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# OVEREXPOSED

## HOW THE IPCC'S 1.5°C REPORT DEMONSTRATES THE RISKS OF OVERINVESTMENT IN OIL AND GAS

23 APRIL 2019

# EXECUTIVE SUMMARY

Overinvestment in oil and gas creates risks for investors, regardless of whether the world is effective in tackling climate change. Either investors face assets being stranded as demand for fossil fuels falls in a transition to a low carbon economy, or the overinvestment contributes to excess emissions from fossil fuels, the failure to transition and the financial costs of a dramatically changed climate.

This report assesses what the Intergovernmental Panel on Climate Change (IPCC)'s landmark report on 1.5°C means for the future of investment in the upstream oil and gas industry. By comparing data from the IPCC's climate models with forecasts from industry analysts Rystad Energy, this report demonstrates the degree to which future production and capital expenditure (capex) is incompatible with limiting warming to 1.5°C.

In October 2018, the world's leading authority on climate change published its groundbreaking report on limiting warming to 1.5°C, the temperature goal of the Paris climate agreement.[1] The IPCC's report demonstrated, unequivocally and comprehensively, the enormous risks from climate change that remain if warming reaches 2°C and the significant benefits of limiting warming to 1.5°C.[2] The IPCC also found that limiting warming to 1.5°C is still possible if ambitious action is taken now, drawing on a range of climate scenarios demonstrating how that goal could be achieved.[i]

[i] This briefing will refer to the 90 1.5°C scenarios assessed by the IPCC as the IPCC scenarios

## CAPITAL INVESTMENT IN NEW FIELDS IS INCOMPATIBLE WITH 1.5°C

Our analysis compared average oil and gas demand in the IPCC scenarios that are not reliant on high levels of future carbon capture or removal with industry production forecasts.[ii] It found that over the next decade:

- **Any production from new oil and gas fields, beyond those already in production or development, is incompatible with limiting warming to 1.5°C.**
- **All of the $4.9 trillion forecast capex in new oil and gas fields is incompatible with limiting warming to 1.5°C.**
- **9% of oil and 6% of gas production forecast from existing fields is incompatible with limiting warming to 1.5°C.[3]**

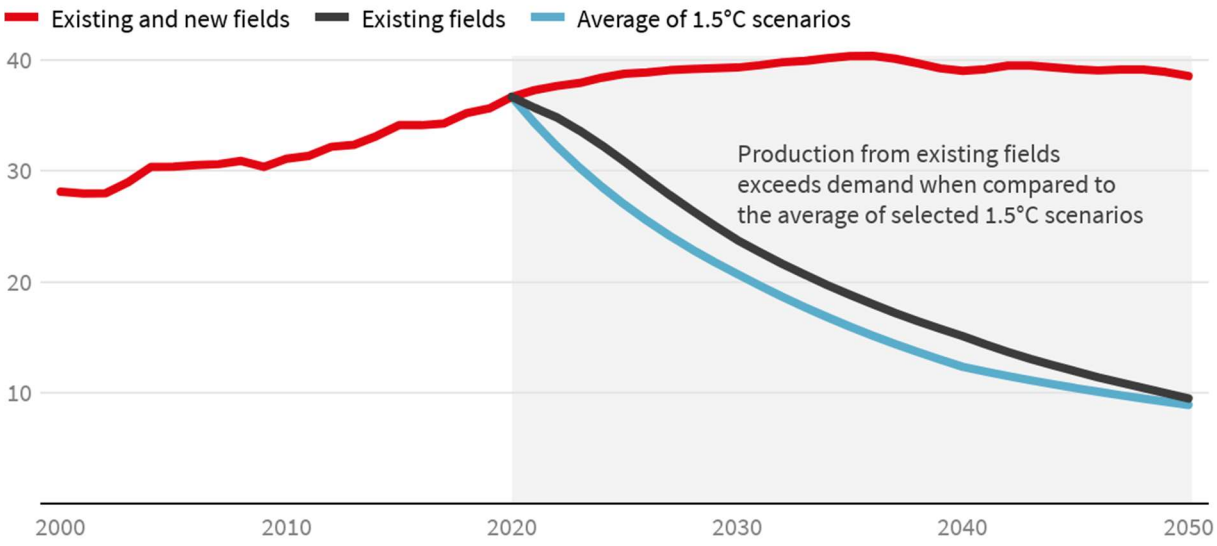
The oil and gas industry is at a crucial turning point. Capex has fallen by over a third since 2014, largely because of a slump in oil prices.[iii] Yet it is forecast to rise by over 85% over the next decade, reaching over $1 trillion a year.[4] Two thirds of that investment is set to take place in new fields where development has not yet started and investments have not yet been sanctioned.[5] Major capex projects that are forecast to be approved in new fields over the next decade include US domestic shale expansion, the Vaca Muerta shale in Argentina, the Kashagan oil field in Kazakhstan and the Yamal megaproject in Russia.[6]

[ii] For our analysis we defined this as CCS and BECCS deployment in 2040 less than or equal to the IEA's SDS target and cumulative CCS and BECCS up to 2100 below the average of the IPCC scenarios that do not significantly overshoot 1.5°C.

[iii] Throughout this report capex refers to capital expenditures to find and prove hydrocarbons as well as investment costs incurred related to development of infrastructure.

## OIL: NEW AND EXISTING FIELDS VS 1.5°C

Forecast production from new and existing fields compared to the average of selected 1.5°C scenarios




*Billion barrels (bbl)*

Chart: Global Witness calculations • Source: Rystad Energy & IAMC 1.5°C Scenario Explorer hosted by IIASA. • •

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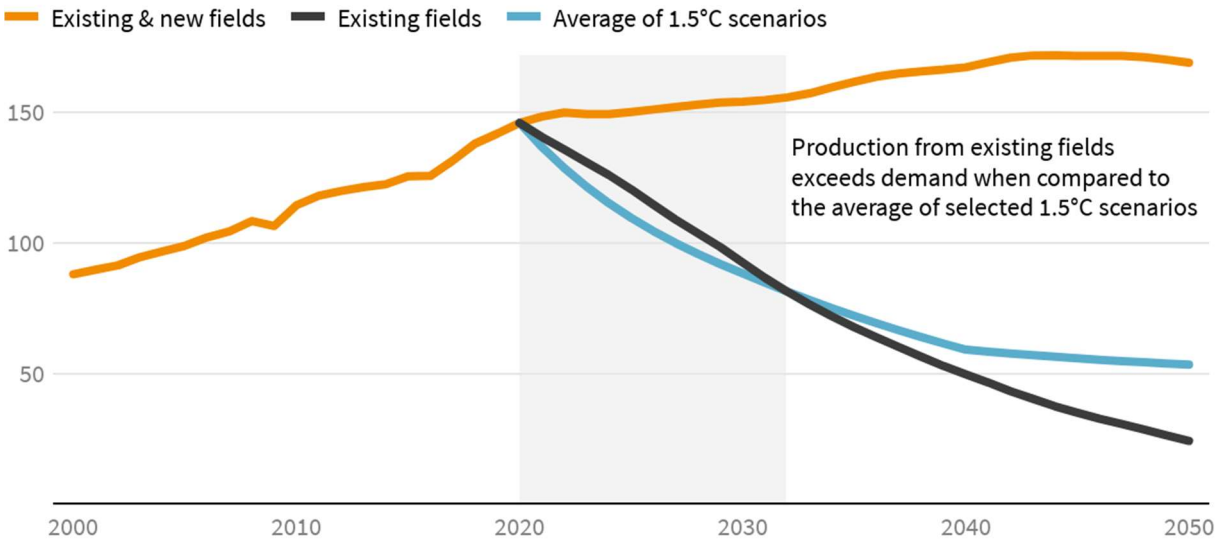
## GAS: NEW AND EXISTING FIELDS VS 1.5°C

Forecast production from new and existing fields compared to the average of selected 1.5°C scenarios




*Trillion cubic feet*

Chart: Global Witness calculations • Source: Rystad Energy & IAMC 1.5°C Scenario Explorer hosted by IIASA. • •

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The oil and gas majors are set to lead this surge in investment, making up five of the ten largest investors in new fields over the next decade, led by ExxonMobil, Shell and Chevron.[7] In light of our findings, this investment represents a potentially enormous misallocation of capital.

### THE RISKY GAMBLES OF CARBON CAPTURE AND REMOVAL TECHNOLOGIES

This analysis focuses on IPCC scenarios that do not rely on high levels of future carbon capture or removal because of the significant risks associated with these technologies. Not least is the fact that neither of the main technologies modelled – CCS and BECCS – yet exist at a meaningful scale.

### CARBON CAPTURE AND REMOVAL: CCS, CDR & BECCS

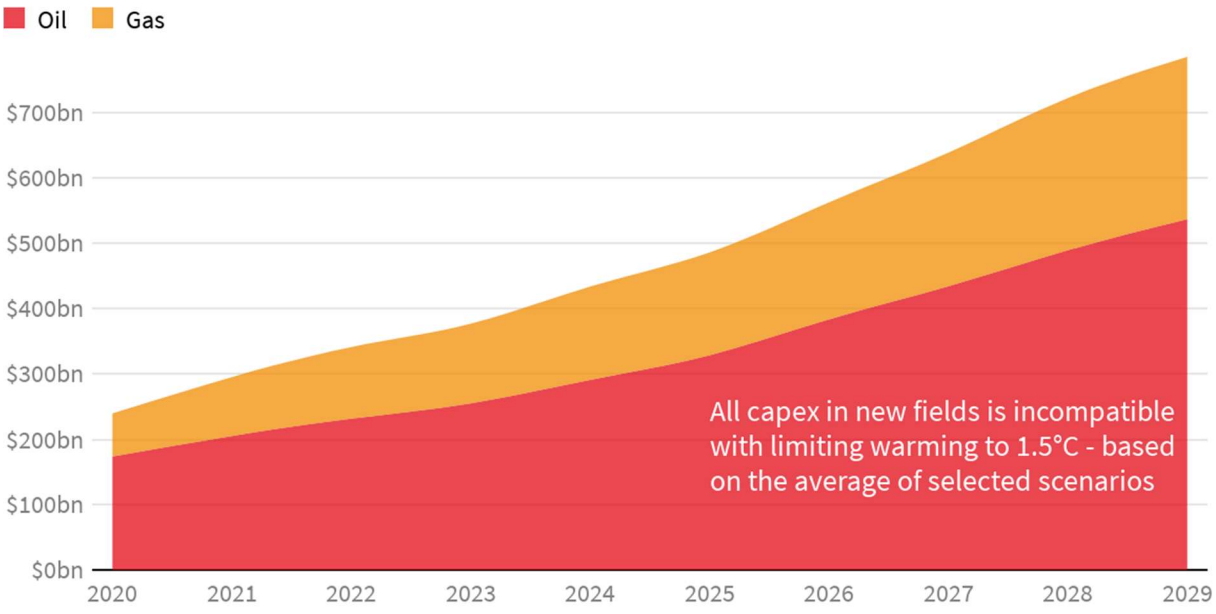
**CCS – Carbon Capture and Storage** is a technology that captures CO2 at the point of emission (e.g. a power station), preventing it from being released into the atmosphere and then storing it.

**CDR – Carbon Dioxide Removal** is the process of removing CO2 from the atmosphere.

**BECCS – Bioenergy with Carbon Capture and Storage** is a CDR technology in which plants are grown (which removes CO2 from the atmosphere), burnt to generate energy, and then the resulting carbon emissions are captured and stored using CCS.

## ANNUAL CAPEX IN NEW FIELDS

Forecast capital expenditure per year in new fields.




Source: Rystad Energy • •

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Despite considerable effort, including the commitment of $28 billion of public funds to CCS projects, there are only two operational in the power sector worldwide.[8] Yet both use the captured $CO_2$ to enable further oil extraction, in turn leading to further $CO_2$ emissions.[9]

While CCS has had negligible success to date, some climate scenarios rely on nearly as much $CO_2$ being captured in the 21st Century as has been emitted worldwide since the Industrial Revolution.[10]

CDR also plays a central role in many climate scenarios, yet the IPCC report repeatedly highlights the risks, uncertainties and limitations of CDR deployment at scale. [11] It found that "CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C".[12]

BECCS is one of the primary CDR technologies used in climate scenarios,[13] yet a study for the leading intergovernmental body on carbon sequestration reported that large-scale BECCS deployment would "necessitate planting bioenergy crops on […] approximately one-third of the arable land on the planet".[14]

The IPCC report highlights concerns that raising expectations of "large-scale CDR deployment in the future can lead to an actual reduction of near-term mitigation efforts"; in effect building complacency that difficult decisions about short-term emissions reductions are not needed because of the future panacea of CDR.[15]

## UNRELIABLE SCENARIOS, UNDERESTIMATING RISKS

Investors are using scenarios to assess the risks they face from the energy transition, in line with the recommendations of the Taskforce on Climate-related Financial Disclosures (TCFD).[16] At present, they are at risk of substantially underestimating those risks by relying on scenarios that fail to limit warming to 1.5°C and rely excessively on carbon capture and removal.

The scenario most widely used by investors is the International Energy Agency's (IEA) Sustainable Development Scenario (SDS),[17] which the IEA claims is aligned with the Paris goals[iv].[18] However, analysis by Oil Change International has shown that the SDS can only be considered to be on track for 1.5°C - 1.8°C if it assumes the use of CDR technologies at levels considered unrealistic by both the IEA and the IPCC.[19] In fact the SDS has the same emissions trajectory as the IEA's previous '450' scenario, which only gave a 50% chance of limiting warming to 2°C. [20]

Oil and gas companies' scenarios also include highly questionable assumptions about these technologies. For example, Carbon Tracker found that Shell's 2°C scenario would require "some 10,000 large-scale carbon capture and storage facilities to be built over the timeframe (more than one every other day for the next 50 years)."[21]

Such scenarios push the boundaries of plausibility and do not serve as a credible guide to alignment with the Paris goals.

[iv] In this briefing the Paris goals refers specifically to Articles 2.1.a and 4.1 of the Paris Agreement, including pursuing efforts to limit warming to 1.5°C above pre-industrial levels.

## THE RISKS OF OVERINVESTMENT IN OIL AND GAS

This report's findings have profound implications for the future of the oil and gas industry. Continuing investment on a business as usual pathway would massively increase the financial risks for oil and gas companies and their investors from a transition to a 1.5°C world.

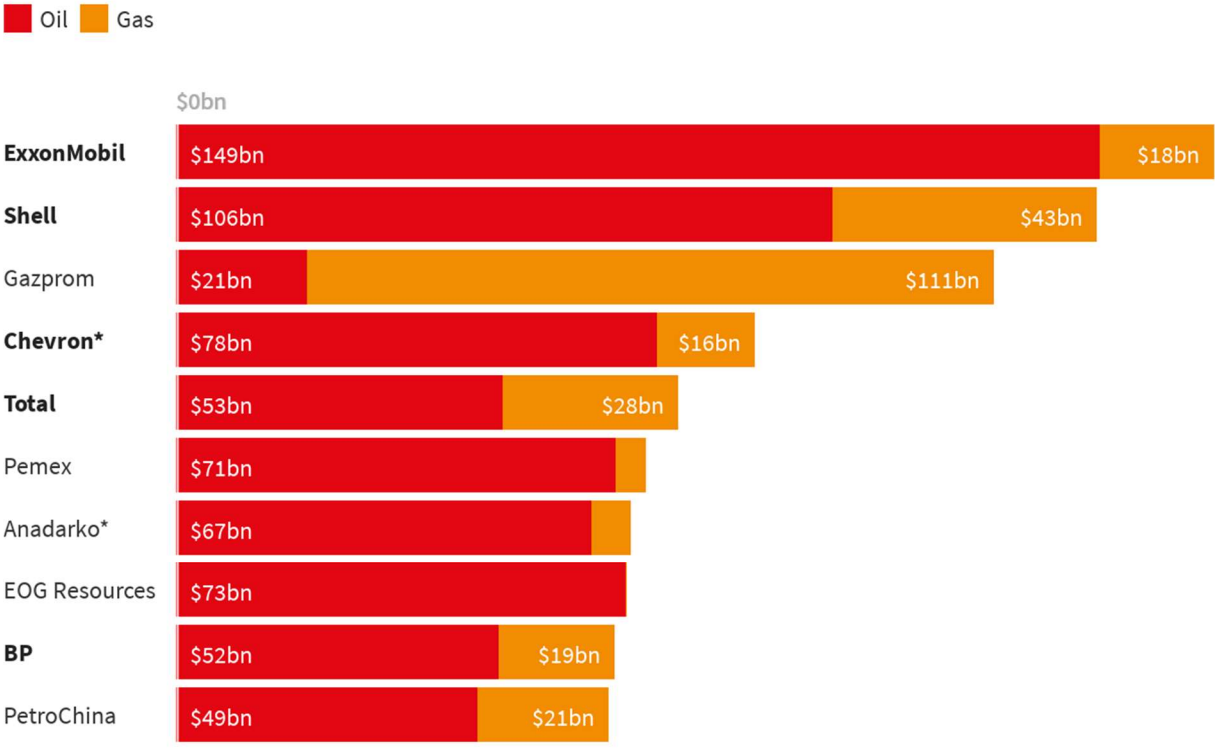
At present, that excess investment can only be justified as being consistent with the world's climate goals by a heavy reliance on future carbon capture and removal. However, given the risks and uncertainties in these technologies it is highly likely that they will not materialise at the pace and scale that these scenarios require.

As a result, an ever-increasing gap emerges between the current emissions pathway – where high levels of fossil fuel emissions continue on the assumption that they will be mitigated by future large-scale deployment of carbon capture and removal - and a technically achievable pathway to 1.5°C. The growth of this gap increases the risk of a sudden and disorderly transition of the kind the Governor of the Bank of England Mark Carney has warned of, as closing this growing gap would require increasingly heavy-handed intervention.[22]

The UN Principles for Responsible Investment (PRI) has suggested that such a forceful intervention would be likely to include government action such as restricting demand for fossil fuels or

## HIGHEST COMPANY CAPEX IN NEW FIELDS

Top 10 companies by forecast capital expenditure in new fields - 2020-2029. Oil and gas majors in bold.




**Based on latest available data - Chevron has since bought Anadarko.*

Source: Rystad Energy • •

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reducing the supply of fossil fuels through the sudden and immediate phasing out of existing fossil fuel infrastructure.[23] Such a policy response would have a significant and immediate impact on the valuation of oil and gas companies.

These risks are often perceived as long-term risks, materialising over decades in line with the energy transition. Yet perceptions of the future of the energy transition will result in market changes over a far quicker timescale than the transition itself.

The financial risks of excess investment in oil and gas extraction are not limited to the sector; they extend across the global economic system. This investment creates huge risks to the world's climate from locking in long-term emissions from new oil and gas production that is incompatible with limiting warming to 1.5°C. Doing so puts the world closer to a dangerous 'business as usual' pathway and increases the risk of a failure to transition in line with the Paris goals.

The potential costs of a failure to transition are vast. A study by Schroders found that the world is currently on track for around 4°C of warming which could lead to global economic losses of up to $23 trillion per year - the equivalent of three to four times the losses incurred in the 2008 financial crisis, every year.[24] This scale of loss represents a systemic threat to the global financial system.

The risks to the sector and the systemic risk to the financial system can by minimised through avoiding overinvestment in new oil and gas fields. Capex decisions made in the short to medium term will shape the extent to which these risks materialise.

Our analysis has focused on new fields, as there is significantly more scope to adjust capex plans where development has not yet started. Project investment decisions now will shape the energy transition, either locking in higher emissions and raising the risks of a disorderly transition, or avoiding overinvestment and ensuring a smooth transition to achieve the Paris climate goals. To minimise the risks and ensure an orderly transition, companies should align capex with robust 1.5°C scenarios that do not rely on unrealistic models of future carbon capture and removal.

## PRIMARY RECOMMENDATIONS

- **Oil and gas companies** should align their capex planning with scenarios that limit warming to 1.5°C without reliance on unrealistic levels of future carbon capture and removal.

- **Investors** should require oil and gas companies to explain how each new material capex investment is aligned with the Paris goals. This assessment should be made in the context of the company's whole portfolio, include alignment with 1.5°C and full disclosure of the assumptions on the scale of carbon capture or removal used in their assessment.

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## 1. THE IMPORTANCE OF 1.5°C

Since the 2015 UN climate talks in Paris, much focus has been placed on the summit's agreement to limit warming to 2°C. Yet in the Paris Agreement, countries committed themselves to "pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels".[25]

In October 2018, the Intergovernmental Panel on Climate Change (IPCC) published its landmark report on *Global Warming of 1.5°C*.[26] This report found stark differences in the predicted impacts from limiting warming to 1.5°C compared to 2°C, including:

- Several hundred million fewer people exposed to climate-related risks and susceptible to poverty;
- 10 million fewer people affected by rising sea levels;
- Up to 50% reduction in the proportion of the world population exposed to increased water stress;
- Reducing impacts on biodiversity and ecosystems including species loss and extinction, such as limiting the decline of coral reefs to 70-90%, compared to a total loss at 2°C.
- Preventing the thawing of 1.5 – 2.5 million $km^2$ of permafrost.[27]

These findings demonstrate that even 1.5°C of warming will have vast and damaging consequences on human society and the natural world. Just 1.5°C of warming still comes with the risk of major climactic changes such as the collapse of the Greenland or Antarctic ice sheets that would lead to multi-metre sea level rises.[28] In short, the IPCC report laid bare the imperative of achieving the 1.5°C goal.

# 2. EXCESS CAPITAL EXPENDITURE ABOVE A 1.5°C PATHWAY

## METHODOLOGY

To assess how much forecast oil and gas production and capex is compatible with the 1.5°C goal, we analysed how oil and gas demand in the IPCC scenarios compare to industry forecasts of production from new and existing fields.

The IPCC analysed 90 scenarios that model different approaches to how to achieve the 1.5°C target. These scenarios vary widely, most notably in the extent to which they overshoot 1.5°C before reducing global temperatures to meet that target, and in the extent to which Carbon Capture and Storage (CCS) or Carbon Dioxide Removal (CDR) are deployed.

The variation in the scenarios' reliance on carbon capture and removal is vast – in the case of CCS varying from no use to capturing nearly as much $CO_2$ in the 21st Century as has been emitted worldwide since the Industrial Revolution.[29] Despite their large role in many of the scenarios, the IPCC is clear that there are significant risks and uncertainties to achieving large-scale deployment of either CCS or CDR technologies (these are detailed in sections 4 and 5).

On that basis, we excluded scenarios with a high overshoot of the 1.5°C target and with unrealistic growth in or above average deployment of carbon capture and removal technologies.

The criteria used are not stringent. For example, the International Energy Agency (IEA) states that the world is currently off-track to meet its target for CCS,[30] therefore scenarios that rely on CCS deployment increasing rapidly above current trends are still included in our assessment. Similarly two of the scenarios included rely on Bioenergy with Carbon Capture and Storage (BECCS) deployment in the late 21st Century that is at the upper end of that considered technically possible by 2050 by the IPCC.[31]

Five of the 90 scenarios met these criteria and included data on primary energy from oil and gas.[32] We then calculated the mean future oil and gas demand across these five to illustrate average demand in these lower carbon capture and removal scenarios.

We compared this data to a model based on industry forecasts from Rystad Energy for

**Scenario selection**

| Factor | Selection criteria |
|---|---|
| **Overshoot of 1.5°C** | Categorised as no or low overshoot of 1.5°C target |
| **Rate of growth of CCS and BECCS** | CCS and BECCS deployment in 2040 less than or equal to the IEA's Sustainable Development Scenario 2040 target for CCS in the Power Sector. |
| **Ultimate scale of deployment of CCS and BECCS** | Cumulative CCS and BECCS up to 2100 below the average of the IPCC scenarios that do not have a high overshoot of the 1.5°C goal. |

production from existing fields, those currently producing or under development, and new fields where investment decisions have not yet been made.[v] This distinction is important as there is significantly more scope to stop capex going ahead in fields where no development or production has yet started.

In our analysis, we have assumed that due to capital lock-in, existing fields will be fully utilised and assets will not be retired early. Due to the sunk capital costs in these projects it is more economically rational to continue to operate these projects at a loss than to retire them early and invest fresh capital in a new field with a lower operating cost (capital lock-in is discussed in more detail in section 7).

Our methodology differs from previous similar assessments by comparing production data with pathways from the IPCC scenarios as it allows a comparison of the trajectory over time. This differs from previous analyses that have either compared total reserves to carbon budgets[vi], or used a cost-optimising methodology to assess projects against a carbon supply cost curve.[33] The methodology we have used both accounts for capital lock-in in existing fields and produces granular, year by year, data on supply and demand trends over the energy transition.

We focused on our findings on the next decade (2020-2029) to demonstrate the misalignment between capex decisions being in the near-term and the 1.5°C goal.

*This analysis is not intended to identify a definitive 1.5°C scenario and the model used has limitations. For example, we have not sought to forecast the growth of CCS or BECCS – only to exclude scenarios with the highest and least probable levels of deployment.*

*A full explanation of the methodology and data sources, including its limitations, and an overview of the five selected scenarios is included in the methodology, available at: www.globalwitness.org/overexposed*

## OIL

Compared to the average demand across the scenarios, all forecast production from new oil fields over the next decade was incompatible with limiting warming to 1.5°C. The same is true in four of the scenarios; in only one of the five scenarios was any production from new fields compatible with 1.5°C.

Over the next ten years, the industry is forecast to invest $3.3 trillion in production from new oil fields. In the one scenario where there was space for new production, only 18% of that total capex in new oil fields is compatible with 1.5°C. For all of the other scenarios and compared to the average of these scenarios – none of this capex is compatible with limiting warming to 1.5°C.

## GAS

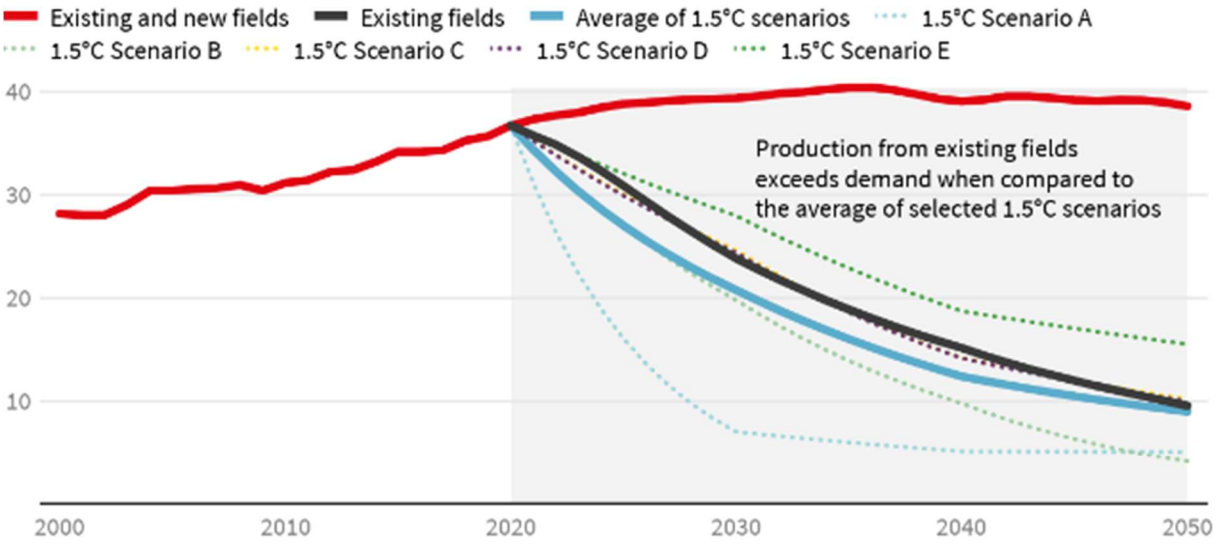
All gas production from new fields over the next decade is also incompatible with the average of these 1.5°C scenarios. Models of future gas demand vary more across the underlying scenarios, with all production from new fields being incompatible with two of the five scenarios over the next decade. In the other three scenarios, some production from new gas fields would be compatible with 1.5°C.

[v] This data was based on Rystad's Base Case Oil price, Rystad Energy's own price forecast for long term oil liquids supply and demand balance. We consider it a 'business as usual' scenario that is reflective of current market trends.

[vi] Carbon budget refers to the cumulative total $CO_2$ that can be emitted over a time period in order to keep temperatures below a set threshold.

## OIL: NEW AND EXISTING FIELDS VS 1.5°C

Forecast production from new and existing fields compared to the average of selected 1.5°C scenarios




*Billion barrels (bbl)*

Chart: Global Witness calculations • Source: Rystad Energy & IAMC 1.5°C Scenario Explorer hosted by IIASA. • •

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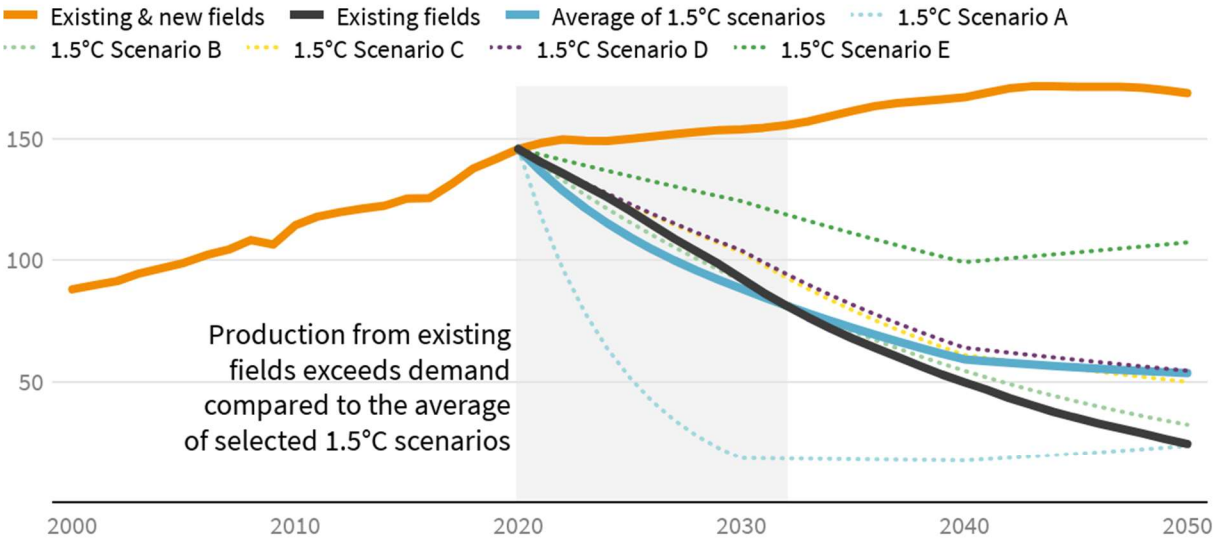
## GAS: NEW AND EXISTING FIELDS VS 1.5°C

Forecast production from new and existing fields compared to selected 1.5°C scenarios




*Trillion cubic feet*

Chart: Global Witness calculations • Source: Rystad Energy & IAMC 1.5°C Scenario Explorer hosted by IIASA. • •

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For two of the three scenarios where some investment in new gas fields was compatible with 1.5°C over the next decade, this was a small fraction of the total $1.6 trillion forecast to be spent in that time – just 11% and 12% of that total. Only one of the scenarios allowed for any large-scale investment in new gas production over the next decade with 48% of the forecast total investment potentially being compatible.

Over the longer term, a small degree of new gas production above that forecast from existing fields would be compatible with the average of these 1.5°C scenarios from 2032 onwards.

Taking the average of these scenarios, none of the $1.6 trillion forecast investment in the next decade in new gas production is compatible with limiting warming to 1.5°C. These findings stand in stark contrast to claims from the industry that sustained growth in gas production is compatible with, if not a vital part of, achieving the world's climate goals.[34]

**In total, none of the total $4.9 trillion forecast investment in new oil and gas fields is compatible with the average of IPCC scenarios that limit warming to 1.5°C without a heavy reliance on carbon capture and removal.**

## TOTAL CAPEX IN NEW FIELDS

Forecast capital expenditure in new fields vs. capex in new fields that is compatible with selected IPCC 1.5C scenarios: 2020-2029

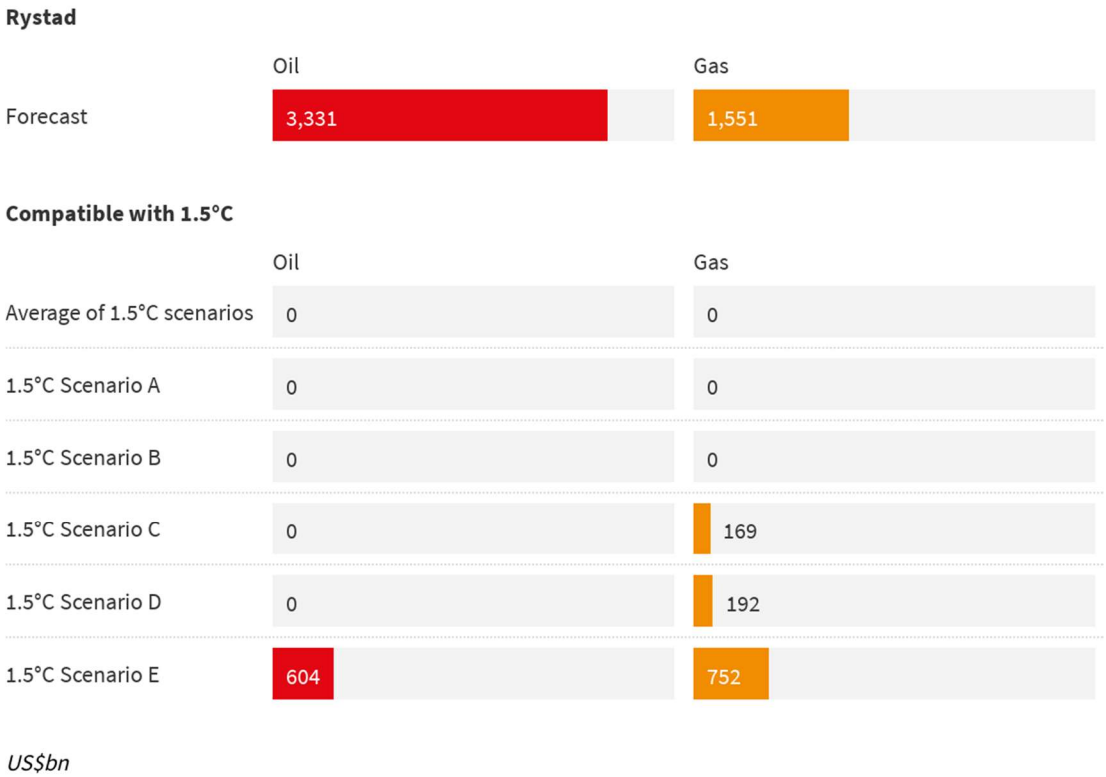


Chart: Global Witness calculations • Source: Rystad Energy & IAMC 1.5°C Scenario Explorer hosted by IIASA. • •

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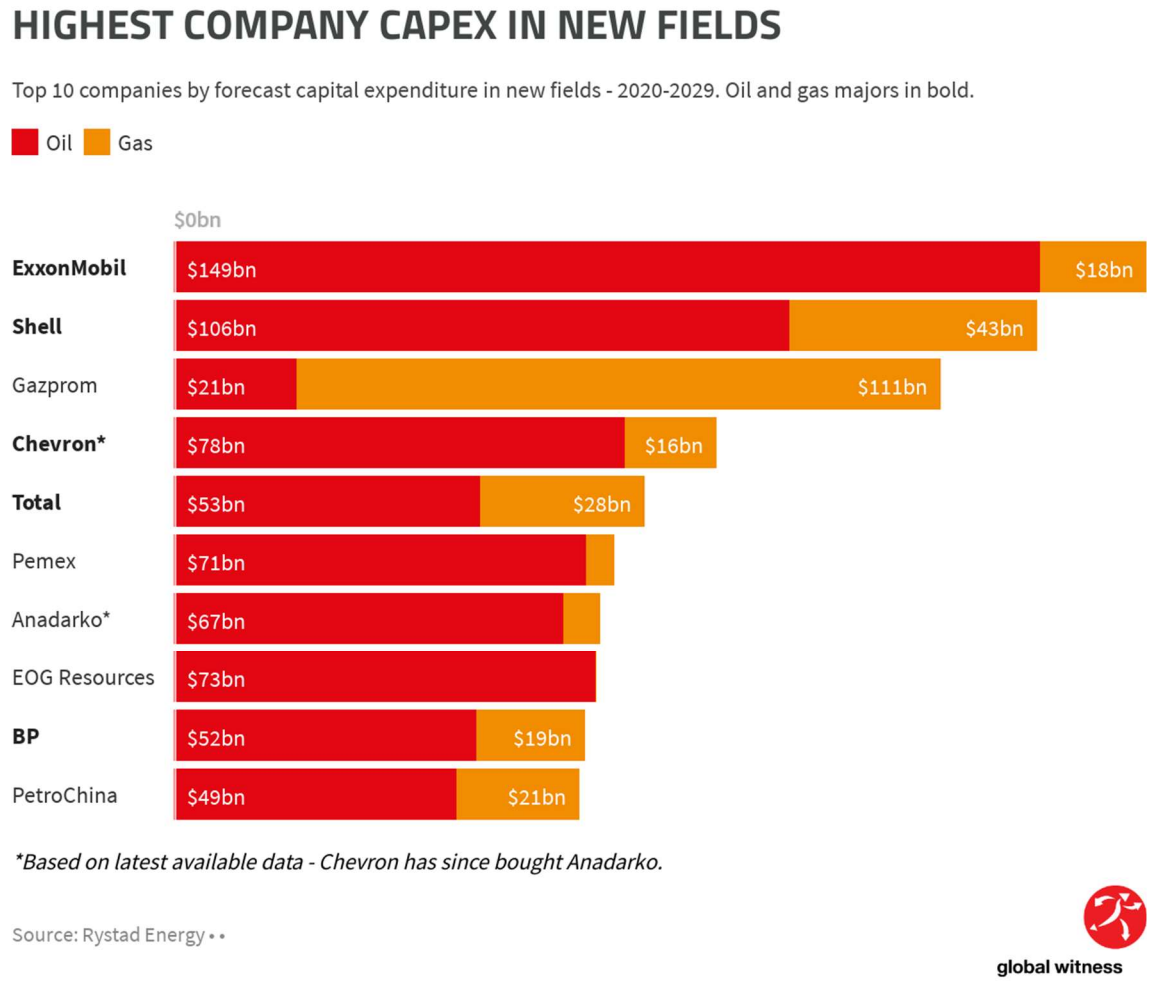


The oil and gas industry is currently at a crucial turning point. Capex has fallen by over a third since 2014, largely because of falling oil prices.[35] That trend is now set to reverse with capex forecast to rise by over 85% over the next decade, reaching over $1 trillion per year.[36] Two thirds of that is set to take place in new fields.[37] Major capex projects in new fields that are forecast to be approved include US domestic shale expansion, the Vaca Muerta shale in Argentina, the Kashagan oil field in Kazakhstan and the Yamal megaproject in Russia.[38] This analysis has shown that investment is incompatible with limiting warming to 1.5°C without a reliance on unrealistic levels of carbon capture and removal.

The oil and gas majors are set to lead this investment boom, making up five of the top ten biggest investors in new fields over the next decade, led by ExxonMobil, Shell and Chevron.[39]

These findings do not just affect investment in new fields; 11% of oil and 7% of gas production forecast from currently producing fields over the next decade is incompatible with the average of these 1.5°C scenarios. Therefore, keeping oil and gas production in line with these scenarios would require production from these fields to decline more rapidly than is currently forecast.

In light of our findings, this $4.9 trillion of capex in new fields represents an enormous and high-risk potential misallocation of capital.

# 3. UNRELIABLE SCENARIOS, UNDERESTIMATING RISKS

Investors are using scenarios to assess the potential capital at risk from the energy transition.[40] At present, they may be using scenarios that underestimate those risks by failing to aim to limit warming to 1.5°C and by relying excessively on carbon capture and removal.

The importance of scenario analysis for assessing climate risks was one of the key recommendations of the Taskforce on Climate-related Financial Disclosures (TCFD).[41] Since the taskforce published its recommendations, momentum is growing amongst investors through initiatives such as the Climate Action 100+.[42] Investors are also increasing pressure on oil and gas companies to disclose climate risks, with BP recently conceding to demands to disclose how its spending plans and strategy align with the goals of the Paris Agreement.[43]

Such disclosures all rely on the use of scenarios, yet the most prominent scenarios do not provide a reliable guide to investors.

## THE IEA'S NOT-SO-SUSTAINABLE DEVELOPMENT SCENARIO

The IEA describes itself as "the global energy authority",[44] and its Sustainable Development Scenario (SDS) is the scenario most commonly used by investors,[45] however it is not aligned with the Paris goals.

The IEA claims that the SDS is "fully aligned" with the Paris goals and that emissions in the SDS are at the lower end of scenarios that predict temperature rises of around 1.8°C and are within the range of the IPCC 1.5°C scenarios.[46] Yet a recent analysis by Oil Change International has shown that the SDS can only be considered to be on track for 1.5°C - 1.8°C if it assumes the use of CDR technologies at levels considered unrealistic by both the IEA and the IPCC.[47] The SDS also requires CCS deployment to increase 135 fold from the mid-2020s by 2040.[48] In fact the SDS has the same emissions trajectory as the IEA's previous '450' scenario, which only gave a 50% chance of limiting warming to 2°C.[49]

Because the SDS places the burden of emissions reductions on vast future deployment of CCS and CDR, it models an increase in gas demand and only a 23% reduction in oil demand by 2040.[50]

It should not be surprising that the IEA's scenario does not focus on reducing the use of fossil fuels given its close ties to the fossil fuel industry. The IEA holds its governing meetings in joint sessions between its member governments and the Energy Business Council (EBC), which consists of the leaders of the world's largest energy companies.[51] The single largest sector represented in the EBC is oil and gas.[52] The IEA also encourages secondments from the energy industry, including the oil and gas industry, meaning that it is part-staffed by individuals paid for by those companies.[53]

Some investors may still view the SDS as a robust tool, yet its assumptions on the future growth of CCS and CDR and the resulting projections for oil and gas demand are simply not credible. As a result, it significantly underestimates the pace and scale of change required and the consequential risks that investors face.

Leading investors including Hermes, Allianz Group and Legal & General have criticised the SDS for failing to meet the ambition of the Paris agreement and called on the IEA to

produce a scenario that limits warming to 1.5°C.[54]

A comprehensive analysis of the how the IEA's SDS fails to align with the Paris goals is available in Oil Change International & Greenpeace's *Q&A for Investors - The International Energy Agency and the Paris Goals*.[55]

### OIL AND GAS COMPANIES' SCENARIOS

The scenarios used by oil and gas companies make even more far-fetched assumptions about carbon capture and removal. For example, an analysis by Carbon Tracker found that Exxon's 2°C scenario involves "exponential growth in bio-fuels and pervasive use of CCS".[56] The same report found that Shell's 2°C Sky Scenario "places the burden of emissions reductions on CCS" requiring "some 10,000 large-scale carbon capture and storage facilities to be built over the timeframe (more than one every other day for the next 50 years)."[57]

Such scenarios push the boundaries of plausibility and do not serve as a credible guide to alignment with the Paris goals. Companies and investors should use scenarios that limit warming to 1.5°C and that use credible estimates for the growth and scale of carbon capture and removal.

## 4. UNPROVEN TECHNOLOGY #1 - CARBON CAPTURE AND STORAGE

While CCS is used extensively in many scenarios, the IPCC report is clear that there is uncertainty in the future deployment of CCS given the very limited pace of deployment, the development of the technology and the current lack of incentives.[58]

Despite considerable effort over the past decade, there are only two operational CCS projects in the power sector worldwide, which capture just 2.4 $MtCO_2$/yr.[59] Yet both these projects are part funded by using the captured $CO_2$ for Enhanced Oil Recovery. Enhanced Oil Recovery is a technique that uses $CO_2$ to get more oil out of depleting fields, leading to further $CO_2$ emissions from further exploitation of existing fields.[60]

CCS also faces considerable challenges in scaling up to the extent required by many scenarios. Taking into account the planned pipeline of new CCS projects in the power sector, this is only set to reach 11 $MtCO_2$/yr by 2020, compared to the SDS target of 350 $MtCO_2$/yr by 2030.[61]

Overall, government and private sector spending on large-scale CCS has fallen dramatically since 2014 and was around $120 million per year worldwide in 2017, the last year for which IEA data is available.[62] The International Energy Agency describes CCS as being "far off track" in the power sector and "woefully off track" in the industrial sector.[63]

The failure to scale up CCS is long-standing. The IEA produced its first CCS roadmap in 2009, aiming for 22GW of power generation

with CCS by 2020. With just a year to go to that date, the world is less than 2% of the way to that target.[64]

Even where governments have put incentives in place, the outcomes have been poor. Of the $28 billion in public funds earmarked for investment in CCS projects, 15% has been spent - only two-thirds of which has gone to projects that are now in operation.[65] For example, the European Commission provided €424 million to six CCS projects between 2008 and 2017. Of these six projects, only one was completed, however this was only a pilot facility and did not represent a commercial-scale demonstration CCS plant.[66]

Given this limited growth to date despite public funding, it appears highly unlikely that CCS will scale up to the extent required by many scenarios. The IPCC itself notes that "CCS is largely absent from the [national action plans under the Paris Agreement] and lowly ranked in investment priorities".[67] In that context, it is enormously risky to rely on scenarios that are dependent on large-scale future CCS. Credible climate scenarios should rely on CCS playing at most a minimal role in reducing emissions unless the outlook for the technology changes significantly.

## 5. UNPROVEN TECHNOLOGY #2 – CARBON DIOXIDE REMOVAL

Reliance on large-scale deployment of unproven carbon dioxide removal (CDR) technologies is the second major risk underpinning many climate scenarios. As the IPCC highlights in its report there are concerns that raising expectations about "large-scale CDR deployment in the future can lead to an actual reduction of near-term mitigation efforts."[68]

The IPCC report repeatedly and extensively highlights the risks, uncertainties and limitations of CDR deployment at scale. These include that:

- CDR is unproven and relying on it is a major risk in the ability to limit warming to 1.5°C.[69]
- CDR is subject to multiple technical, political and social feasibility constraints that present considerable barriers to future deployment.[70]
- Most CDR measures currently considered could have significant impacts on either land, energy, water, or nutrients and raise substantial concerns about adverse side effects on and environmental and social sustainability.[71]
- No proposed CDR technology is close to deployment at scale and regulatory frameworks are not established.[72]

A range of potential CDR approaches have been proposed.[73] Of these, BECCS and afforestation are the primary CDR approaches used in climate scenarios,[74] yet it does not exist at a commercial scale. At present, there is one only full-scale project in operation, which captures just 1 $MtCO_2/yr$.[75] By comparison, on average the IPCC 1.5°C

scenarios rely on over 1,000 $MtCO_2$ of BECCS deployment by 2035.[76]

There are also serious concerns about the impacts of large-scale BECCS deployment. The IPCC highlights a range of potential consequences including greatly increased freshwater use, increased competition for land, loss of biodiversity and/or impacts on food security.[77] To put these concerns in context, a study by the intergovernmental Carbon Sequestration Leadership Forum found that large-scale BECCS deployment would "necessitate planting bioenergy crops on […] approximately one-third of the arable land on the planet".[78] It is almost completely inconceivable that such a dramatic shift in land use could take place in the near term.

Given these risks and challenges, a prudent approach would be not to rely on BECCS or other CDR technologies until there is strong evidence that they can be sustainably deployed at scale and that the scale of investment is on course to match the scale of deployment required by scenarios. Based on present research and trends, this would mean CDR playing a marginal role in global emissions reductions.

Planning for BECCS or CDR to play a major role in achieving the Paris goals is a highly risky strategy, leading to short-term complacency and overinvestment in carbon emitting industries. This excess investment carries with it major risks for the oil and gas sector and the broader global economic system.

## 6. THE FRYING PAN - SECTOR RISK AND DISORDERLY TRANSITION

Ongoing investment above a 1.5°C pathway increases the capital at risk of stranding in the oil and gas sector as a transition to the Paris goals progresses. At present, excess investment well above that level is being justified by scenarios that rely heavily on future carbon capture and removal.

However, given the risks and uncertainties in carbon capture and removal technologies it is likely that they will not materialise at anything like the pace and scale that many scenarios require. Therefore relying on future carbon capture and removal to justify overinvestment increases the gap to a technically achievable pathway to 1.5°C.

The growth of this gap in turn increases the risk of a disorderly transition, as the closing of this growing gap would require increasingly heavy-handed intervention. A disorderly transition is characterised by a more dramatic, disruptive and rapid series of shifts. Mark Carney, the Governor of the Bank of England has warned of the risks that can arise "through a sudden and disorderly adjustment to a low carbon economy", where rather than there being a steady and progressive shift "there's a bigger adjustment that comes […] where there's much tougher regimes put in place".[79]

The Bank of England has warned that such a "late, abrupt and significant" policy intervention would substantially increase financial risks, particularly in carbon-intensive sectors.[80] Likewise, it states that financial risks can be minimised if there is an orderly transition, "but the window for an orderly transition is finite and closing".[81]

These risks are often perceived as long-term risks, materialising over decades in line with the energy transition. Yet a recent survey of investors found that uncertainties around the energy transition are already changing behaviours, concluding that uncertainty around the transition impacts the energy markets on a much shorter time scale than the transition.[82] In short, investors' perceptions of the future of energy will result in market changes over a far quicker timescale than the transition itself.

In 2018 the UN Principles for Responsible Investment (PRI) completed a study of "a rapid and forceful policy response to close the gap to [meet the ambition of] the Paris Agreement."[83] The PRI report found that in the absence of sufficient action to reduce emissions, such a response is to be expected.[84] It identified a range of drivers that could trigger such a forceful and urgent response including:

- the wider acceptance and realisation of the gap between current emissions and a pathway to "well below 2°C",
- increasing pressure from investors and companies as the physical costs of the impacts of climate change increasingly affect businesses,
- technological changes driving down costs and increasing utilisation of low carbon technologies compared to fossil fuels.[85]

It also outlined the building blocks of such a pathway, including:

- restricting demand for fossil fuels through carbon pricing or regulation; and
- reducing the supply of fossil fuels, including the sudden and immediate phasing out and premature retirement of the existing stock of fossil fuel infrastructure that is incompatible with the carbon budget.[86]

It is clear that such a policy response would have a significant and immediate impact on the valuation of oil and gas companies. These risks can be minimised by companies aligning capex with robust scenarios that limit warming to 1.5°C without high and unrealistic reliance on carbon capture and removal.

## 7. THE FIRE - SYSTEMIC RISK OF FAILURE TO TRANSITION

Overinvestment in oil and gas supply would create huge risks to the world's climate from "locking in" long-term emissions from new oil and gas production that is incompatible with limiting warming to 1.5°C. Doing so would substantially increase the risks of a failure to transition, with emissions continuing above that needed to effectively limit warming, resulting in increasingly catastrophic damage and enormous financial costs.

Relying on scenarios with significant future carbon capture and removal serve to delay emissions reductions. As the IPCC's report states, delaying emissions reductions risks "the economic and institutional lock-in into carbon-intensive infrastructure, that is, the continued investment in and use of carbon-intensive technologies that are difficult or costly to phase-out once deployed".[87]

Oil and gas extraction projects require large upfront capital investment, which is then paid off over the lifetime of the project, often over decades. As a result, there are significant financial barriers to retiring these assets and taking them out of production. As long as the revenue generated from operating a project exceeds the operating costs, it is likely to keep on producing, even if the producer is not able to recover the sunk costs from the initial

capital investment. For example, a study by Carbon Tracker estimates that over 40% of all coal power stations worldwide could be currently operating at a loss.[88] As a result, overinvestment now would lock-in emissions for decades to come, contributing to increasing the risk of failure to transition.

The potential financial costs of a failure to transition are vast:

- A 2018 analysis by Schroders found that the world is currently on track for around 4°C of warming which could lead to global economic losses of up to $23 trillion per year by 2100 - the equivalent of three to four times the losses incurred in the 2008 financial crisis, every year.[89]

- The US' Fourth National Climate Assessment found that the costs to the US economy under a high emissions scenario where the world fails to mitigate climate change could exceed $500 billion a year by 2090.[90]

This scale of loss represents a systemic threat to the global financial system. These risks can be minimised through avoiding overinvestment and carbon lock-in by aligning company capex with robust 1.5°C scenarios with realistic models of future carbon capture and removal.

# 8. RECOMMENDATIONS

### OIL AND GAS COMPANIES

- **Oil and gas companies should align their capex planning with scenarios that limit warming to the 1.5°C ambition of the Paris Agreement without reliance on unrealistic models for carbon capture and removal.**

### INVESTORS

- **Investors should require oil and gas companies to explain how each new material capex investment, including in the exploration, acquisition or development of oil and gas resources, is aligned with the 1.5°C ambition of the Paris Agreement. This should include assessment in the context of the company's existing operations and reserves and disclosure of the scale of carbon capture and removal technologies used in their assessment.**

This analysis has demonstrated the potential scale of investment by the oil and gas industry that is not compatible with limiting warming to 1.5°C. It should be of major concern to investors that oil and gas companies are forecast to make $4.9 trillion of capex that significantly increases the risk to the sector from a disorderly transition and the risk of a failure to transition.

To address these risks, investors should require oil and gas companies to explain how their capex is aligned with the 1.5°C ambition of the Paris goals. Such disclosures should not be isolated assessments of the financial viability of new projects in a lower demand environment, as doing so ignores the overall emissions from the company's existing projects and reserves. Instead, companies'

disclosures should place any new capex in the context of their existing operations, for example by identifying which existing projects will be retired to make way for any proposed new projects.

Investors must also interrogate the credibility of the assumptions for carbon capture and removal used in scenarios relied upon for developing their assessments. Questions investors should ask include:

- What forecasts for CCS and or CDR deployment have the companies used in developing their assessments?
- How did they assess the feasibility and probability of achieving those levels of CCS and CDR deployment?
- What is the financial cost of that scale of CCS and CDR deployment, and where do they see that investment coming from (e.g. public or private sector)? How does that compare with the company's own investment in those technologies?

### INTERNATIONAL ENERGY AGENCY

- **The IEA should produce a genuinely 1.5°C compliant scenario based on realistic projections for the feasibility, scale, and effectiveness of future deployment of CCS and CDR technologies, such as BECCS.**

The IEA SDS is not aligned with 1.5°C, relies on short-term growth of CCS that the world is not on track to achieve and long-term reliance on CDR technologies at levels its own analysis considers unrealistic.

The IEA should produce a 1.5°C scenario which:

- Is based on a high percentage likelihood of limiting warming to 1.5°C; and,
- Includes transparent, realistic and prudent models of the growth and overall deployment of carbon capture and removal technologies.

The IEA's member and associate governments should call on it to produce such a scenario.

### GOVERNMENTS

- **Governments should require oil and gas companies to disclose climate risks on a project-by-project basis, including against a 1.5°C scenario.**

Governments, particularly those where the largest oil and gas companies are headquartered or listed, should ensure that investors have the data they need to assess whether oil and gas companies are aligning their operations with the 1.5°C goal of the Paris Agreement. Companies should be required to disclose:

- The current and future potential, direct and indirect, greenhouse gas emissions of each of its assets, reserves and proposed capex.
- How the valuation of those assets and reserves would be affected under a range of scenarios, including a robust 1.5°C scenario.
- The company's methodology and working assumptions in making those assessments.
- The company's risk management strategies related to the physical and transition risks posed by climate change.

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