Riskier Bets, Smaller Pockets:

How National Oil Companies Are Spending Public Money Amid The Energy Transition

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Contents

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Key messages

- Expecting a slow energy transition away from fossil fuels, national oil companies (NOCs) will likely invest USD 1.8 trillion in upstream oil and gas developments and expansions over the next 10 years.
- But $425 billion–a quarter of the NOCs' planned investment–will be unprofitable if oil demand falls to 55 million barrels a day, in line with the International Energy Agency's Announced Pledges Scenario. This is the highest risk portion of the portfolio and has doubled since the Russian invasion of Ukraine.
- NOCs will only profit from around $1.2 trillion of investment (71 percent of the total NOC investment) if humanity fails to contain global temperature rise to below 1.5˚C, pushing the world toward climate catastrophe.
- While NOCs are making riskier bets, their debt is rising in some regions. Between 2011 and 2022, the average debt to total asset value of NOCs in sub-Saharan Africa, the Middle East and North Africa, and Latin America rose by a third.
- Governments' financial pockets are shrinking. Between 2011 and 2021, the average government debt as a proportion of gross domestic product doubled.
- Yet many NOCs have not publicly acknowledged the growing risks of the energy transition. They and their governments must examine how they can generate sufficient revenue and energy for citizens without making even riskier bets with public money.

Summary

As the energy transition accelerates and government finances deteriorate national oil companies (NOCs) are gambling their countries' wealth.

As NOCs, along with the rest of the oil industry, expect oil demand to stay high, they will likely invest USD 1.8 trillion in new upstream developments and project expansions over the next 10 years. However, $425 billion of this investment is unlikely to be profitable if global oil demand falls from the current 100 million barrels a day to 55 million barrels a day by 2050, in line with the International Energy Agency's Announced Pledges Scenario. This is twice the investment NOCs were planning in 2021 before the Russian invasion of Ukraine. In addition, NOCs will likely invest $1.2 trillion in projects that will only break even if humanity fails to keep the global rise in temperatures below 1.5°C, pushing the world toward climate catastrophe.

Even if demand persists, the future is not business-as-usual for NOCs and their governments. Continued burning of fossil fuels will result in further climate damage to nature, societies and economies: a 13 to 29 percent fall in gross domestic product (GDP) for non-OECD countries by mid-century. Nine out of the ten most affected economies have NOCs. Governments should examine how this radically increases uncertainty and challenges the roles of NOCs and the public capital they are investing.

NOCs in China, Saudi Arabia, Russia and Brazil are set to spend the most. In particular, Chinese and other Asia-Pacific NOCs are increasing their investments significantly compared to their plans two years ago. Conversely, NOCs in Latin America, Eurasia and sub-Saharan Africa are reducing their investments.

NOCs in Sub-Saharan Africa, Asia-Pacific and Eurasia are generally the most exposed to risk. A third of all NOCs—including Indonesia's Pertamina, Nigeria's NNPC and Mexico's Pemex—are due to invest more than a third of their investment pipeline in projects that would not break even under the IEA's Announced Pledges Scenario (APS). A scenario in which governments meet their climate pledges to reduce oil and gas demand. Some smaller NOCs are highly exposed: four-fifths of Uganda's UNOC and Cameroon's SNH investment pipelines fail to break even in the APS.

NOC debt is rising in some regions. Between 2011 and 2022, the average debt to total asset value of NOCs in sub-Saharan Africa, the Middle East and North Africa, and Latin America rose by a third.

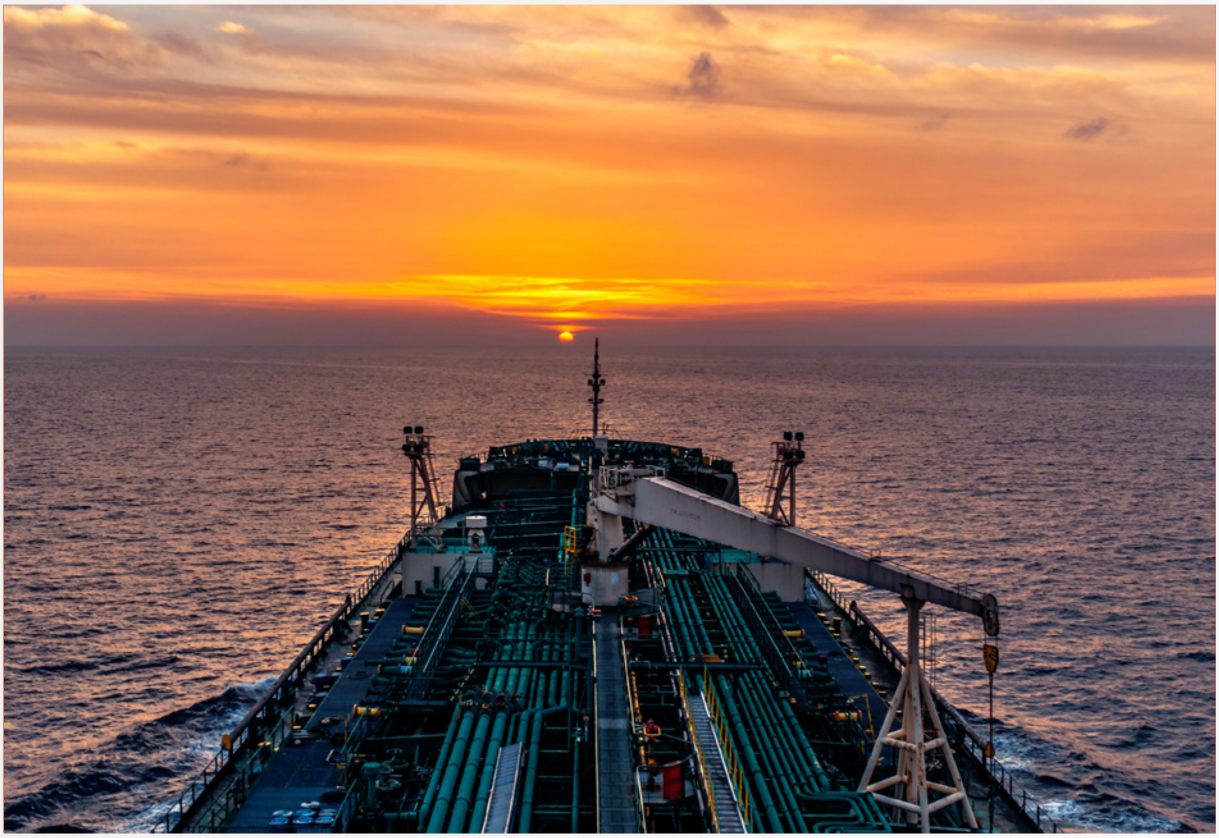
NOCs' investment in risky assets represents a large portion of state budgets—with significant consequences for governments' ability to fund public services in the future. UNOC and NNPC are due to invest an amount equivalent to more than 30 percent of their governments' annual expenditure in projects that do not break even in the APS. QatarEnergy and Mozambique's ENH are also betting large amounts relative to their governments' budgets, but their focus on gas may reduce their risk exposure.

While investment risk is growing, the financial pockets of NOCs' governments are shrinking. Between 2011 and 2021, the average debt of governments with NOCs doubled as a proportion of GDP. Debt is rising the most in Latin America, MENA and sub-Saharan Africa. At the same time, the NOCs in these three regions are also becoming more indebted, particularly in Latin America and sub-Saharan Africa. If their next-generation investments do not perform, NOCs will need more support at a time when governments can least afford to give it.

NOCs and their governments must acknowledge and address the risk of a steep drop in oil and gas demand over the next few decades. Fossil fuel demand has peaked in much of the global economy, but it is not clear whether the oil industry has climbed a true peak, with a steep drop in demand the other side, or reached a sustained plateau with continued demand for many years to come.

However, there is growing evidence to suggest the energy transition away from fossil fuels will first lead to reduced demand for oil and then later for gas—meaning that even if an NOC's leadership believes it is "safe" from the transition, it is poor public stewardship to ignore the possibility of a steep collapse in global oil and gas demand.

Governments should ensure that NOCs' pursuit of revenue and provision of energy to citizens do not come at the cost of unmanageable risky bets using public funds. Government officials (including finance ministers) and civil society actors should scrutinize NOCs' use of public capital, particularly if the dynamics of the energy transition further diminish government finances; decision-making should not be left to NOCs alone. While there may be a role for the private sector to share the greatest risks with NOCs, governments should strongly tax private companies' operations.



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Introduction

The global energy transition offers significant opportunities for much of humanity, but also creates risks.

This report focuses on how national oil companies (NOCs) are changing their exposure to these risks, and whether the finances of their own governments are strong enough to tolerate the chances NOCs take.

We focus on NOCs because they produce half of the world's output of oil and 43 percent of its gas; they also manage billions of dollars of public wealth.[1]

In addition, four-fifths of NOCs are based in middle- and low-income countries whose governments depend on oil and gas revenues from NOCs. This report is an evolution of one we published in 2021: *Risky Bet: National Oil Companies in the Energy Transition*.[2] At the time, we worried that a post-pandemic boom would result in both a near-term boom in NOCs' oil and gas investment, and acceleration in the energy transition that would in the longer term prevent many of these investments from breaking even. We found that NOCs were making substantial risky bets on oil and gas projects with citizens' money—that $400 billion out of $1.7 trillion in investments projected from 2021 to 2030 would not break even if humanity reduced oil and gas production enough to limit the global temperature rise to 1.5°C.[3]

Since we published the report, governments have lifted pandemic restrictions and Russian forces have invaded Ukraine.

The resulting energy crisis, high prices and record profits for the oil industry, and renewed concerns for energy security, have fueled the expectations of NOCs and their governments.

However, the same energy crisis has also encouraged greater investment in clean energy technologies, so much so that many observers now predict that oil demand will peak sometime this decade.[4] But seeing the peak is not the same as knowing how steep the slope is on the other side. It is not clear what sort of mountain the oil industry has climbed—it might be at the top of a true peak facing a steep slope down, or have reached a sustained plateau with many more years of oil and gas demand left to go.

This is why we are analyzing NOCs' risk exposure. NOCs' bets on continued demand could pay off for them—and the winnings matter, given the poor finances of many of their governments.

Yet NOCs are betting huge amounts of public capital and their governments are increasingly unable to withstand the potential losses; it is therefore poor public financial stewardship to ignore the possibility of a sharp decline in demand for oil.

1 Authors' calculations using Rystad Energy UCube.
2 David Manley and Patrick R.P. Heller, *Risky Bet: National Oil Companies in the Energy Transition* (Natural Resource Governance Institute, 2021).
3 We have improved our calculations since the first report in 2021, using a different set of oil and gas demand and price scenarios. This means the results from the two reports are not comparable.
4 International Energy Agency, *Net Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach (2023)*; BloombergNEF, *Electric Vehicle Outlook* (2023).

Unfortunately, few of the 21 NOCs we recently surveyed have publicly acknowledged the risk of the energy transition, while some believe in escape plans that exempt them from addressing the risk. Only two have published detailed assessments of this risk or plans to mitigate it.[5] One of these is Indonesia's Pertamina, which stated: "Along with the energy transition that is continuously sounded globally, Pertamina… is projected to lose around 50% of its revenue by 2030 if the Company does not immediately respond by developing other sources of revenue besides fossil-based energy…"[6]

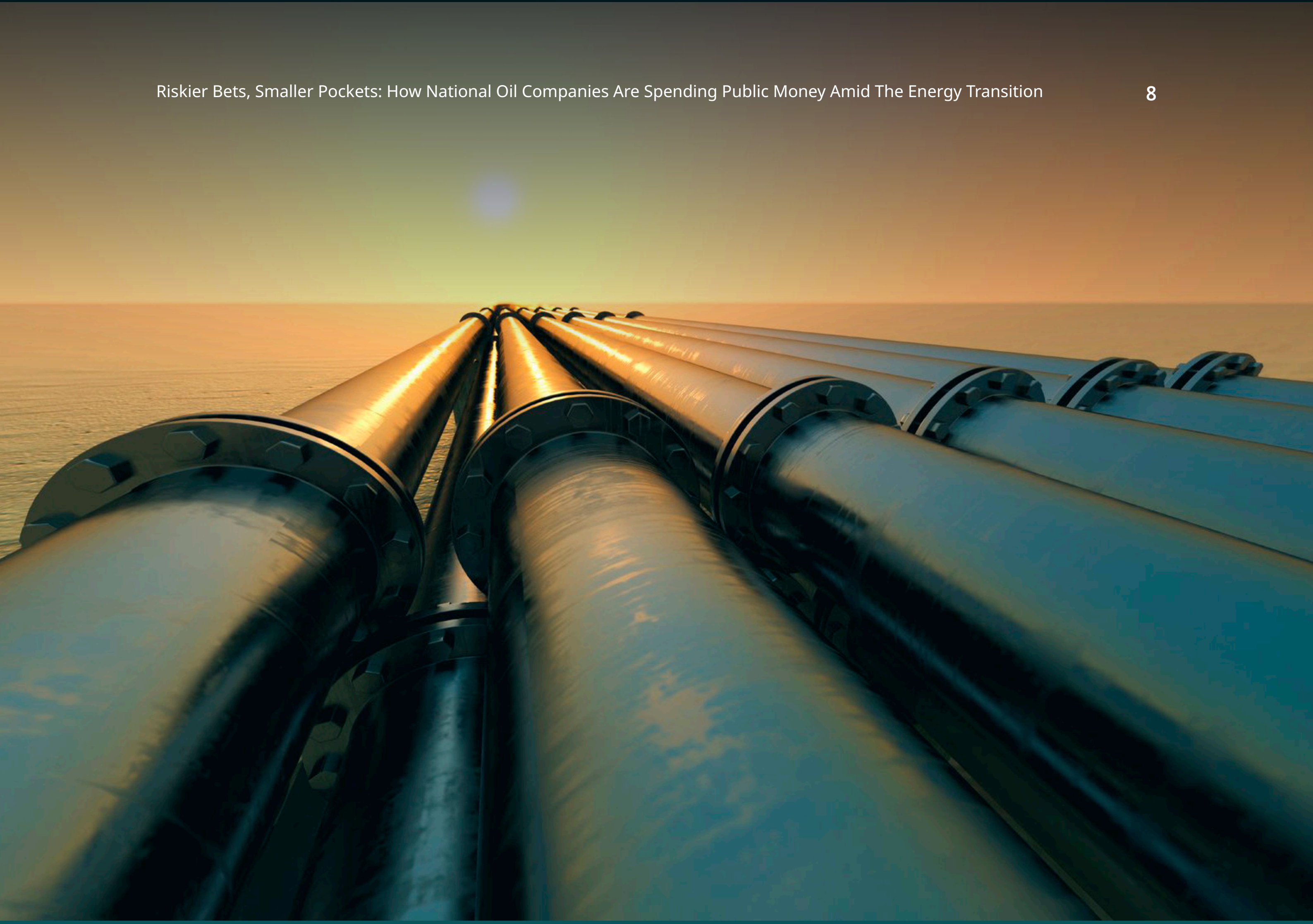
This comports with our results here that show Pertamina is the fifth-most exposed NOC to transition risk, but the company should not be the only NOC with concerns about what the energy transition means for business.

As NOC investment decisions are not always made under the full and informed gaze of the public, they need to be examined with care. This report therefore considers how NOCs, their governments, and civil society actors can fully acknowledge the risk and decide how to more wisely invest public funds.

Photo by Paranyu Pithayarungsarit for Getty

5 Andrea Furnaro and David Manley, *Facing the Future: What National Oil Companies Say About the Energy Transition* (Natural Resource Governance Institute, 2023).

6 Pertamina, *Annual Report 2022* (2023), 5.



National oil companies are betting huge amounts of public capital and their governments are increasingly unable to withstand the potential losses; it is therefore poor public financial stewardship to ignore the possibility of a sharp decline in demand for oil.

Conceptual framework

Focus on transition risk for NOC investments

The term “transition risk” refers to the impact on NOCs and their governments from a long-term decline in oil and gas demand.

There are other related risks. NOCs may experience decreased access to external finance (via international oil company (IOC) joint-venture partners; non-state shareholders; corporate and sovereign bond markets; and banks). NOCs could also inherit substantial decommissioning costs when IOCs divest assets.[7,8,9]

Rather than analyzing all of these risks, in this report we focus on the impact of the decline in demand on NOCs’ investments. The other issues are strongly linked with financiers’ expectations around oil and gas demand. Understanding the implications of a decline in demand is also informative about finance and decommissioning.

We focus on the global transition risk—the decline in global demand for oil and gas—as the global market determines demand and price for most NOC sales and influences fuel prices in most domestic markets. Even NOCs which predominantly sell to their home market, or aspire to do so, are exposed to transition risk if prices in those markets are influenced by global oil and gas prices.

We also focus on how a decline in demand might impact the returns NOCs make on their investments. Although there are various other impacts (the most important being declining government revenue), we focus on investments because this is the area in which NOCs and their governments have most control. NOCs can decide whether to risk public capital, but they cannot control global oil and gas prices and so cannot control whether government revenue declines.

However, simply halting NOC investment is not a straightforward decision. There are strong pressures on NOCs to continue investing. Some governments intend to accelerate the development of their subsoil resources before oil demand falls, and many NOCs are mandated to supply fuels to their home markets or generate revenues for their governments.[10] But NOCs and their governments must weigh these goals against the fact that as NOCs invest billions of dollars of public capital, they increase the portion of their countries’ wealth that is exposed to transition risk.

7 The three transition risk factors are related to what the Task Force in Climate-Related Disclosure describes as the four main aspects of transition risk: regulatory, technological, market and reputational risks. Transition risk is equivalent to the term “stranded asset risk,” although, as we argue, there is a difference in how this concept should be applied to public capital investment. ClimateWise, *Transition risk framework. Managing the impacts of the low carbon transition on infrastructure investments* (2019).

8 Angela Picciariello and Paasha Mahdavi, *Opportunity NOCs: How investors can jumpstart energy transitions in national oil companies* (International Institute for Sustainable Development and the University of California, Santa Barbara, 2023).

9 Naadira Ogeer, *Oil and Gas Decommissioning Toolkit: Practical Guidance for Governments* (Commonwealth Secretariat, 2022), 20.

10 See the strategies of Nigeria and Ghana in Andrea Furnaro and David Manley, *Too Little, Too Few*.

Fast transition is still uncertain, but a growing possibility

Transition risk is not a mere academic concept. A fast transition could save nature and humanity from catastrophe. But it is also a growing practical worry for the oil industry. Even though emissions from fossil fuel use continue to rise, there is growing evidence that the energy transition is on a fast trajectory that brings a peak in global oil, gas and coal demand within sight.[11]

Peaks have already passed in some places and industries. In OECD countries, for example, fossil fuel consumption peaked in 2005.[12] Fossil fuel use for electricity has already peaked in countries representing 38 percent of global electricity use.[13] Even in emerging economies, peaks are close: the Chinese NOC Sinopec has said that Chinese gasoline demand peaked in 2023 and overall oil demand will peak in 2026.[14,15]

What matters, however, is not the peak, but the grade of the slope on the other side. To examine this slope, we must consider scenarios. The International Energy Agency (IEA) scenarios are among the most widely used for assessing the pace of the energy transition. Based on extensive data modeling to provide a structured framework for understanding potential developments in the energy sector, the IEA outlines three possibilities:[16]

Stated Policies Scenario (STEPS). In this scenario, governments do not impose new climate and energy transition policies, but rely on policies already being implemented and developed. The global energy transition is slow, barely counteracting the growth in global energy use. Oil demand by 2050 is 99 million barrels a day, similar to current global production, while gas demand is 4,357 billion cubic metres (bcm) a year, slightly higher than today. In this scenario humanity does not meet the Paris Agreement global temperature rise limit of 1.5°C, resulting in a 2.5°C rise above the temperature in the pre-industrial era, with a 50 percent probability.

Announced Pledges Scenario (APS). In this scenario, governments implement all of their climate pledges, regardless of whether they are written into legislation or policy. The global energy transition is fast, so that oil demand by 2050 is 55 million barrels a day and gas demand is 2,661 bcm a year. This scenario is consistent with a 1.7°C temperature rise, also with a 50 percent probability.

Net Zero Emissions by 2050 Scenario (NZE). In this scenario, humanity meets the Paris Agreement temperature goal, with the global energy sector achieving net zero CO2 emissions by 2050. The energy transition is even faster than under the APS, so that oil demand is 22 million barrels a day by 2050, and gas demand is 1,159 bcm a year.

NOCs and governments should consider all of these scenarios, but evidence, although this still far from certain, suggests an increasing likelihood that transition will be faster than STEPS.

11 International Energy Agency, *Net Zero Roadmap*.
12 Kingsmill Bond, *Decline and Fall: The Size and Vulnerability of the Fossil Fuel System* (Carbon Tracker, 2020).
13 Chelsea Bruce-Lockhart, Nicola Fulghum and Dave Jones, *Half of the world is past a peak in fossil power* (Ember, 2023).
14 Greg McMillan, "What 'peak oil' will mean for China," *Financial Times*, 27 September 2023.
15 Colin McKerracher, "China Reaches Peak Gasoline in Milestone for Electric Vehicles," Bloomberg, 29 August 2023.
16 International Energy Agency, *World Energy Outlook 2022* (2022).

Clean energy technologies are growing exponentially

Such a fast transition is becoming more likely because it appears clean technology industries are adhering to an S-curve growth model. Akin to previous technological transitions, new technologies competing against a dominant incumbent technology initially grow slowly, with hardly any noticeable change. This gives way to an exponential expansion before growth plateaus at a high level as the new technology saturates the market. Conversely, the incumbent technology demonstrates the opposite trend.

In many previous transitions, demand for *both* incumbent and new technologies has risen. This is happening with fossil fuels and clean technologies today. The key factor driving growth in the new technologies is industries' rapid learning, creating a positive feedback effect. More growth leads to more learning, lower costs, bigger markets and more growth.[17,18]

The extent to which clean technology is following this S-curve model and taking market share from fossil fuels has consistently surprised the main forecasters of the energy transition.[19] However, the key question is how long this phase of exponential growth will continue. There could be far more growth at the expense of fossil fuels, even when accounting for rising energy demand in South Asia and sub-Sarahan Africa.

The future of oil demand

Many sectors of economies use products from crude oil, including aviation and shipping, however the most import in terms of understanding the future of oil demand is the road transport market, since almost half of all crude oil is used to make fuel for road transport.[20]

The growth in electric vehicles (EVs) may be following an S-curve. EVs' global share of new car sales has risen from 5 percent in 2020 to 18 percent in 2023.[21] Analyst forecasts suggest that by 2030 electric vehicles will constitute between 40 and 86 percent of sales, driven by government bans on the sale of vehicles with internal combustion engines.[22] Markets representing around half of global sales of road vehicles are covered by targets for 2035 or earlier.[23]

Despite this growth in new car sales, it will take longer for EVs to displace the use of oil in transport, since the total stock of cars currently in use is the key driver of consumption. EVs have so far only displaced 1.5 million barrels per day (mb/d) of oil demand. However, in BloombergNEF's "Economic Transition" scenario—which Bloomberg deems its most probable—50 percent of the global passenger fleet will be electric by 2040.[24]

Another large user of crude oil is the petrochemicals industry, consuming about 12 percent of crude oil. In the IEA's STEPS, petrochemical demand grows significantly to become the largest driver of world oil demand, adding nearly seven mb/d by 2050.[25] This prediction has received much attention, but a 7 mb/d rise is far from enough to counter the fall in oil consumption in other parts of the global economy, while under the APS and NZE scenario, oil demand for petrochemicals hardly increases at all.

17 Arnulf Grübler, Nebojša Naki'enovi' and David G. Victor, "Dynamics of energy technologies and global change," *Energy Policy*, 27 no. 5 (1999).

18 Within past energy transitions in the U.K. and the U.S., technologies from sailing ships to steam ships, horses to cars, gas to electric lighting, steam to electricity generation, and coal to gas heating have all followed this trend. Roger Fouquet, "Historical energy transitions: speed, prices and system transformation," *Energy Research & Social Science*, 22 (2016).

19 Kingsmill Bond et al., *X-change: Cars: the end of the ICE age* (Rocky Mountain Institute, 2023).

20 International Energy Agency, *Oil total final consumption by sector, 1971–2018*, last updated 27 August 2020.

21 International Energy Agency, *Net Zero Roadmap*.

22 Kingsmill Bond et al., *X-change: Cars: the end of the ICE age*, 16.

23 International Energy Agency, *Global EV Outlook 2023* (2023).

24 BloombergNEF, *Electric Vehicle Outlook* (2023).

25 International Energy Agency, *The Future of Petrochemicals* (2018).

The future of gas demand

Many NOCs aim to stay in business by pivoting to gas, seeing it as a "transition fuel."[26] The role for gas differs between high-income countries with stagnant energy consumption and lower-income countries with expanding energy consumption. In high-income countries, energy systems increasingly use gas as a "peaker" only when variable renewable energy is not available.

With gas relegated in this way, countries still need gas-fueled power generators, but have less need for gas itself. Conversely, in lower-income countries, gas is likely to provide more "baseload" power—usually the bulk of supply.[27] Gas demand in these countries may remain high for some time.

Nor is gas as clean as some people believe. The extraction and use of gas results in methane leaking into the atmosphere. If 3 to 5 percent of the gas is leaked before combustion, then gas is more damaging than coal within a twenty-year horizon. Unfortunately, leaks in many countries are above this level.[28]

These ideas may have helped spread the "transition fuel" narrative in many oil- and gas-producing countries. However, for most NOCs in this report, exports rather than domestic sales determine transition risk.

However, while the IEA scenarios suggest a slower fall in demand for gas than for oil, the IEA still predicts an eventual decline in gas demand. While coal and gas generate most electricity globally, use of renewable energy has significantly progressed. Between 2012 and 2022, costs per megawatt hour for onshore wind, offshore wind, solar and batteries have fallen by 57 percent, 73 percent, 80 percent and 80 percent respectively.[29]

Renewables investment is also rising and has exceeded that in gas generators: In 2022, investors spent 10 times more on solar and wind than on gas power. [30] Crucially, this progress is not only in high-income economies, but also in many emerging economies, such as Chile, Namibia and Uruguay.[31]

This all means that while NOCs may find a market for their gas at home, they should not ignore the growing competition from renewable energy in their gas export markets.

26 Andrea Furnaro and David Manley, *Facing the Future.*
27 Aaron Sayne, *Framework for Countries Evaluating Gas-to-Power Pathways* (Natural Resource Governance Institute, 2022).
28 Karin Rives, "Natural gas use may affect climate as much as coal does if methane leaks persist" *S&P Global Market Intelligence*, 27 December 2021.
29 Kingsmill Bond et al., *X-change: Electricity* (Rocky Mountain Institute, 2023).
30 International Energy Agency, *World Energy Investment 2023* (2023), 32.
31 Joel Jaeger, *These 8 Countries Are Scaling Up Renewable Energy the Fastest* (World Resources Institute, 2023).

There is no 'business as usual'

While a fast transition scenario such as the APS or NZE scenario poses financial risks for NOCs and their governments, a slower transition resembling the STEPS does not necessarily favor them.[32] Failure to meet the Paris Agreement goals would likely lead to serious climate impacts on countries and the global economy, from a growing inability to produce sufficient food or generate electricity from hydropower dams, to the upheaval of new migration and disrupted trade. The economic impact will be most severe in regions with the lowest incomes.

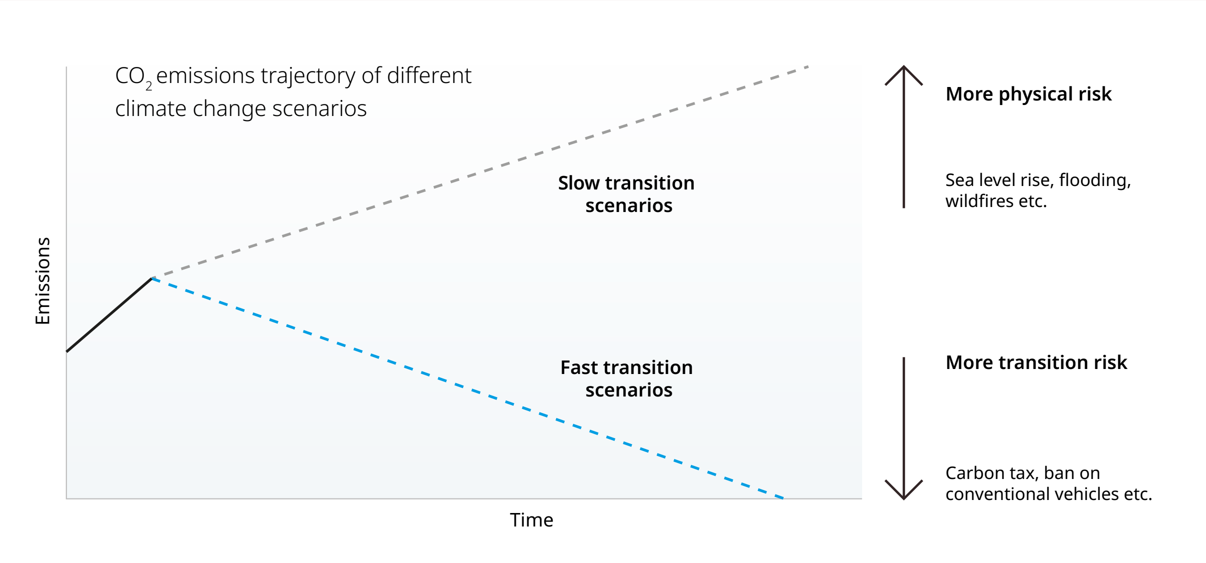
Envisioning a temperature rise of 2.6°C by mid-century (close to the 2.5°C assumed in STEPS), Swiss Re Institute's Climate Economics Index estimates a reduction in GDP of 8 percent by 2050 in OECD countries compared to a world without climate change, but 13 percent in South America, 22 percent in Middle East and Africa combined, and 29 percent in Southeast Asian countries. Nine out of the 10 most affected countries in the index operate NOCs.[33] A future like that envisioned under STEPS therefore presents governments with a difficult paradox.

They may receive high returns from NOC investments, but simultaneously face high demands to address climate damage just as their tax bases are shrinking from climate-induced damage. Estimates of annual adaptation costs for developing countries as a whole range from $75 billion to $300 billion a year.[34]

In addition, given climate-related economic disruption, the world economy may not demand the 99 million barrels a day envisaged by STEPS. The IEA does not fully consider this economic disruption in its modeling. The higher temperatures may increase demand for cooling services, and climate adaptation programs may require energy partially sourced from oil and gas. However, the economic crisis from climate change could reduce oil and gas demand.[35]

This means that governments cannot believe in both continued oil and gas demand and "business as usual" for the rest of their economies in the future. This may seem a distant prospect for most politicians, but they must consider it when responses such as economic diversification and climate adaptation will take decades to effect.

Figure 1. Types of risk relating to levels of emissions



32 For a deeper discussion of this issue, see Nicolas Stern, "A Time for Action on Climate Change and a Time for Change in Economics," *The Economic Journal*, 132 no. 644 (2022).

33 Swiss Re Institute, *The economics of climate change: no action not an option* (2021), 2–8.

34 Lisa Dougherty-Choux, *The Costs of Climate Adaptation, Explained in 4 Infographics* (World Resources Institute, 2015).

35 Francesco Pietro Colelli, Johanne Emmerling, Giocomo Marangoni, Malcolm N. Mistry and Enrica De Cian, "Increased energy use for adaptation significantly impacts mitigation pathways," *Nature Communications*, 13 (2022).

Methodology

To measure how exposed NOC investments are to transition risk we:

01

Found the oil demand and respective average oil price over the period 2023 to 2040 for three IEA scenarios: Stated Policies Scenario (STEPS), Announced Pledges Scenario (APS) and the Net Zero Emissions Scenario (NZE).

02

Identified projects (both greenfield and brownfield expansions) in which NOCs are likely to invest over the next 10 years. We call these investments NOCs' "investment pipelines."

03

Calculated the break-even price for each project, and identified those projects that do not break even if future oil demand follows the faster transition scenarios (NZE and APS).

04

Totaled the value of NOC investments in these projects. This is the value exposed to transition risk.

Demand scenarios and prices

For each of the IEA scenarios, we estimated an average oil price over the period 2023 to 2040. To do this, we extrapolated levels of demand over time using the current demand for oil and the IEA's estimates for 2030 and 2050 in its three scenarios. We then took oil industry cost curves from Rystad Energy across this period and estimated the price in each year by finding the break-even price of the marginal project in each cost curve equal to our extrapolated demand.

The result is $20 a barrel in the NZE scenario, $45 in the APS and $56 in the STEPS. Although the IEA publishes its estimates of oil and gas prices, we found that its price assumptions were not consistent with Rystad's available cost curves.

This is partly due to differing assumptions about factors such as discount rates (we could not alter this rate in Rystad's database), and partly due to the IEA's assumption that "major resource-holders" such as the Organization of Petroleum-Exporting Countries will continue to pursue "active market management strategies" and keep the price of oil higher than if the oil price was freely determined.[36]

Since we used Rystad data throughout, we decided to calculate oil prices as an endogenous outcome of our modeling, rather than as an exogenous input, to ensure we apply prices consistently within the model.

Our calculations resulted in lower oil prices in the APS and the NZE scenario than in the STEPS. This is because we assumed that global oil industry investment is following a trajectory aligned with the STEPS, and so in the APS and NZE scenario there is an oversupply.

However, if governments imposed strong restrictions on oil investments, or a large portion of the oil industry voluntarily reduced investment sufficiently, oil supply might decline faster than demand. This would instead lead to high prices.[37] However, this seems unlikely, as we show below, because the global oil industry is reducing investments, although not fast enough to align with a fall in demand envisaged in the APS.

We did not account for differences in demand between oil and gas, although in the results section and the appendix we show how outcomes might change if we did.

Photo by Alvaro Ardisana for Shutterstock

36 International Energy Agency, *World Energy Outlook 2023* (2022).

37 Lukas Boer, Andrea Pescatori and Margin Stuermer, *Not All Energy Transitions Are Alike: Disentangling the Effects of Demand- and Supply-Side Policies on Future Oil Prices* (International Monetary Fund, 2023).

Investment pipelines

To assess the amount of capital NOCs might invest in the future, we analyze NOCs' 10-year investment pipelines. We chose 10 years as this covers a reasonable strategic horizon around which NOCs can plan.These pipelines correspond to the list of upstream investments in both exploration and development projects by NOCs included in Rystad Energy Ucube. These investments:

- are taking place between 2023 and 2032
- have already started production with the additional investment being measured as brownfield development, or are greenfield developments and have a production start date on or before 2032
- include both investments to which NOCs have committed and discretionary investments.

The investment pipeline does not include midstream and downstream projects such as liquid natural gas (LNG) terminals, refineries, oil and gas pipes, electricity generation or petrochemical plants. Nor do we explicitly account for differences in timing between the periods in which projects are operating, although based on the average end dates of the projects in the database, we do not believe our results would change significantly if we did.

Nor do we account for differences in carbon and methane intensities in the extraction of oil and gas in each project, and therefore the impact of future carbon pricing policies, although our results note how certain NOCs' risk exposure might change if we did account for these emissions. These are areas for further research which we discuss in the appendix.

The investment pipelines we constructed are not necessarily the same as those that NOCs are actually planning. Normally, NOCs do not publish detailed investment plans for the next 10 years. However, analyzing the investment pipeline tells us what investments are likely given the price assumed.

Our analysis therefore acts as a warning: there is still time to avoid investing in the riskiest assets, but if NOCs do not adequately recognize transition risk, these are the investments that they are likely to make.

To determine which projects enter the investment pipeline, Rystad Energy Ucube requires we input a price that NOCs use to decide whether a project is commercially viable. We assumed all NOCs choose to invest in projects anticipating that oil demand resembles STEPS. This adheres to the IEA observation that "fossil fuel investments are now broadly aligned with the Stated Policies Scenario in 2030."[38] Although, based on the production plans stated by governments of large oil and gas producing countries, this assumption is likely conversative.[39]

There is no evidence to suggest that NOCs will invest more cautiously than IOCs and reduce investments in line with a faster energy transition, and NOCs may even be under pressure to invest when investments are not commercially viable. Our analysis of NOCs' attitudes toward transition risk found that only two out of 21 NOCs—Petrobras and Ecopetrol—have publicly acknowledged the risks that the global transition poses to their finances, and have disclosed risk assessment analyses and mentioned risk mitigation plans. At the other extreme, nine NOCs have not acknowledged the risk at all. It is also likely that NOCs will prioritize non-commercial goals, as explained on page [6].

In addition, volatile prices are likely to cloud decision making. A period of high prices could encourage many NOCs to bet that oil and gas demand will remain high. Price volatility is likely to continue just as it has in the past.

Demand will still change unexpectedly, and uncoordinated investment will lead to periods of oversupply and undersupply. As Figure 2 illustrates, short periods of high prices are consistent with long-term trends in both fast and slow transitions.

38 IEA, *World Energy Investment 2023*, 62.

39 Stockholm Environment Institute, Climate Analytics, E3G, International Institute for Sustainable Development and United Nations Environment Programme, The Production Gap: *Online Appendix (2023)*, 4.

Figure 2. How oil price volatility clouds long-term trends

Break-even prices

We use Rystad Energy's estimated break-even prices for each project. The break-even price includes all development and operating costs, the hurdle rate of investment (the internal rate of return on capital invested required for the company to invest in the project) and the project's payments to government, over the expected life of the project.

We argued in our previous report that governments might reduce taxes on their NOCs' projects to ensure they remain viable, to bail out the NOC or to prioritize non-commercial objectives such as energy security. However, doing so keeps public capital within the NOC and therefore increases transition risk exposure. We therefore keep production share, taxes and royalty payments in the break-even price definition. A key part of the break-even price is the hurdle rate.

Rystad's default assumption for this is 10 percent of the capital invested. However, 10 percent is probably an underestimate of the cost of capital for upstream oil and gas projects today. Goldman Sachs reports that investors' and companies' hurdle rates for offshore oil projects have increased from about 11 percent in 2013 to about 23 percent in 2020.[40]

Rystad Energy reports that large exploration and production companies are using rates of 15 to 20 percent.[41] A survey of oil and gas company shareholders in 2019 showed rates ranging from 14 percent for LNG to 21 percent for emerging market "mega-projects."[42] We have retained 10 percent, to be conservative, but using a higher hurdle rate would have increased the amount of NOC investment that fails to break even, particularly for projects with long estimated lifespans.[43]

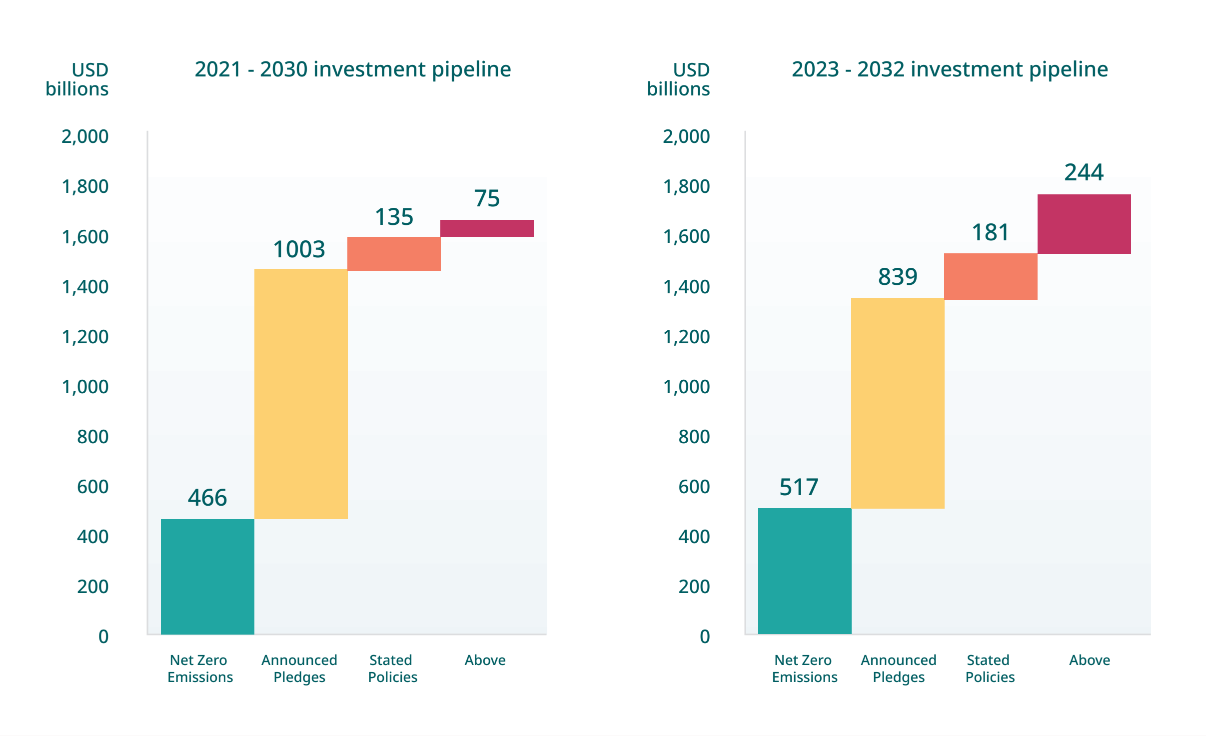
40 Michele Della Vina, Zoe Stavrinou and Alberto Gandolfi, *Carbonomics: the green engine of economic recovery* (Goldman Sachs, 2020), 11.
41 Rystad Energy, *Higher capital cost expected to hike long-term prices and promote tight oil* (2023).
42 Oxford Institute for Energy Studies, *Energy Transition, Uncertainty, and the Implications of Change in the Risk Preferences of Fossil Fuel Investors* (2019).
43 Our subscription to Rystad Energy's UCube also prevents us from changing the discount rate assumption.

Results

Riskier bets

Unless NOCs change their outlook of global oil and gas demand, they will probably invest $425 billion in projects that would not break even in the APS. This is twice the amount that was in NOCs' 10-year investment pipelines when we issued our last report in 2021 ($210 billion).[44] Figure 3 shows the 10-year investment pipeline for all NOCs, segmented by the IEA scenarios under which the investments break even.

Figure 3. Value of all NOCs' aggregate "investment pipelines" measured in 2021 and 2023, by scenarios in which they break even[45]



However, NOCs may invest $1.2 trillion—71 percent of the global NOC investment pipeline—in projects that do not break even in the NZE scenario. This would mean that $1.2 trillion worth of oil and gas projects would only make a profit if humanity fails to meet the 1.5°C temperature target.

Investment breaking even in the NZE scenario is not inconsistent with the IEA's statement that no new long lead-time projects are compatible with net zero, since we include projects yet to reach a final investment decision and brownfield projects in which expansion investment will occur.[46]

44 The results from our previous report differ because we have applied our new methodology to the investment pipelines we measured in 2021.
45 NRGI analysis based on Rystad Energy UCube data.
46 International Energy Agency, *Net Zero Roadmap*.

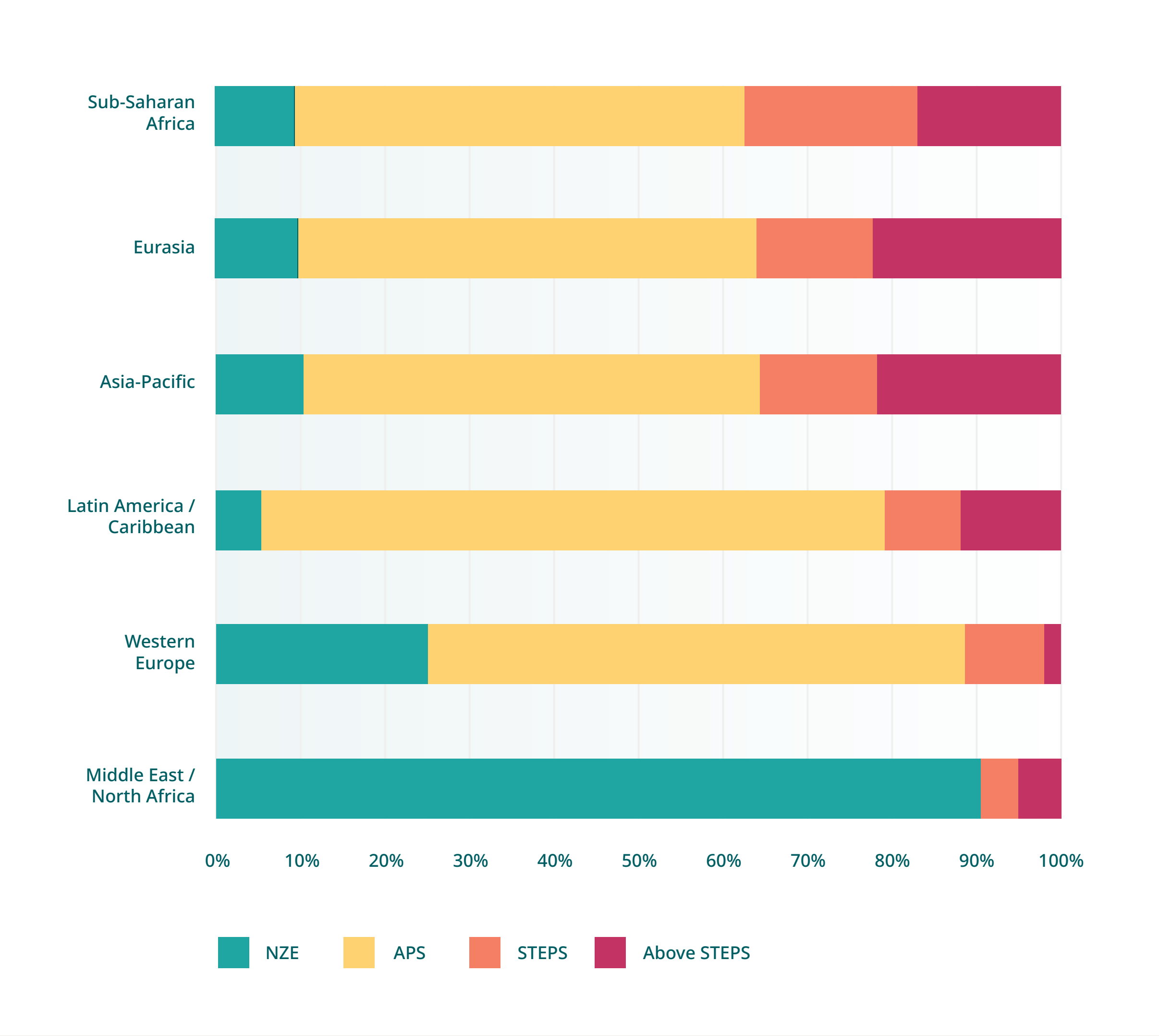
Figure 4 shows the difference in NOCs' transition risk exposure by region as a proportion of their total investment pipeline. NOCs in sub-Saharan Africa, Asia-Pacific and Eurasia are most exposed.

Figure 5 shows the individual exposure of each NOC. Over a third of the investment pipeline of 18 NOCs—including Indonesia's Pertamina, Nigeria's NNPC and Mexico's Pemex—do not break even in the APS. For Uganda's UNOC and Cameroon's SNH, four-fifths of their investment pipeline would fail to break even in the APS.

Accounting for different gas prices and applying carbon prices on methane emissions may alter NOCs' exposure. For example, QatarEnergy would be less exposed to a carbon price as Qatar's gas production is in the bottom decile of gas-producing countries.[47]

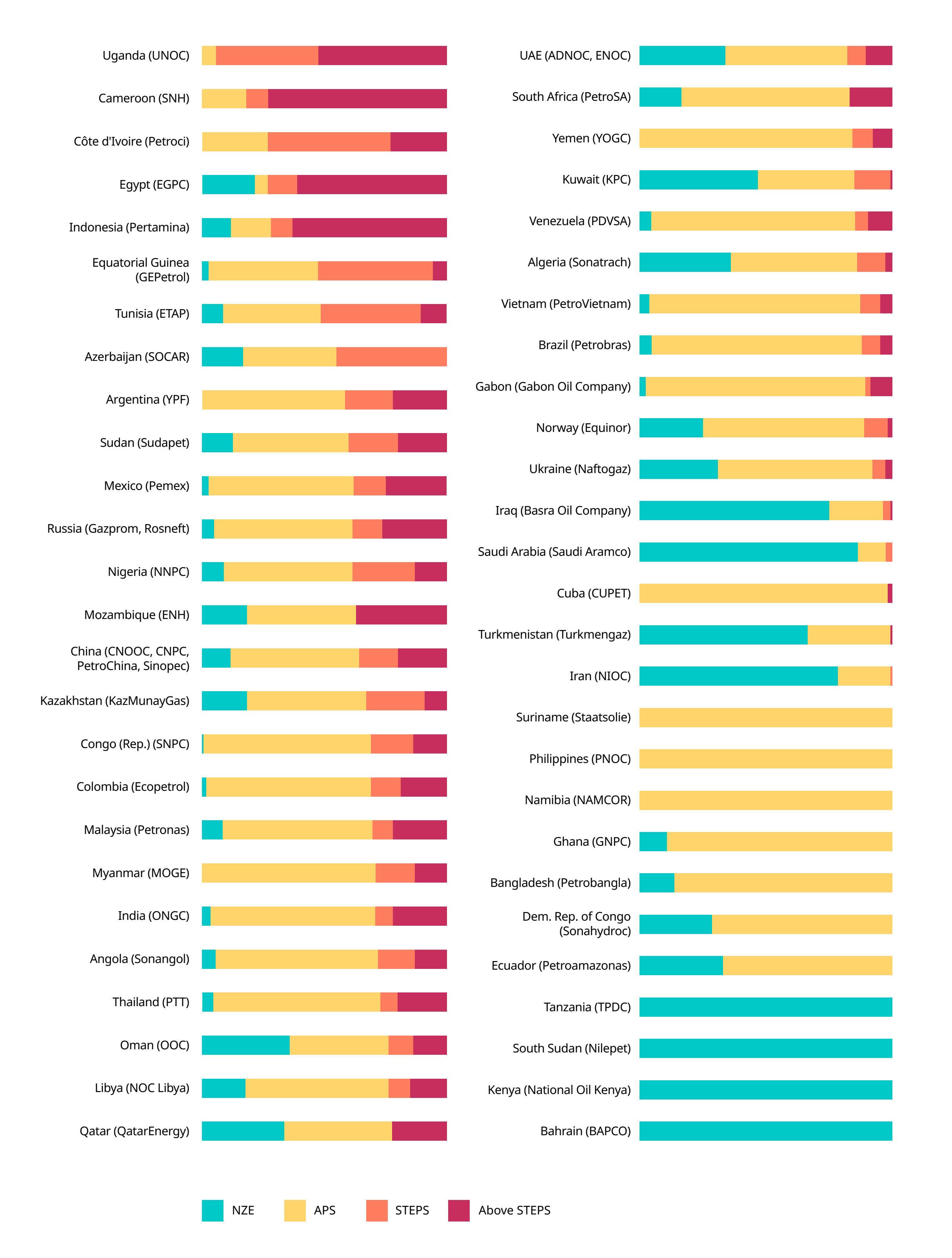
However, in Figure 5 there are some countries with low-risk exposure that have high methane emissions: Iran and Iraq are both in the top decile of countries for methane emissions from oil production.[48] We discuss this further in the appendix.

Figure 4.
Proportion of NOC investment pipelines that breaks even in each IEA scenario, aggregated by region[49]



47 Authors' calculations using data from Global Registry of Fossil Fuels, accessed 23 October 2023.
48 Authors' calculations from the Global Registry of Fossil Fuels, accessed 23 October 2023
49 NRGI analysis based on Rystad Energy UCube data.

Figure 5.
Proportion of investment pipelines breaking even in each IEA scenario[50]

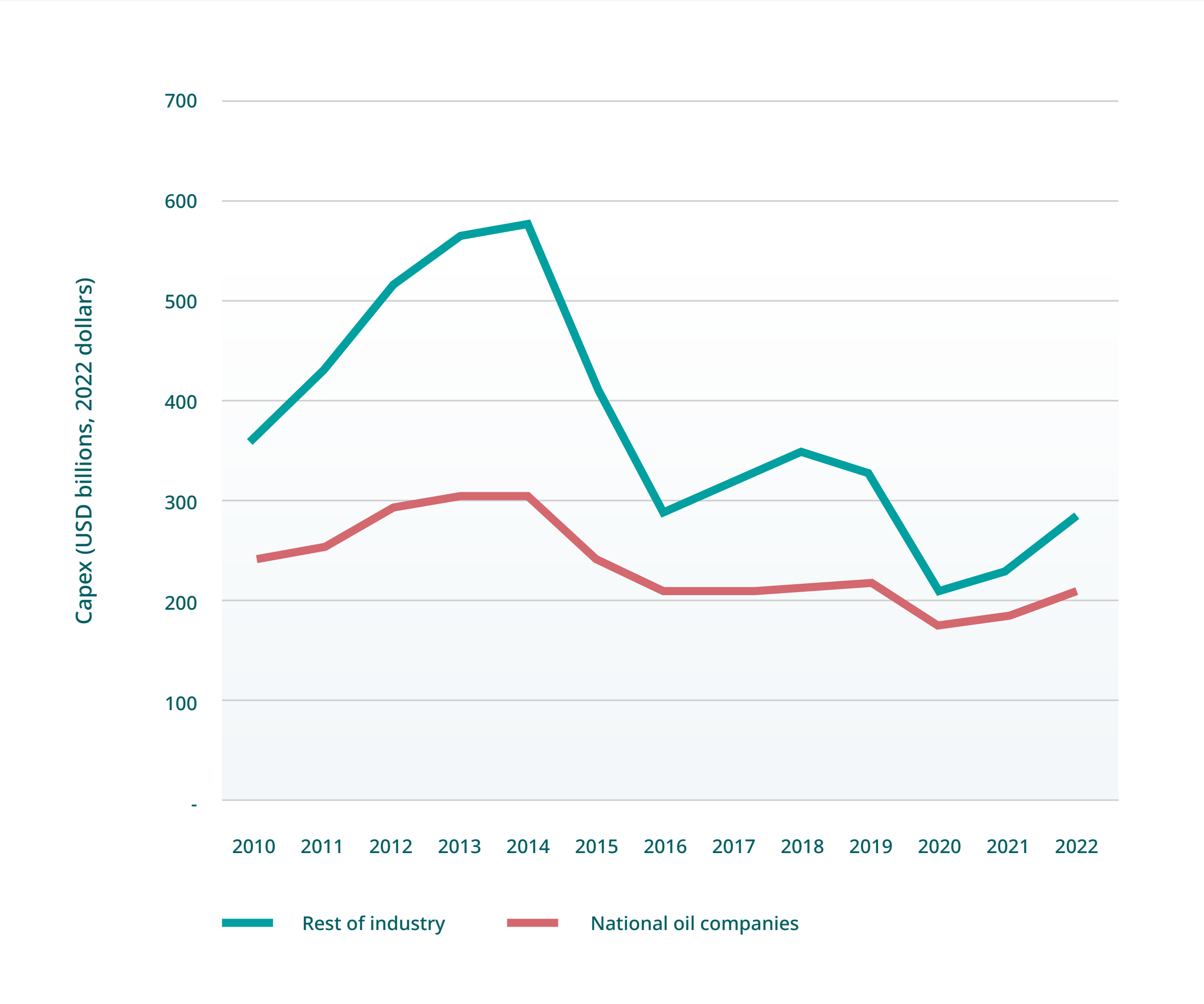


50 Ordered by highest proportion of pipeline that breaks even only in the STEPS scenario.

Reversing a decade of declining investment

Along with the rest of the oil industry, NOCs' investment has been falling since 2014, after the last oil boom. This decline may have contributed to the undersupply relative to current demand, but as mentioned earlier, the IEA believes the industry is still investing in line with the STEPS. However, as prices increased after the end of the pandemic and the 2022 Russian invasion of Ukraine, both NOCs and IOCs have reversed this decline. Since 2020, NOCs' capital expenditures have grown by 10 percent ($20 billion).

Figure 6.
Capital expenditure by NOCs and other oil companies from 2010 to 2022, adjusted for inflation[51]



NOCs are collectively on course to spend $1.8 trillion in upstream capital investment from 2023 to 2032. This is $100 billion more than they were projected to spend two years ago, but less than NOCs invested over the previous decade ($2.6 trillion in real terms). However, now transition risk is greater, and countries have less time to diversify.

51 NRGI analysis based on Rystad Energy UCube data.

Future investment growth concentrated

Projected growth in investment pipelines is not uniform across NOCs. Half of all NOC investment over the coming decade is likely to come from NOCs based in just four countries: China, Saudi Arabia, Russia and Brazil.

Figure 7.
Value of NOCs' 10-year investment pipelines (USD billions)[52]

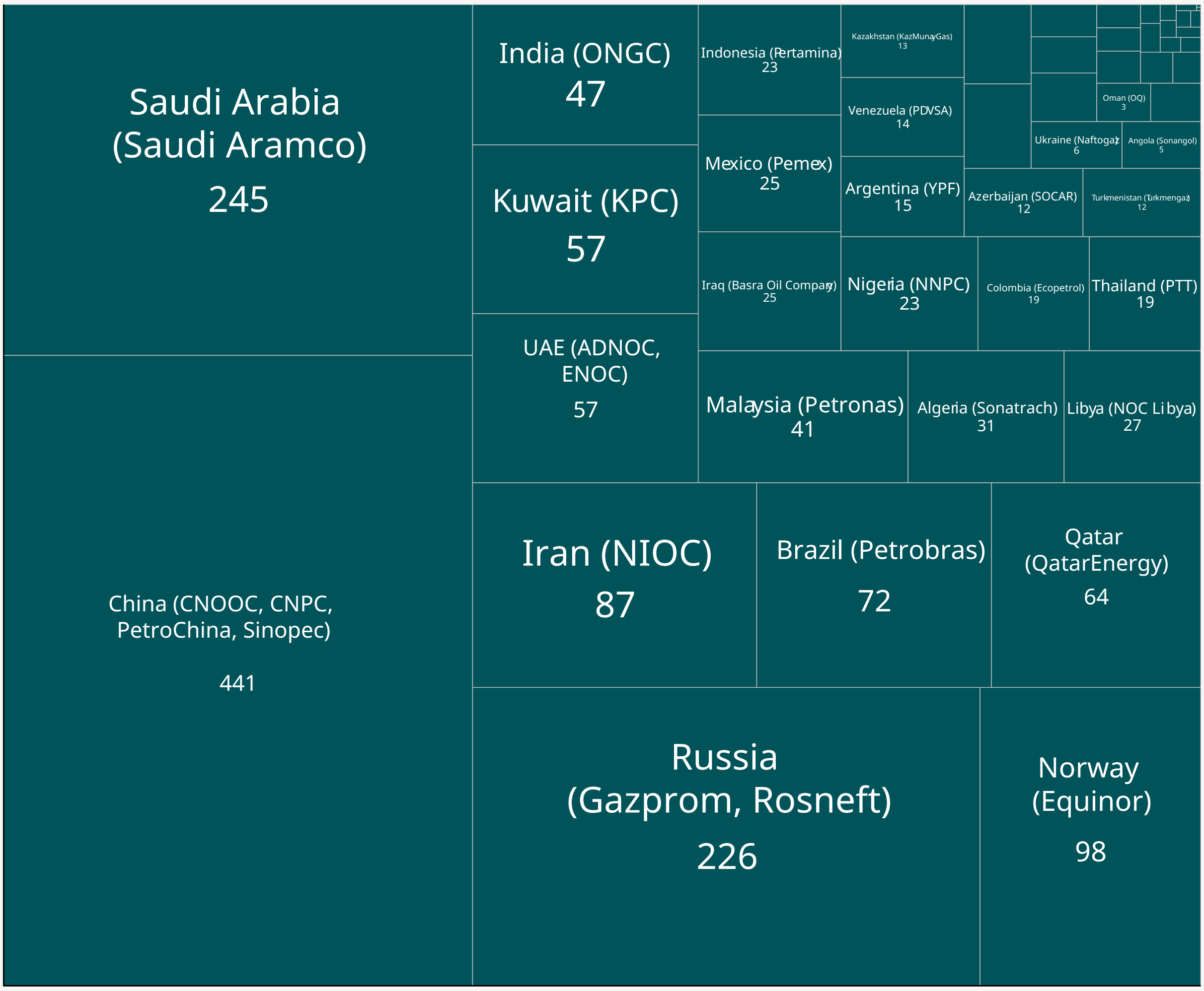
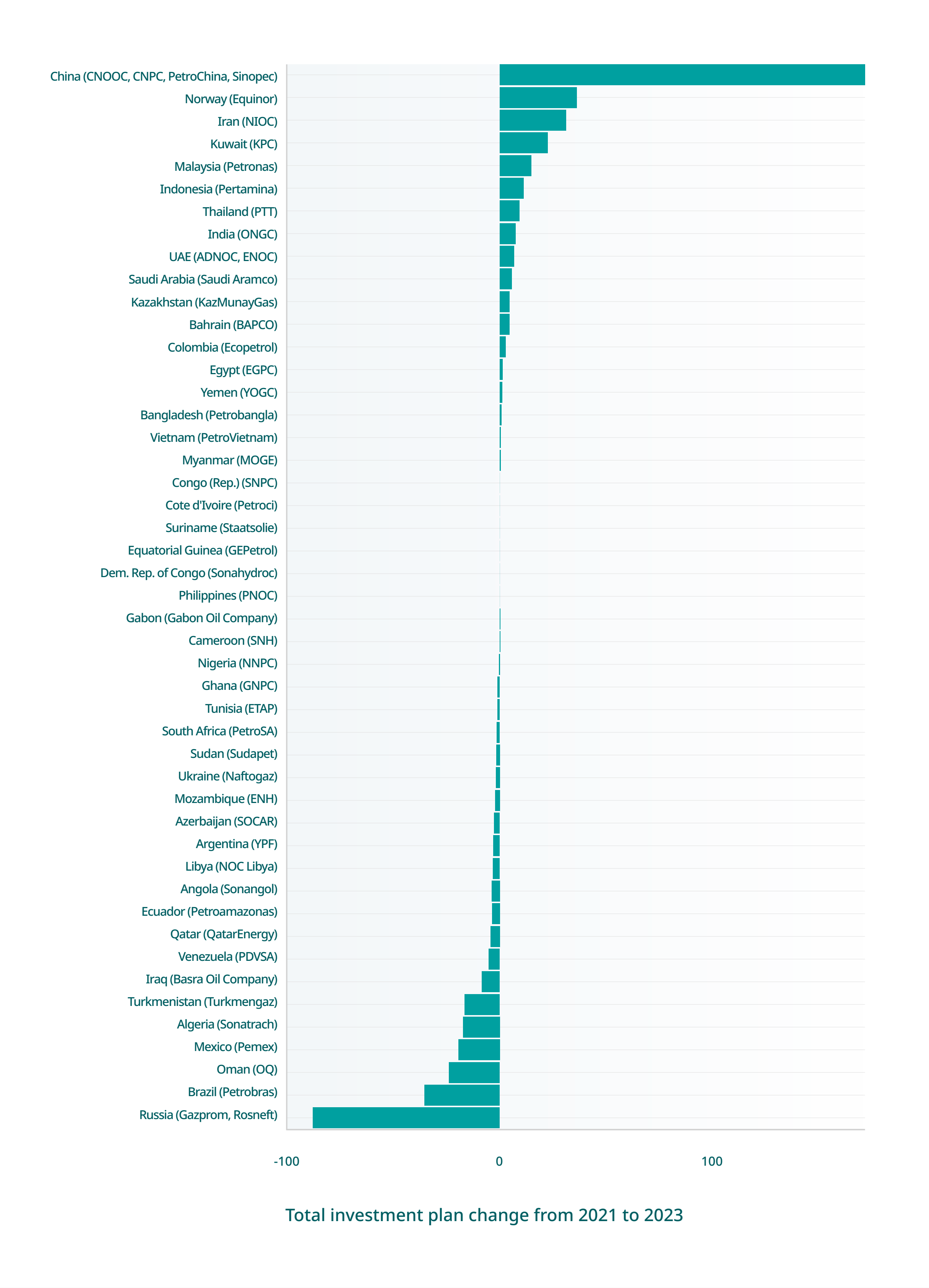


Figure 8 shows that the three Chinese NOCs (CNOOC, CNPC and Sinopec) have added by far the most to their investment pipelines since 2021. Other Asia-Pacific NOCs—Malaysia's Petronas, Indonesia's Pertamina, and Thailand's PTT—have also increased their investment pipelines, making the region as a whole the largest area of investment growth. Conversely, investment pipelines of NOCs in Latin America, Eurasia and sub-Saharan Africa have fallen.

52 NRGI analysis based on Rystad Energy UCube data.

Figure 8.
Change in NOCs' investment pipelines from 2021 to 2023 (USD billions)



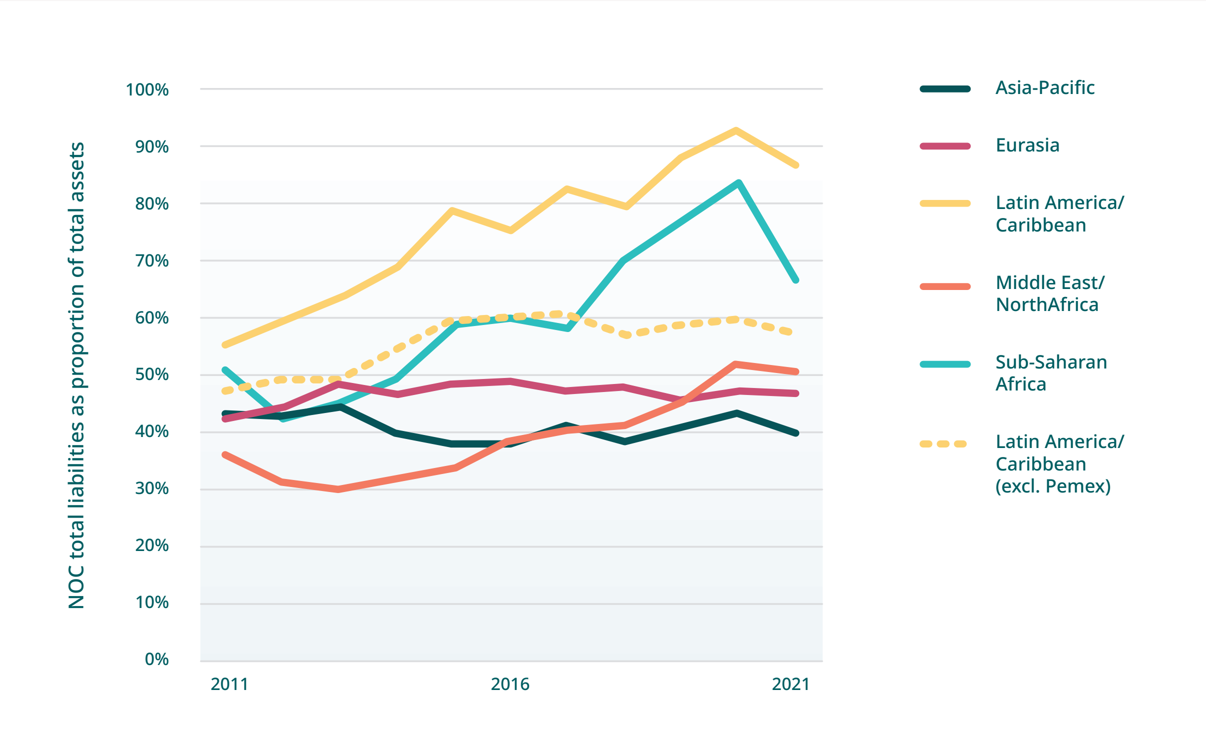
Smaller pockets

NOCs' risk taking may be fiscally acceptable if their own finances and those of their governments are strong enough to support them should their bets turn bad. However, NOCs are making riskier bets even as governments' financial pockets are shrinking.

NOCs' indebtedness

On average, NOC debt is growing in Latin America, MENA and sub-Saharan Africa. In particular, Latin American and sub-Saharan African NOCs have experienced significant increases in leverage. Revenues deriving from currently high prices may help NOCs to reduce this debt, yet the NOC debt climbed even during periods of high oil prices. Governments of highly indebted NOCs have cause for concern when these NOCs invest heavily in high-cost projects—the cost to the public treasury from future bailouts could be substantial. For example, from 2019 to 2023, the Mexican government transferred $57 billion in bailouts to Pemex (in 2022 prices), the most indebted of all NOCs, and reduced its tax burden and provided other support valued at another $42 billion. Moody's estimates that the government will need to transfer about $9 billion in 2024. In total this is 15 percent of the Mexican government's own debt.[54]

Figure 9.
NOCs' total liabilities as proportion of total assets, 2011 to 2021[53]



53 Authors' calculations using the Natural Resource Governance Institute *National Oil Company Database* (2023), accessed 23 October 2023. We removed Timor GAP for 2020 and 2021, as leverage above 1,000 percent was skewing the overall average.

54 Authors' calculations based on César Augusto Rivera de Jesús, *Apoyos fiscales y patrimoniales a Pemex* (Centro de Investigación Económica y Presupuestaria, 2023).

Government debt

NOCs' exposure to transition risk comes as the fiscal space of governments in most low-income and lower-middle-income economies is shrinking.[55] External public debt in these economies has tripled, and debt service payments as a percentage of government revenue rose from 6 percent in 2010 to 16 percent in 2021.[56] In a fast transition scenario such as the APS or the NZE scenario, this situation is likely to worsen for governments dependent on oil and gas revenues as these revenues fall. The effect may be accelerated if lenders anticipate the fall or the potential for NOC bailouts, and therefore lend less to governments. Figure 10 shows one measure of fiscal space: the value of central government debt as a proportion of GDP. The chart shows that the debt held by governments of NOCs in all regions is rising. On average, indebtedness is back to the levels last seen at the turn of the millennium.[57] In particular, government debt is rising significantly in Latin America and the Caribbean, MENA and sub-Saharan Africa.

Figure 10.
Central government debt as a proportion of gross domestic product, 2000 to 2021[58]

55 The fiscal space of a government with NOCs shows how much room the government has to provide extra funding for the NOC, or other increases in spending, "without jeopardizing the sustainability of its financial position or the stability of the economy." Peter Heller, "Fiscal Space: What it is and how to get it," *Finance and Development*, International Monetary Fund, 42 no. 2 (2005).

56 United Nations Conference on Trade and Development, *Trade and Development Report 2023* (2023).

57 For a fuller examination of this issue, see Shandelle Steadman, Ipek Gençsü, Shakira Mustapha, Sarah Colenbrander and Judith Tyson, *Indebted: how to support countries heavily reliant on oil and gas revenues to secure long-term prosperity* (Overseas Development Institute, 2023).

58 Authors' calculations using the International Monetary Fund *Global Debt Database* (2023), accessed 23 October 2023.

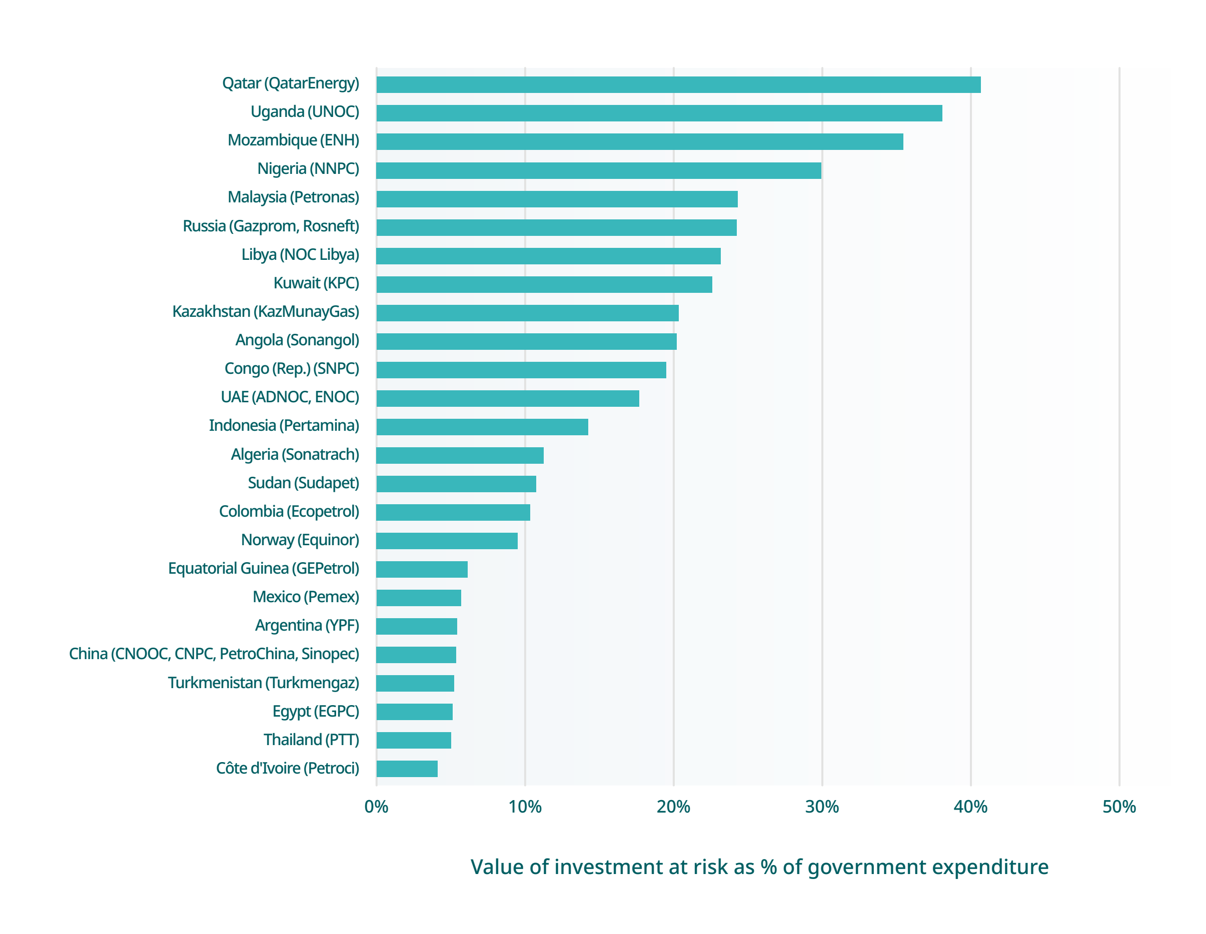
Risky bets compared with government budgets

We also compared government expenditures with NOCs' investments in projects that are unlikely to break even if the energy transition resembles the APS.[59] The greater the value of highly exposed investments as a proportion of a government's spending, the less the government can afford for its NOC to take such risks, and the more important the opportunity cost of capital becomes.

Figure 11 puts QatarEnergy, Uganda's UNOC, Mozambique's ENH and Nigeria's NNPC at the top, although, as we mentioned earlier, NOCs with high proportions of gas production and low emission intensities (such as QatarEnergy) are probably less exposed than our results suggest.

These NOCs may invest an amount equivalent to more than 30 percent of their governments' annual expenditure in projects that do not break even in the APS. There are 16 NOCs in total spending $181 billion on such high-risk projects in countries where this investment represents at least a tenth of annual government expenditure. In the NZE scenario, $522 billion of investment does not break even in countries where this investment is at least a tenth of government expenditure.

Figure 11. Capital expenditure that does not break even in the APS as a share of annual government expenditure[60]



59 We compare the value of capital expenditure that does not break even in the APS as a share of the five-year average government expenditure.

60 Authors' calculation using Rystad Energy UCube and World Bank Open Data, *General government final consumption expenditure* (% of GDP), accessed 23 October 2023.

Governments of highly indebted NOCs have cause for concern when these NOCs invest heavily in high-cost projects—the cost to the public treasury from future bailouts could be substantial.

Photo by WherezJeff for Flicker

Recommendations

Given the high exposure of some NOCs to transition risk, and the closing fiscal space of many of their governments, what should NOCs and their governments—especially ministries of finance and energy, and parliaments—do? Here we build on the recommendations in our previous report to support NOCs to:

- Acknowledge the fact that the global energy transition threatens the viability of NOC investments,
- Assess how exposed investments are to transition risk
- Act by mitigating transition risk[61]

Acknowledge transition risk

NOCs and their governments need to acknowledge:

- the increasing probability of a substantial decline in global oil and gas use,
- a decline in financing for NOCs and in capital from IOC partners, and
- the related deterioration in government finances and higher interest on sovereign debt.

Even NOCs that sell predominantly to home markets where energy transitions are occurring very slowly could still be exposed if global prices affect domestic prices.

NOCs and their governments should also acknowledge that if governments across the world fail to meet their climate pledges, although oil and gas demand might stay high, the substantial physical and economic damage that climate change will impose on countries will be immense.

It is not clear whether this means that governments should invest the capital NOCs are investing elsewhere, but it does mean that both NOCs and governments should more carefully scrutinizes investment decisions.

In other words, there is no "business as usual" for NOCs and their governments. In their scenario planning NOCs should consider both a climate-positive steep fall in oil and gas demand and a climate-catastrophic sustained plateau. NOC managers may do this privately, but publicly, few NOCs have acknowledged transition risk. Pertamina, Petrobras and Ecopetrol are rare exceptions.[62]

61 David Manley and Patrick R.P. Heller, *Risky Bet.*
62 Andrea Furnaro and David Manley, *Facing the Future.*

Assess transition risk

Assess NOCs' transition risk exposure using credible but challenging scenarios

Governments and NOCs should assess how exposed NOCs' investment plans are in a wide range of energy transition scenarios, and how affordable those risks are for the economy. The measurements discussed above can be important components of this assessment:

- **High and low export demand and price scenarios for oil and gas.** There are many available scenarios for oil and gas demand and prices that have credible pathways. Government officials and civil society actors should call out NOCs' attempts to ignore scenarios that result in unfavorable outcomes for an NOC.
- **Current NOC investment plan.** NOCs should also assess and disclose information about the financial viability of current investment plans under different scenarios, including ongoing projects that can be affected by a decline in prices.
- **Costs of long-term plans.** Beyond current operating plans, NOCs' long-term investment plans are likely to be particularly risky, as they will happen further into the future. These include ambitions by NOCs that are presently not operating their own projects to become operators.

Review how public capital is put at risk

The ways in which an NOC is using public capital might not be obvious. NOC financial operations can be complicated and opaque even to other parts of government.[63] Therefore government agencies and civil society need to both advocate for greater disclosures and review the mechanisms through which public capital is shifted among subsoil resources, NOCs and the government. This includes:

Capital flows into an NOC:[64]

- **Revenue from oil and gas sales.** This is public capital in the sense that in most countries, the oil and gas subsoil resource is the property of the public or the state, and that the revenues of a state-owned company are public property.
- **Revenue from non-core activities.** This may come from NOC activities in oil and gas service provision, financial investments or other sectors.
- **Equity capital.** This is often private capital, and not public unless the government has explicitly bought more equity in the NOC.
- **Debt capital.** This might be either private capital from banks or bond markets, or public capital if sourced through explicit loans from the government. In some cases, state banks or domestic banks might lend to the NOC, which might be private capital, but covered by implicit state guarantees that may put public capital at risk indirectly.
- **Transfers from state to NOC.** Formal budget allocations, subsidies and bailouts.

Capital flows out of the NOC:

- Taxes, dividends and other transfers from NOC to the state
- Dividends from the NOC to private shareholders
- Operational expenditures, capital investments and financial payments (including debt payments)
- Transfers from the NOC to the state

See our previous report for a fuller discussion of how governments might control these capital flows.[65]

63 As of the finalization of this report in late 2023, 47 of the 70 NOCs covered by NRGI's *National Oil Company Database* had not published financial statements presented according to International Financial Reporting Standards for the year 2021.
64 Charlotte Huebner and Patrick R.P. Heller, *National Oil Company Database Methodology Guide* (Natural Resource Governance Institute, 2021), 18–26.
65 David Manley and Patrick R.P. Heller, *Risky Bet: National Oil Companies in the Energy Transition* (Natural Resource Governance Institute, 2021).

Forecast governments' fiscal space in a fast transition scenario

What matters is what is best for each country, not just what is best for an NOC. This means a risk assessment should include both the NOC's exposure and the government's, and a measure of how tolerant the government can be of NOC risk-taking. In countries with small financial pockets, NOCs should take less risk than those in countries with deeper pockets.

Crucially, this assessment should forecast fiscal space in scenarios in which NOC investments fail. Governments should ask whether they will be able to cope with NOC failures during times when their revenue from the oil industry is also likely to be low.

Involve actors outside of NOCs

Governments should expand the risk assessment process and subsequent decision-making steps beyond the NOC itself. NOC executives may hold cognitive biases that prevent them challenging their prior beliefs, making it difficult for them to accurately assess transition risk, while NOC relationships with their governments and their citizen shareholders regularly suffer from principal-agent challenges.

NOCs are created to achieve national goals, but the company's own performance targets may not always match those of the state. Like other state-owned entities, NOCs may have incentives to maximize their own size, revenues or influence, even where this may exacerbate long-term risks for governments. In addition, NOCs may suffer from moral hazard if governments provide financial security. In other words, knowing that the state will bail it out, an NOC is likely to take greater risks.[66]

When considering fiscal implications for the government, actors should involve finance ministries as a crucial contributor. More fundamentally, the broad plans to respond to the energy transition need to be open to public consultation. Thinktanks, NGOs and academics concerned with fiscal and macro-economic issues within producer countries will play an important role, but it is also important that the government and the NOC communicate their plans in plain language, so that citizens can contribute to the national strategy.

66 For a discussion of the challenges of principle-agent problems around NOCs and other public enterprises, see David G. Victor, David R. Hults, Mark C. Thurber, "Introduction," in *Oil and Governance*, ed. David G Victor; David R. Hults, Mark C. Thurber (Cambridge: Cambridge University Press, 2011), 3-32; Silvana Tordo, Brandon Tracy, Noora Arfaa, "National Oil Companies and Value Creation," World Bank Working Paper 218 (2011); David E. M. Sappington and J. Gregory Sidak, "Anti-Competitive Behavior by State-Owned Enterprises: Incentives and Capabilities," in *Competing with the Government: Anti-Competitive Behavior and Public Enterprises*, ed. R. Richard Geddes (Hoover Institution Press, 2004).

Mitigate transition risk

Scrutinize plans that NOCs use to avoid responding to the energy transition

Some NOCs argue they have escape plans to avoid the effects of the global energy transition.[67] These include promoting a domestic or regional market for oil and gas to replace falling demand from export markets, pivoting from oil to gas, or producing more petrochemicals. However, these escape plans are not foolproof. NOCs should disclose their analysis of these plans for wider scrutiny before they dismiss the need to take strong action to mitigate transition risk.

Decide whether to 'stay at the table' or 'cash out'

In our previous report, we described the decisions NOCs and their governments make as akin to gambling in a casino. Some NOCs are in a fortunate position and might "stay at the table" by continuing to invest—for instance, NOCs with a predominant amount of their portfolio in low-cost assets (see Figure 4), with low debt themselves (Figure 10) or backed by a government with ample fiscal space (Figures 11 and 12). Other NOCs will be in a less fortunate position, meaning that "cashing out" by stopping investment in high-cost projects will be the best option to avoid wasting public capital.

Share risk of high-cost projects with the private sector without sacrificing taxes

Even if cashing out from high-cost projects is the appropriate policy for many NOCs, their governments may still require the revenues or fuels these projects generate. Continued development of new oil and gas projects goes against the global effort to slow climate change, yet there is a strong economic rationale for some low-income governments to continue doing so.

In such cases private-sector investors may have an expanded role, either investing their capital in the NOC (in the form of a partial privatization) or taking a larger share in joint-venture partnerships. This means the NOC is exposing less public capital if oil and gas demand does fall quickly, while the government still benefits via higher taxes if high demand continues.

However, as we described, transition risk is already deterring private-sector investors, so attracting them to invest more capital in high-cost projects will be difficult. Governments have often provided investment incentives, such as reducing taxes. In such cases, governments should understand the underlying reason for attracting the investment. Reducing taxes obviously works against a revenue-raising objective, although there is a stronger rationale if the investment is to ensure a country's energy supply. However, it is important to factor in the tax reduction when comparing the relative costs of a country's energy options.

Governments may also have a political concern: Although allowing the private sector to risk its capital protects the government in the case of a fast transition, government officials might worry that the public will blame them for not taking the opportunity to continue making money in the case of a slow transition. Progressive taxation, so that tax payments are high when profits are high, and vice versa, covers the government in both scenarios.

In many of the countries covered in this report, nationalism is likely to make the idea of private-sector participation almost impossible. Mexico's Pemex is a case where nationalism strongly influences investment decisions—the government has discouraged most private-sector investment.

67 Andrea Furnaro and David Manley, *Too Little, Too Few.*

Resist filling the gap that others have left

At a minimum, governments should be skeptical of any path that increases NOC shares in risky projects. As our results show, private capital in the sector has declined over the last decade.

If private investors grow squeamish in the face of a global climate movement pushing unrealistically fast transition scenarios, some NOCs may see this as an opportunity to buy up the assets from which IOCs divest. However, such arguments warrant heavy scrutiny from governments, using the tools discussed above for assessing transition risk.

Ensure government departments and NOC are not following conflicting goals

Key factors in deciding whether an NOC cashes out, shares risk with the private sector, or "stays at the table" are the goals it pursues. For instance, these might be to maximize revenues, to secure fuel supplies, to become an operator, or to maintain national or corporate prestige (even if only implicitly).

The government and civil society actors must decide whether the goals the NOC is following are leading the company to take risky bets that expose public capital to transition risk, and to take the hard decision to change these goals if such risk is intolerable. A particular problem arises if different parts of the government have different targets; hence the need to widen the scope of people involved in these decisions.

Oil and Gas Photographer for Shutterstock

Some NOCs argue they have escape plans to avoid the effects of the global energy transition. However, these are not foolproof. NOCs should disclose their analysis of these plans for wider scrutiny before they dismiss the need to take strong action to mitigate transition risk.

Appendix

Data

Where possible we use data from NRGI's National Oil Company Database: financial data drawn from official public documents and assembled using a consistent method to facilitate cross-cutting analysis and benchmarking of companies.[68] However, for much of the analysis, particularly forecasts, we rely on data from Rystad Energy's UCube. This uses a mix of information publicly reported by companies, along with interviews and modeling.

By their prospective nature, company reports themselves are forecasts. As such, while oil and gas analysts widely use the data, they may not reflect NOCs' own internal projections for all projects, and are subject to revision. While we do not believe there is a significant upward or downward bias at the global level, we welcome any corrections from NOCs and others.

68 Natural Resource Governance Institute, *National Oil Company Database*, accessed 23 October 2023.

Identification of NOCs

We have identified 58 NOC groups (the aggregate of parent and subsidiary companies) based on companies in the National Oil Company Database. Rystad Energy lists more, but its list includes subsidiaries and government investment schemes.

Table 1. Names and countries of national oil companies used in this study

ADNOC (UAE)	GNPC (Ghana)	Pertamina (Indonesia)	SNG (Cameroon)
BAPCO (Bahrain)	KazMunayGas (Kazakhstan)	Petroamazonas (Ecuador)	SNPC (Rep. of Congo)
Basra Oil Company (Iraq)	KPC (Kuwait)	Petrobangla (Bangladesh)	SOCAR (Azerbaijan)
CNOOC (China)	MOGE (Myanmar)	Petrobras (Brazil)	Sonahydroc (Dem. Rep. of Congo)
CNPC (China)	Naftogaz (Ukraine)	PetroChina (China)	Sonangol (Angola)
CUPET (Cuba)	NAMCOR (Namibia)	Petroci (Cote d'Ivoire)	Sonatrach (Algeria)
Ecopetrol (Colombia)	National Oil Kenya (Kenya)	Petronas (Malaysia)	Staatsolie (Suriname)
EGPC (Egypt)	Nilepet (South Sudan)	PetroSA (South Africa)	Sudapet (Sudan)
ENH (Mozambique)	NIOC (Iran)	PetroVietnam (Vietnam)	TPDC (Tanzania)
ENOC (UAE)	NNPC (Nigeria)	PNOC (Philippines)	Turkmengaz (Turkmenistan)
Equinor (Norway)	NOC Libya (Libya)	PTT (Thailand)	UNOC (Uganda)
ETAP (Tunisia)	ONGC (India)	QatarEnergy (Qatar)	YOGC (Yemen)
Gabon Oil Company (Gabon)	OQ (Oman)	Rosneft (Russia)	YPF (Argentina)
Gazprom (Russia)	PDVSA (Venezuela)	Saudi Aramco (Saudi Arabia)	
GEPetrol (Equatorial Guinea)	Pemex (Mexico)	Sinopec (China)	

Areas for further research

There are three main areas in which further research could strengthen our calculations. Here we outline the issues and discuss how improving the calculations in each of these areas might change our results.

Gas prices

In order to simplify the scope of our modeling, we assume that there are no differences in the way gas and oil prices change in each of the IEA scenarios. However, we know that investment in gas fields is significant for some NOCs. However, we do calculate risk exposure by using the gas prices reported directly by the IEA, which reports prices for the United States (Henry Hub), Europe, China and Japan.

Taking a straight average of these (with the exception of the Henry Hub price, given that the United States does not import much gas), the prices for each scenario in 2030 are: STEPS, $9.7 per million British thermal units (mBtu); APS, $8.5/mBtu and NZE, $5.3/mBtu.

We apply these prices to all gas and gas-condensate fields, but not to gas associated with oilfields. Based on this set of gas prices, the overall effect is to reduce some countries' risk exposure. However, considering just the proportion of NOCs' portfolios exposed in the APS, only 14 out of 53 countries are affected. Algeria, Angola and Argentina are impacted the most, each seeing at least a 10 percent fall in exposure.

Timing

One factor that would change projects' risk exposure is the timing of their cash flows. It is possible to obtain year-by-year data on projects' expected cash flows, but we did not construct a model that takes these explicitly into account. However, the estimated break-even price does this implicitly. This is the price that should be maintained across the entire life of a project for that project to break even. A project with a 10-year life span requires the price to be maintained for those 10 years.

Our calculations lack recognition of the advantage gained by projects with early end dates, if prices decline over time. If an NOC invests predominantly in such projects, its risk exposure should reduce. However, we do not think this improvement would radically reduce our estimates of NOC risk exposure. Seventy-four percent of the projects in our data end after 2040—the end point of the period we analyzed. The median year is 2051.

Carbon risk

A final area for improvement is to include the impact of carbon pricing policies which affect carbon taxes and emission trading schemes. The impact of such policies is one aspect of transition risk, but due to a lack of available project-level data, we did not include it in the analysis.

Although the current effect of carbon pricing policies on NOCs is relatively small, it is growing. There are three factors to consider:

1. Geographical coverage

Carbon pricing policies currently cover 23 percent of global emissions, up from only 7 percent a decade ago.[69] Government revenues from these policies totaled $100 billion in 2022, so there is an increasing incentive to maintain these policies.

2. Price

Despite this overall coverage, only five percent of emissions are covered by a direct carbon price at or above the level required to reduce emissions sufficiently to meet the Paris Agreement target.

Few affect major oil and gas producing areas at a rate above US$20 per ton, although this may eventually change given announcements in Canada, the United States and Norway.[70]

3. Carbon and methane intensities

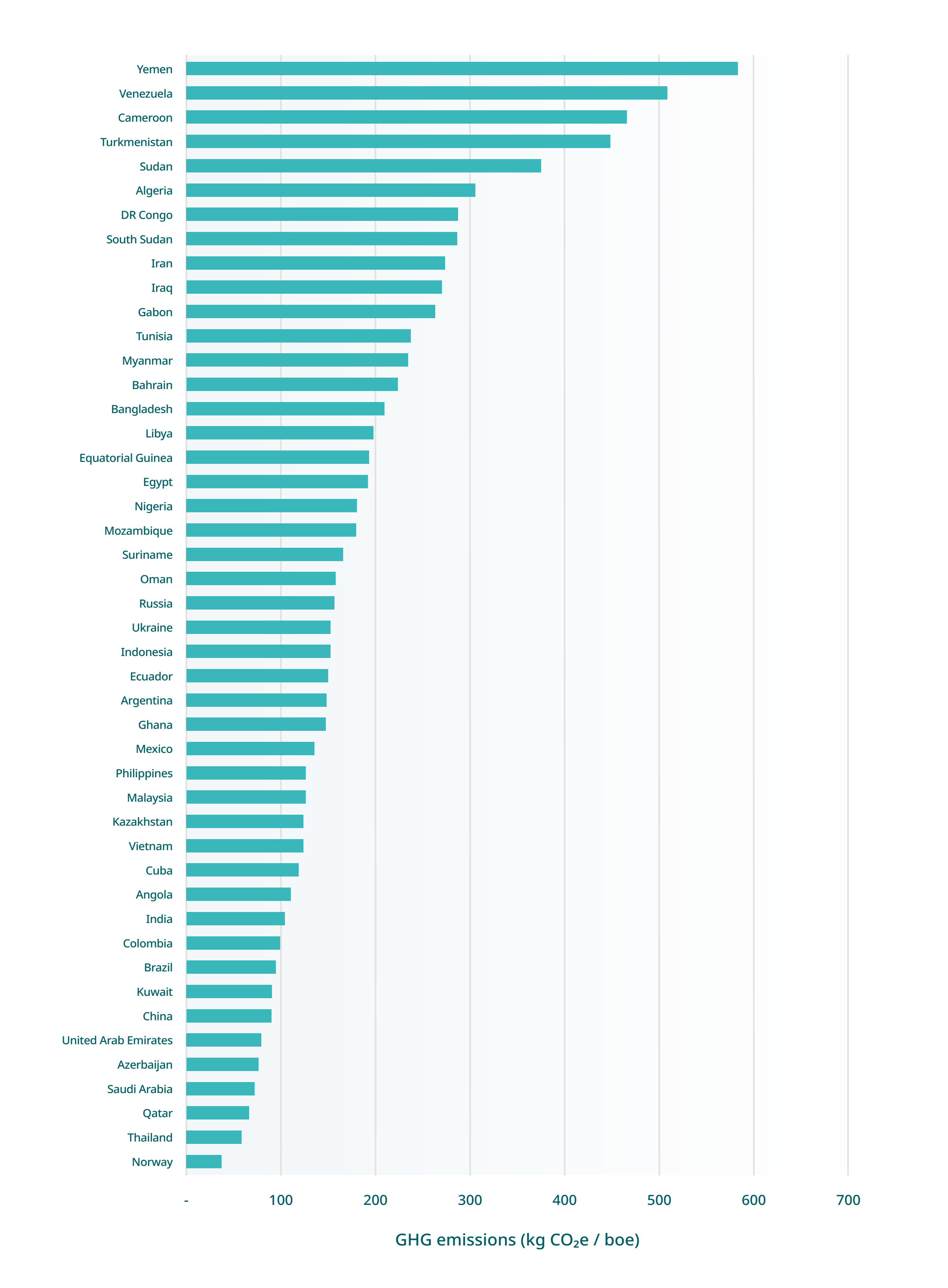
The projects included in our analysis have a wide range of carbon and methane intensities, so including the impact of a carbon price could significantly change the relative exposure of NOCs.

For example, the Global Registry of Fossil Fuels provides carbon and methane emissions for oil and gas across the whole supply chain (production, refining and end-use), aggregated at country level.[71]

Total emissions per barrel of oil from the top quartile of countries are over 60 percent higher than oil from countries in the bottom quartile.[72] The equivalent figure for gas is over 90 percent. Figure 12 shows the wide range of methane intensities across countries for oil production.

69 World Bank, *State and Trends of Carbon Pricing 2023* (2023).
70 Wood Mackenzie, *Carbon pricing plans 'could transform upstream oil and gas economics'* (2021).
71 Global Registry of Fossil Fuels, accessed 23 October 2023.
72 William Davis and Amir Shafaie, *Why Resource-Rich Countries Should Cut Emissions from Extractive Operations* (Natural Resource Governance Institute, 2023).

Figure 12. Estimated emissions from oil supply chains, kilogram of CO_2 equivalent per barrel of oil.[73]



73 Global Registry of Fossil Fuels, accessed 23 October 2023.

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