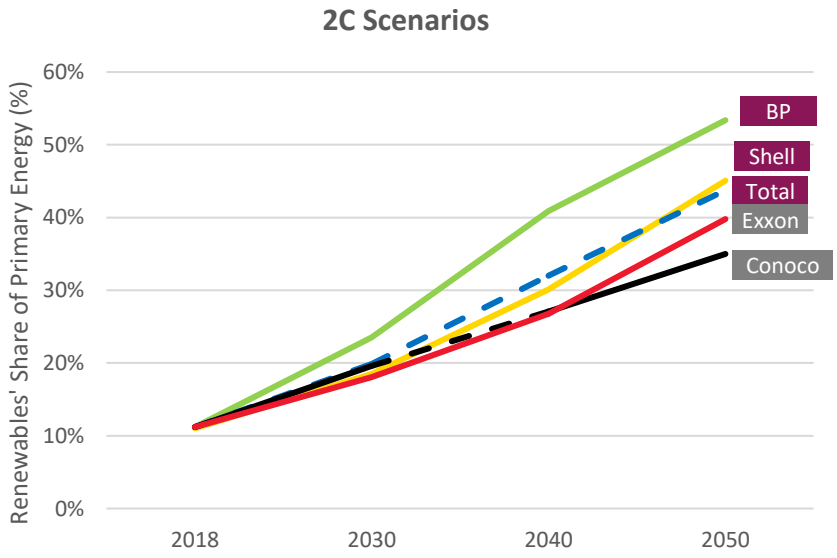
Scenario Comparison - Growth in renewable energy

Expectations of the growth in renewable energy are an important factor in long term views of the oil demand. Conoco Phillips and Exxon see much less growth in renewable energy than their EU counterparts.

Renewable share of energy demand varies considerably between IOCs. BP has the highest projections, accounting for ~30% of total primary energy demand in 2050 under current trends, and almost 55% under a 2°C scenario, while Conoco's 2050 estimates lie around 12% and 35% for current trends and 2°C, respectively. Until 2030, renewable production is still driven primarily by hydro-electricity, after which solar and wind begin to outstrip hydro in terms of total capacity.

Growth is also regionally divergent, being led mostly by additions from OECD countries, while uptake in non-OECD is considerably slower until the 2040s. Most 2°C scenarios, however, see much more rapid uptake, with global policy and economic coordination facilitating widespread and low-cost scaling



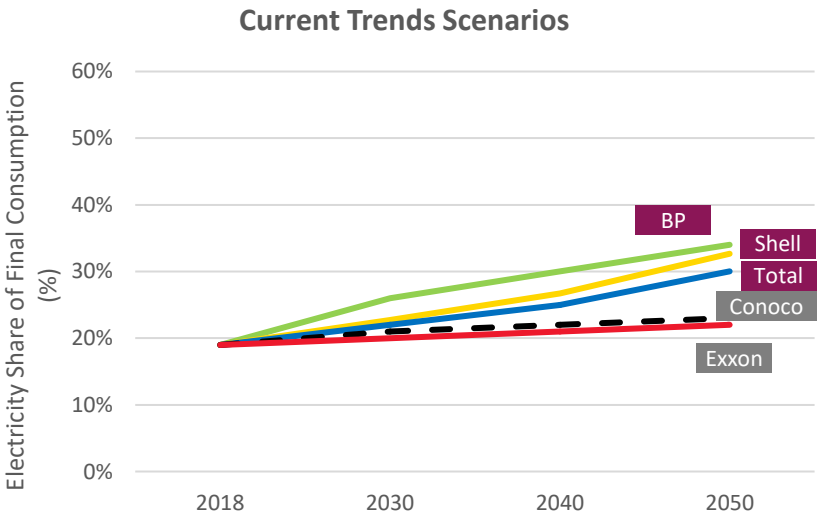


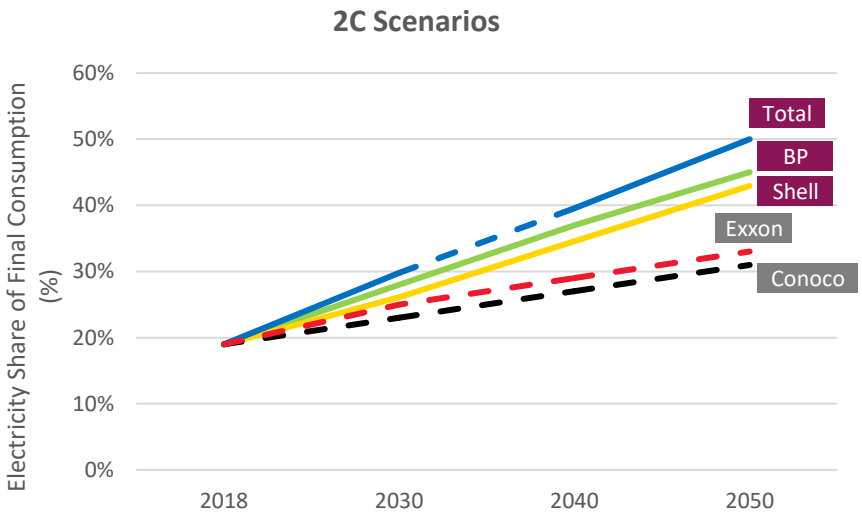
Scenario Comparison - Electrification

Rate of growth in electrification is forecast to be higher from European IOCs than their US counterparts. Forecasts between European firms are closely clustered in both scenario categories, with similar increases for each firm.

Electricity, an energy carrier, not a source, facilitates reductions in fossil fuel consumption in the power sector through transmission of energy generated from renewable sources, as well as in through storage improvements which reduce the dependence on chemical energy sources.

Growth is seen to be mostly consistent, with BP reporting the highest share of electricity in total final consumption, at around 35% in 2050, with Exxon, the lowest 2040 estimate, around 9% less under current trends scenarios. For scenarios aligned with 2°C of warming, Total sees electricity carrying 50% of final consumption, with BP and Shell closely behind on 45% and 43%, respectively.





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