

BREAKING THE HABIT

Why none of the large oil companies are “Paris-aligned”, and what they need to do to get there

Report includes an update to
“2 Degrees of Separation” for 2019

September 2019

About Carbon Tracker

The Carbon Tracker Initiative is a team of financial specialists making climate risk real in today's capital markets. Our research to date on unburnable carbon and stranded assets has started a new debate on how to align the financial system in the transition to a low carbon economy.

www.carbontracker.org | hello@carbontracker.org

About the Authors

Andrew Grant – Senior Analyst

Andrew joined Carbon Tracker in 2014 as a Senior Analyst leading research on oil & gas and coal mining, and has authored a number of Carbon Tracker's major reports on these sectors. Prior to joining Carbon Tracker, Andrew worked at Barclays Natural Resources Investments, a private equity department of Barclays that committed capital across a range of commodities and related industries. Andrew has previous experience in remuneration and corporate governance at Barclays Capital and New Bridge Street LLP. He is also a Senior Advisor to Critical Resource, a management consultancy specialising in political, stakeholder and sustainability challenges in the energy and mining sectors. Andrew has a degree in Chemistry & Law from Bristol University.

Mike Coffin – Analyst

Mike Coffin joined Carbon Tracker in 2019, and is currently focussed on researching oil & gas companies' financial disclosures, and identifying transition risk under different climate scenarios. Prior to joining Carbon Tracker, Mike worked as a Geologist for BP for 10 years, on projects across the upstream from early access to development.

Mike has experience working in petroleum basins across the world, including time spent working abroad in Norway, with specialist experience in unconventional exploration and in leading technical project teams.

Mike has an MA and MSci in Natural Sciences from Cambridge University, and is a Chartered Geologist (CGeol).

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Key Findings

The most common climate-related question facing investors – “how can we tell if a company is aligned with Paris”? Carbon Tracker’s framework for addressing this challenge in the oil and gas sector is based solely on the economics of potential project portfolios.

In this report, we lay out our approach and apply it to a universe of the largest listed oil and gas producers. For the first time, we look at alignment in terms of short term actions – which individual projects are non-Paris compliant and shouldn’t go ahead in an economically rational Paris-aligned world, yet nonetheless either a) were sanctioned last year; or b) are targeting sanction this year.

Key takeaways:

- The shift to a Paris-compliant world will require a dramatic change in behaviour from the ingrained growth model. Compared to the IEA’s central scenario (which incorporates the Paris INDCs, but is associated with 2.7°C warming), 2019-2030 capex on new oil projects is 83% lower in a 1.6°C scenario and 60% lower in a 1.7-1.8°C scenario.
- Last year, all of the major oil companies sanctioned projects that fall outside a “well below 2 degrees” budget on cost grounds. These will not deliver adequate returns in a low-carbon world. Examples include Shell’s \$13bn LNG Canada project and BP, Total, ExxonMobil and Equinor’s Zinia 2 project in Angola. We highlight \$50bn of recently sanctioned projects across the oil and gas industry that fail the Paris alignment test by a margin.
- This includes the large European companies that are doing the most to reassure investors that they are responsive to climate concerns – BP, Shell, Total and Equinor.
- The majors also hold a number of projects targeting approval this year which don’t fit in a Paris-compliant world. Examples include Total’s assets in Uganda, and various projects in Brazil. Some have already been given a final investment decision, e.g. BP, Chevron, ExxonMobil and Equinor’s ACG project in Azerbaijan.
- No new oil sands projects fit within a Paris-compliant world. Despite this, ExxonMobil sanctioned the \$2.6bn Aspen project last year – the first new oil sands project in 5 years. Indeed, only a handful fit within a business-as-usual world of missed climate targets; industry growth expectations look optimistic.
- Several US shale specialists have portfolios that are entirely out of the budget. Their relatively homogenous cost structures put them in an “all or nothing” position – substantially all in if the world misses Paris commitments, but all out if temperatures are limited to “well below 2 degrees”.
- The oil and gas in projects that have already been sanctioned will take the world past 1.5°C, assuming carbon capture and storage remains sub-scale.

Executive Summary

Introduction

How to tell if a company is “Paris-aligned”, i.e. has a business model consistent with international climate change commitments to limit warming to “well below 2 degrees” and “pursue efforts” for 1.5 degrees? An easy question to ask, a hard one to answer.

For fossil fuel companies, Carbon Tracker’s starting point is the “carbon budget”, or the finite amount of carbon emissions that can be released into the atmosphere to result in a reasonable probability of a given level of warming. Coming directly from climate science, this fundamental principle illustrates that ultimately the planet must reach net zero emissions – if global emissions are still being added to every year, the atmospheric concentration of greenhouse gases continues to rise, and hence so does the temperature. Hence, to meet climate goals, it is an unavoidable consequence that fossil fuel use must drop dramatically.

The precise pathway that the world takes to that outcome is, of course, unknowable. But benchmark scenarios can be used to work back from the Paris temperature constraints, and understand which fossil fuel projects might fit within that limited remaining budget. Carbon Tracker uses individual project economics to make this determination, and illustrate the risks to investors in financial terms.

In our view therefore, **the only way that fossil fuel companies can be “Paris-aligned” is to commit to not sanctioning projects that fall outside this constraint,**

and shrink where necessary. The eternal search for growth in the context of finite planetary limits means either the failure of climate targets, exposure of investors to “stranded assets” – investments that destroy value when industry dynamics change – or both.

This shift represents quite a wrench from the industry’s longstanding norms – and indeed, fossil fuel demand continues to increase annually for now. However, with societal pressure being channelled through investors, it may be that the only way that fossil fuel producers can retain their social licence to operate is to break the habit of a lifetime.

Background

In a series of reports since 2011, Carbon Tracker has explored the financial implications of the shift to a lower carbon economy in line with international carbon commitments. In particular, we have examined the risks to fossil fuel capital expenditures, and hence to the investors that provide that capital.

Carbon Tracker’s lens is that of the market – which potential fossil fuel developments do not make economic sense and might destroy value in the energy transition, at the same time as taking the planet into a progressively more dangerous climate.

In this report we continue that theme, further refining our approach to better understand the implications of more ambitious global warming outcomes and in particular focusing on the short term

implications for fossil fuel producers.

What's new – a test of short term alignment for corporates, and 1.5°C scenarios

For this analysis, we have updated our model so that investors can understand whether oil and gas companies' sanction activity is compliant with various low carbon outcomes in the near term and in recent history. Throughout the financial system, market actors are struggling with the question of how to become "Paris-compliant"; here we lay out a framework for understanding to what extent the upstream oil and gas companies in their portfolio satisfy this demand.

In addition to examining the fossil fuel supply picture under various scenarios published by the International Energy Agency (IEA), in this report we also look at a 1.5°C outcome using scenarios published by the Intergovernmental Panel on Climate Change (IPCC), including one that assumes no use of carbon capture and storage. As the risks of damage even at lower warming outcomes become clearer, there is increasing demand to understand the implications of the lower end of the Paris commitments to "pursue efforts" for 1.5°C. However, as the message that results is a simple one, we do not provide further detailed results.

Societal and investor pressure is increasing

Societal awareness and pressure on climate issues has increased markedly since the Paris Agreement, and particularly in the last year or two. This is reflected in increased investor efforts to understand and mitigate climate risks, and drive change at their portfolio companies. The clearest example is the Climate Action 100+ initiative (CA100+), comprising investors

with over \$34 trillion in assets under management at the time of writing, formed to drive reductions in greenhouse gas emissions and improvements in disclosure and governance through engagement. Initial results give encouragement, but this report indicates the scale of the challenge ahead.

Comparison of demand scenarios reveals the limits to growth

We often hear that fossil fuels are likely to be around for a long time. This is probably true, however meeting climate goals will mean much less new development. Compared to a the IEA's central 2.7°C scenario, capex on new oil projects is 83% lower in a 1.6°C scenario and 60% lower in a 1.7-1.8°C scenario – even with significant deployment of carbon capture and storage (CCS).

The majors all sanctioned non-Paris compliant projects in 2018

In this analysis, we look at the break even requirements of recently-approved projects and compare them to the oil price environment implied by various low carbon scenarios, to establish which investments run the greatest risk of being stranded.







Despite increased investor pressure on climate issues, we find that projects are still being sanctioned which don't fit into a cost-optimised Paris-aligned scenario. All of the majors sanctioned such projects last year, including the European majors that are making the greatest moves to reassure investors that they are consistent with the energy transition – Shell, BP, Total and Equinor.

Following engagement with the CA100+, BP and Equinor have announced that they will disclose how their future capital

investments are compliant in a well-below 2°C world; this demonstrates the challenges that their business models will face going forward.

Examples include the following projects.

SELECTED PROJECTS SANCTIONED IN 2018 OUTSIDE 1.7-1.8 °C BUDGET

Project	Resource theme	2019-2030 capex	Country	Partners (* denotes operator)
LNG Canada T1	 Conventional (land/shelf)	\$6.5 bn	Canada	Shell* , Petronas, Mitsubishi Corp, Korea Gas, PetroChina
LNG Canada T2	 Conventional (land/shelf)	\$6.5 bn	Canada	Shell* , Petronas, Mitsubishi Corp, Korea Gas, PetroChina
Gorgon/Jansz Stage 2	 Deep water	\$3.6 bn	Australia	Shell, Chevron* , ExxonMobil, Osaka Gas, Tokyo Gas, Chubu Electric
Aspen Phase 1	 Oil sands	\$2.6 bn	Canada	ExxonMobil* , Imperial Oil
Amoca FFD	 Conventional (land/shelf)	\$1.4 bn	Mexico	Eni* , Qatar Petroleum
Zinia 2	 Deep water	\$1.3 bn	Angola	BP, ExxonMobil, Total* , Equinor

Source: Rystad Energy, CTI analysis

Short-term alignment test reveals a long list of non-Paris compliant projects targeting 2019 sanction

Our analysis can be used to look at projects which fall outside a Paris world but are due to undergo final investment decision in the short term (based on estimated approval dates in our supply database). These projects represent an imminent challenge for investors and companies looking to align with climate goals. Examples include potential developments in Brazil, Uganda and Russia, with companies including Total and Shell holding interests.

Several US onshore producers are substantially all outside the budget

Short cycle projects are sometimes suggested as advantageous during the energy transition due to the flexibility with which production/investment can be ramped up and down. As producers that focus on particular plays can have relatively homogenous cost structures, we find that this makes them highly sensitive to climate outcomes, with some having almost the entirety of their potential future capital spend outside a low-carbon world on a least-cost basis.

No new oil sands projects fit in a Paris-compliant world

We continue to find that, in a Paris-aligned world, no oil sands projects would go ahead in at least the next 20 years. This determination is made solely on the grounds of their high production costs and without taking into account their relatively high carbon intensity – an additional risk factor to the extent carbon prices are increased.

Despite this, November 2018 saw the first sanction of a greenfield oil sands project in 5 years – ExxonMobil/Imperial Oil's \$2.6bn Aspen project, which has already been delayed since. According to our supply database, the project requires an oil price of over \$80/bbl to return 15% IRR.

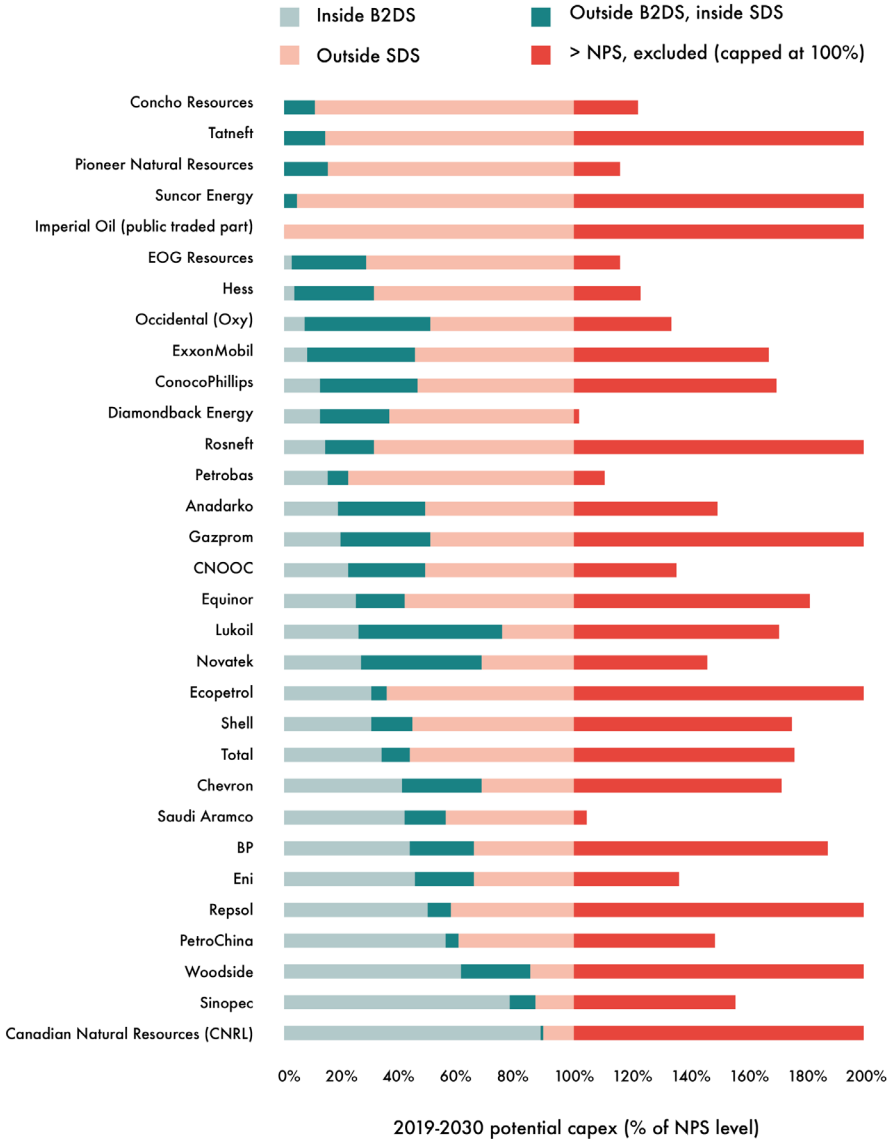
Even in the IEA's 2.7°C central New Policies Scenario, which misses climate targets by a long way, we find that additional oil sands sanctions are likely to be minimal; industry forecasts of >40% production growth in the next 15 years will have to be revisited.

Company exposures vary considerably

As in our previous "2 Degrees of Separation" reports, we include breakdowns of exposure by company, measured in terms of the potential capex that could be spent on projects that don't fit within a given carbon-constrained scenario. The scenarios used here are the 1.7-1.8°C Sustainable Development Scenario (SDS) and the c.1.6°C Beyond 2 Degrees Scenario (B2DS) published by the IEA, with results given relative to the IEA's central 2.7°C New Policies Scenario (NPS).



2019-2030 POTENTIAL CAPEX OUTSIDE GIVEN SCENARIOS, SELECTED COMPANIES. UNSANCTIONED PROJECTS ONLY



Source: IEA, Rystad Energy, CTI analysis

Note: Extent of potential capex that falls outside NPS shown capped at 100% of NPS capex levels

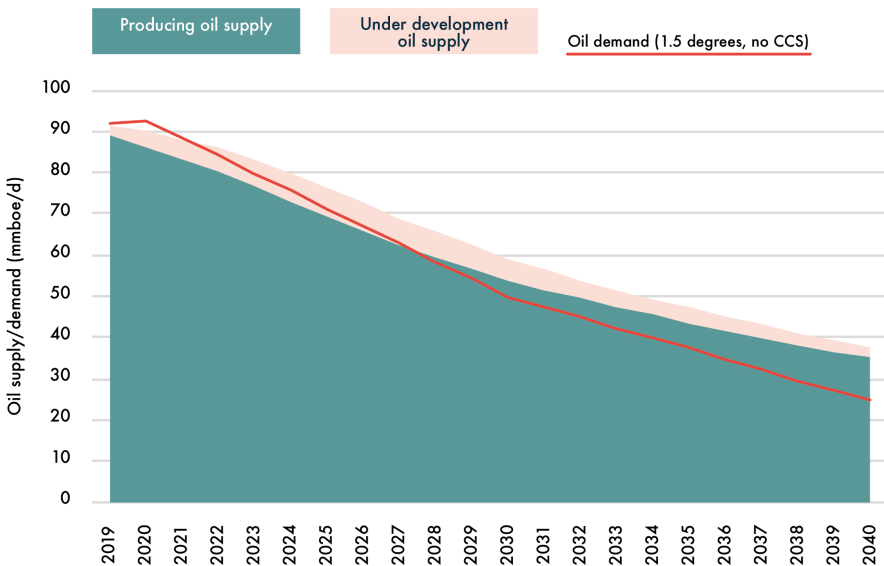
Without CCS, 1.5°C is exceeded by already sanctioned projects

We find that demand for oil and gas under the IPCC's no-CCS 1.5°C scenario is exceeded in aggregate by assets that have already been sanctioned. Carbon Tracker has previously shown that sanctioned coal assets exceed demand under higher temperature scenarios that do include CCS¹. This does not mean no more capex at all from the fossil fuel industry – capex on sanctioned projects will continue, and there will be some new gas production in certain regions.

However, it does mean that we are reliant on a policy and technology response sufficient to close existing projects and/or future technological developments to bail us out.

Without this, a warming of 1.5°C is already effectively locked in, and effectively no new projects are compliant with the low end of the Paris goals. See the appendix for further details.

FIGURE 1. COMPARISON OF 1.5°C (NO CCS) PATHWAY TO POST-FID OIL PRODUCTION



Source: IPCC, Rystad Energy, IEA, CTI analysis

¹ See Carbon Tracker, "Mind The Gap: the \$1.6 trillion energy transition risk", March 2018 Available at <https://www.carbontracker.org/reports/mind-the-gap/>

Other research reports have reached similar conclusions, including by Global Witness² and Oil Change International³ relating to upstream, and Tong et al⁴ relating to infrastructure.

Future gas use is subject to considerable uncertainty in a low-carbon world

Gas is often made out to be a “bridge fuel” that can be part of the energy transition, and is a significant part of future decarbonisation strategy for many oil and gas companies. To the extent that gas replaces coal in power applications, it has benefits in carbon emissions terms.

However, there must be strict limits – the 1.5°C IPCC scenarios we review here require global gas use falling at -4.5% p.a. where there is no CCS and -3.2% p.a. where there is limited CCS. The IEA scenarios assume considerably more gas use, but note that grid carbon intensity falls to 69 g CO₂/kWh in 2040 in the 1.7-1.8°C scenario; a required intensity that amounts to one-fifth that of even a new combined cycle gas turbine (350 g CO₂/kWh).



2 Global Witness, “Overexposed: How the IPCC’s 1.5°C report demonstrates the risks of overinvestment in oil and gas”, April 2019

Available at <https://www.globalwitness.org/en/campaigns/oil-gas-and-mining/overexposed/>

3 See for example Oil Change International, Platform, Friends of the Earth Scotland, “Sea Change: Climate Emergency, Jobs and Managing the Phase-out of UK Oil and Gas Extraction”, May 2019. Available at <http://pri-ceofoil.org/content/uploads/2019/05/SeaChange-final-r3.pdf>

4 Tong et al, “Committed emissions from existing energy infrastructure jeopardize 1.5°C climate target”, July 2019. Available at <https://www.nature.com/articles/s41586-019-1364-3>

Setting the scene – the macro picture

The Carbon Tracker framework

Overview

As an introduction to our company specific work, we lay out the framework used and present some high-level macro conclusions.

Key takeaways:

- Carbon Tracker uses an economic model to compare the universe of potential supply to a range of different carbon-constrained scenarios; the projects which have the lowest supply costs are assumed to be most competitive, with higher cost projects more likely to be “stranded”.
- Compared to a “business-as-usual”⁵ scenario, 83% of capex on new oil projects doesn’t go ahead in an estimated 1.6°C global warming scenario, and 60% under 1.7-1.8°C – even assuming a large roll out of CCS. Companies that progress these projects run the risk of destroying value.
- Arctic and oil sands projects are particularly high risk due to their project economics. No new oil sands projects are Paris-compliant.
- Shale projects are highly leveraged to future demand levels, given significant resource potential, a need to maintain continuing

investment due to high decline rates, and a relatively homogenous cost distribution near key cost intervals.

- Results can be aggregated at the company level to assess where investors should be focusing their efforts, and understand the risk to their portfolios related to particular fossil fuel projects.

Further details are shown in this section.

What’s new

In this iteration of our analysis, we make two key changes to our methodology to correct for some areas where we have previously arguably been too generous in terms of future fossil fuels allowed:

1. Producing and under development (i.e. post-final investment decision) assets are all assumed to continue producing for their base case lives, and their production/emissions are effectively “locked-in” once approved. This better reflects that it is rare for a project not to enter production once it has been sanctioned, and then the additional challenges of sanctioning a new project in a scenario of weak demand compared to a project that is already in operation. Company disclosures generally suggest that they do not expect producing assets to shut down due to climate pressures; this approach helps us explore that thesis.

⁵ The IEA’s New Policies Scenario, see below and accompanying methodology document

2. Co-production of associated oil/gas is better reflected in supply apportionment. For this analysis we have developed an iterative equilibrium model that fills demand using the lowest cost oil and gas projects. This also reflects that if an oil project is within a given budget, the associated gas will also enter the market and therefore mean that less gas field development is required, and vice versa for liquids produced from gas fields.

The assumption that post-FID projects produce for their base case lives means that, once the decision has been made, they will take up carbon budget in volume terms. However, that doesn't mean they will make money in a low carbon scenario. They may not be physically "unburnable", but some may yet be financially "stranded" – i.e. get built and continue to produce, but never deliver an adequate return. As below, we can use this model to estimate which recently-sanctioned projects would not have gone ahead in an economically-rational low-carbon world.

For further details on methodology, please see the accompanying document⁶.

Low carbon scenarios

In this report we focus on a comparison of potential supply to demand levels based as closely as possible on two different scenarios, published by the International Energy Agency (IEA):

Beyond 2 Degrees Scenario (B2DS)

We estimate that our interpretation of the B2DS is approximately consistent with a 50% chance of 1.6°C warming.

Sustainable Development Scenario (SDS)

The SDS is noted by the IEA to be comparable to other published scenarios in the range 1.7- 1.8°C in terms of trajectory over the period to 2040 (with no probability estimate provided).

New Policies Scenario (NPS)

As a "business-as-usual" reference point, we also use the New Policies Scenario (NPS) – considered by the IEA to be consistent with a 50% chance of 2.7°C warming.

As each of these scenarios ultimately results in a given level of global warming, the modelled resulting aggregate amount of demand for each fossil fuel can be thought of as a "budget" for that fossil fuel to result in that warming outcome. The IEA is explicit that none of these scenarios should be taken as a long-term forecast.

We also lay out high level conclusions for 1.5°C pathways in the appendix.

⁶ <https://www.carbontracker.org/wp-content/uploads/2019/09/Breaking-the-Habit-Methodology-Final-1.pdf>

⁷ As the scenarios do not incorporate trends from the last few years, CTI has adjusted the scenarios to incorporate emissions under the Current Policies Scenario (CPS) to 2020, followed by tapering down to each respective scenario's values by 2025 and following the various trajectories thereafter. The SDS, NPS and CPS are drawn from the IEA World Energy Outlook 2018, the B2DS from the IEA Energy Technology Perspectives 2017. See the appendix for further details.

CCS in climate scenarios

Both the B2DS and SDS are heavily reliant on carbon capture and storage (CCS)⁸ to achieve their goals. When combined with bioenergy (BECCS), the use of CCS can be used to deliver negative emissions; biomass growth captures CO₂ from the atmosphere, the biomass is then burned for energy and the resulting CO₂ captured and stored rather than being re-released. Scenarios can therefore allow global emissions to “overshoot” those permitted for a given temperature target, with negative emissions being used to draw atmospheric carbon back down at a later date once it is assumed to be financially viable.

While such technologies are technically feasible⁹, there are clear challenges to their economic roll out at the required scale required by many scenarios. For example, the IEA’s Sustainable Development assumes 2.4 GtCO₂ captured annually by 2040 (around 1,000x the amount captured by the two currently operational large-scale CCS plants¹⁰), and then does not give details of carbon capture/negative emissions beyond this date. There is therefore the significant risk that both of these scenarios are over-generous in their permitted fossil fuel use if technological development does not live up to hopes. Furthermore, achieving climate goals will require a steep reduction in fossil fuel use even with significant CCS use¹¹.

While the continued development of CCS will be beneficial to achieving our climate goals, a precautionary approach would suggest that it is preferable not to be so reliant on assumed future technological developments.

Applying the logic of the market

Since 2014, Carbon Tracker has sought to understand the distribution of risk related to capital investment in potentially stranded assets.

Our main methodology for upstream fossil fuels is based on the logic of the cost curve – comparing the universe of potential fossil fuel supply to various demand scenarios. In a world of limited demand or space for new projects under climate constraints, the supply options that will satisfy that demand will be those that are most competitive in terms of production costs.

The chart on the next page illustrates this, with a focus on new (unsanctioned) projects. Projects that are either already producing or under development are assumed to continue producing for their base-case lives. The vertical demand lines show the excess demand for oil that will need to be filled by new projects, or the “call” on new oil projects. The curved line represents the cumulative supply available from new oil fields which have not yet taken final investment decision (FID), including potential expansion projects to existing fields.

8 Here we also include carbon capture usage and storage (CCUS)

9 “Today, according to the Global CCS Institute CO₂RE database, there are 23 large-scale CCS facilities in operation or under construction, capturing almost 40 Mtpa of CO₂”. Global CCS Institute, “The Global Status of CCS 2018”. Available at <https://www.globalccsinstitute.com/resources/global-status-report/>

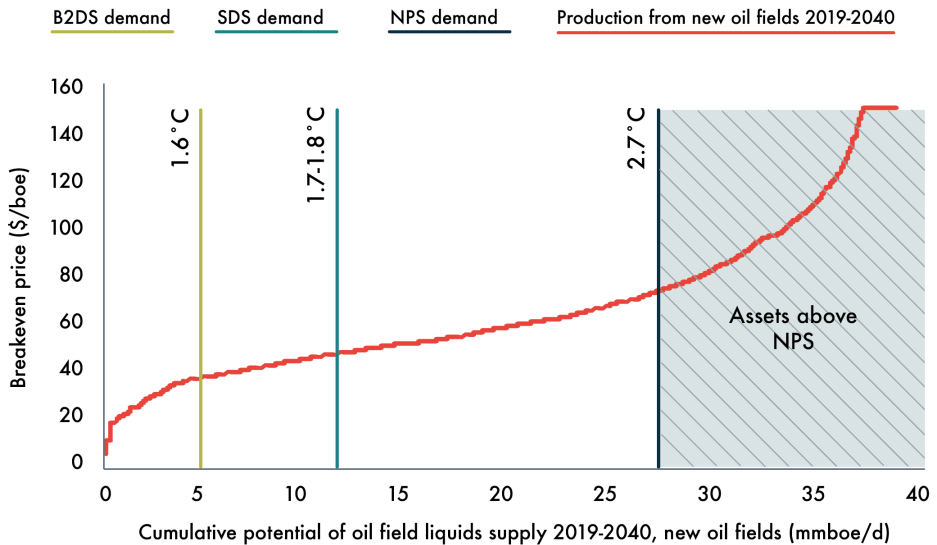
10 See Financial Times, “Coal industry stakes survival on carbon capture plan”, August 2019. Available at <https://www.ft.com/content/52552bf8-c024-11e9-89e2-41e555e96722>

11 See also Carbon Tracker, “CCS: important, but not a “get out of jail free” card”, September 2018. Available at <https://www.carbontracker.org/ccs-important-but-not-a-get-out-of-jail-free-card/>

Note that the supply curve in this chart is for oil fields only; it does not include associated liquids produced by gas fields, which reduce the need for new oil fields to be developed.

At lower demand levels, reduced supply from new projects is required, with lower pricing implied. Higher cost projects run the risk of being stranded if pursued.

FIGURE 2 – UNSANCTIONED OIL FIELDS SUPPLY COST CURVE, 2019-2040



Source: Rystad Energy, IEA, CTI analysis

Note: potential oil supply with a breakeven of >\$150/boe has been aggregated at that level

Future capital expenditure

Capex analysis illustrates the risk to future investment

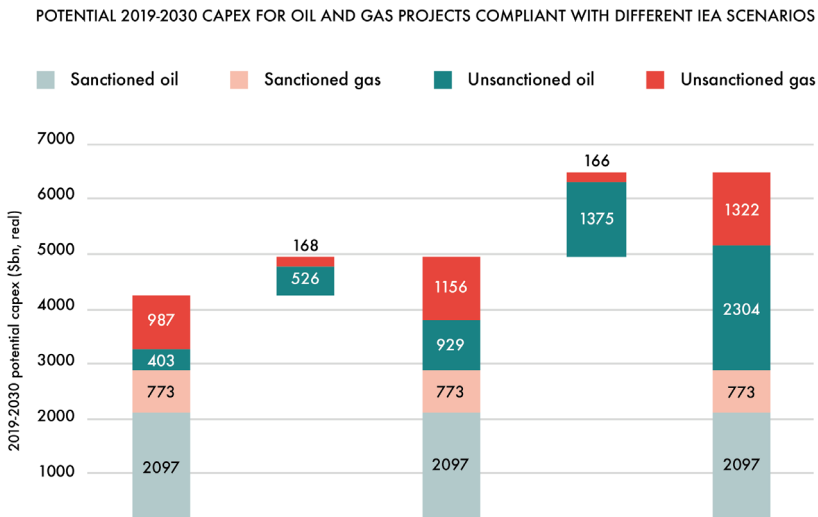
We estimate that satisfying NPS levels of demand would require \$6.5tr of capex (real 2019 dollars) over the period to 2030¹²; the B2DS and SDS would require \$4.3tr and \$5.0tr respectively, i.e. reductions of approximately a third and a quarter. This is consistent with prior findings¹³.

As we assume expenditure on post-FID projects is effectively "locked in", the impact on spending on new projects is much clearer; spending on unsanctioned developments in the B2DS is 62% lower than in the NPS, and 42% lower in the SDS.

As gas experiences more benign demand trends in the IEA scenarios, this is reflected in a lower required reduction in capex. B2DS oil capex is 43% lower than the NPS, and 31% lower in the SDS. Conversely, gas capex is only 16% lower in the B2DS and 8% lower in the SDS.

Again, focusing on new (unsanctioned) projects alone makes the point more starkly – compared to NPS, capex on new oil projects is 83% lower in the B2DS and 60% lower in the SDS (\$403bn and \$929bn going ahead in the B2DS and SDS respectively, compared to \$2.3tr for NPS). Oil therefore displays greater leverage to climate outcomes than gas in the IEA scenarios – although we highlight that our assumption of all gas outside our 5 focus markets being within the budget means that gas's capex leverage is significantly understated in our analysis.

FIGURE 3 – POTENTIAL 2019-2030 CAPEX FOR OIL AND GAS PROJECTS COMPLIANT WITH DIFFERENT IEA SCENARIOS



Source: Rystad Energy, IEA, CTI analysis

¹² Note that, for this report we use the periods 2019-2030 for capex and 2019-2040 for production/demand. In previous reports we have used the periods to 2025 and 2035 respectively.

¹³ See Carbon Tracker, "Mind The Gap: the \$1.6 trillion energy transition risk", March 2018. Available at <https://www.carbontracker.org/reports/mind-the-gap/>

Results by Resource Theme

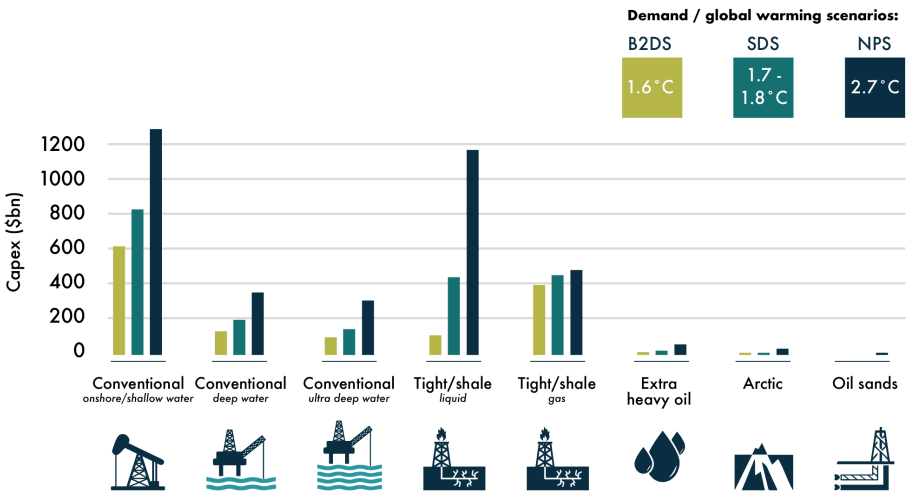
Investment in different resource themes varies significantly by scenario

Between different oil and gas projects there is significant variation in development and operating environment as well as hydrocarbon type, resulting in different cost profiles and capital intensities for different themes.

Company project portfolios that are focused on particularly exposed themes may therefore represent a concentration of risk, and experience a greater proportionate impact – for example, an oil sands specialist may face more existential challenges than a diversified player for whom an oil sands project is one of many options.

The below charts show capex under each scenario on both an absolute and relative basis.

FIGURE 4 – POTENTIAL 2019-2030 CAPEX FOR OIL AND GAS PROJECTS COMPLIANT WITH DIFFERENT IEA SCENARIOS, BY RESOURCE THEME

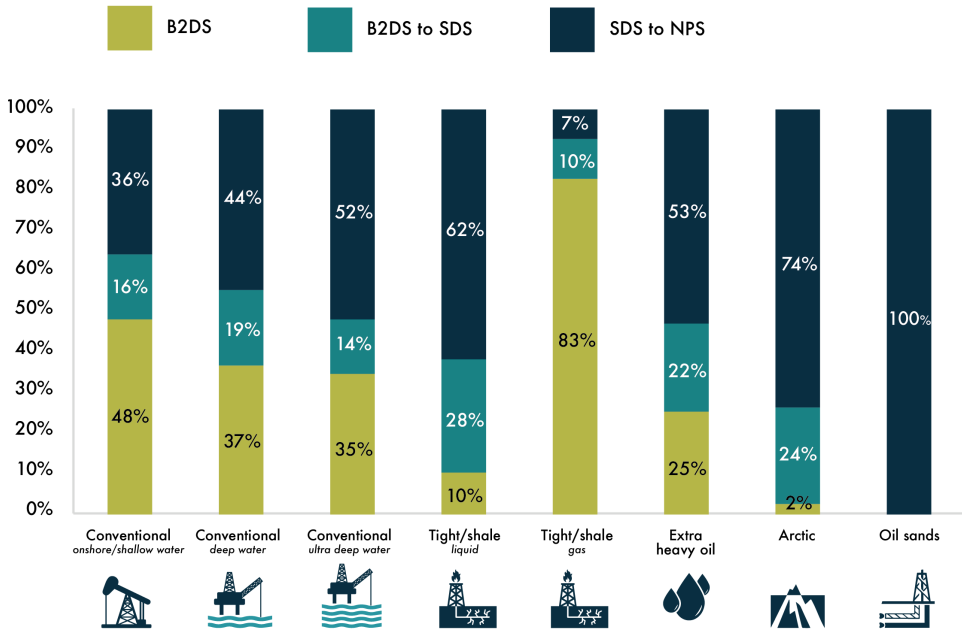


Source: Rystad Energy, IEA, CTI analysis



Mud Pit in North Dakota drilling, photo: Joshua Doubek

FIGURE 5 – POTENTIAL 2019-2030 CAPEX FOR OIL AND GAS PROJECTS COMPLIANT WITH DIFFERENT IEA SCENARIOS, BY RESOURCE THEME



Source: Rystad Energy, IEA, CTI analysis

No oil sands projects fit in a low carbon world

We continue to find that new no oil sands projects fit within either a B2DS or SDS budget. Although the above charts show capex to 2030, this conclusion extends to 2040, the end of our analysis period. Accordingly, we do not consider any new oil sands projects to be Paris-aligned for the foreseeable future.

In fact, barely any fit within the NPS, with just a handful of projects going ahead by 2040 in even a 2.7°C world (hardly visible in the above chart due to their small scale). Therefore we do not envisage a return to material growth for the oil sands

sector even if climate targets are missed. The Canadian Association of Petroleum Producers forecasts a 41% increase in oil sands production from 2019-2035¹⁴; we think expectations will have to be revised down significantly.

Shale oil is particularly leveraged to market outcomes

Shale oil production/capex can be seen to be highly sensitive to the assumed demand, with B2DS production being just 10% of that under NPS (\$112bn going ahead in B2DS, \$429bn going ahead under SDS, and \$1.1tr going ahead under NPS). This reflects both the marginal positioning of much of the industry between the demand levels on cost grounds, and the need

14 CAPP forecasts 2035 oil sands production of 3.0 mmbbl/d in 2019 and 4.3 mmbbl/d in 2035 Canadian Association of Petroleum Producers, "2019 Crude Oil Forecast, Markets and Transportation", June 2019 . Available at <https://www.capp.ca/publications-and-statistics/crude-oil-forecast>

for continuing investment to maintain production.

This would probably be expected given recent experience – in weak market conditions, US oil production fell by 1.1 mmbbl/d (12%) from April 2015 to September 2016¹⁵.

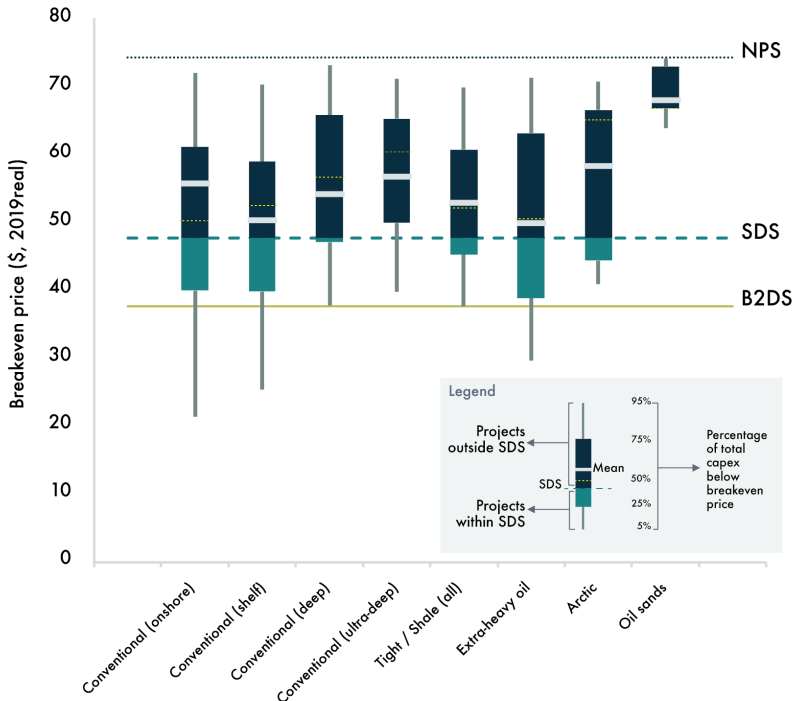
Price sensitivity of project themes

For project themes with a flat cost curve, a small change in development scenario marginal break-even price could significantly alter the proportion of projects that fit within budget. Furthermore, different themes might be in or out of the money by different degrees.

To demonstrate this, Figure 16 shows the range in project break-even price (capex-weighted) for unsanctioned oil projects by project theme.

The box shows the inter-quartile range of projects, with the whiskers representing the 5-95% project range. This allows the additional insight compared to the results shown in Figure 13, by showing both the relative proportion of capex that fits within each scenario, but also an indication of the proportion of a company's projects which would be impacted by a change in SDS-breakeven price.

FIGURE 6. BREAK-EVEN PRICE SENSITIVITY FOR UNSANCTIONED OIL PROJECTS BY THEME



Source: Rystad Energy, IEA, CTI analysis

As this project theme data is aggregated across multiple geographies and operators, there is a broader spread, and thus reduced sensitivity, compared to the company-specific charts shown later.

Shallow water projects are more cost-competitive than deep/ultra-deep water

Looking at Figure 6, nearly 50% of unsanctioned shallow water (continental shelf) conventional oil projects fit within SDS, and approximately 75% of projects within \$10/bbl of this level.

In contrast, less than 25% of unsanctioned ultra-deep water projects fit within SDS, and only 50% of projects within a further \$10/bbl.

Distribution of costs shows oil sands high and dry

The cost distribution in Figure 6 shows similar thematic trends to the split of capex in Figure 5; however, the poor competitive position of oil sands projects is highlighted yet further. Even if the SDS marginal

breakeven price was \$15/bbl higher, only 5% of NPS-level oil sands projects capex would be economic. Therefore not only are oil sands projects generally outside a low-carbon budget, they are outside by a long way.

Most themes show a range of project economics

The chart also makes the general point that most themes have both high cost projects and low cost projects, even in conventional projects on land and in shallow water. Even the Arctic includes some relatively low-cost projects, despite the theme overall being mostly outside the SDS budget having a high mean/median project cost. The Arctic theme covers a range of different regions/environments, meaning that e.g. Equinor's Johan Castberg project in the Norwegian Barents sea might fit within an SDS budget (but not B2DS in this case), whereas Hilcorp's Liberty project offshore Alaska does not.

Accordingly, it is important that each potential supply option is considered on its own merits.



Transocean drill vessel, photo by: U.S. Coast Guard

Measuring company alignment

The company alignment debate

Investor interest in climate continues to rise

Since the Paris Agreement and over the last couple of years in particular, there has been a step-change in societal awareness and resolve on climate issues, perhaps most visibly through the Extinction Rebellion and the efforts of Greta Thunberg, amongst others. In parallel, investors have become increasingly concerned about the possible effects of climate change on their portfolios, their exposure to undesirable outcomes, and their responsibility in furthering climate objectives.

Reflecting that investors are not a homogenous bloc, climate action may be driven by one of a number of motivations, or indeed a combination of these.

There may be moral motivations. Some may not have any particular intent to drive climate outcomes themselves, but want to mitigate risks to which they may be exposed – under either runaway climate change or a successful low carbon transition. Others may take a wider view of fiduciary duty than purely financial returns, and want to limit the environmental damage that will be experienced by the beneficiaries of the capital that they steward. For wide-ranging portfolios with the “universal owner” perspective, it may be that an adverse climate outcome will have wide-ranging impacts across multiple different sectors and geographies which cannot be

reliably diversified away, and would not be compensated by steady performance in fossil fuel stocks. The conclusion is therefore that the only rational economic decision is to act to prevent climate change happening in the first place.

Resilient or consistent?

Where fossil fuel producers have commented on their climate positioning, they have generally sought to portray themselves as “resilient” – not necessarily expecting a low-carbon outcome, but believing they will be ok if it happens. This leaves open the option of exploring for, developing and selling the fossil fuels that will take the world into dangerous climate territory, provided that it is profitable to do so.

This is a quite different concept from being “consistent” or “aligned” with climate goals, which implies a business plan that takes positive actions to help deliver them, or at least prohibits actions that would undermine them.

For a fossil fuel producer, being “Paris-aligned” intuitively suggests committing to refraining from producing projects that would exceed a “well below 2°C” carbon budget. It is difficult to argue that company is aligned with Paris if it would contribute to its failure.

The Carbon Tracker view: a company cannot be Paris-aligned if it sanctions non-Paris compliant projects

Carbon Tracker's position is that for any company to be seen as aligned with or consistent with Paris, this must be reflected in its investment planning, which must incorporate the finite nature of our planet's physical limits as demonstrated by the concept of the carbon budget.

Paris alignment therefore requires a corporate commitment not to sanction any project that doesn't fit within the confines of the Paris Agreement, and a demonstration of how the company is complying with this commitment. Carbon Tracker applies a framework to establish which oil/gas/coal projects might be in and out of a given carbon budget or demand scenario based on the estimated economics of those projects.

What the company then chooses to do with any surplus cash is then a matter for its management and shareholders to decide – whether to redeploy into different sectors where they think they have the ability to deliver adequate returns, or to return it to shareholders to redeploy at the portfolio level where not.

If capital is invested in such a way, then scope 3 emissions will follow suit – Paris compliant investment practice will result in Paris compliant emissions on an absolute, rather than relative basis. Of course, we encourage fossil fuel producers to continually seek to improve the emissions intensity of their operations as well.

Decreasing market share does not mean the loss of shareholder value

While companies may worry about losing out to competitors, we would note a loss of market share alone does not equate to a destruction of shareholder value; this is best preserved by focusing on the highest return projects. Fretting about market share is the opposite of the “value over volume” philosophy that has been the focus of the last few years.

If companies do not want to commit to aligning investment with climate commitments then that is up to them. However, they cannot claim to be consistent or supportive of Paris in any meaningful

way. This may result in challenges to their social licence to operate, and ultimately a need to find other investors.

Application of methodology to short term alignment

Applying our model to: (1) supply data from a third-party database published by Rystad Energy and (2) demand pathways from carbon constrained scenarios published by the IEA yields implied project-level supply pathways. As our database associates projects with the companies that hold equity stakes in them, we can therefore understand to what extent particular companies are exposed to a given carbon/demand outcome.

Our calculation is undertaken in aggregate, based on the concept of the carbon budget: we seek to fill aggregate demand using the lowest cost aggregate supply. We therefore are not trying to match the supply pathways exactly on a year-by-year basis, however, our analysis

yields results that may be comparable, particularly for oil. Given that the key determining factor in ultimate warming is the sum of aggregate emissions rather than the pathway¹⁶, we are comfortable with this approach.

FIGURE 7 – MODELLED OIL SUPPLY PATHWAY FOR THE SUSTAINABLE DEVELOPMENT SCENARIO (SDS)

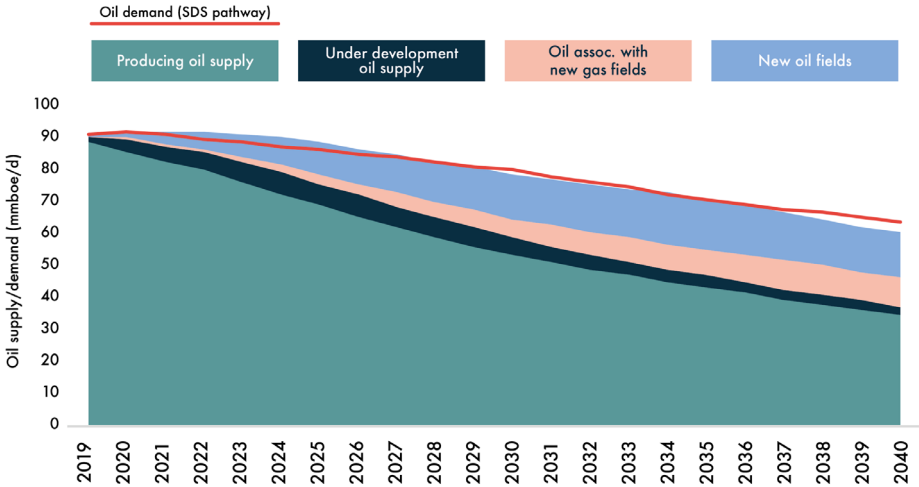
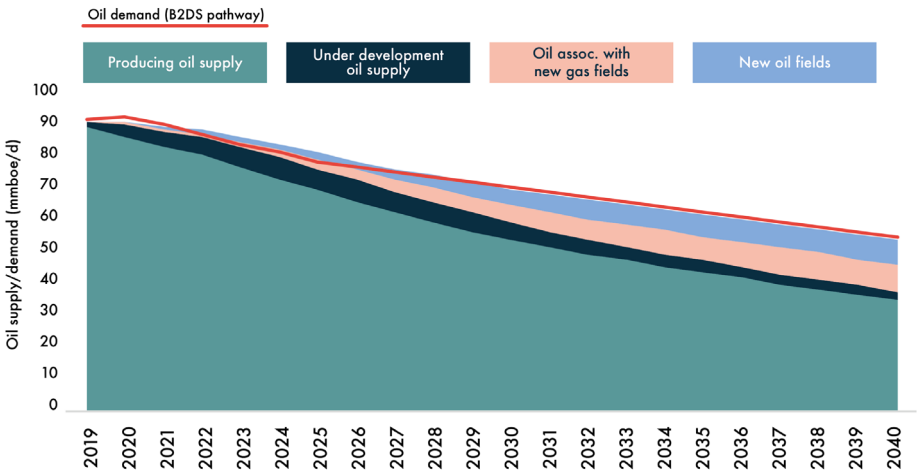


FIGURE 8 – MODELLED OIL SUPPLY PATHWAY FOR THE BEYOND 2 DEGREES SCENARIO (B2DS)



Source Fig. 8 and 9: Rystad Energy, IEA, CTI analysis

16 Ilen, M. R. et al. *Nature* 458, 1163–1166 (2009). Via Glen Peters, "Beyond Carbon Budgets", *Nature Geoscience* vol 11 378-383 June 2018

Where our supply pathways do deviate materially from the demand pathways, this tends to be through an excess of supply in the near timeframe (to 2030) and then a shortfall in later years. Our assumption is therefore that, should the demand pathway follow the precise trajectory in the scenarios, projects will be deferred as necessary.

Short term alignment – theory and reality

Our model can identify assets that have been sanctioned, or might be sanctioned in the near term, that would fail to deliver adequate returns in an economically efficient pathway to a well below 2°C world.

However, it probably doesn't need to be pointed out that markets aren't perfectly economically efficient, and that we aren't presently on course for a well below 2°C world. Therefore, any assets highlighted here that aren't compliant with Paris may still make money in the short term. This may be particularly true of assets with short payback periods.

The focus here is therefore not on projects that definitely won't be economic, but on those that won't be if the world takes a low carbon pathway, and hence which are at higher risk of becoming stranded due to shifting demand trends.

We expect that commodities markets will continue to exhibit cyclical pricing, even in structural decline of demand. There will therefore be periods when prices are above those needed to incentivise the necessary supply, even in a world heading for a well-below 2°C outcome.

Indeed, with uncertainty about the pace of the transition, there may be times of tight markets when the stranded asset concept looks as unlikely as the idea of an oil supply glut and price crash to \$27/bbl seemed to most in 2013.

Given the industry's reliance on commodity pricing as an investment signal, this implies that there will always be the temptation to invest in stranded assets – or put another way, that there will be times when being Paris-compliant will mean forgoing investment opportunities that appear profitable at the time.

"Outside budget" projects sanctioned in 2018

We estimate that the below 15 projects were the largest (in terms of 2019-2030 capex) that wouldn't have gone ahead in an SDS world, assuming economic rationality.

In order to focus on the projects that are the clearest examples of this, we have allowed a margin of error in the below chart of \$10/boe for oil fields and \$1.5/kcf for gas fields. That is, the below projects will fail to deliver an economic return¹⁷ even if oil prices were \$10/boe higher than in the 1.7-1.8°C SDS in our modelling.

These projects are therefore not even on the cusp; they are deep out of the money in a low-carbon world.

17 Defined as 15% IRR here

TABLE 1 – THE 15 LARGEST PROJECTS SANCTIONED IN 2018 OUTSIDE SDS BUDGET

Asset	Country	2019-2030 capex (\$bn)	Resource theme	Partners (* denotes operator)
LNG Canada T1, CA	Canada	6.5	Conventional (land/shelf)	Shell* , Petronas, Mitsubishi Corp, Korea Gas, PetroChina
LNG Canada T2, CA	Canada	6.5	Conventional (land/shelf)	Shell* , Petronas, Mitsubishi Corp, Korea Gas, PetroChina
Gorgon/Jansz Stage 2, AU	Australia	3.6	Deep water	Shell, Chevron*, ExxonMobil , Osaka Gas, Tokyo Gas, Chubu Electric
Aspen (Phase 1), CA	Canada	2.6	Oil sands	ExxonMobil* , Imperial Oil
Katmai (GC040), US	United States	1.8	Deep water	Fieldwood Energy LLC*, ILX Prospect, Ridgewood
Amoca FFD, MX	Mexico	1.4	Conventional (land/shelf)	Eni* , Qatar Petroleum
Zinia 2, AO	Angola	1.3	Deep water	BP, ExxonMobil, Total*, Equinor
Ahmeyim FLNG 1, MR	Mauritania	1.2	Ultra deep water	BP* , Petrosen, Kosmos Energy, Société Mauritanienne des Hydrocarbures
Fenja-Phase 1 (Pil), NO	Norway	1.2	Deep water	Vaar Energi, Suncor Energy, DNO, Neptune Energy*
Gavrikovskoye, RU	Russia	1.0	Conventional (land/shelf)	NZNP Trade*
Traygo-rodsko-Kondakovskoye (Tomsk), RU	Russia	0.8	Conventional (land/shelf)	Rosneft*, Gazprom, Gazprom Neft (Public traded part)
Rakushechnoye (Caspian Sea Bed), RU	Russia	0.7	Conventional (land/shelf)	Lukoil*
Al Shaheen Gallaf (Phase 1), QA	Qatar	0.7	Conventional (land/shelf)	Qatar Petroleum, Total (JV North Oil Company*)
Mizton FFD, MX	Mexico	0.7	Conventional (land/shelf)	Eni* , Qatar Petroleum
Menzel Ledjmet (Phase IV development), DZ	Algeria	0.5	Conventional (land/shelf)	Pertamina*, Repsol

Source: Rystad Energy, CTI analysis

Note: Onshore tight/shale excluded. \$10/boe margin of error allowed above SDS marginal breakeven for oil fields, \$1.5/kcf for gas. Equity interests held by the majors (ExxonMobil, Chevron, ConocoPhillips, Eni, Total, BP and Shell) plus Equinor have been highlighted.

Aspen, the first greenfield oil sands project sanctioned in five years, is the oil project with the highest capital requirement and also the highest breakeven, requiring above \$80/boe. The project was given the green light in November 2018¹⁸, but since then has already been deferred by at least a year¹⁹.

LNG projects also feature; those in the list have estimated breakevens of c.\$9/kcf or above.

The majors are strongly represented, including those that cite climate limits on sanction

A number of the larger oil companies have indicated that they will test their new investments for consistency with low-carbon scenarios, for example:

- **Shell** (November 2017): "This means only proceeding with those investments that are climate-competitive"²⁰.
- **BP** (February 2019): "In accordance with the proposed resolution BP will describe how its strategy is consistent with the Paris goals, as well as setting out a range of additional related reporting."²¹

18 Imperial Oil, "Imperial investment in Aspen project to proceed", November 2018. Available at <https://news.imperialoil.ca/press-release/operations/imperial-investment-aspen-project-proceed>

19 Imperial Oil, "Imperial ramps down Aspen oil sands project execution", March 2019. Available at <https://news.imperialoil.ca/press-release/community/imperial-ramps-down-aspen-oil-sands-project-execution>

20 Royal Dutch Shell, 2017 Management Day webcast transcript. Available at https://www.shell.com/investors/news-and-media-releases/investor-presentations/2017-investor-presentations/2017-management-day/_jcr_content/par/textimage.stream/1511882280943/e506ac79ac0931b2669a24d45f775aa6a185ac028473125b-f2e7485973c40b3b/shell-2017-management-day-media-webcast-transcript.pdf

21 BP, "BP to support investor group's call for greater reporting around Paris goals", February 2019. Available at: <https://www.bp.com/en/global/corporate/news-and-insights/press-releases/bp-to-support-investor-groups-call-for-greater-reporting-around-paris-goals.html>

Supported resolution text refers to the company describing "... how the Company evaluates the consistency of each new material capex investment, including in the exploration, acquisition or development of oil and gas resources and reserves and other energy sources and technologies, with (a) the Paris Goals and separately (b) a range of other outcomes relevant to its strategy"

Resolution available at <https://www.iigcc.org/download/bp-2019-shareholder-resolution-supporting-statement/?wpdmdl=2021&refresh=5cf12431a0c381559307313>

22 Equinor, "Equinor strengthens its commitment to climate leadership", April 2019. Available at <https://www.equinor.com/en/news/2019-04-24-climate-action-100plus.html>

23 ConocoPhillips's Greater Moose's Tooth project has a breakeven above our marginal cut off for compliance with SDS, but within the \$10/boe margin of error described above.

- **Equinor** (April 2019): "From 2019 Equinor will assess its portfolio, including new material capital expenditure investments, towards a well below 2 °C scenario."²²

We find all of the above three companies have equity stakes in this list of significant projects that were sanctioned last year, but which our analysis suggests would not have passed such a test. So did Eni, Chevron, ExxonMobil and Total²³. We estimate that for each of Chevron, ConocoPhillips, ExxonMobil, Total, Equinor, Shell, Eni and BP, at least c.30% of their 2018 upstream capex was on projects that would not fit inside a B2DS budget based on a supply cost basis.

This demonstrates that even those companies which have expressed ambition to align with Paris have yet to fully integrate this ambition into the project sanction process.

Outside budget projects for 2019 sanction

An advantage of focusing on company alignment in the short term is that, as well as reviewing investment history to check for compliance with climate outcomes,

investors can also look forward at projects that might be targeting final investment decision (FID) in the near term.

The largest projects that are outside the SDS budget in our analysis with a base

case FID in 2019 are shown in the table below.

These projects are a mixture therefore of projects that have already been approved this year (e.g. Azeri Central East was

TABLE 2 – THE 15 LARGEST PROJECTS FOR 2019 SANCTION OUTSIDE SDS BUDGET

Asset	Country	2019-2030 capex (\$bn)	Resource theme	Partners (* denotes operator)	Status
Kharasaveyskoye (Cenomanian-Apt), RU	Russia	10.5	Conventional (land/shelf)	Gazprom*	Construction started March 2019
Jubarite (pre-salt) (Parque das Baleia FPSO), BR	Brazil	4.3	Deep water	Petrobras*	Approval expected 2019
ACG (Azeri Central East), AZ	Azerbaijan	4.3	Deep water	BP*, Chevron, ExxonMobil, Equinor , Inpex, ONGC, TPAO, ITOCHU, Socar	Approved April 2019
Buzios (x-Franco) V, BR	Brazil	3.9	Ultra deep water	Petrobras*	Approval expected 2019
Mero 2 (x-Libra NW), BR	Brazil	3.7	Ultra deep water	Petrobras*, Shell , CNPC (parent), Total , CNOOC	Approved June 2019
Jobi-Rii (x-Buffalo-Giraffe), UG	Uganda	2.8	Extra heavy oil	Total* , CNOOC, Tullow Oil, Government of Uganda	Approval expected 2019
Lufeng 14-4/14-8/8-1, CN	China	1.3	Deep water	CNOOC*	Unclear
Cawthorne Channel (redevelop), NG	Nigeria	1.3	Conventional (land/shelf)	NNPC, Sahara Energy Field Limited, MidWestern, San Leon Energy, Bilton Energy Limited (operator = Eroton Exploration and Production)	Unclear
Lapa (x-Carioca) South-west (BM-S-9), BR	Brazil	1.2	Ultra deep water	Total* , Shell , Repsol, Sinpec Group (parent)	Unclear
Cheviot (Emerald redevelop) (2/15- 1), GB	United Kingdom	1.2	Deep water	Alpha Petroleum Resources Limited*	Unclear
Ngiri (x-Warthog), UG	Uganda	1.1	Conventional (land/shelf)	Total* , CNOOC, Tullow Oil, Government of Uganda	Approval expected 2019
Tambakboyo, ID	Indonesia	1.1	Conventional (land/shelf)	Saka Energi*	Unclear
Kravtsovskoye (D-33), RU	Russia	1.0	Conventional (land/shelf)	Lukoil*	Approval expected 2019
Nsoga, UG	Uganda	0.8	Conventional (land/shelf)	Total* , CNOOC, Tullow Oil, Government of Uganda	Approval expected 2019
Neon/Neon Sul (x-Echidna), BR	Brazil	0.8	Deep water	Karoon Energy*	Development plan due Q3 2019

Source: Rystad Energy, CTI analysis

Note: Onshore tight/shale excluded. \$10/boe margin of error allowed above SDS marginal breakeven for oil fields, \$1.5/kcf for gas. Equity interests held by the majors (ExxonMobil, Chevron, ConocoPhillips, Eni, Total, BP and Shell) plus Equinor have been highlighted.

approved in April²⁴, and Mero 2 in June²⁵), and some others that are expected to be approved this year (e.g. Buzios V, the Jobi-Rii/Ngiri/Nsoga assets which are components of the the Tilenga project).

Again, the majors are strongly represented, along with national oil companies (NOCs). Particular themes of the list include Petrobras-operated fields in pre-salt Brazil and Tullow/Total/CNOOC's discoveries in Uganda.

Assets approved in 2018 and 2019 to date highlighted in this report as being comfortably outside a cost-optimised SDS demand level amount to c.\$50bn of capex over the period 2019-2030.

Positive steps

There are notable examples of companies seeking to position themselves as contributors to climate goals including via their products, most of which have been announced over the last year and frequently in response to engagement with the CA100+²⁶. These generally fall into two categories:

- **Capital allocation** (BP, Glencore, Equinor) – during the first half of 2019, three companies have stated that they will disclose how each of their future material investments will be compliant with the Paris Agreement. None of these companies have laid out how they make this determination or

shown results as yet. The devil will be in the detail – it is not hard to imagine a situation where everyone gives themselves a clean bill of health and sees everyone else as having to make sacrifices²⁷.

- **Scope 1-3 carbon intensity targets** (Shell, Repsol, Total) – to date, most fossil fuel producers have limited their target setting to their scope 1 and 2 emissions (those resulting from the process of producing a unit of oil/gas), and resisted the implication of responsibility for scope 3 emissions (those resulting from the actual use of the products, e.g. the burning of gasoline in a car engine, and by far the bulk of life cycle emissions for fossil fuels). However, some companies have now set plans to reduce the full lifecycle carbon intensity of their energy products in relative terms – lowering CO₂ emitted per joule of energy delivered. Leaving aside the specific target levels, we see the principal drawback as being that the companies leave themselves space to keep producing or even growing in absolute terms as long as they also add low carbon energy to their portfolios, whereas the science of the carbon budget requires hard limits to emissions. Indeed, Shell plans to “fully sustain the Upstream business through the next decades”²⁸.

24 BP, “BP and partners sanction \$6 billion Azeri Central East development offshore Azerbaijan”, April 2019. Available at <https://www.bp.com/en/global/corporate/news-and-insights/press-releases/bp-and-partners-sanction-6-billion-dollar-azeri-central-east-development-offshore-azerbaijan.html>

25 Total, “Brazil: Total Launches Phase 2 on the Giant Mero Field Development”, June 2019. Available at <https://www.total.com/en/media/news/press-releases/brazil-total-launches-phase-2-giant-mero-field-development>

26 The Climate Action 100+ (CA100+) is an initiative comprised of investors with over \$34 trillion in assets under management at the time of writing which drives for greater climate action from the companies its members hold stakes in. See <http://www.climateaction100.org/>. Carbon Tracker is a key data provider to the CA100+.

27 For further discussion, see Carbon Tracker, “When Capex met Climate”, February 2019 Available at <https://www.carbontracker.org/when-capex-met-climate/>

28 Royal Dutch Shell, “Management Day 2019: Shell, strongly positioned for the future of energy, provides strategy update and financial outlook to 2025” June 2019. Available at <https://www.shell.com/media/news-and-media-releases/2019/management-day-2019-shell-strongly-positioned-for-the-future-of-energy.html>

We have discussed relative carbon intensity targets at greater length elsewhere²⁹.

Overall, we continue to believe that the industry has a lot further to go, and we await demonstrable commitments to abide by the constraints of the Paris Agreement.



29 See Carbon Tracker, "Scope for Improvement", January 2019. Available at <https://www.carbontracker.org/scope-for-improvement/>

Measuring company portfolio alignment in the longer term

Longer term alignment brings in the wider portfolio view

Estimating company alignment in the longer term involves formulating metrics that not only include projects that have been sanctioned or are targeting imminent sanction, but also factoring the company's wider portfolio of project options.

These range from the relatively near-term advanced developments, to longer term, less certain projects that are at an earlier stage in their life cycle and hence may have less value or importance in the minds of both the oil and gas company and its investors. Given that a company will have a range of different options available that will make sense in particular economic environments, assumptions have to be made about to what extent assets are reasonably likely to progress or not.

Carbon Tracker has previously explored this topic in our "2 Degrees of Separation" series of reports³⁰.

Updated capex exposure

Previous iterations of our "2 Degrees of Separation" reports have attributed capex that doesn't fit in a given carbon constrained scenario by company. Here we show new numbers based on data as of April 2019 and updated methodology.

As previously, results for B2DS and SDS scenarios are shown relative to modelled capex under the NPS, the IEA's central case. Potential capex on projects that would not go ahead under the NPS is excluded. The focus is therefore on the gap down from a "business as usual" world to a low-carbon one, or a relative measure of the investment that might be left stranded in a world where the oil and gas industry misreads future demand trends.

We highlight that this approach does not capture all opportunities to destroy value, as companies may hope to develop projects that fall outside our NPS "cut-off". We therefore also show % of potential capex above NPS to illustrate this (i.e. the full potential opportunity set), but caution that much of this above NPS capex would not go ahead without oil/gas prices much higher than those seen in the market today. Hence, including this in the main benchmark would not give a properly representative picture of risk exposure, but it is indicative of the large quantum of fossil fuels available beyond our climate limits.

Results should be considered on a relative basis

Companies have the ability to react to developments, and have the discretion not to push ahead with projects that don't fit in a low carbon world. Indeed, we consider this an advantage of our approach, which indicates projects and exposures that

³⁰ See for example Carbon Tracker, "2 Degrees of Separation: Company-level transition risk July 2018 update", July 2018. Available at <https://www.carbontracker.org/reports/2-degrees-of-separation-update/>

investors may wish to scrutinise and press their investee companies not to progress.

Furthermore, as previously, we note that the modelling exercise is based on long term estimates and hypothetical scenarios. We therefore continue to believe that results are best interpreted in a relative manner and without assuming spurious accuracy. Thus we do not provide precise numbers in this analysis – a full table is shown in the appendix with companies presented alphabetically in quartiles, and with capex exposure in 10% bands.

We also reiterate that capex results are not a direct read across for valuation risks. This is due to a number of factors, including that they do not reflect subsequent revenues or the time value of money, much of this capex is currently uncommitted as above, and that they do not relate to current market pricing expectations. Please see the accompanying document for further details of methodology.

Setting marginal cost relative to new projects only causes a material shift

As noted above, in our updated methodology we assume that all existing fields continue to produce for their base case lives, and therefore that the marginal cost that determines whether projects fit within a low carbon demand scenario or fall outside it is set by reference to new projects only. This produces a material shift downwards in the marginal cost of the last barrel needed to satisfy supply, and hence pushes out some projects that would have been within budget under our previous methodology. This is explored further in subsequent sections.

Company exposure varies widely

As previously, we use a company universe of the E&P and integrated constituents of the S&P Global Oil index plus a handful of selected companies (totalling 71 companies). The results for the 30 largest constituents of the universe by market cap plus Saudi Aramco are shown in the chart below, with the full table shown in the appendix.

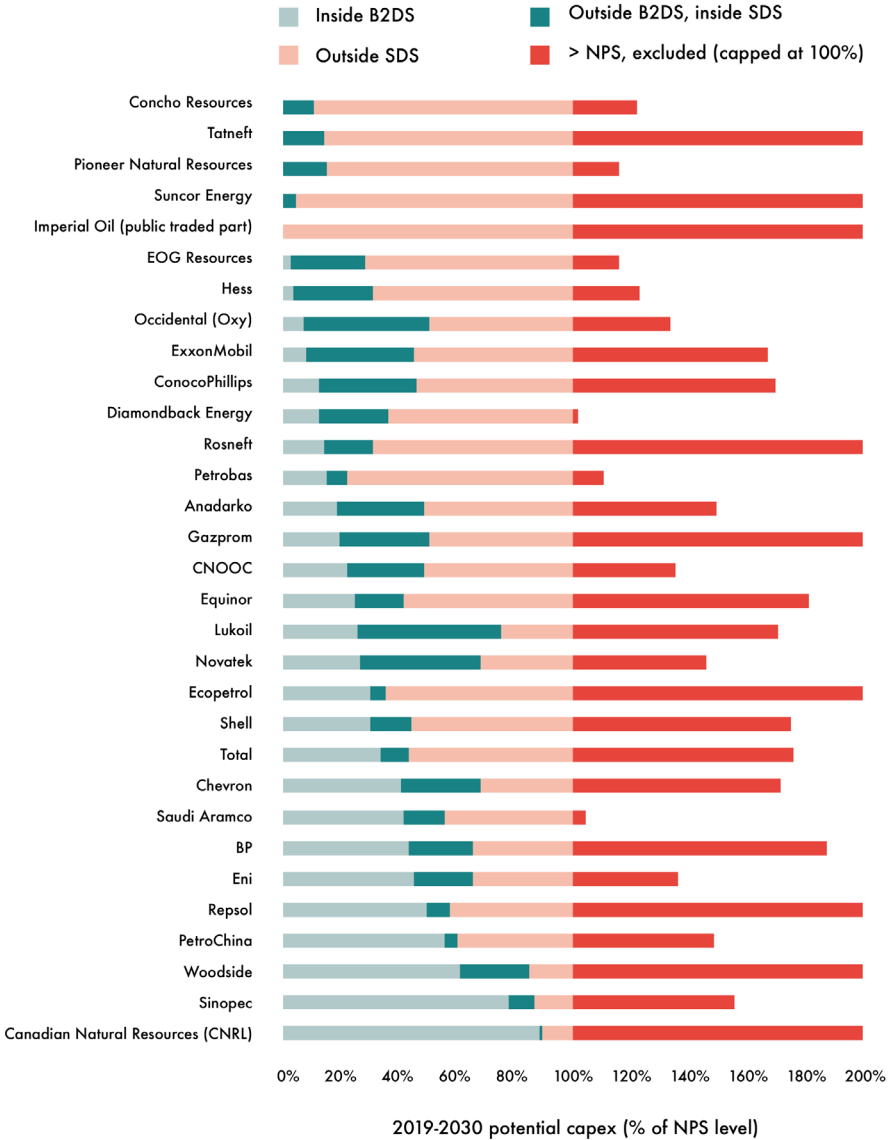
The chart below shows what proportion of 2019-2030 potential capex goes ahead in various scenarios, relative to our model of the “business as usual” NPS. Capex that goes ahead in both low carbon scenarios is in light green, capex that doesn’t go ahead in the 1.7-1.8°C SDS is in light red, and further capex that doesn’t go ahead in the 1.6°C B2DS is in dark green (i.e. total capex that doesn’t go ahead in the B2DS is the sum of the dark green and light red).

In this iteration we focus on results for unsanctioned projects only³¹, in contrast to previous iterations that included sanctioned projects in future capex. Comparable results including capex on sanctioned assets can be found in the appendix.

As noted above, our analysis generally excludes capex that doesn’t go ahead in the NPS on grounds of conservatism. However, we highlight that this shouldn’t be ignored, and show it in dark red. For the purposes of the below chart only, the portion of excluded potential capex that falls above NPS levels is capped at 100% of NPS levels (for new/unsanctioned projects).

³¹ As noted above, sanctioned projects are all assumed to be committed and hence take up their share of the carbon budget, whether economic in the low carbon transition or not.

FIGURE 10. 2019-2030 POTENTIAL CAPEX OUTSIDE GIVEN SCENARIOS, SELECTED COMPANIES. UNSANCTIONED PROJECTS ONLY



Source: IEA, Rystad Energy, CTI analysis

Note: Extent of potential capex that falls outside NPS shown capped at 100% of NPS capex levels

The results demonstrate a wide range of outcomes, with some lower cost producers having the bulk of their potential capex within the IEA carbon constrained scenarios, and others having a majority outside.

Several over-arching conclusions can be drawn, of which key aspects are discussed further below:

- **The best-positioned companies have projects that go ahead in low carbon scenarios, and no overhang of excluded projects.**

For example, Saudi Aramco's portfolio substantially all fits within the SDS and B2DS budgets, and without an overhang of excluded high cost projects. For companies that have exposure to >NPS projects, investors must assess to what extent companies plan to progress these projects and to what extent these are baked into company valuations by the rest of the market. Accordingly, we caution that our % capex figures should not be considered in isolation.

- **Oil sands companies place well – but only with the exclusion of their >NPS projects.** CNRL and Imperial Oil are at the low end of the list, with a majority of NPS capex going ahead in low-carbon scenarios. However, this is only because our modelling assumes that their oil sands projects don't go ahead even in the NPS on the basis of their high costs. This can be seen in the dark red overhang on the chart. To the extent that companies still plan to progress these projects, our methodology understates their exposure.
- **The flat cost structure of shale liquids projects places them mostly outside low-carbon scenarios.** Shale liquids specialists generally place at the top of the list

in terms of NPS capex that doesn't fit into the B2DS and SDS. For those that are focused on a particular play, the homogeneity of their costs tends to mean that they are either all in, or all out of a given budget. Their assets tend to fit in the middle of the cost curve - while marginal compared to low-carbon scenarios, these companies do not tend to have the heavy exposure to excluded high cost projects that those developing other project types may have. This makes them highly sensitive to demand outcomes and hence oil prices.

- **Of the majors, we continue to find that ExxonMobil has the greatest potential capex exposure in low carbon scenarios.** This particularly relates to Exxon's tight/shale exposure, of which the over 90% falls outside a B2DS budget - nearly double the proportion of Chevron's shale acreage.

Exclusion of high cost projects doesn't give oil sands producers a free pass

As detailed in Figure 6 above, our analysis shows that no oil sands projects should go ahead in either the B2DS or SDS in the next 20 years. In fact, only a handful of projects should go ahead even in the NPS, and so the vast majority of oil sands projects are excluded from our analysis for conservatism.

This does not mean that oil sands companies are risk free, but the opposite: their projects are so uncompetitive that they are generally not needed in the next two decades even in the IEA's central case, which is aligned with 2.7°C of warming.

Figure 11 shows this effect, by showing the proportion of potential capex associated

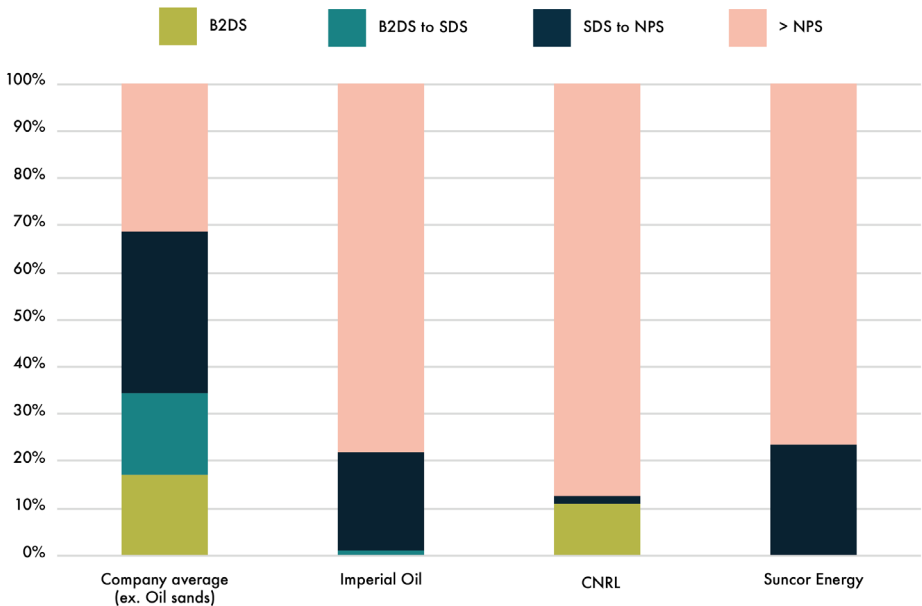
with discovered (but unsanctioned) projects which are outside even NPS for the three oil sands-focused companies in the 30 largest constituents of our universe, and comparing it to the average of the other 27.

For the average of the non-oil sands companies, just under a third of potential capex is excluded as uneconomic under NPS (the light orange bar). Conversely, for CNRL, Imperial Oil and Suncor, the proportion of potential capex that has been excluded is closer to 80%. This demonstrates the greater extent of high cost project options available in the oil sands companies' portfolios.

However, this approach does not capture that the companies may plan to progress these projects, and may indeed sanction them in periods of higher prices. For example, Teck Resources (not in our universe) is currently progressing its Frontier oil sands project: "Given the current project timing, and the future demand we see, we think it's a strong project to move ahead"³². However, in our analysis, this project falls outside NPS due to its high production costs (requiring oil prices of over \$100/bbl) and is excluded. Teck's regulatory filings assume a Western Canada Select oil price \$79.50/bbl³³, around double current levels.

This should be borne in mind when considering relative company positionings.

FIGURE 11. 2019-2030 CAPEX FOR DISCOVERED OIL AND GAS PROJECTS BY IEA SCENARIO



Source: IEA, Rystad Energy, CTI analysis

32 Financial Post, "Teck Resources takes \$20.6B Frontier oilsands mine project to joint hearing", September 2018. Available at <https://business.financialpost.com/pmn/business-pmn/teck-resources-takes-20-6b-frontier-oil-sands-mine-project-to-joint-hearing>

33 "Teck Resources Limited Responses to Joint Review Panel Information Request Package 10", February 2018. Available at <https://www.ceaa-acee.gc.ca/050/documents/p65505/121936E.pdf>

Cost distribution shows sensitivity to future pricing

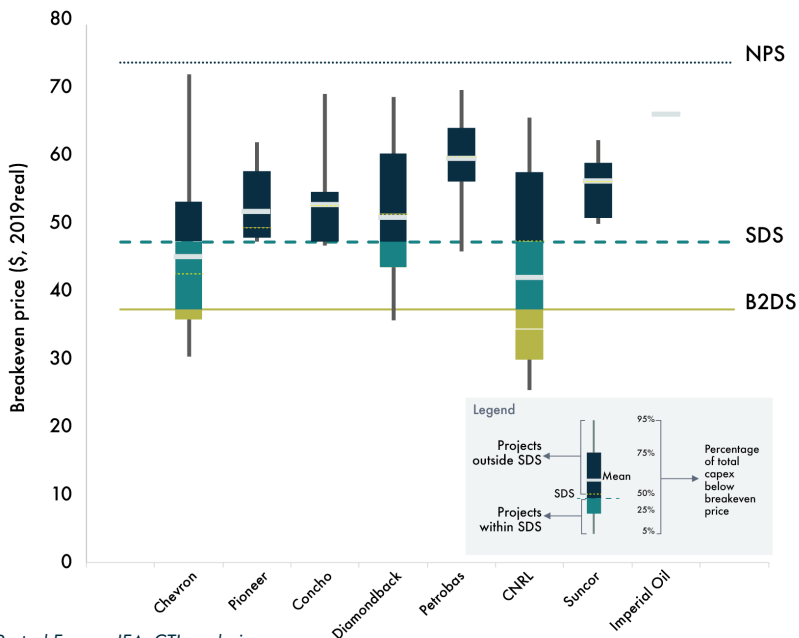
All other things being equal, a broader range of portfolio project costs may give lower sensitivity to demand outcomes. This diversification is likely to be related to diversification in terms of project theme, and other key drivers such as geography (e.g. tax regime / political stability). For such portfolios, future changes in commodity prices will result in more linear changes in overall viability compared to those those that specialise in a particular theme.

Figure 12 shows the range in project break-even price (capex-weighted) for unsanctioned projects for a basket of selected companies to illustrate this point, for oil projects only in this case. As above, projects outside NPS are excluded.

The box shows the inter-quartile range of projects, with the whiskers representing the 5-95% project range. This therefore shows both the relative proportion of capex that fits within each scenario, but also an indication of the proportion of a company's projects which would be impacted by a change in SDS-breakeven price.

Taking Chevron as an example, we see that just over 25% of potential capex is associated with projects that fit within B2DS. More than 50% of project capex is compliant with SDS, and were the SDS marginal price to increase by \$10/bbl then over 75% of projects would fall within SDS. The length of the green box indicates a wider distribution of project costs in its portfolio than exhibited by companies that are focused on particular regions or development types.

FIGURE 12. BREAKEVEN OIL PRICE SENSIVITY FOR UNSANCTIONED OIL PROJECTS FOR SELECTED COMPANIES.



Source: Rystad Energy, IEA, CTI analysis
Note: Excludes projects outside NPS

Chevron therefore has a fairly wide range of different projects in its portfolio, as might be expected from a diversified major, with a significant proportion within the SDS.

Conversely Petrobras, with just 8% of oil project capex within SDS, has a narrow range of relatively high-cost projects reflecting its relatively focused portfolio.

Among the oil sands players, CNRL places at the low cost end of the chart while Imperial Oil and Suncor are less favourably positioned. However, while CNRL may seem competitive, like Imperial Oil and Suncor the majority of its unsanctioned potential projects fall outside NPS and are therefore not shown (see Figure 11). Its position is therefore predicated on their oil sands projects not being considered for development.

Relative portfolio homogeneity for shale specialists gives "all or nothing" outcomes

As shale operators may specialise in a particular basin or play, their cost structures are frequently very flat, with portfolio project costs "bunching" around a particular breakeven band compared to a more diversified company. This may mean that they are disproportionately impacted in our methodology, which puts projects as a binary in/out of the budget.

For example, in Figure 12 above, Permian basin specialists Pioneer and Concho can be seen to have their portfolios in a narrow band just outside the SDS. This makes them highly sensitive to outcomes – hitting the SDS outcome means their projects are entirely stranded, whereas a demand outcome closer to NPS puts them entirely within the budget.

However, shale positions are not all alike, even with a particular basin. Another Permian player, Diamondback, has over 25% of its potential capex within SDS owing to the lower costs of a portion of its acreage.

Tight/shale players – greater flexibility, or greater sensitivity to demand outcomes?

The positioning of US tight/shale onshore players in our capex analysis may also be affected by the short term nature of their operations, in that post-FID long cycle projects are likely to have a greater amount of capex over a longer period than an "existing" shale well which is drilled with production then dropping off rapidly. If post-FID projects are assumed within budget, this continuing capex will lead towards a natural bias in % of future capex against companies where effectively all of their future capex is "new".

It is often argued that short cycle projects are preferable in the energy transition, as the relatively short payback periods mean that operators can take advantage of temporary price spikes or lower investment according to deteriorating conditions. We think the reality is more complex. For example, this flexibility did not help the over 170 North American oil and gas producers that have filed for bankruptcy since 2015³⁴. Short cycle operations may give the ability to increase or lower production rapidly, but this also means that production and hence cashflows can be very sensitive to commodity prices. Cessation of drilling in challenging conditions leads to rapidly falling production, and hence cashflow, making it difficult to cover other costs such as debt service.

34 Haynes and Boone LLP, "Oil Patch Bankruptcy Monitor", May 2019. Available at http://www.haynes-boone.com/-/media/files/energy_bankruptcy_reports/oil_patch_bankruptcy_monitor.ashx?la=en&hash=D-2114D98614039A2D2D5A43A61146B13387AA3AE

One can imagine a scenario where a shale company could increase production to capture a short-term price spike, then lower production to avoid a downturn while returning that cash to shareholders – making it “safer” than other producers. Given a) this scenario’s reliance on being able to “see it coming” in the context of the industry’s generally poor track record of predicting future price volatility; b) the assumption that cash could be taken off the table for distributions when shale operations are reliant on continuous investment; and c) the shale patch’s inability to generate satisfactory returns for investors as it is, we see this argument as wishful thinking.

“Oxydanko” deal will be reliant on synergies to improve Occidental’s relative positioning

In May 2019, it was announced that Occidental Petroleum (“Oxy”) would acquire Anadarko Petroleum Corporation for \$57bn³⁵, gazumping a prior bid from Chevron and incurring a further \$1bn termination fee in the process³⁶. A separate deal was agreed to sell Anadarko’s assets in Africa to Total for \$8.8bn on completion of the bid³⁷.

We find that adding Anadarko’s portfolio to Occidental’s and removing Anadarko’s African assets does not materially improve Occidental’s relative positioning and still leaves a large majority outside low carbon budgets.

Looking at unsanctioned assets only, compared to Occidental on a standalone basis the combined entity has a very slightly lower exposure under B2DS, but still with nearly 90% of NPS level capex outside the budget. Exposure under SDS is marginally worse.

However, our analysis does not yet include any estimated synergies that might arise. Given that much of the shale industry has a marginal positioning close to budget limits as discussed above, economies of scale may be the difference between in/out of a budget. Further consolidation in the shale patch is therefore anticipated as the industry looks to move towards a more financially sustainable footing, but also as a possible defence strategy against weakening demand. Indeed, part of Occidental’s rationale for the deal was that it “Creates a global energy leader with enhanced scale and expertise to lead energy into a low carbon future”³⁸.

The deal has been called “fundamentally misguided and hugely overpriced” by investor Carl Icahn³⁹. We do not comment on current valuations or prices paid in M&A transactions, or include these in our analysis which looks solely at project economics. Investors preparing for a world of lower fossil fuel demand may wish to consider the extent to which synergies can actually be realised, and balance this against the potential additional exposure.

35 Occidental Petroleum, “Occidental to Acquire Anadarko”, May 2019. Available at <https://www.oxy.com/News/Pages/Article.aspx?Article=6090.html>

36 Anadarko, “Anadarko Agrees To Be Acquired By Occidental”, May 2019. Available at <http://investors.anadarko.com/2019-05-09-Anadarko-Agrees-To-Be-Acquired-By-Occidental>

37 Total, Total agrees with Occidental to contingent acquisition of Anadarko’s assets in Africa”, May 2019. Available at <https://www.total.com/en/media/news/press-releases/total-agrees-occidental-contingent-acquisition-anadarkos-assets-africa>

38 Occidental Petroleum, “Occidental to Acquire Anadarko”, May 2019. Available at <https://www.oxy.com/News/Pages/Article.aspx?Article=6090.html>

39 Bloomberg, “Icahn Sues Occidental and Threatens Fight for Board, Sale”, May 2019. Available at <https://www.bloomberg.com/news/articles/2019-05-30/icahn-challenges-occidental-s-hugely-overpriced-anadarko-deal>

Appendix I

Oil and gas in a 1.5°C world

Advancing ambition

The Paris Agreement of December 2015 set out an international commitment to limit the global temperature rise this century to “well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius”⁴⁰. In response, the Intergovernmental Panel on Climate Change (IPCC) prepared a Special Report on Global Warming of 1.5°C⁴¹, published in October 2018.

The report concluded that humans activities had caused “approximately 1.0°C of global warming” to date, and that warming is “likely to reach 1.5°C between 2030 and 2052 if it continues at the current rate”. The report further emphasised the importance of limiting temperatures to lower outcomes and the less severe damages that would result at 1.5°C rather than 2°C, including relating to flooding, drought, sea level rise, species extinction, “health, livelihoods, food security, water supply, human security, and economic growth”. It was pointed out that “Populations at disproportionately higher risk of adverse consequences with global warming of 1.5°C and beyond include disadvantaged and vulnerable populations”.

We have previously relied on IEA scenarios in our analysis (all of which assuming >1.5°C of warming), which are accompanied by sufficient underlying detail to enable detailed modelling. Due to the importance of the 1.5°C target and the need to set high climate ambitions, in this report we also consider oil and gas potential supply in the context of a 1.5°C demand outcome.

Comparing 1.5°C scenarios to fossil fuel supply

1.5°C pathways

In this report we draw on two illustrative 1.5°C scenarios based on the IPCC’s Special report. These scenarios are described in the report as follows⁴²:

P1 – “A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR [carbon dioxide removal] option considered; neither fossil fuels with CCS nor BECCS are used.”

40 <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

41 Available at <https://www.ipcc.ch/sr15/>

42 IPCC, Global Warming of 1.5°C Summary for Policy Makers, October 2018. Available at <https://www.ipcc.ch/sr15/>

P2 – “A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.” While CCS is restricted in this scenario, it still amounts to capture of 348 GtCO₂ by 2100, of which 151 GtCO₂ is BECCS, with the 3.1 GtCO₂ captured in 2040 a little higher than that captured in the SDS at that point.

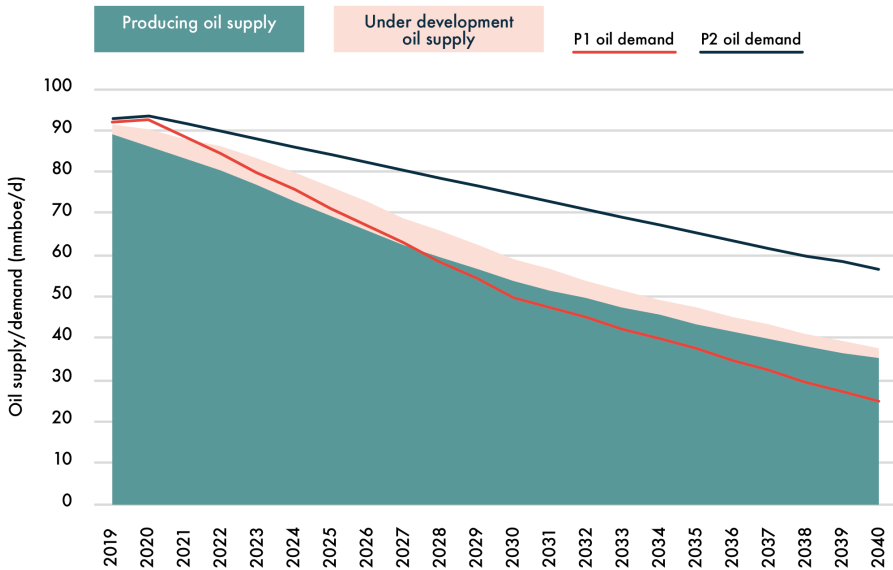
Carbon Tracker has made adjustments to standardise these scenarios; see the accompanying document⁴³ for further details.

Oil and gas in sanctioned projects exceeds 1.5°C with no CCS

In the P1 pathway, oil demand is satisfied by post-FID production alone, i.e. assets that are already producing or under development. In the P2 pathway, the addition of CCS makes additional room for some new oil projects, but in very limited quantities compared to the growth aspirations of industry companies.

An annual decline in production from producing and under development fields in aggregate is 4.1%, compared to compound annual falls in demand of 6.1% and 2.3% under the P1 and P2 pathways. The below chart shows the same for global gas demand. On a global aggregate basis, post-FID gas production is approximately similar to that required under P1, with a small shortfall in P2.

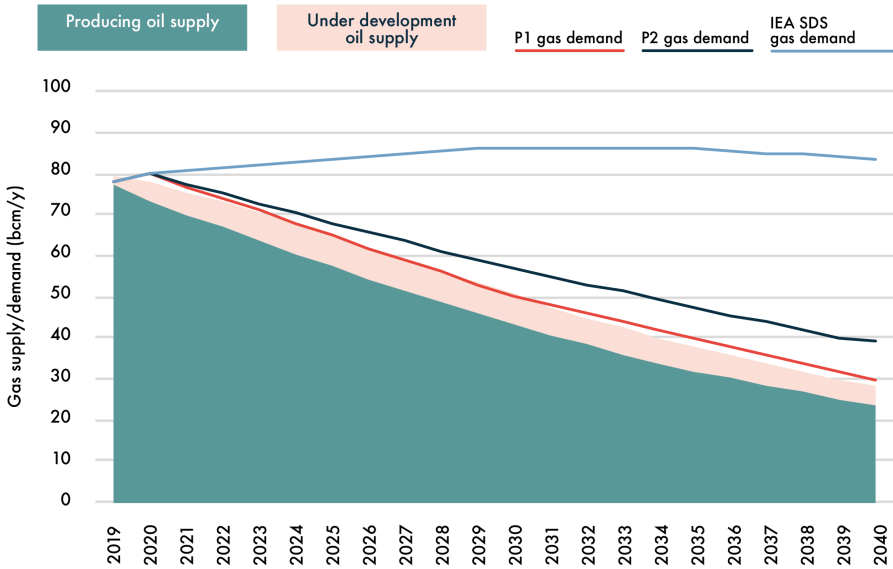
FIGURE 13 – COMPARISON OF 1.5°C PATHWAYS TO POST-FID OIL PRODUCTION



Source: IPCC, Rystad Energy, IEA, CTI analysis

43 <https://www.carbontracker.org/wp-content/uploads/2019/09/Breaking-the-Habit-Methodology-Final-1.pdf>

FIGURE 14 – COMPARISON OF 1.5°C PATHWAYS TO POST-FID GAS PRODUCTION



Source: IPCC, Rystad Energy, IEA, CTI analysis

However, this is not to say that investment stops entirely under even these scenarios. Capex continues on existing projects, and due to the regional nature of gas markets, the global headline figures do not mean that there would be no new production in some markets driven by local supply/demand dynamics. For example, our modelling suggests that some very limited gas drilling would occur in North America to offset steep production declines, even against rapidly falling demand (assumed to fall at nearly 6% p.a.). However, this would add to the global overshoot beyond 1.5°C limits.

Carbon Tracker has already shown that coal associated with existing mines exceeds the SDS and B2DS scenarios, which are more generous to coal than the P1 and P2 scenarios. In our interpretations of the P1 and P2 scenarios, global coal demand falls by 10.2% p.a. and 7.0% p.a. respectively 2019-2040.

What this analysis does indicate is that, without a sufficiently strong policy response and accelerated developments in alternative energies and carbon mitigation technologies sufficient to force the closure of existing projects, the 1.5°C budget will be exceeded by fossil fuel projects that are already committed⁴⁴. We note consistent conclusions for oil and gas in aggregate found by Oil Change International and others⁴⁵.

⁴⁴ See Carbon Tracker, "Mind The Gap: the \$1.6 trillion energy transition risk", March 2018. Available at <https://www.carbontracker.org/reports/mind-the-gap/>

⁴⁵ Oil Change International, Platform, Friends of the Earth Scotland, "Sea Change: Climate Emergency, Jobs

The Paris Agreement is not to achieve 1.5°C, but to aim for 1.5°C and achieve well below 2°C (although achieving 1.5°C would of course have huge environmental and societal benefits, as emphasised in the IPCC report). Therefore, the daunting challenge of 1.5°C should not mean that efforts to pursue it are abandoned; rather that aiming for such stretch goals will be how the Paris targets are ultimately achieved.

Gas use remains subject to carbon constraints

Gas is often described as a “bridge fuel”, meaning that it can be expanded while renewables are scaled up, or even a continuing key component of a lower carbon future. This is driven by its lower CO₂ intensity for power generation compared to coal, as well as better resulting air quality with regard to other pollutants.

However, it is still a fossil fuel and a significant source of carbon emissions, hence carries strict limits on its use in order to deliver a scenario of relatively low global warming. The P1 and P2 pathways firmly reinforce this point. In scenarios with no or limited CCS, gas demand has to fall sharply; -4.5% CAGR in P1 and -3.2% CAGR in P2. The addition of CCS in P2 makes relatively more space for oil than it does gas.

In the IEA low carbon scenarios – which have higher temperature outcomes and allow significant CCS use – gas use is given some space to increase in the medium term; demand peaks in 2025 in the 1.6°C⁴⁶ B2DS and 2030 in the 1.7-1.8°C SDS. However, the limits are still clear: in the SDS, the average carbon intensity of electricity generation falls from 484 grammes of CO₂ per kilowatt-hour (g CO₂/kWh) in 2017 to 69 g CO₂/kWh in 2040⁴⁷. This compares to the carbon intensity of a new combined cycle gas turbine of 350 g CO₂/kWh⁴⁸.

Therefore, it should not be assumed that gas is “safe” in the energy transition. There is considerable uncertainty regarding future demand in a decarbonising globe, and plenty of opportunity to invest in supply options that would destroy value.

The corporate context

As shown above, the P1 budget is exceeded by existing oil and gas in aggregate, and the P2 scenario leaves very limited space for new development even when viewed on a regional basis. Accordingly, there is limited differentiation between companies – the message of little/no new projects widely applicable – we have not modelled these scenarios in detail and do not present analysis for them on a company level.

No oil and gas companies can be considered compliant with a scenario of 1.5°C and no CCS, with continued plans to invest in new sources of supply and maintain, or even expand, production.

and Managing the Phase-out of UK Oil and Gas Extraction”, May 2019. Available at <http://priceofoil.org/content/uploads/2019/05/SeaChange-final-r3.pdf>

46 Approximately estimated by Carbon Tracker from its interpretation of the IEA B2DS from the 2017 Energy Technology Perspectives publication, and based on emissions to net-zero year. The B2DS was originally formulated as a 50% chance of success of limiting warming to 1.75°C.

47 IEA, “World Energy Outlook 2018”, November 2018

48 IEA, “World Energy Outlook 2017”, November 2017

Appendix II

Full company results

The full table of results for our universe of companies (the E&P and integrated components of the S&P Global Oil Index, plus other selected companies e.g. BHP, Saudi Aramco) is shown below⁴⁹.

As well as each company's proportion of potential capex (excluding projects that are above NPS) that does not fit in a B2DS or SDS scenario, the table also shows the

proportion of projects have been excluded relative to the NPS level. The first table shows results relating to unsanctioned projects only.

Companies are organised alphabetically within quartiles based on their % of NPS 2019-2030 upstream potential capex that is outside the B2DS budget.

TABLE 3 – 2019-2030 POTENTIAL CAPEX OUTSIDE GIVEN SCENARIOS, UNSANCTIONED PROJECTS ONLY

Quartile (4 is highest % of capex outside B2DS budget, 1 is lowest)	Company	% of NPS upstream capex outside B2DS budget (% band)	% of NPS upstream capex outside SDS budget (% band)	Upstream capex excluded as above NPS (shown as % of NPS capex)
4	Aker BP	90% - 100%	50% - 60%	60% - 70%
4	Centennial Resource Development	100%	30% - 40%	0% - 10%
4	Concho Resources	100%	80% - 90%	20% - 30%
4	Crescent Point Energy	90% - 100%	90% - 100%	>100%
4	EOG Resources	90% - 100%	70% - 80%	10% - 20%
4	Hess	90% - 100%	60% - 70%	20% - 30%
4	Imperial Oil (Public traded part)	90% - 100%	90% - 100%	>100%
4	Lundin Petroleum	90% - 100%	40% - 50%	70% - 80%
4	Matador Resources	100%	60% - 70%	10% - 20%
4	Oasis Petroleum	100%	70% - 80%	10% - 20%
4	Parsley Energy	100%	100%	0% - 10%
4	Pioneer Natural Resources	100%	80% - 90%	10% - 20%

⁴⁹ Compared to last year's list, the following companies have been excluded as no longer in the S&P Global Oil Index: Surgutneftegas, Energen (acquired by Diamondback), Gulfport Energy, Newfield Exploration (acquired by Encana), Peyto, RSP Permian (acquired by Concho). The following companies have been added to the index: Oasis Petroleum, PDC Energy, Matador Resources, Whiting Petroleum, Centennial Resource Development.

4	QEP Resources	100%	90% - 100%	0% - 10%
4	Suncor Energy	90% - 100%	90% - 100%	>100%
4	Tatneft	100%	80% - 90%	>100%
4	Vermilion Energy	90% - 100%	50% - 60%	>100%
4	Whiting Petroleum	100%	100%	40% - 50%
4	WPX Energy	100%	70% - 80%	50% - 60%
3	Anadarko	80% - 90%	50% - 60%	40% - 50%
3	Chesapeake	80% - 90%	60% - 70%	40% - 50%
3	Cimarex Energy	80% - 90%	10% - 20%	0% - 10%
3	CNOOC	70% - 80%	50% - 60%	30% - 40%
3	ConocoPhillips	80% - 90%	50% - 60%	70% - 80%
3	Continental Resources	90% - 100%	20% - 30%	40% - 50%
3	Diamondback Energy	80% - 90%	60% - 70%	0% - 10%
3	Encana	80% - 90%	70% - 80%	50% - 60%
3	Equinor	70% - 80%	50% - 60%	80% - 90%
3	ExxonMobil	90% - 100%	50% - 60%	60% - 70%
3	Galp Energia SA	70% - 80%	50% - 60%	10% - 20%
3	Gazprom	80% - 90%	40% - 50%	>100%
3	Origin Energy	70% - 80%	0% - 10%	>100%
3	Oxy	90% - 100%	40% - 50%	30% - 40%
3	PDC Energy	70% - 80%	60% - 70%	0% - 10%
3	Petrobras	80% - 90%	70% - 80%	10% - 20%
3	Rosneft	80% - 90%	60% - 70%	>100%
3	Tullow Oil	90% - 100%	70% - 80%	>100%
2	Apache	50% - 60%	40% - 50%	>100%
2	BHP	70% - 80%	30% - 40%	>100%
2	BP	50% - 60%	30% - 40%	80% - 90%
2	Chevron	50% - 60%	30% - 40%	70% - 80%
2	Devon Energy	60% - 70%	40% - 50%	30% - 40%
2	Ecopetrol	70% - 80%	60% - 70%	>100%
2	Eni	50% - 60%	30% - 40%	30% - 40%
2	Husky Energy	60% - 70%	60% - 70%	>100%
2	Lukoil	70% - 80%	20% - 30%	70% - 80%
2	Marathon Oil	70% - 80%	20% - 30%	20% - 30%
2	Murphy Oil	50% - 60%	30% - 40%	40% - 50%
2	Noble Energy	60% - 70%	40% - 50%	20% - 30%
2	Novatek	70% - 80%	30% - 40%	40% - 50%
2	OMV	60% - 70%	30% - 40%	50% - 60%

2	Saudi Aramco	50% - 60%	40% - 50%	0% - 10%
2	Shell	60% - 70%	50% - 60%	70% - 80%
2	Total	60% - 70%	50% - 60%	70% - 80%
1	Antero Resources	0% - 10%	0% - 10%	10% - 20%
1	Arc Resources	30% - 40%	30% - 40%	20% - 30%
1	Cabot Oil and Gas	0% - 10%	0% - 10%	0% - 10%
1	Canadian Natural Resources (CNRL)	10% - 20%	10% - 20%	>100%
1	Cenovus Energy	10% - 20%	0% - 10%	>100%
1	EQT Corporation	30% - 40%	10% - 20%	>100%
1	Inpex	40% - 50%	40% - 50%	90% - 100%
1	Oil Search	50% - 60%	40% - 50%	30% - 40%
1	PetroChina	40% - 50%	30% - 40%	40% - 50%
1	Range Resources	10% - 20%	0% - 10%	30% - 40%
1	Repsol	50% - 60%	40% - 50%	>100%
1	Santos	40% - 50%	20% - 30%	90% - 100%
1	Sasol	0% - 10%	0% - 10%	10% - 20%
1	Seven Generations Energy	0% - 10%	0% - 10%	0% - 10%
1	Sinopec	20% - 30%	10% - 20%	50% - 60%
1	Southwestern Energy	0% - 10%	0% - 10%	70% - 80%
1	Tourmaline Oil	30% - 40%	0% - 10%	0% - 10%
1	Woodside	30% - 40%	10% - 20%	>100%

Source: Rystad Energy, CTI analysis

Note: GTL and CTL are excluded from the analysis, and therefore are not included in Sasol's potential portfolio.

The table and chart on the next pages shows the same, but including the effect of already-sanctioned projects. The table also gives the proportion of future capex that is on "new" pre-FID projects rather than already-sanctioned projects. This is then shown graphically following the table, on a similar basis to Figure 10.

TABLE 4 – 2019-2030 POTENTIAL CAPEX OUTSIDE GIVEN SCENARIOS, ALL PROJECTS (SANCTIONED AND UNSANCTIONED)

Quartile (4 is highest % of capex outside B2DS budget, 1 is lowest)	Company	% of NPS upstream capex outside B2DS budget (% band)	% of NPS upstream capex outside SDS budget (% band)	Upstream capex excluded as above NPS (shown as % of NPS capex)	% of NPS capex associated with pre-FID projects
4	Anadarko	70% - 80%	40% - 50%	40% - 50%	89%
4	Centennial Resource Development	90% - 100%	30% - 40%	0% - 10%	95%
4	Chesapeake	80% - 90%	60% - 70%	40% - 50%	96%
4	Cimarex Energy	80% - 90%	10% - 20%	0% - 10%	95%
4	Concho Resources	90% - 100%	80% - 90%	20% - 30%	95%
4	Continental Resources	80% - 90%	20% - 30%	40% - 50%	94%
4	Crescent Point Energy	80% - 90%	80% - 90%	>100%	81%
4	Diamondback Energy	80% - 90%	60% - 70%	0% - 10%	95%
4	Encana	80% - 90%	70% - 80%	50% - 60%	96%
4	EOG Resources	90% - 100%	60% - 70%	10% - 20%	94%
4	Hess	70% - 80%	50% - 60%	10% - 20%	82%
4	Matador Resources	90% - 100%	60% - 70%	10% - 20%	94%
4	Oasis Petroleum	90% - 100%	70% - 80%	10% - 20%	95%
4	Parsley Energy	90% - 100%	90% - 100%	0% - 10%	97%
4	Pioneer Natural Resources	90% - 100%	80% - 90%	10% - 20%	97%
4	QEP Resources	90% - 100%	90% - 100%	0% - 10%	97%
4	Whiting Petroleum	90% - 100%	90% - 100%	30% - 40%	95%
4	WPX Energy	90% - 100%	60% - 70%	50% - 60%	94%
3	Aker BP	60% - 70%	30% - 40%	30% - 40%	65%
3	CNOOC	50% - 60%	30% - 40%	20% - 30%	64%
3	ConocoPhillips	40% - 50%	20% - 30%	30% - 40%	52%
3	Devon Energy	50% - 60%	30% - 40%	20% - 30%	87%
3	Equinor	30% - 40%	30% - 40%	40% - 50%	52%
3	ExxonMobil	60% - 70%	30% - 40%	40% - 50%	66%
3	Galp Energia SA	50% - 60%	30% - 40%	0% - 10%	67%
3	Lundin Petroleum	60% - 70%	30% - 40%	50% - 60%	73%
3	Marathon Oil	60% - 70%	20% - 30%	20% - 30%	92%
3	Murphy Oil	50% - 60%	30% - 40%	30% - 40%	93%

3	Noble Energy	60% - 70%	40% - 50%	20% - 30%	93%
3	Novatek	40% - 50%	20% - 30%	20% - 30%	63%
3	Oil Search	30% - 40%	30% - 40%	20% - 30%	76%
3	Oxy	50% - 60%	20% - 30%	20% - 30%	61%
3	PDC Energy	70% - 80%	50% - 60%	0% - 10%	89%
3	Shell	30% - 40%	30% - 40%	40% - 50%	56%
3	Tullow Oil	50% - 60%	40% - 50%	60% - 70%	60%
3	Vermilion Energy	30% - 40%	20% - 30%	>100%	42%
2	Apache	30% - 40%	20% - 30%	>100%	67%
2	Arc Resources	30% - 40%	30% - 40%	20% - 30%	95%
2	BHP	30% - 40%	10% - 20%	80% - 90%	54%
2	BP	20% - 30%	10% - 20%	40% - 50%	49%
2	Chevron	30% - 40%	10% - 20%	30% - 40%	55%
2	Eni	30% - 40%	10% - 20%	20% - 30%	57%
2	EQT Corporation	20% - 30%	10% - 20%	80% - 90%	88%
2	Gazprom	30% - 40%	10% - 20%	30% - 40%	38%
2	Husky Energy	20% - 30%	20% - 30%	50% - 60%	36%
2	Inpex	20% - 30%	20% - 30%	50% - 60%	58%
2	OMV	20% - 30%	10% - 20%	20% - 30%	42%
2	Petrobras	30% - 40%	30% - 40%	0% - 10%	44%
2	Repsol	20% - 30%	20% - 30%	90% - 100%	56%
2	Santos	30% - 40%	10% - 20%	60% - 70%	71%
2	Total	30% - 40%	20% - 30%	30% - 40%	52%
2	Tourmaline Oil	30% - 40%	0% - 10%	0% - 10%	95%
2	Woodside	30% - 40%	10% - 20%	>100%	80%
1	Antero Resources	0% - 10%	0% - 10%	10% - 20%	98%
1	Cabot Oil and Gas	0% - 10%	0% - 10%	0% - 10%	93%
1	Canadian Natural Resources (CNRL)	0% - 10%	0% - 10%	60% - 70%	14%
1	Cenovus Energy	0% - 10%	0% - 10%	50% - 60%	13%
1	Ecopetrol	10% - 20%	10% - 20%	20% - 30%	20%
1	Imperial Oil (Public traded part)	10% - 20%	10% - 20%	50% - 60%	13%
1	Lukoil	10% - 20%	0% - 10%	10% - 20%	24%
1	Origin Energy	20% - 30%	0% - 10%	>100%	28%
1	PetroChina	10% - 20%	10% - 20%	10% - 20%	29%
1	Range Resources	10% - 20%	0% - 10%	30% - 40%	96%
1	Rosneft	10% - 20%	10% - 20%	20% - 30%	20%
1	Sasol	0% - 10%	0% - 10%	0% - 10%	54%

1	Saudi Aramco	10% - 20%	0% - 10%	0% - 10%	22%
1	Seven Generations Energy	0% - 10%	0% - 10%	0% - 10%	96%
1	Sinopec	0% - 10%	0% - 10%	10% - 20%	28%
1	Southwestern Energy	0% - 10%	0% - 10%	70% - 80%	95%
1	Suncor Energy	10% - 20%	10% - 20%	50% - 60%	13%
1	Tatneft	0% - 10%	0% - 10%	20% - 30%	3%

Source: Rystad Energy, CTI analysis

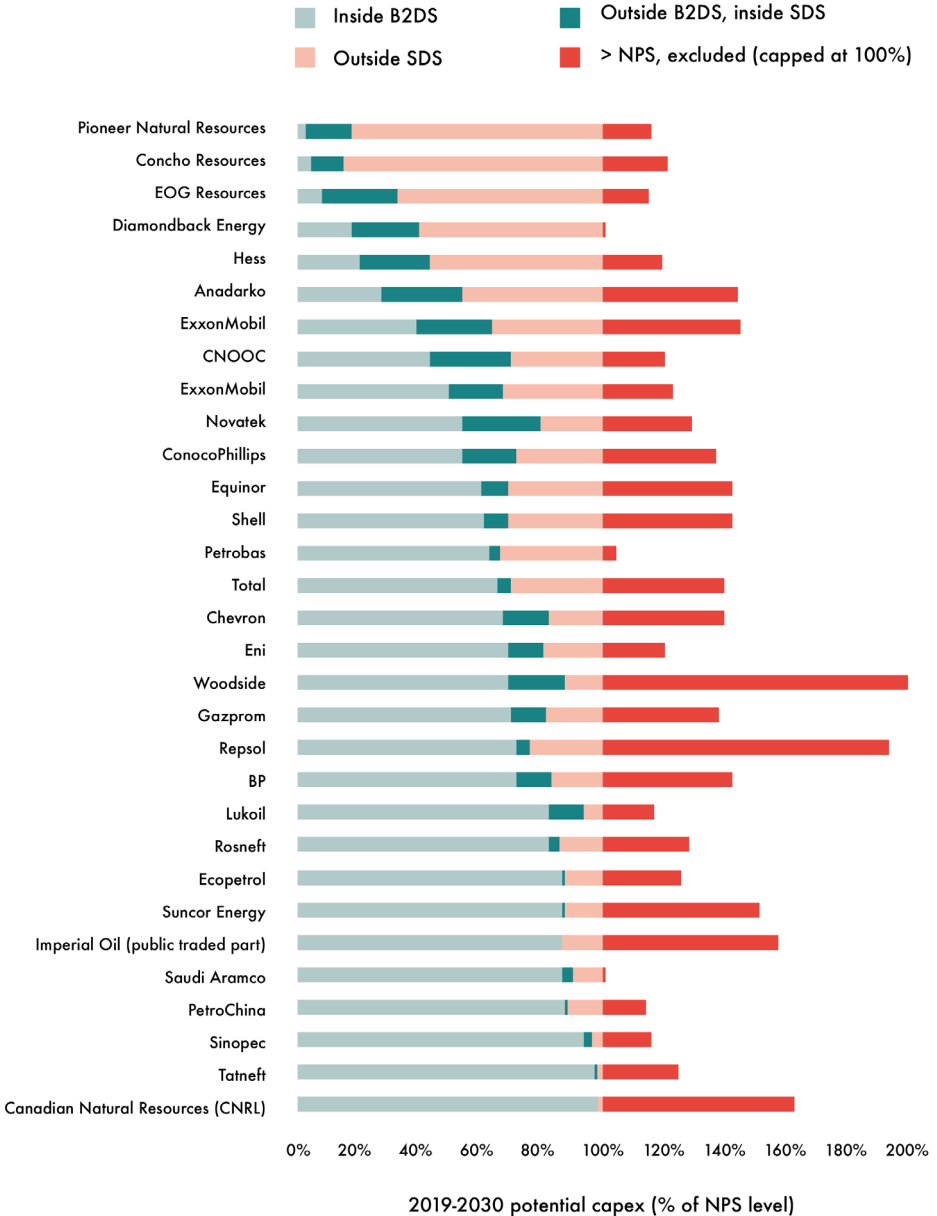
Note: GTL and CTL are excluded from the analysis, and therefore are not included in Sasol's potential portfolio.

Note that the chart on the next page does not feature a cap on the extent of above NPS capex displayed, as does the counterpart for unsanctioned projects only

shown previously in the document; when including unsanctioned projects as well, no company shown in the chart has greater than 100% of potential NPS capex excluded.



FIGURE 15. 2019-2030 POTENTIAL CAPEX OUTSIDE GIVEN SCENARIOS, SELECTED COMPANIES. SANCTIONED AND UNSANCTIONED PROJECTS



Source: IEA, Rystad Energy, CTI analysis

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