



SHELL'S FOSSIL FUEL PRODUCTION:

STILL PUSHING THE WORLD
TOWARDS CLIMATE CHAOS

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Oil Change International is a research, communications, and advocacy organization focused on exposing the true costs of fossil fuels and facilitating the ongoing transition towards clean energy.

Milieudefensie is a Dutch Environmental Organisation and a member of Friends of the Earth International, the largest grassroots environmental network in the world.

INTRODUCTION



This briefing exposes the scale and implications of Shell's fossil fuel extraction assets and potential expansion plans – and how they conflict with Shell's obligation, under the Dutch court verdict handed down in May 2021, to align its business plans with the goals of the Paris Agreement on climate change.

Recognizing that Shell's business activities have been a relevant cause of the climate damage that is putting people's lives at risk, the Dutch court ordered Shell to take responsibility for its ongoing pollution and change course. Specifically, Shell is charged with reducing the net carbon-dioxide (CO₂) emissions caused by its business activities, including the oil and fossil gas it sells to customers, by 45% below 2019 levels by 2030. This rate of reduction aligns with the scientific imperative to cut carbon dioxide emissions almost in half globally within this decade in order to preserve a 1-in-2 chance of holding global warming below or at 1.5 degrees Celsius (°C).

4 To fulfill this verdict, Shell will need to wind down its fossil fuel business activities across the board – extraction, processing and sales of oil and gas – and the related emissions. In this analysis, we focus upstream: on the oil and gas and associated carbon that Shell directly extracts from the ground. In 2021, Shell reported that its own production accounted for close to 40% of the end use (scope 3) emissions from its total oil and gas sales.¹ Thus, the findings and recommendations in this briefing address only part of the actions the company must take to reduce its emissions.


This briefing shows that Shell's oil and gas extraction activities continue to undermine the world's chances of curtailing the climate crisis and contradict the court's directive. Specifically, we find that:

- There is no room for new oil and gas extraction projects if Shell wants to execute the verdict and align its production with the 1.5°C limit. Yet, since the May 2021 court ruling, Shell has taken final investment decisions (FIDs) to develop ten new oil and gas extraction assets, committing an additional 900 million barrels of oil equivalent to extraction.² These projects could lock in additional CO₂ pollution (325 million metric tonnes) two times greater than the Netherlands' total CO₂ emissions in 2021.³
- Shell owns stakes in more than 750 oil and gas assets that are yet to be developed, and estimated to hold commercial resources. By continuing to approve new projects, Shell will commit more oil and gas reserves to extraction, locking in more CO₂ emissions over the lifetime of these projects. If Shell proceeds with developing

these projects, it would cumulatively cause 4.3 billion tonnes (Gt) of additional CO₂ emissions, which is almost 30 times the CO₂ emissions of the Netherlands as of 2021. These emissions would be additional to 7.4 Gt of CO₂ emissions already committed by Shell's producing and under construction projects.

- If Shell were to stop approving new extraction projects as of September 2022, as well as cease construction of projects that had yet to come online, the decline in production from already producing projects would lead to a 43% drop in CO₂ emissions from Shell's own production by 2030, relative to 2019 levels. If Shell had taken this action immediately after the May 2021 court ruling, the projected drop would likely be larger than 43%.
- If Shell were to stop approving new extraction projects as of September 2022, CO₂ emissions caused by burning the oil and gas Shell extracts are projected to drop by 32% by 2030, relative to 2019 levels.
- Although stopping new extraction projects would not be enough to meet the court-mandated reduction target for total company emissions of 45% below 2019 levels by 2030, it would be a much needed first step towards aligning Shell's oil and gas production with the 1.5°C limit.

WHY NEW FOSSIL FUEL DEVELOPMENT IS INCOMPATIBLE WITH THE 1.5°C LIMIT

An abstract, colorful pattern with swirling, wavy lines in shades of blue, yellow, orange, and red, resembling a marbled or liquid effect. The pattern is dense and fills the right side of the page.

Preserving life for people and ecosystems requires keeping the vast majority of oil, fossil gas, and coal in the ground.⁴ Fossil fuels are the largest cause of global heating.⁵ At just over 1°C of global average temperature rise above pre-industrial levels to date, climate disasters are already causing death and devastation across the globe. From 1965 to 2018, Shell ranks as the world's seventh largest corporate greenhouse gas polluter, its business activities contributing more to the climate crisis than nearly every other company in the world.⁶

In large part because the fossil fuel industry, including Shell, has spent the past 30 years blocking solutions to the climate crisis,⁷ the world must now phase out fossil fuels rapidly to keep warming to 1.5°C, and avoid even more catastrophic tipping points. From the beginning of 2022, climate scientists estimate that the world can emit a maximum of 420 billion tonnes (Gt) of carbon dioxide (CO₂) to preserve a 50% chance at limiting warming to 1.5°C.⁸ This represents just ten years of global emissions at current rates.⁹

6 Research shows that oil and gas fields and coal mines that are *already operating or being constructed* – where the infrastructure is built and billions of dollars invested – contain far more fossil fuels than the world can afford to extract. This is at the root of the International Energy Agency (IEA)'s May 2021 conclusion that approving new fields and mines for construction, let alone exploring for new reserves, is inconsistent with the 1.5°C limit.¹⁰ A peer-reviewed study published in May 2022 builds on the IEA's analysis and goes further, finding that nearly 40% of the fossil fuel reserves within already approved and developed fields and mines globally must stay in the ground to avoid warming the planet beyond 1.5°C.¹¹


When you're in a hole, the first step is to stop digging. The implication of this science for Shell and other fossil fuel companies is clear:

- 1) New exploration or development of oil and gas projects must stop, and
- 2) Some already producing projects will need to be decommissioned early, keeping some of their reserves in the ground and stranding associated capital and value.

This does not mean production would end overnight. Rather, the answer is a managed phase-out – to stop locking in more heat-trapping pollution and start winding down fossil fuel production at a pace that aligns with climate goals whilst scaling up clean alternatives to meet people's energy needs in a sustainable and just way. As the UN Secretary General Antonio Guterres pointedly said upon release of the latest report from the world's leading climate scientists, "It is time to stop burning our planet and start investing in the abundant renewable energy all around us."¹²



SHORT OVERVIEW OF SHELL'S CLIMATE AMBITION



Although Shell has known about the dangers of the greenhouse gasses associated with its products for decades, it wasn't until the autumn of 2017 that Shell launched its first climate ambition¹³. The aim of Shell's so-called Net Carbon Footprint (NCF) is to reduce the carbon intensity of the products it sells.

The carbon intensity targets have been adjusted over the years and in Shell's latest 'Powering Progress' strategy the company has committed to a reduction in carbon intensity of 6-8% by 2023, 20% by 2030, 45% by 2035 and 100% by 2050.¹⁴

An intensity target such as the NCF is misleading and does not guarantee that CO₂ emissions will be reduced. Shell can lower its NCF by merely producing or trading more renewable energy. In other words, if Shell maintains or even increases the current size of its oil and gas activities and expands with the same volume of its renewable energy and low carbon fuels, Shell can achieve its ambition.

8 In addition, Shell’s net zero target relies heavily on Carbon Capture and Storage (CCS) and Nature Based Solutions (NBS).¹⁵

In October 2021 Shell announced it would halve its absolute emissions of scope 1 and 2 by 2030. It plans to do this by slightly changing its portfolio such as acquisitions and investments in low-carbon projects on the one hand and asset divestment on the other. The rest of the reduction Shell plans to achieve through among other things improving energy efficiency, the capture, and storage of carbon and “CO₂-compensation” through NBS to reduce its (net) absolute emissions.¹⁶

However, more importantly, the target for scope 1 and 2 only covers about 5% of Shell’s total emissions as the majority of Shell’s emissions is in scope 3. This target would only lead to a reduction of 2.4% of Shell’s total CO₂-emissions. For 95% of Shell’s emissions, there is no absolute emission target in place before 2050 as is confirmed by Shell’s Annual Report.¹⁷ Shell, therefore, does not commit to reducing the Group’s total emissions by 2030.

A recent forecast of Shell’s emissions by Global Climate Insights – part of the Australasian Centre for Corporate Responsibility – shows that Shell’s emissions are even set to grow by 3% by 2030.¹⁸

PERFORMANCE - ABSOLUTE EMISSIONS

Scope	Absolute emissions million tonnes of CO ₂ e				Targets	
	2016	2019	2020	2021	Target 2030	Target 2050
Scope 1	72	70	63	60	50% reduction compared with 2016 levels on a net basis	0
Scope 2	11	10	8	8		0
Scope 3	1,545	1,551	1,305	1,299	No target	0

Shell’s Annual Report indicates there are no absolute emission targets for scope 3 for 2030¹⁹

EXAMINING SHELL'S PLEDGE TO STOP NEW 'FRONTIER' EXPLORATION BY 2025

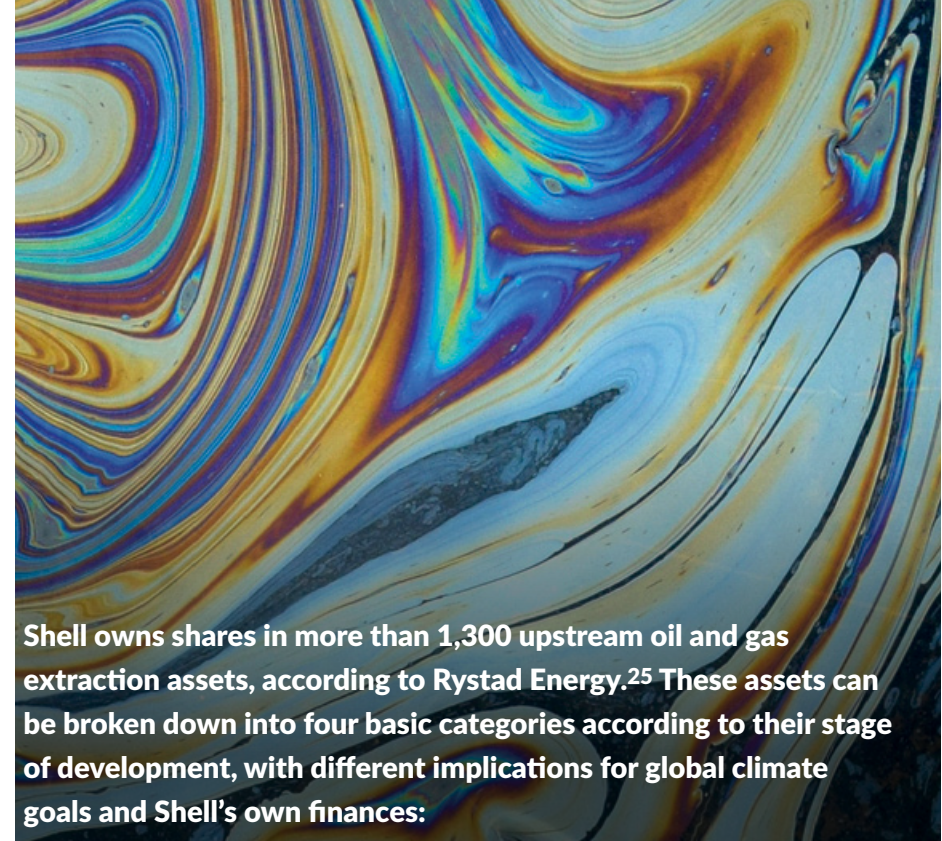
An oil and gas company cannot claim to be aligning its business with the 1.5°C warming limit while continuing to explore for and develop new oil and gas reserves: The world's stock of oil, gas, and coal projects already operating or being constructed hold far more fossil fuel reserves than can be burned under the Paris Agreement. Even in this case Shell's ambition may appear more significant than it is in reality. Shell says it anticipates ending new 'frontier' exploration post-2025



(meaning exploration in regions that are not yet host to significant oil and gas extraction). Yet, the company is actively pursuing new frontiers at present and Shell has no plans to stop exploration in areas where it already has significant production assets.

In 2021, Shell spent USD 1.4 billion on new oil and gas exploration,²⁰ and Shell has indicated it plans to continue spending around USD 1.5 billion per year on exploration through to 2025.²¹ Shell's 2021 Annual Report highlights new exploration activities and discoveries in the Gulf of Mexico, Brunei, Brazil, Malaysia, the UK, Argentina, Namibia, South Africa, and Suriname,²² and Shell identifies Argentina, Mexico, South Africa, Namibia, and Mauritania as new 'frontiers' it is actively pursuing.²³ Shell made a new discovery off the coast of Namibia in early 2022 estimated to hold 200 million barrels of oil equivalent (BOE); if developed, the project would likely not *start* producing oil until the 2030s.²⁴

STILL ADDING FUEL TO THE FIRE

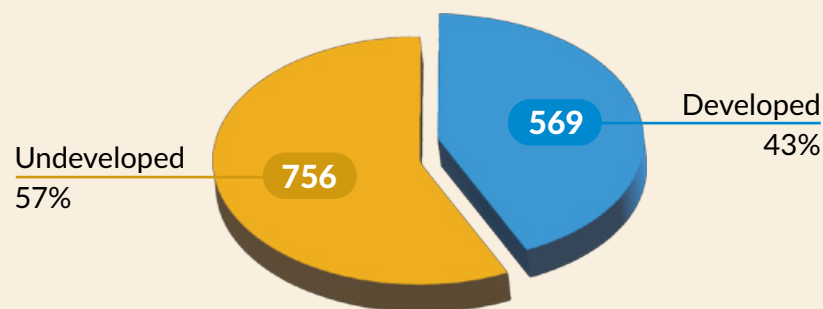


Shell owns shares in more than 1,300 upstream oil and gas extraction assets, according to Rystad Energy.²⁵ These assets can be broken down into four basic categories according to their stage of development, with different implications for global climate goals and Shell's own finances:

- **Developed assets (existing projects):**
 - **Producing:** Assets actively producing oil and gas.
 - **Under construction:** Assets for which a final investment decision (FID) has been made, but production has not yet started.
- **Undeveloped assets (potential new projects):**
 - **Discovered:** Assets Shell has already explored and announced discoveries of oil and gas it could choose to develop, but no FID has been made.
 - **Undiscovered** (licensed but not yet explored): Assets where Shell has a stake in an exploration license but has not yet finished exploration and/or confirmed a discovery.

FIGURE 1:

Shell's Oil and Gas Extraction Assets, by Developed vs Undeveloped



Source: Oil Change International using data from the Rystad Energy UCube (September 2022).

Rystad Energy data indicate that, of the more than 1,300 upstream assets Shell wholly or partly owns, more than half, 756, are currently undeveloped (e.g., have not yet received a final investment decision) (Figure 1). All of these undeveloped assets are categorically incompatible with the IEA's Net Zero Emissions scenario, given its conclusion that no oil and gas fields beyond those approved by the end of 2021 fit within a 1.5°C-aligned pathway.

Accordingly, these are assets that Shell and its investors should already be considering as “stranded” if the company is committed to aligning with 1.5°C, with sunk investment in these assets’ exploration and appraisal, and their projected value, being written off as a loss or impairment to the company. Instead, in the context of high oil prices, Shell did the opposite in the second quarter of 2022, announcing that it was reversing previous impairments worth a net USD 4.3 billion post-tax.²⁶ The company’s move shows that it is making decisions based on economic considerations and not on a commitment to being Paris-aligned.

Rystad projects that Shell’s current assets hold close to 32 billion barrels of oil equivalent of oil and gas that is commercially extractable²⁷ under a long-term oil price case of USD 50 per barrel (bbl) (real \$2022) (Table 1).²⁸ More than 60% of this resource base is within fields and shale wells already producing or under construction, whilst close to 40% is contained in fields or shale resources yet to receive a final investment decision.

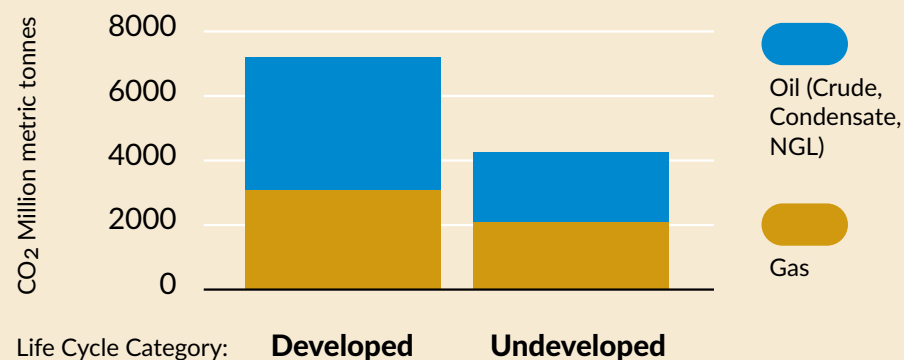
If Shell extracts all of these resources, they would cause 11.6 Gt CO₂ of emissions when burned, 54% from oil (including condensate and natural gas liquids) and 46% from gas (Figure 4). This amount of CO₂ emissions is equivalent to around 80 years worth of annual CO₂ emissions from all residents and companies in the Netherlands, as of 2021.²⁹ If Shell fully extracts these resources, its upstream production alone (which accounts for less than half of the company’s total oil and gas sales) would exhaust 2.8% of the world’s remaining carbon budget for a 50% chance of holding warming to 1.5°C (420 Gt CO₂ from the start of 2022).

If Shell would commit to cease new oil and gas development, that action alone would keep almost 12 billion BOE in the ground, avoiding 4.3 Gt of CO₂ emissions (Figure 2). For reference, 4.3 Gt of CO₂ emissions is equivalent to 30 times the annual emissions of all residents and companies in the Netherlands.³⁰

Again, these projections count only the emissions from burning the oil and gas Shell extracts itself. The total climate impact of Shell's business activities is significantly larger: Shell reported in 2021 that more than 60% of its scope 3 emissions from oil and gas sales came from products that were produced by others and sold through Shell's distribution channels.³¹

FIGURE 2:

Projected CO₂ emissions from burning Shell's remaining oil and gas resources, by fuel and developed vs undeveloped assets



Source: Oil Change International calculations using data from the Rystad Energy UCube (September 2022) and IPCC⁵⁵

TABLE 1:

Shell's commercially extractable oil and gas resources, and estimated CO₂ emissions from combustion, by stage of development (as of September 2022).

Stage of development	Total resources, billion BOE	Projected CO ₂ emissions from combustion, billion tonnes CO ₂
Producing	17.2	6.4
Under construction	2.7	1.0
Discovered	7.9	2.9
Undiscovered (licensed)	3.9	1.4
Total	31.7	11.6

Source: Oil Change International calculations using data from the Rystad Energy UCube (September 2022) and IPCC⁵⁴

Since the climate case verdict and the IEA's recommendation came down in May 2021, Shell has continued to move forward with new expansion projects, committing more oil and gas reserves to extraction and thus causing harmful emissions.

We track ten assets for which Shell has approved a final investment decision from May 2021 through September 5, 2022: the Marjoram and Rosmari offshore gas fields in Malaysia (September 2022),³² the Rydberg deep-water offshore oil project in the U.S. (September 2022),³³ the Jackdaw offshore gas field in the UK (July 2022),³⁴ the Crux offshore gas field linked to the Prelude LNG export facility in Australia (May 2022),³⁵ an expansion of the Vaca Muerta fracking mega-project in Argentina (November 2021),³⁶ the Ormen Lange subsea gas compression project offshore of Norway (September 2021), an expansion of the Mero deep-water offshore oil project in Brazil (August 2021),³⁷ the Timi gas project offshore of Malaysia (August 2021),³⁸ and the Whale deep-water offshore oil project in the U.S. Gulf of Mexico (July 2021).³⁹ These projects together add up to another 900 million BOE of fossil fuels that Shell has committed to develop and extract from the ground, locking in additional CO₂ pollution (325 million metric tonnes) two times greater than what the Netherlands emits in a year.⁴⁰

OIL AND GAS PRODUCTION

Shell announced in February 2021 that its oil production peaked in 2019, and states in its Energy Transition Strategy that it expects oil production to decline by 1-2% per year to 2030.⁴¹ Whilst Shell's oil production declined by close to 4% year-on-year during the disruption of the Covid-19 pandemic, Shell's 2022 Energy Transition Progress Report reiterates that the aim is for oil to decline by "an average of 1-2%" per year to 2030, which leaves room for fluctuations up or down.⁴² At the same time, Shell intends to develop 7 million tonnes per annum of new liquefied natural gas (LNG) production capacity by the mid-2020s.⁴³ Shell gives no guidance and makes no additional commitment as to how its total oil and gas production will change between now and 2030, apart from having said in its strategy that gas will make up 55% of its production by 2030.⁴⁴

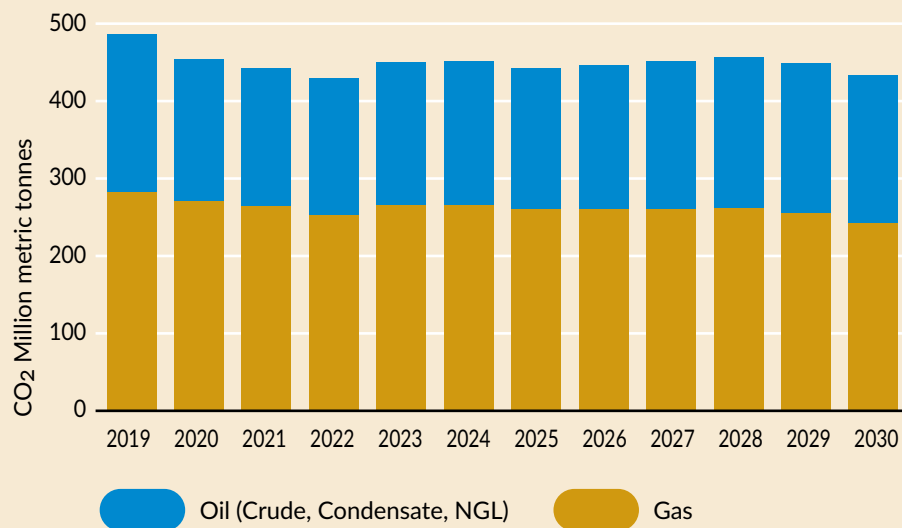
In a scenario in which Shell's oil production declines by an annual average of 1% per year between 2019 and 2030, and gas makes up 55% of production volumes in 2030, Shell's total oil and gas production in 2030 could increase by 2% compared to 2019 levels. Under the same scenario, a 2% annual average decline in oil production from 2019 would result in Shell's total production decreasing by only 9% by 2030, relative to 2019 levels.⁴⁵

Based on modeling Shell's current asset base, Rystad Energy projects that Shell's total net oil and gas production will remain relatively flat in the 2020s, hovering around 3.1 to 3.3 million barrels of oil equivalent per day (Mmboe/d) (Shell's total production available for sale was

3.2 Mmboe/d in 2021).⁴⁶ The resulting CO₂ emissions from Shell's extracted oil and gas would thus remain flat as well (Figure 3), in clear contradiction to Shell's legal obligation to reduce emissions from its business activities by 45% by 2030. These data also indicate that the majority of CO₂ emissions caused by Shell's production will continue to come from oil over the coming decades (Figure 4).

FIGURE 3:

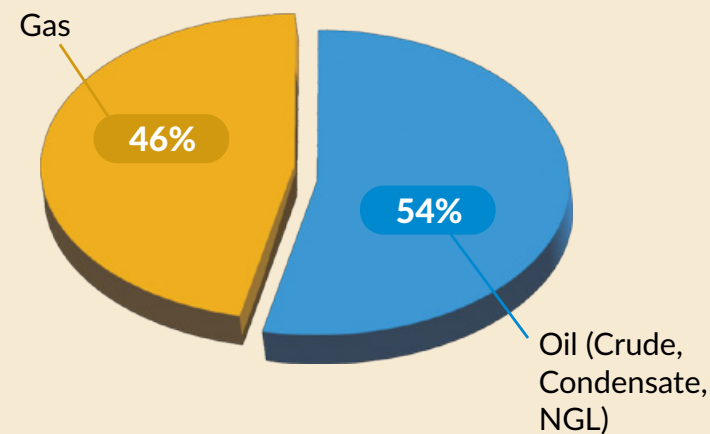
Estimated CO₂ Emissions from Shell's Annual Oil and Gas Extraction, 2019-2030 (including existing fields and projected new development)



Source: Oil Change International calculations using data from the Rystad Energy UCube (September 2022) and IPCC⁴⁷

FIGURE 4:

Projected Ratio of CO₂ Emissions from Extracted Oil vs Gas, 2022-2100

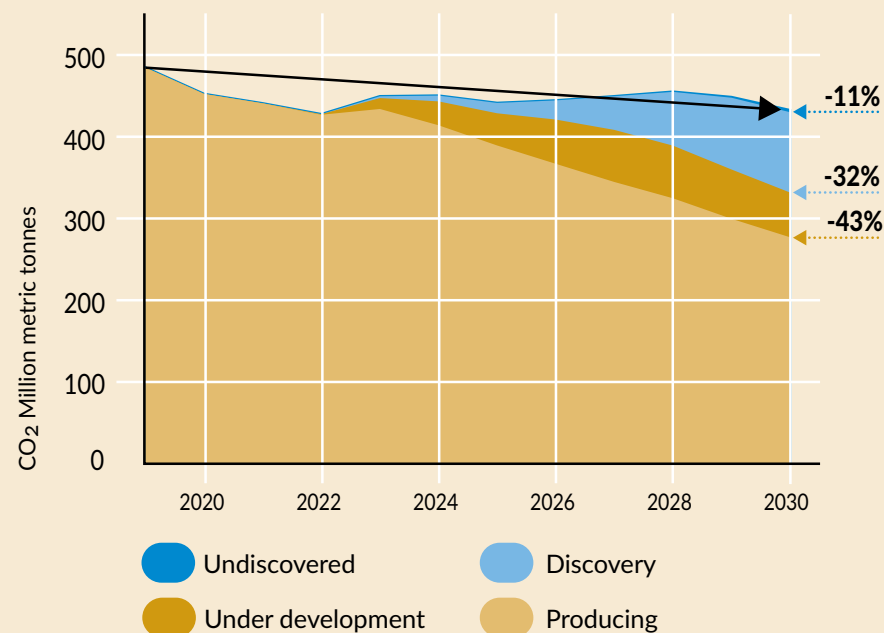


Source: Oil Change International calculations using data from the Rystad Energy UCube (September 2022) and IPCC⁴⁸

CEASING NEW PROJECTS

FIGURE 5:

Projected Annual CO₂ Emissions from Shell's Oil and Gas Extraction, 2019-2030, by Producing, Under Construction, and Undeveloped Fields



Source: Oil Change International calculations using data from the Rystad Energy UCube (September 2022) and IPCC⁴⁹

Figure 5 shows that, by ceasing to develop new projects, Shell could begin to align its oil and gas production with the Dutch court verdict. If Shell were to stop approving new extraction projects for development as of September 2022, emissions from burning extracted oil and gas would be expected to fall by ~32% below 2019 levels by 2030, as production drops from 3.7 to ~2.4 Mmboe/d through the managed decline of fields that are already producing or under development. This would still not meet the 45% reduction of emissions from all company activities that is mandated by the climate case verdict, but it would be a step in that direction. Ceasing construction of recently approved projects that have yet to come online, in addition to stopping new ones, would result in a 43% drop in CO₂ emissions from extracted oil and gas by 2030.

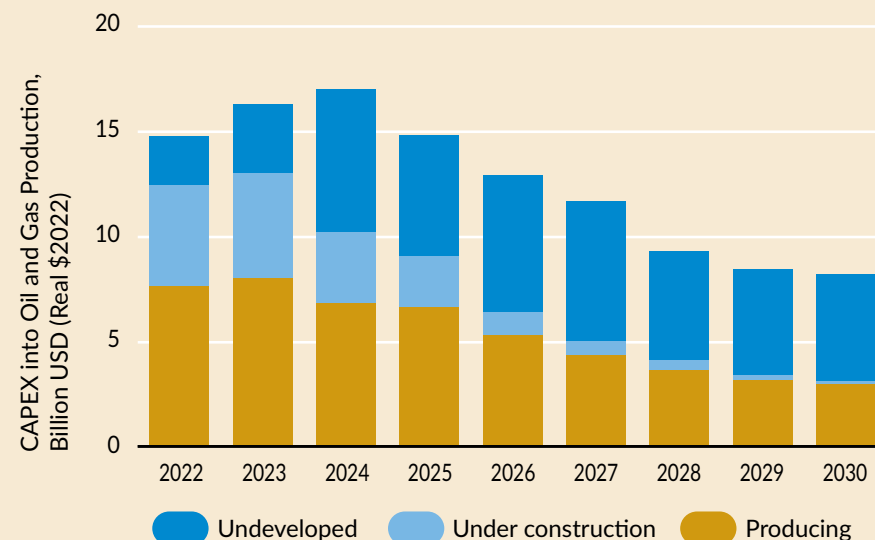
FINANCING A FOSSIL FUTURE

Since the May 2021 court ruling, Shell has also continued to direct the overwhelming majority of the company's capital expenditure towards fossil fuels. In 2021, Shell's capital expenditure (capex) totalled USD 19.7 billion dollars, with close to USD 10 billion of that spent on Upstream and Integrated Gas (including LNG production) segments and another USD 7.5 billion spent on Chemicals and Oil Products. Shell reported just USD 2.4 billion of capex towards its "Renewables and Energy Solutions" segment, which includes fossil fuel activities such as Shell's selling and trading of gas power and pipeline gas.⁵⁰ Shell's second quarter results indicate the company is on track to increase its capex to USD 24 billion in 2022, with just USD 2.6 billion for Renewables and Energy Solutions.⁵¹

Rystad Energy data indicates that Shell is on track to invest an annual average of more than USD 12 billion (real \$2022) into upstream oil and gas extraction from 2022 through 2030, adding up to USD 113 billion cumulatively (Figure 6).

FIGURE 6:

Shell's Projected Annual Capital Expenditure on Upstream Oil and Gas Extraction, 2022-2030, by Current Stage of Project Development

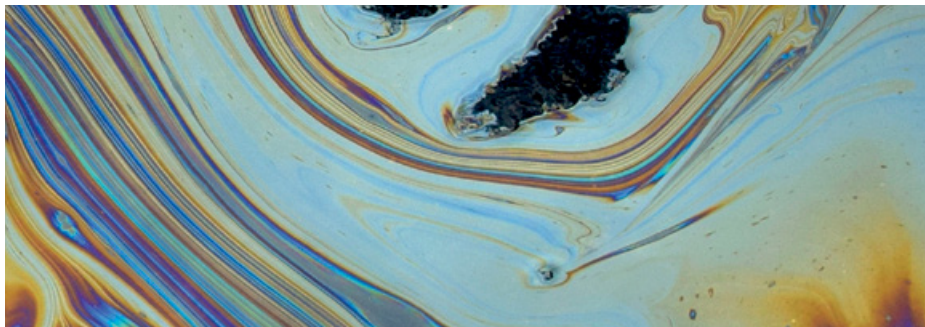


Source: Oil Change International using data from the Rystad Energy UCube (September 2022)⁵²

17 These data capture only the capex Shell is projected to spend exploring for, developing, and sustaining upstream production. This compares to what Shell reports as Upstream capex, plus the portion of Shell's Integrated Gas segment capex going towards gas production for LNG (which Shell does not disaggregate in its own Integrated Gas reporting). These data exclude projections for Shell's capex on midstream and downstream fossil fuel and petrochemical infrastructure.



From 2022 through 2030, Rystad projects that Shell will direct 41% (USD 46 billion) of cumulative upstream production capex towards developing new oil and gas assets, meaning those that have not yet received an FID as of September 2022. None of this USD 46 billion of investment in new fossil fuel supply is compatible with the IEA's 1.5°C scenario. An additional 16% of capex (USD 18 billion) over this period is projected to go towards assets under construction, but not yet producing as of September 2022. This includes capex being spent on expansion projects Shell approved since the May 2021 court verdict. Capital expenditure for new upstream development, combining currently under construction and pre-FID projects, is thus on track to account for 57% of Shell's upstream production capex from 2022-2030, at an annual average of just over USD 7 billion. Less than half of Shell's upstream capex over this period (43%) is projected to go towards assets already producing oil and gas.

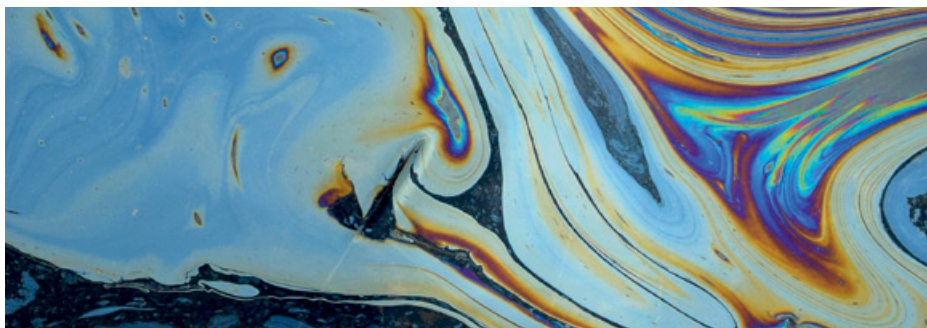


CONCLUSION

This briefing shows that since the May 2021 ruling by the The Hague District Court in The Netherlands Shell has decided to develop ten new oil and gas projects. Furthermore, Shell fully or partly owns more than 750 assets that are yet to be developed.

If Shell were to proceed with these developments, they would lock in cumulative CO₂ emissions equivalent to 30 years of emissions from the Netherlands. Between 2022 and 2030, 57% of Shell's cumulative capex on upstream oil and gas production is projected to be spent on the development of new oil and gas assets, including those under construction as of September 2022. If Shell ceased approval of new assets as of September 2022, as well as ceased construction of projects that have yet to come online, the decline in production from already producing projects would lead to a 43% drop in CO₂ emissions from Shell's own production by 2030, relative to 2019. If Shell had started doing this straight after the verdict in May 2021, this would have likely resulted in an even larger decline. Simply ceasing to approve new projects as of September 2022, would lead to a reduction in CO₂ emissions from burning Shell's oil and gas of 32% by 2030, relative to 2019.

There is no room for new fossil fuel projects if we want to limit warming to 1.5°C. The oil and gas fields that are already licensed would push us past the remaining carbon budget. Shell and other fossil fuel companies need to stop new exploration and development of oil and gas projects and decommission some already producing projects early. However, Shell is doing the exact opposite.



METHODOLOGY FOR ESTIMATING SHELL'S FUTURE PRODUCTION AND ASSOCIATED CO₂ EMISSIONS

The data and projections in this briefing relate to Shell's current upstream oil and gas asset base as of September 2022.

Data on Shell's commercial oil and gas resources and future oil and gas production and upstream capex are derived from Rystad Energy's UCube database, unless otherwise specified.

Rystad Energy's UCube is a commercial, asset-based database and model that contains reserves, production, economics and valuation data for every oil and gas field, discovery and exploration license globally. Historical data and forward projections span 1900 to 2100, and are updated monthly. Projections are based on Rystad's assessment of the geology and costs of each asset – using governmental databases, company presentations, professional and scientific reports, media reports, and independent analysis – and the asset's expected rate of return, under a future oil price forecast.

The projections used in this analysis are sensitive to Rystad's base Brent oil price case as of September 2022. This base price case sees an average oil price of USD 100/bbl in 2022, falling to USD 75/bbl in 2025, and flattening at USD 50/bbl from 2028 through 2050 (all expressed in real \$2022).

The estimates of Shell's commercial oil and gas resources and future production represent net volumes, according to Shell's ownership share in each asset and excluding production owed to governments and thus not saleable by Shell. The data accounts for already executed divestments as of the start of September 2022.

Calculations of the CO₂ emissions that would result from burning Shell's resources and production in the future are by Oil Change International. We apply CO₂ emissions factors of 0.423 tCO₂/bbl of oil and condensate, 0.235 tCO₂/bbl of natural gas liquids, and 54.7 tCO₂/Mmcf of gas to the oil and gas volumes taken from Rystad. These emissions factors are derived from the IPCC.⁵³

- 1 Shell, “Greenhouse Gas and Energy Data,” In: Sustainability Report 2021, 2021, available at: <https://reports.shell.com/sustainability-report/2021/our-performance-data/greenhouse-gas-and-energy-data.html>. See table “Scope 3 GHG emissions.” Shell reports 1,010 million tonnes (Mt) CO₂-equivalent (CO₂e) emissions from “use of sold products” (scope 3, category 11) in 2021. Under Shell’s reporting methodology, the company classifies 380 MtCO₂e of these emissions as from its own production and 630 MtCO₂ as from third-party production sold by Shell.
- 2 These include the Marjoram, Rosmari and Timi assets in Malaysia, Jackdaw in the UK, Crux in Australia, the Vaca Muerta – Bajada de Anelo Phase-2 fracking project in Argentina, Ormen Lange in Norway, Mero 4 in Brazil, and Rydberg and Whale in the United States.
- 3 Centraal Bureau voor de Statistiek, “Uitstoot broeikasgassen 2,1% hoger in 2021”, 16 March 2022, <https://www.cbs.nl/nl-nl/nieuws/2022/11/uitstoot-broeikasgassen-2-1-procent-hoger-in-2021>. CBS data show 141.5 megatonnes of CO₂ was emitted in the Netherlands in 2021.
- 4 Leon Clarke and Yi-Ming Wei et al, “Chapter 6: Energy Systems,” In: Climate Change 2022: Mitigation of Climate Change, Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.008, Box 6.13: Stranded Assets. Also see: Dan Welsby, James Price, Steve Pye and Paul Ekins, “Unextractable fossil fuels in a 1.5 °C world,” Nature 597, 230–4, 2021, <https://doi.org/10.1038/s41586-021-03821-8>; Carbon Tracker Initiative, “Unburnable Carbon: Ten Years On,” 2022, available at: <https://carbontracker.org/reports/unburnable-carbon-ten-years-on/>; Kelly Trout et al, “Existing fossil fuel extraction would warm the world beyond 1.5 °C,” Environ. Res. Lett. 17, 2022, <https://iopscience.iop.org/article/10.1088/1748-9326/ac6228>.
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- 6 Climate Accountability Institute, “Carbon Majors 2018 Data Set,” 2020, <https://climateaccountability.org/carbonmajors.html>. See table: Top Twenty CO₂e 1965-2018.
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