

Risky Bet

National Oil Companies in the Energy Transition

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Key messages

- If national oil companies follow their current course, they will invest more than \$400 billion in costly oil and gas projects that will only break even if humanity exceeds its emissions targets and allows the global temperature to rise more than 2°C.
- Either the world does what's necessary to limit global warming, or national oil companies can profit from these investments. Both are not possible.
- State oil companies' investments could pay off, or they could pave the way for economic crises across the emerging and developing world, and necessitate future bailouts that cost the public. Some oil-dependent governments in Africa, Latin America and Eurasia are making particularly risky bets with public money.
- Many national oil companies have incentives to continue spending big on new oil and gas projects. As a result, company officials might not, on their own, change course to account for the energy transition away from fossil fuels toward green energy, nor make investment decisions that serve the interests of citizens.
- Governments—through finance and planning ministries, presidential offices and public accountability bodies—must act to promote a more sustainable economic path. Governments should:
 - Understand the extent of national oil companies' exposure to a decline in oil and gas prices
 - Revisit rules on cash flows into and out of state-owned companies
 - Require or incentivize lower-risk investment decisions
 - Benchmark and measure national oil company performance, improve corporate governance, and report consistently to citizens

Introduction

The global energy transition—from using predominantly fossil fuels to cleaner energy—will have a profound effect on the global economy. It will limit how much greenhouse gases humanity emits and hopefully avoid catastrophic global warming. This transition will, however, also have a profound effect on government-owned national oil companies (NOCs).

NOCs are important actors in the oil and gas markets. They produce half of the world’s oil and gas, and invest 40 percent of the capital in the oil and gas industry. They are also important for millions of people. Many of them are based in countries with serious development challenges—280 million people live below the poverty line in countries with NOCs.¹

NOCs take various forms, ranging from major global players such as Saudi Aramco that develop and operate international projects themselves, to tiny NOCs that manage small equity stakes or regulate their own country’s oil sector.

All NOCs manage public money. This money comes from two main sources: the sale of the state’s oil and gas (which constitute the vast majority of revenues for most NOCs), and transfers from the treasury or other public accounts to the NOC (which is particularly important for some new and small NOCs). In this report, we focus on NOCs’ investment of public money in the oil and gas industry, whether as state equity in partnerships with other companies or in projects that the NOCs lead themselves.

NOCs are closely tied to the economic fate of their countries. In at least 25 countries, the revenue collected by the NOC is equivalent to more than 20 percent of total government revenue.² Yet, the NOC spends most of this money. The median NOC for which data was available transferred only about one in four dollars it collected to the government in 2018, reinvesting the rest back into its own activities.³

NOCs are the principal vehicle that many governments use to invest in the oil industry. Governments reason that taking a commercial role in the industry, through the NOC, enables the country to capture a larger share of the available profits, develop valuable skills and over time increase the control that the country exerts over its oil and gas. However, these investments carry considerable risk.

This paper looks at how the energy transition makes these investments riskier for NOCs and their governments. Global fossil fuel divestment campaigns have focused on international oil companies (IOCs). Some of these companies have published plans to rebalance their activities away from oil extraction. But there has been relatively little attention paid to NOCs, and few NOCs have published detailed plans to navigate the energy transition.

This lack of attention matters. Countries with NOCs must adapt to a changing global energy system to develop their economies and maintain stability. Failing to adapt to the unpredictable shift away from fossil fuels could bring economic trouble for both these countries and the global financiers who invest in them.⁴

1 World Bank, “Poverty headcount ratio at \$1.90 a day (2011 PPP) (% of population),” *World Development Indicators*, last updated Oct 2020, data.worldbank.org/topic/poverty. We took the average poverty rate from 2014 to 2018 and multiplied by the population estimate for 2019. We chose \$1.90 a day income as the poverty definition.

2 Patrick R. P. Heller and David Mihalyi. *Massive and Misunderstood: Data-Driven Insights into National Oil Companies* (Natural Resource Governance Institute, 2019), 19-21, resourcegovernance.org/analysis-tools/publications/massive-and-misunderstood-data-driven-insights-national-oil-companies.

3 Natural Resource Governance Institute, *National Oil Company Database*, May 2020. In 2018, the median NOC in the sample transferred 22 percent of its gross revenues to government (via taxes, dividends and other fiscal mechanisms). Of the 36 NOCs in the sample with available data, 20 of them transferred less than 25 percent of their gross revenues to government.

4 For in-depth discussion of the potential consequences of energy transition on fossil fuel producers, see Sian Bradley, Glada Lahn and Steve Pye, *Carbon Risk and Resilience: How Energy Transition is Changing the Prospects for Developing Countries with Fossil Fuels* (Chatham House, 2018), www.chathamhouse.org/sites/default/files/publications/research/2018-07-12-carbon-risk-resilience-bradley-lahn-pye-final.pdf; Glada Lahn and Sian Bradley, *Left Stranded? Extractives-Led Growth in a Carbon-Constrained World* (Chatham House, 2016), www.chathamhouse.org/sites/default/files/publications/research/2016-06-17-left-stranded-extractives-bradley-lahn-final.pdf.

Tremendous uncertainty surrounds the pace of energy transition, and we do not seek to predict the future. Rather, we aim to offer a warning to governments and NOCs as they consider their future investment plans. This report:

- Explains that the energy transition shortens the odds on the bets that NOCs make
- Illuminates the risk these bets present given the energy transition
- Examines which categories of oil-producing economies and governments can afford to take on financial risk and which cannot
- Argues that some NOCs' interests may not align with the long-term interests of their public
- Recommends policies to ensure that governments and NOCs exercise stronger scrutiny on the investments that they are making—both in the oil and gas business and outside it—and reduce investments that put their economies at risk

Box 1. Notes on the research approach

We analyze both oil and gas production together, which is a significant simplification. The energy transition will affect oil and gas in quite different ways, although it presents a risk to both fuels. However, we think that our assumption provides a rough indication of the potential impact of a decline for both oil and gas markets. Future research could examine the difference further. For gas production, this has meant converting gas unit into barrels of oil equivalent.⁵ When assuming a particular oil price, we are assuming a corresponding gas price. We show the costs of gas production in terms of barrels of oil equivalent.

In this report, we also rely heavily on information from the Rystad Energy UCube database, principally to understand in what projects NOCs might invest, and the production volume, costs and other cash flows. Rystad Energy uses a mix of information reported by companies and modeling, based on these reports and other information. Company reports themselves are, by their prospective nature, forecasts. As such, while oil and gas analysts widely use the data, it will be inaccurate to some extent. We do not believe there is a significant upward or downward bias at the global level, but numbers for some projects and perhaps for particular NOCs may differ from estimates by other data providers. Again, future research and funding to purchase additional datasets could provide a more comprehensive picture.

In particular, we rely heavily on Rystad Energy's scenario forecasts, which Rystad regularly adjusts based on new information. For example, since January 2018, its base case total capital expenditure forecast for 2025 has fallen by 38 percent. This forecast has shifted even over the time it took to write this report. Our results therefore show a snapshot in time given the current information available.

However, while analysis that is more detailed, using more data, could further enrich our results, the need for the warning we make for NOCs and their governments is clear.

5 Rystad Energy converts a Brent oil price to gas price based on the specific gas market. For example, the gas price in the East Asia LNG spot market is converted in the following way: Gas price (in mmBtu) = (Brent oil price per barrel / 7) * 0.976. Our main oil price of \$40 per barrel therefore roughly converts to \$5.6 per mmBtu. Rystad Energy, *UCube Technical Handbook* (2016), 39-40. Another useful conversion is: one thousand British thermal units of natural gas contains about the same energy as 0.172 barrels of crude oil. BP, *Approximate conversion factors*, www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2019-approximate-conversion-factors.pdf.

1. The energy transition makes investments riskier

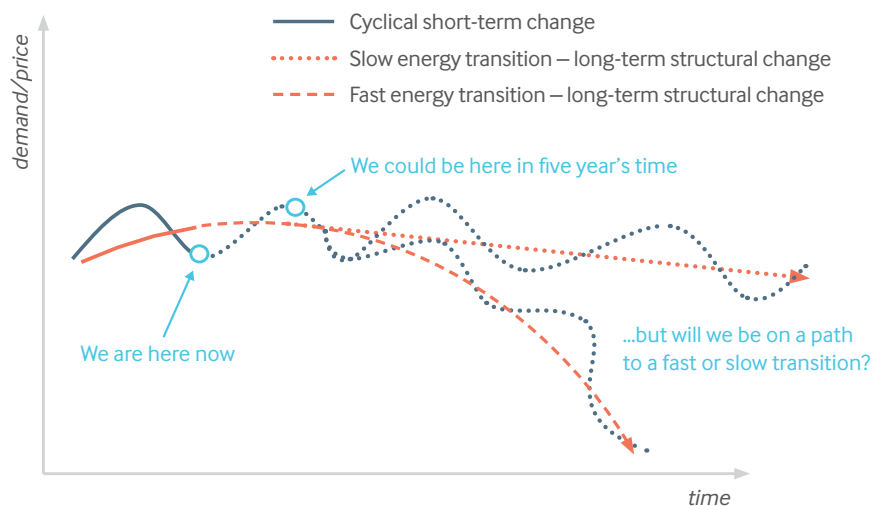
Over the next few decades, the energy transition is likely to result in a structural decline in the oil market. Declining demand averaged out over the long-term. However, prices will likely remain volatile and cyclical, even if the structural decline forces prices to cycle at ever lower values. As is illustrated in Figure 1, prices could rise in the next few years, but this rise could be consistent with both a slow or sharp decline in the oil and gas markets over the long term. This cyclical rise in prices will likely prompt a fresh wave of investment, which could perform well if the long-term transition is slow, but fail if the transition is fast.

Since 2014, the last pre-pandemic decline in the oil price, capital expenditure has been low. As the world recovers from the coronavirus pandemic, global oil and gas supply may not be sufficient to meet the rising demand without prices rising too.

Companies will then have to decide how much to invest in extracting more resources.

Oil and gas projects started in the next decade in countries with NOCs will operate for an average of 31 years, and many will operate past the 2050s.⁶ That is the point at which the governments of the world's largest economies have pledged or proposed to be carbon-neutral.⁷ Much of the value of these projects will come from early in their operation because of both the typical production profile of an oil well and the effect of discounting future values. However, a structural decline in the oil price will still be a worry for any company with projects operating long into the future. It is this possibility—that NOCs invest in projects expecting high prices, but are disappointed as prices structurally decline—that we examine in the rest of the report.

Figure 1. Illustration of structural and cyclical changes in oil demand (not to scale)



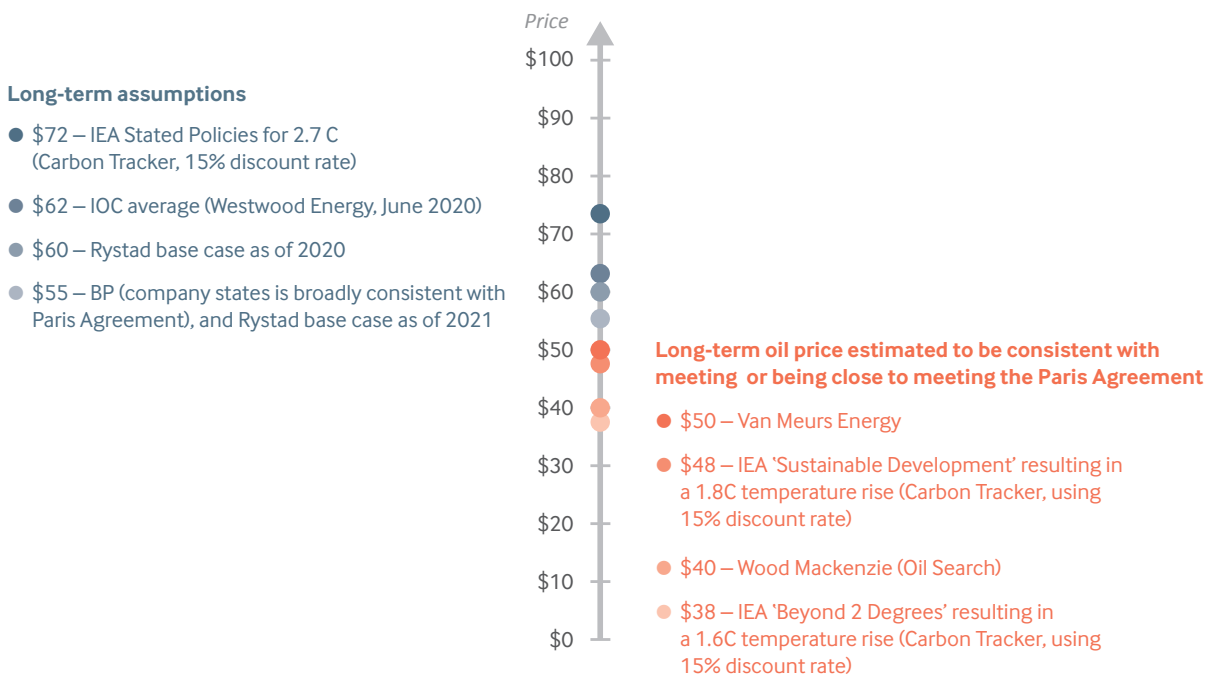
⁶ Authors' calculations using Rystad Energy UCube.

⁷ For example, China, Japan, South Korea, France, Germany, the U.K. and the EU have all pledged or signed into law carbon neutrality targets for years between 2030 and 2060. Presidential Candidate Joe Biden has pledged to make the US carbon neutral by 2050. See Akshat Rathi, "These countries have committed to a net-zero emissions goal – could it solve the climate crisis?" *World Economic Forum*, 5 July 2019, www.weforum.org/agenda/2019/07/the-growing-list-of-countries-committing-to-a-net-zero-emissions-goal; Matt McGrath, "Climate change: China aims for 'carbon neutrality by 2060,'" *BBC News*, 22 September 2020, www.bbc.co.uk/news/science-environment-54256826; Economist, "Japan promises to be carbon-neutral by 2050," 29 October 2020, www.economist.com/asia/2020/10/29/japan-promises-to-be-carbon-neutral-by-2050; Joe Biden, "The Biden plan for a clean energy revolution and environmental justice," joebiden.com/climate-plan.

How demand for oil and gas declines over the next few decades, and how the Organization of the Petroleum Exporting Countries (OPEC), Russia and other major suppliers reacts are far from certain. Oil companies will have to make assumptions about the long-term prices of oil and gas when deciding on their investments. Our report investigates the consequences of these assumptions and decisions, and the discrepancy between what companies expect and what the energy transition might deliver.

Figure 2 illustrates this discrepancy. The set of prices on the left in blue show analysts' and companies' long-term assumptions. Except for BP's, these are unlikely consistent with meeting the Paris Agreement. However, depending on the nature of each oil and gas project and the company, these long-term assumptions will drive investment decisions. Conversely, the prices on the right in orange show a range of oil price estimates that some analysts believe are broadly consistent with achieving the Paris Agreement goal.⁸

Figure 2. Oil price assumptions (real, 2020 prices)⁹



8 However, both the IEA's scenarios require the global adoption of carbon, capture and storage technologies that, so far, are unproved and risky in terms of keeping stored carbon out of the atmosphere. Without these technologies, the oil industry has already developed and sanctioned too much oil production to meet the 1.5 degree goal. See Greg Muttitt, *Off Track: How the International Energy Agency Guides Energy Decisions Towards Fossil Fuel Dependence and Climate Change*, (Oil Change International and Institute for Energy Economics and Financial Analysis, 2018), priceofoil.org/content/uploads/2018/04/Off-Track-IEA-climate-change1.pdf.

9 The definition of long-term, and the methods for estimating the price consistent with meeting the Paris Agreement vary across organizations. Therefore, this diagram is only illustrative of the difference in prices between different possible futures. Price assumptions from BP and most other oil companies are for 2020 to 2050. Sources: Carbon Tracker, *Breaking the Habit: Methodology* (2019) 5, carbontracker.org/reports/breaking-the-habit; Pedro van Meurs, *World Petroleum Industry Perspectives* (2020), 14, app.vanmeursenergy.com/documents/free/80001008.pdf; and Westwood Energy, from Keith Myers, email, 21 September 2020.

By assuming lower long-term oil prices, some international oil companies announced that they have written down the value of their assets, or will do so in the future.

The following price quotes are all in real, 2020 prices (i.e., adjusted for future inflation).

Amid the coronavirus pandemic, a number of IOCs have published their assumptions for a long-term oil price.¹⁰ For most companies, this means the average price between 2021 and 2050. A study by Westwood Energy found an average long-term price assumption of \$62, though some IOCs, notably several U.S.-based companies, were not included in the study.¹¹ ExxonMobil recently revised its 2026 to 2027 price forecast from \$72 to \$60.¹² Since Westwood Energy's survey, some companies have revised down their long-term price assumption, although the low \$60s appears to remain consistent with a rough average of available company assumptions.

BP, Total and Shell have published long-term assumptions of \$55, 56 and 60 respectively.¹³ These forecasts were lower than previous forecasts issued by the same companies. The companies cited the coronavirus pandemic's effects on global transport, which may bring forward the energy transition. In June 2020, BP

stated that its assumed price is \$55, a price it said was "broadly in line with a range of transition paths consistent with the Paris climate goals."¹⁴

By assuming lower long-term oil prices, some of the IOCs announced that they have or will be writing down the value of their assets. BP announced it would write down assets by \$13.5 to 17.5 billion.¹⁵ Shell's write-down was \$15 to 22 billion.¹⁶ ENI's was around EUR 3.5 billion.¹⁷

Only some NOCs have published their forecasts. As of October 2020, Equinor assumes a long-term price of \$64, down from \$80, writing off \$2.9 billion in the value of its assets in the process.¹⁸ Russian NOCs may be assuming an oil price below \$60.¹⁹ Others have published price forecasts only covering the upcoming year.²⁰ Two Reuters reports suggest that Saudi Aramco is targeting a long-term price of over \$60 or even \$70.²¹

Saudi Aramco is also positioning itself to be the "last one standing" in the oil market by buying assets as other companies divest.²² Although Saudi

10 Keith Myers, "BP highlights diverging views on the future of oil and gas, Westwood Global says," *Energy Voice*, 16 June 2020, www.energyvoice.com/opinion/246179/bp-highlights-diverging-views-on-the-future-of-oil-and-gas-westwood-global-says/.

11 Westwood Energy, from Keith Myers, email, 21 September 2020.

12 Christopher M. Matthews, "Exxon Documents Reveal More Pessimistic Outlook for Oil Prices," *The Wall Street Journal*, 25 November 2020, www.wsj.com/articles/exxon-documents-reveal-more-pessimistic-outlook-for-oil-prices-11606307763.

13 In their 2019 annual report, BP assumed that \$50 a barrel is the long-term oil price that they deemed broadly consistent with achieving the Paris Agreement. BP, "Energy with Purpose: BP Annual report and Form 20-F 2019," www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/investors/bp-annual-report-and-form-20f-2019.pdf.

14 BP, "Progressing strategy development, bp revises long-term price assumptions, reviews intangible assets and, as a result, expects non-cash impairments and write-offs," 15 June 2020, www.bp.com/en/global/corporate/news-and-insights/press-releases/bp-revises-long-term-price-assumptions.html.

15 *Ibid.*

16 Shell, "Shell Second Quarter 2020 Update Note," 30 June 2020, www.shell.com/media/news-and-media-releases/2020/shell-second-quarter-2020-update-note.html.

17 Eni, "Board of Directors Communication: Eni remains committed to its decarbonization strategy, revises long-term price assumptions, having assessed the disruptions in the trading environment due to COVID-19," 6 July 2020, www.eni.com/en-IT/media/press-release/2020/07/eni-remains-committed-to-its-decarbonization-strategy-revises-long-term-prices-assumptions.html.

18 Nerijus Adomaitis and Nora Buli, "Oil and gas group Equinor takes \$2.9 billion hit in asset write-offs," Reuters, 29 October 2020, www.reuters.com/article/us-equinor-results/oil-and-gas-group-equinor-takes-2-9-billion-hit-in-asset-write-offs-idINKBN27E0MU; and Nerijus Adomaitis, "Equinor beat earnings forecasts and refinery and trading shine," Reuters, 24 July 2020, uk.reuters.com/article/uk-equinor-results/equinor-beats-earnings-forecasts-as-refinery-and-trading-shines-idUKKCN24POEI.

19 John Kemp, "Column: Oil prices likely to average less than \$60 over next cycle – Kemp," Reuters, 17 June 2020, www.reuters.com/article/us-global-oil-kemp/column-oil-prices-likely-to-average-less-than-60-over-next-cycle-kemp-idUSKBN23028E.

20 E.g., Pemex for 2021. Amy Stillman and Max de Haldevang, "Mexico Is Cutting Pemex's Oil Output Forecast in Latest Setback," Bloomberg, 8 September 2020, www.bloomberg.com/news/articles/2020-09-08/mexico-is-cutting-pemex-s-oil-output-forecast-in-latest-setback.

21 Kemp, "Column: Oil prices likely to average less than \$60 over next cycle – Kemp"; Rania El Gamal, Davide Barbuscia, Marwa Rashad, "Sole survivor? Saudi Aramco doubles down on oil to outlast rivals," Reuters, 7 October 2020, www.reuters.com/article/saudi-aramco-strategy/insight-sole-survivor-saudi-arabia-doubles-down-on-oil-to-outlast-rivals-idUSL8N2GS311.

22 *The Economist*, "The message from the world's biggest and wildest IPO," 31 October 2019, www.economist.com/leaders/2019/10/31/the-message-from-the-worlds-biggest-and-wildest-ipo.

A growing number of analysts and international oil companies are assuming much lower oil prices in the longer term. Are national oil companies paying attention to these divergent opinions?

Aramco is in a better position than most to follow this strategy, other NOCs might try to do the same. NOCs may believe that as some IOCs leave the market, they can seize upon the opportunity to realize their global visions.

In addition to these estimates by oil companies, there are projections from analysts considering the oil price consistent with achieving the Paris Agreement. The International Energy Agency publishes scenarios that estimate supply and demand of oil and gas under various scenarios. The Sustainable Development Scenario estimates the emissions reductions and carbon, capture and storage deployment necessary to reduce global warming to the Paris targets. The Stated Policies Scenario tracks what would occur if governments did nothing more on climate than executing the policy commitments they have already made, exceeding the carbon budget.²³ The energy research consultancy Wood Mackenzie estimated a price of \$40 given the Sustainable Development Scenario.²⁴ Think tank Carbon Tracker used the estimated demand in the IEA's scenarios to estimate the associated long-term oil prices, finding a long-term price in the high \$40s under the Sustainable Development Scenario. Carbon Tracker estimated a price in the low \$70s for the Stated Policies

Scenario.²⁵ In addition to modeling the Sustainable Development Scenario, Carbon Tracker also found that a price in the high \$30s would result from the kinds of more dramatic shifts away from fossil fuels that would be necessarily to definitively meet the Paris goals under the International Energy Agency's Beyond 2 Degrees Scenario.²⁶

The oil and gas consultancy Van Meurs Energy also estimated that the long-term oil price will be close to \$50 a barrel (also in real, 2020 prices), irrespective of whether the world meets the Paris Agreement goal. This estimate derives from the firm's optimism about the spread of renewable energy across the world economy. Van Meurs Energy believes OPEC will not have the ability to limit production and maintain high prices, while U.S. and Canadian production will be able to come online quickly if the price rises above \$50 a barrel.²⁷

As is clear from all these estimates, the oil price could rise in the next few years, particularly following the low investments in the industry currently. But a growing number of analysts and even oil companies are assuming much lower oil prices in the longer term. Are NOCs paying attention to these divergent opinions?

23 The Sustainable Development Scenario, as articulated in the World Energy Outlook 2018, is based on the changes that would be necessary in order to reduce CO2 emissions to levels "fully in line with the objectives of the Paris Agreement" and achieve the other objectives of the UN's Sustainable Development Goals that are "most closely related to energy." International Energy Agency, *World Energy Outlook 2018*, (2018), 84 – 85, www.iea.org/reports/world-energy-outlook-2018. For both the Sustainable Development and Beyond 2 Degrees scenarios, the IEA estimate that the scenarios will result in a global temperature rise above pre-industrial average of 1.8C and 1.6C with a 66 percent probability.

24 Wood Mackenzie estimates an oil price consistent with the IEA's 450 scenario. This is around \$40 per barrel from 2022 to 2040. The 450 scenario is a predecessor of IEA's Sustainable Development scenario, but is less severe in estimating the amount of oil and gas production that would have to be cut. Oil Search, *Climate Change Resilience Report* (2017), 31, www.oilsearch.com/_data/assets/pdf_file/0005/18968/OSL-Climate-Change-Resilience-Report_FINAL.pdf. Carbon Tracker notes that the difference between its estimate of \$48 oil under the Sustainable Development Scenario and Wood Mackenzie's \$40 estimate could derive from several factors, including possibly using different discount rates. Carbon Tracker uses a 15 percent rate. Wood Mackenzie does not disclose what rate it used in its analysis, but is likely lower. Carbon Tracker, *Breaking the Habit: Why None of the Large Oil Companies Are Paris-Aligned, and What They Need to Do to Get There* (2019), 6, carbontracker.org/reports/breaking-the-habit/.

25 Carbon Tracker, *Breaking the Habit* (2019), 6, carbontracker.org/reports/breaking-the-habit/.

26 The *Beyond 2 Degrees Scenario*, as articulated in the IEA's 2017 Energy Technology Perspective, assumes an accelerated technology push with the "potential to shift the energy sector transformation beyond the already challenging 2° C Scenario," in order to achieve net-zero emissions by 2060. International Energy Agency, *Energy Technology Perspectives 2017* (2017), 19, 23, www.iea.org/reports/energy-technology-perspectives-2017. As part of its study, Carbon Tracker calculated oil prices consistent with each of the IEA scenarios across the period 2019 to 2040. Its price estimates result from its assumption that oil projects earn an internal rate of return of 15 percent. It says "the oil price that clears the market is in the upper \$30s/bbl for B2DS, upper \$40s for SDS." See Carbon Tracker, *Breaking the Habit: Methodology* (2019) 5, carbontracker.org/reports/breaking-the-habit/.

27 Pedro van Meurs, *World Petroleum Industry Perspectives* (2020), 14, app.vanmeursenergy.com/documents/free/80001008.pdf.

2. National oil companies could risk billions in public funds

If the energy transition is shortening the odds for NOCs and their state owners, how much money is at stake and which NOCs are most at risk? This matters because the public money invested in NOCs prevents governments from using it to invest more productively elsewhere in their economies.

Governments do not invest public capital in NOCs just to make money. Having control over the industry and creating jobs are two other reasons. Yet financial disappointments can serve as crucial reality checks, allowing owners of NOC—governments and the public behind these governments—to ask themselves: are the financial losses we are suffering worth the benefits we are receiving from the NOC acting in these non-commercial roles?

According to Rystad Energy, on average the largest NOCs and IOCs both have a total cost per barrel, (or barrel of oil equivalent for gas) excluding financing costs of \$15.²⁸ However, there is a wide spread among all these companies. On average, Middle Eastern NOCs have the lowest costs. Some NOCs have particularly high costs even compared with IOCs, specifically Colombia’s Ecopetrol, Venezuela’s PDVSA, China’s Sinopec, Brazil’s Petrobras, Mexico’s Pemex, China’s CNOOC and Nigeria’s NNPC.²⁹

The higher the costs of NOCs’ oil and gas projects and the later that they start operating, the more at-risk NOCs will be to a structural decline in prices. Some of these projects may therefore return little for NOCs and their governments—perhaps much less than governments would have made investing in other sectors of their economies.

2.1 FUTURE NATIONAL OIL COMPANY PERFORMANCE

Over the next decade, NOCs could invest more than \$400 billion (in 2021 prices) in oil and gas projects that will only break even if the world exceeds the global carbon budget.³⁰ Most of this—more than \$365 billion—is from developing and emerging economies, of which more than \$80 billion is from low and low-middle income countries that receive international aid. This “Paris-incompatible” spending represents 22 percent of the total \$1.9 trillion of capital expenditure that NOCs are projected to spend through to 2030.³¹ Over this period Rystad projects that the entire oil and gas industry will spend \$4.6 trillion in capital expenditures.

NOCs may end up spending this amount on high cost projects that could fail to make a substantial return. A key concept in our analysis is the idea of opportunity costs. If NOC investments return too little, their government owners might have been able to earn more by investing their money elsewhere, particularly where government spending generates not just financial returns but jobs and other benefits. NOC investments in high cost projects therefore may have high opportunity costs for their countries. By investing in these risky projects, their governments and their public will have lost the opportunities to invest in areas of the economy that could generate jobs, economic growth and development.

28 We took data from Rystad Energy’s UCube, a database of upstream oil and gas projects. We selected all the NOCs identified in NRG’s NOC database, of which 30 had a production rate above 10,000 barrels a day and matched with the UCube list of companies.

29 Some of these NOCs – namely Ecopetrol, Venezuela, Pemex and NNPC – have exploration and production portfolios concentrated exclusively or overwhelmingly within their home countries. Others – Sinopec, Petrobras and CNOOC – engage in operations both within and outside their home markets.

30 We deflated capital expensed over the decade to 2021 prices, assuming a 2.5 percent rate of inflation.

31 Calculated as the value of capital expenditure on projects with a break-even price higher than \$40 a barrel, divided by the total capital expenditure forecasted in Rystad Energy’s base case on projects with a breakeven price below \$70 a barrel. This does not account for timing of production, which future research could improve upon.

To find the amount that NOCs could be risking, we looked at how much capital NOCs might invest in high cost projects, those projects that would generate poor returns if the long-term price of oil were low enough for the world to keep within the global carbon budget. While such a scenario is far from certain—and may not be highly probable—it is sufficiently possible that NOC executives and government officials ought to consider it carefully.

An oil and gas project breaks even if it returns enough income to pay back the costs of the project, the taxes and other payments to government, plus a minimum profit sufficient to justify the investment made in the project. There is no universal number for the minimum return investors hope to make, but we assumed an internal rate of return of 10 percent per year (in nominal terms) of the capital invested. See Box 2 for our reasoning.

A project's post-tax break-even price is therefore the average oil price that would be necessary over the life of the project if a project is to recover the investment costs plus a 10 percent return on the capital invested.³² See the “Effect of taxes” section on page 27 for our reasoning on including taxes in this calculation.

Box 2. Hurdle rates for NOC investments

Following Rystad Energy's default assumption, we use a hurdle rate of 10 percent for all projects as the target internal rate of return. We assume companies develop projects that they forecast will yield a return above this number. Companies do not develop projects they expect will yield a return below the hurdle rate. This rate is close to the rates used by investors in upstream oil and gas. For example, a Wood Mackenzie survey in 2018 showed that investors use hurdle rates between 12.7 percent (for liquefied natural gas projects) to 14.8 percent (for exploration).³³ Another way to estimate the hurdle rate is a company's cost of capital. Aswath Damodaran, of New York University, estimates oil and gas companies' cost of capital for global upstream exploration and production to be 8.6 percent, in real terms.³⁴

NOCs however get most of their capital from their governments. This could mean that the hurdle rate for NOCs should differ to the hurdle rate for IOCs. Some NOCs might have much lower costs of capital if they receive government financing, though this will depend on the country. The mean sovereign debt yield for the sample of countries with an NOC was 9 percent as of June 2020 (the median was 6 percent).³⁵ There is a wide range: while Norwegian sovereign debt yields only 1 percent, Venezuelan debt yields 43 percent.

While some NOCs might therefore access capital at a rate less than 10 percent, we believe that using Rystad Energy's 10 percent baseline is reasonable. First, because most NOCs partner with IOCs to develop projects and IOCs are more likely to use a rate closer to 10 percent to make investment decisions.³⁶ Second, because lending to a sovereign government with a relatively diversified revenue stream is less risky than a government investing in an oil company or an NOC to investing in individual projects. Some risk premium is therefore necessary.

32 For gas projects, Rystad calculates the oil price for the equivalent barrels of oil of the gas.

33 Based on conversations with Wood Mackenzie, we understand that these are in nominal terms. Wood Mackenzie, 'State of the Upstream industry' survey (2018), www.woodmac.com/our-expertise/focus/upstream/emearc-state-of-the-upstream-industry-upstream-online.

34 Damodaran Online, *Costs of Capital by Industry Sector, 5. Global*, accessed 4 June 2020, people.stern.nyu.edu/adamodar/New_Home_Page/datacurrent.html.

35 World Government Bonds, *10Y Bond Yield*, accessed 4 June 2020, www.worldgovernmentbonds.com.

36 In almost two-thirds of cases, they are likely to take a majority share, but will seek IOCs minority partners. In almost a third of the cases, they are likely to take minority stakes and will require IOCs to contribute most of the capital to develop the projects. Authors' calculations using Rystad Energy UCube.

We used the global UCube database from Rystad Energy to examine all upstream oil and gas projects that Rystad Energy analysts expect IOCs and NOCs to operate in next ten years, up until 2030.³⁷ Rystad analysts take currently operating projects and the anticipated new projects, calculate their post-tax break-even price, and compare that with their base case demand and price scenario. This scenario assumes the nominal price of oil will be \$62 in 2025, and \$70 in 2030.³⁸ Rystad Energy assumes that companies will develop only those projects with a break-even price below these prices.³⁹ We make two further simplifying assumptions that future studies could investigate. First, historically, the costs of developing and extracting oil have risen and fallen with the oil price.⁴⁰ If the oil price declines over the long-term, the oil industry is likely to find ways of becoming more efficient and their costs will fall. This will mean that break-even prices for projects will fall too. However, this in turn will affect global prices. Second, we model oil and gas production together, accounting for gas projects with a break-even price measured in USD per barrel of oil equivalent. We assume that future changes to the oil price are mirrored in gas prices. It is unclear whether gas has a better future than oil. Separating oil and gas would lead to a more accurate result.

Each NOC has a set of projects, with a range of break-even prices, that companies could develop. Figure 3 shows this range, which is not weighted by the respective production or capital expenditure of each project. However, we have provided the mean break-even price, which is weighted by each project's share of capital expenditure to the total capital expenditure of each NOC. For gas projects, Rystad Energy converts production to equivalent barrels of oil.

The weighted mean break-even price for this next generation of projects is less than \$40 for most NOCs. However, this is not the case for all companies, and many NOCs are planning a significant number of upcoming projects that exceed this threshold. For example, much of the next generation of investments for Kazakhstan's KazMunayGaz and Saudi Arabia's Saudi Aramco are likely to break even, after taxes, with prices well below \$40. But for Suriname's Staatsolie, Colombia's Ecopetrol, Venezuela's PDVSA and Indonesia's Pertamina, among others, future investment decisions will be more difficult. Outliers also matter, as Box 3 shows.

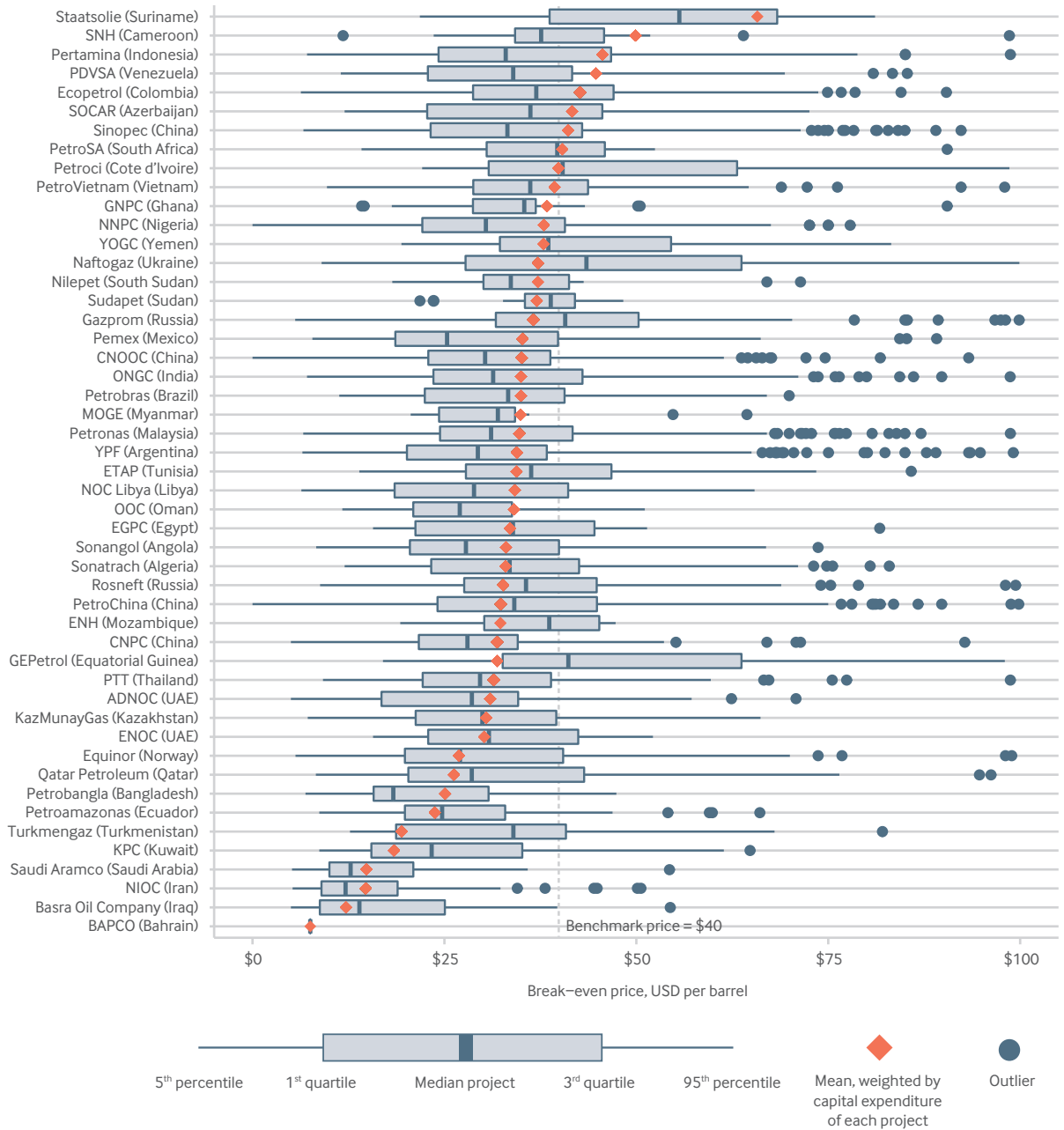
37 We included all capital expenditure on projects with NOC participation. This included both greenfield projects forecasted to start operating in this decade, and brownfield developments on currently operating projects. We took all NOCs in the UCube database that match those in NRG's NOC database. There are some other companies labelled as NOCs in UCube not included in the NOC database, but the total capital expenditure from these companies is relatively small.

38 Rystad Energy assumes an inflation rate of 2.5 percent.

39 This assumption is subject to other assumptions about companies' portfolios of projects, and the scheduling of projects to fit the assumed demand profile.

40 Gerhard Toews and Alexander Naumov, "The Relationship Between Oil Price and Costs in the Oil and Gas Industry," *The Energy Journal* 36, Special Issue 1 (2015): 237-254, www.jstor.org/stable/26606219.

Figure 3. Range of post-tax break-even prices of the next generation of NOC investment⁴¹



41 Authors' calculation using Rystad Energy UCube. Includes those projects that in the Rystad Energy base case scenario, the NOC invests capital over the period 2021 to 2030. Mean is weighted by the proportion of capital expenditure of each project as a proportion of the total capital expenditure for the NOC, measured over the period 2021 to 2030.

Box 3. Cameroon's SNH bets on upcoming oil and gas projects

According to Rystad Energy, the National Hydrocarbons Corporation of Cameroon (SNH), Cameroon's NOC, is planning three new projects—Logbaba, Erong and Isongo—that involve the company contributing capital up until 2030. The first two projects have estimated break-even prices just below \$40. However Isongo, due to start in 2024, is estimated to break even only if the long-term oil price is over \$63 a barrel. SNH is estimated to invest almost \$140 million dollars in this project, which could fail to break even if oil and gas consumption falls to a level consistent with meeting the global carbon budget. Isongo is an outlier in Figure 3, but it is important because of the amount of capital SNH might invest in the project. It is the highest-cost project in which SNH is likely to invest, which poses a substantial risk given that this project alone represents 30 percent of the total \$440 million the company will likely invest over this decade.

Figure 4 shows the total value of capital that NOCs might invest in upstream projects: just over \$1.9 trillion over ten years, in 2021 prices.⁴² About \$1.2 trillion of this spending is in projects with some previous operations, or that have been sanctioned and are already being developed. We separated the capital expenditure by several price ranges at which the underlying projects break even.

These ranges illustrate how the NOCs stand to lose depending on their assumptions and eventual prices. In the first scenario, NOCs take an optimistic long-term view of future oil prices and invest in projects with break-even prices up to \$70 per

barrel. This closely aligns with Carbon Tracker's estimated price consistent with the IEA's Stated Policies Scenario, which might result in a 2.7°C rise in temperatures. However, in this scenario, the global economy transitions fast enough to enable countries to collectively meet the Paris Agreement and keep within the global carbon budget – resulting in an average long-term price of \$40, in line with Wood Mackenzie's estimate shown in Figure 2. In this case, the financial result for NOCs is catastrophic. In this scenario, NOCs invest \$414 billion in projects that fail to break even.⁴³ We use this as our central scenario for the analysis illustrated in Figures 5 and 6 and Table 5, below.

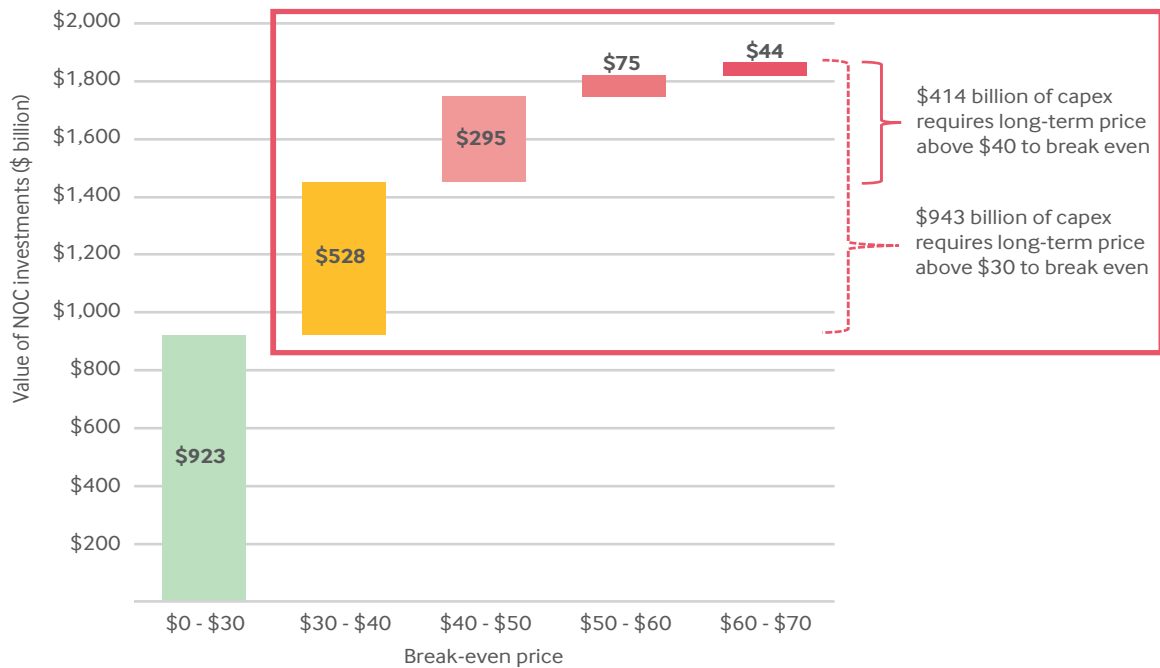
In the second scenario, NOCs invest based on an assumption of a \$60 long-term price. This is in line with the average forecast of IOCs in Westwood Energy's sample, and Rystad Energy's previous (2020) long-term price forecast in its base case scenario. If the actual long-term price ends up at \$40, \$370 billion worth of NOC capital investment in projects fails to break even.

This seems to be a likely scenario for many NOCs. IOCs contribute a large portion of the capital in projects that NOCs participate in, though there is significant variation across NOCs on this front. NOCs in poorer countries – mainly in Africa and Southeast Asia— often serve as non-operating, minority partners in ventures with IOCs. In many richer countries and among the biggest global oil producers, NOCs take majority (or exclusive) stake in most of the projects in the country. See Box 4 for details.

42 Other studies serve as rough comparisons. Carbon Tracker estimated in 2019 that the global oil and gas industry—including both IOCs and NOCs—might invest \$6.5 trillion from 2019 to 2030, given the IEA's New Policies Scenario, which Carbon Tracker estimated is roughly consistent with a long-term oil price in the low \$70s. This does not include projects that, in 2019, were already sanctioned and under development. See Carbon Tracker, *Breaking the Habit*, 16. Using the same database—Rystad Energy UCube—Global Witness estimate that the oil and gas industry might invest \$4.9 trillion between 2020 and 2030. Global Witness estimate that \$3.3 trillion of this amount will be invested in oil projects, of which only 18 percent is compatible with limiting warming to 1.5C. See Global Witness, *Overexposed: How the IPCC's 1.5C report demonstrates the risks of overinvestment in oil and gas* (2019), www.globalwitness.org/en/campaigns/oil-gas-and-mining/overexposed/.

43 This figure could grow even larger if IOCs shy away from investing in high cost projects and NOCs step in to fill the gap themselves. We consider the reasons why this could occur in section 4.

Figure 4. Value of NOC capital expenditure disaggregated by break-even price range⁴⁴



In the third scenario, NOCs invest more conservatively, only investing in projects with a break-even price below \$50. In this scenario, NOCs would invest \$295 billion in projects that would not break even if the actual long-term price was \$40.

So far, we have used the \$40 price consistent with limiting the global temperature rise to no more than 2°C as the possible low-end outcome for our central scenarios. However, Figure 4 also shows what happens if the oil price collapses to \$30 per barrel. This scenario is worth considering for two reasons. First, long-term oil prices are highly unpredictable, and limiting the global temperature

rise to well below 2°C, and closer to 1.5°C, could require consumption reductions that would drive the oil price down closer to \$30.⁴⁵ Second, in the future costs of projects with an estimated break-even price close to \$40 could rise, or the projects could otherwise break even—but only just. NOCs and governments should still be concerned about their investments that under current assumptions are projected to break even between \$30 and \$40. If NOCs were to invest under optimistic price assumptions and prices crashed to a long-term level of \$30, up to \$943 billion in NOC investment would fail to break even.

⁴⁴ Authors' calculation using Rystad Energy UCube.

⁴⁵ Carbon Tracker estimated an oil price in the high \$30s for IEA's Beyond 2 Degrees scenario, resulting in a global temperature rise of 1.6°C. That analysis employs a 15 percent discount rate. Using a ten percent rate, as we have done in this report, suggests an oil price lower than that.

Box 4. Project collaboration between NOCs and IOCs

Some NOCs manage oil and gas projects on their own, while others partner with IOCs (or internationalized NOCs) via a range of legal and contractual mechanisms. These approaches impact NOC exposure to financial risk and their control over investment.

Monopoly operatorship

The NOC executes and finances all its oil projects without partnerships with IOCs. The NOC may hire private companies to provide goods and services (example: Saudi Aramco).

Operatorship in partnership with other oil companies

The NOC partners with other oil companies, each with a financial stake in the project, and the NOC acts as the “operator,” meaning that it is the technical lead on the project and bears principal responsibility for managing and decision-making. The operator commonly, though not always, has the largest stake in the venture (example: Brazil’s Petrobras in many of its projects, including the large offshore pre-salt fields).

Non-operating/minority stakes with fully paid interest

The NOC is a non-operating and/or minority partner in a venture with other oil companies, but is responsible for paying its share of costs from the project’s outset. If the NOC is not the operator, it has less control over project decision-making, but the NOC can still exercise significant influence via their roles in joint operating arrangements and other governance mechanisms (example: the Nigerian National Petroleum Corporation is a non-operating partner in several joint ventures with international oil companies).

Non-operating/minority stakes with carried interest

The NOC’s partners “carry” the NOC stake, meaning that the partners cover upfront costs, and the NOC reimburses these costs later. This arrangement reduces the upfront financial risks taken by the NOC and its governments. The NOC can be carried through exploration (meaning that the NOC must start contributing to development costs upon a commercial petroleum discovery) or through development (meaning that the NOC reimburses costs only once production starts). This arrangement is particularly common for new or small NOCs (example: Liberia’s contracts with ExxonMobil and other operators allowed for the National Oil Company of Liberia to receive a ten percent carried interest in the event of a commercial discovery).⁴⁶ In some cases, contracts are structured to give the NOC some level of carried interest with an option to take an additional paid interest (example: Ghana National Petroleum Corporation in the Jubilee project).⁴⁷

Production-sharing and service contracts

The NOC signs production-sharing or service contracts with IOCs in which private partners take the upfront risk and the NOC does not bear a share of costs. NOCs are commonly responsible for selling the state’s share of oil or gas generated by these projects, and in some instances, NOCs also take a direct financial stake via partnership with IOCs according to one of the mechanisms discussed above.

46 See Restated and Amended Production Sharing Contract between the Republic of Liberia, by and through National Oil Company of Liberia, and ExxonMobil Exploration and Production Liberia Limited and Canadian Overseas Petroleum (Bermuda) Limited, Liberia, Offshore Block 13, Article 19.5. www.resourcecontracts.org/contract/ocds-591adf-6713867467/view#/pdf/page/61/annotation/15162. Accessed 10 November 2020.

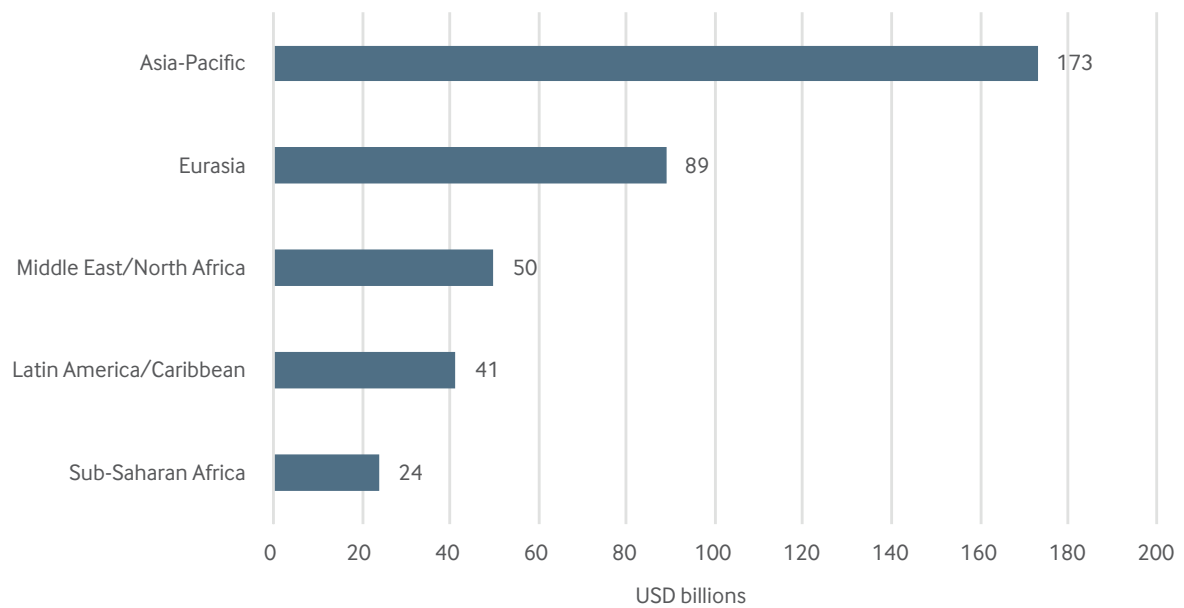
47 See Petroleum Agreement among Government of the Republic of Ghana, Ghana National Petroleum Corporation, and Tullow Ghana Limited, Sabre Oil and Gas Limited, Kosmos Energy Ghana HC in Respect of the Deepwater Tano Contract Area, 2006, Articles 2.4 – 2.5. resourcecontracts.org/contract/ocds-591adf-8934817155/view#/pdf. Accessed 2 September 2020.

Regional distribution of high-risk capital expenditure

Projects that are incompatible with the Paris Agreement are unevenly distributed across NOCs. In absolute terms, much of the lost value would be from NOCs based in China, Russian and India: these companies would lose \$235 billion if they invest assuming a price of \$70 a barrel and the long-term price ends up at \$40.

While NOCs in other countries might invest much less than these large countries in absolute terms, they might put a much larger share of their capital program at risk. More than two-thirds of Mozambican NOC ENH’s projects, and almost half of Nigerian NOC NNPC’s projects and Colombian NOC Ecopetrol’s projects, will fail to break even if the long-term price is \$40.

Figure 5. Regional distribution of NOC capital expenditure that would fail to break even under the central scenario⁴⁸



48 Rystad Energy UCube and authors’ calculations.

Table 4. Value of NOC capital expenditure on projects that would fail to break even at a long-term price of \$40, \$ billions (percent of total capital expenditure)⁴⁹

Country (Company)	If NOCs assume \$50	If NOCs assume \$60	If NOCs assume \$70
China (CNPC, CNOOC, Sinopec)	86.4 (28%)	100.9 (31%)	116.3 (35%)
Russia (Gazprom, Rosneft)	55.3 (21%)	76.3 (27%)	77.7 (28%)
India (ONGC)	33.5 (48%)	36.3 (49%)	40.8 (52%)
Brazil (Petrobras)	16.0 (18%)	16.7 (18%)	20.2 (22%)
UAE (ADNOC, ENOC)	1.5 (3%)	14.7 (21%)	14.7 (21%)
Nigeria (NNPC)	6.5 (30%)	6.9 (31%)	13.7 (47%)
Algeria (Sonatrach)	10.4 (22%)	10.9 (23%)	12.4 (25%)
Malaysia (Petronas)	5.6 (16%)	11.2 (27%)	11.9 (28%)
Oman (OOC)	10.0 (43%)	11.8 (47%)	11.8 (47%)
Norway (Equinor)	8.1 (11%)	10.9 (14%)	11.3 (14%)
Libya (NOC Libya)	9.7 (31%)	10.6 (33%)	10.8 (34%)
Colombia (Ecopetrol)	7.7 (48%)	9.6 (53%)	9.9 (54%)
Mexico (Pemex)	9.4 (24%)	9.4 (24%)	9.7 (25%)
Qatar (Qatar Petroleum)	2.4 (2%)	2.8 (3%)	9.4 (8%)
Azerbaijan (SOCAR)	6.5 (64%)	8.6 (70%)	9.2 (72%)
Mozambique (ENH)	3.8 (55%)	6.6 (68%)	6.6 (68%)
Venezuela (PDVSA)	3.1 (20%)	3.3 (20%)	3.6 (22%)
Indonesia (Pertamina)	2.0 (17%)	2.8 (23%)	3.1 (24%)
Iraq (Basra Oil Company)	1.1 (3%)	2.1 (6%)	2.1 (6%)
Iran (NIOC)	1.8 (3%)	1.8 (3%)	1.9 (3%)
Kazakhstan (KazMunayGas)	1.8 (25%)	1.9 (26%)	1.9 (26%)
Ukraine (Naftogaz)	0.9 (16%)	1.4 (23%)	1.8 (26%)
Angola (Sonangol)	1.5 (17%)	1.7 (18%)	1.7 (18%)
Vietnam (PetroVietnam)	0.7 (6%)	1.0 (9%)	1.4 (12%)
Turkmenistan (Turkmengaz)	1.0 (4%)	1.0 (4%)	1.2 (5%)
Thailand (PTT)	1.0 (8%)	1.0 (8%)	1.0 (8%)
Argentina (YPF)	0.7 (5%)	0.7 (5%)	1.0 (6%)
Ghana (GNPC)	0.9 (25%)	1.0 (25%)	1.0 (25%)
South Africa (PetroSA)	0.8 (42%)	0.8 (42%)	0.9 (44%)
Ecuador (PetroAmazonas)	0.4 (4%)	0.6 (6%)	0.6 (6%)
Congo (Rep.) (SNPC)	0.5 (43%)	0.6 (47%)	0.6 (47%)
Saudi Arabia (Saudi Aramco)	0.5 (0%)	0.5 (0%)	0.5 (0%)
Kuwait (KPC)	0.5 (1%)	0.5 (1%)	0.5 (1%)
Brunei (PetroleumBrunei)	0.5 (13%)	0.5 (13%)	0.5 (13%)
Tunisia (ETAP)	0.4 (26%)	0.4 (29%)	0.5 (31%)
Yemen (YOGC)	0.4 (19%)	0.4 (19%)	0.4 (19%)
Suriname (Staatsolie)	0.3 (99%)	0.3 (99%)	0.3 (99%)
Egypt (EGPC)	0.3 (12%)	0.3 (14%)	0.3 (14%)
Bangladesh (Petrobangla)	0.2 (9%)	0.2 (9%)	0.3 (13%)
Sudan (Sudapet)	0.1 (4%)	0.3 (7%)	0.3 (7%)
Cameroon (SNH)	> 0 (8%)	0.1 (20%)	0.2 (46%)
Myanmar (MOGE)	0 (0%)	0.1 (25%)	0.2 (27%)
Gabon (Gabon Oil Company)	> 0 (12%)	0.1 (30%)	0.1 (30%)
Cote d'Ivoire (Petroci)	0.1 (22%)	0.1 (22%)	0.1 (22%)
Equatorial Guinea (GEPetrol)	> 0 (9%)	> 0 (13%)	> 0 (13%)
Chad (SHT)	> 0 (12%)	> 0 (12%)	> 0 (12%)
Dem. Rep. of Congo (Sonahydroc)	> 0 (40%)	> 0 (40%)	> 0 (43%)
TOTAL	295	370	414

49 Rystad Energy UCube and authors' calculations.

Effect of taxes

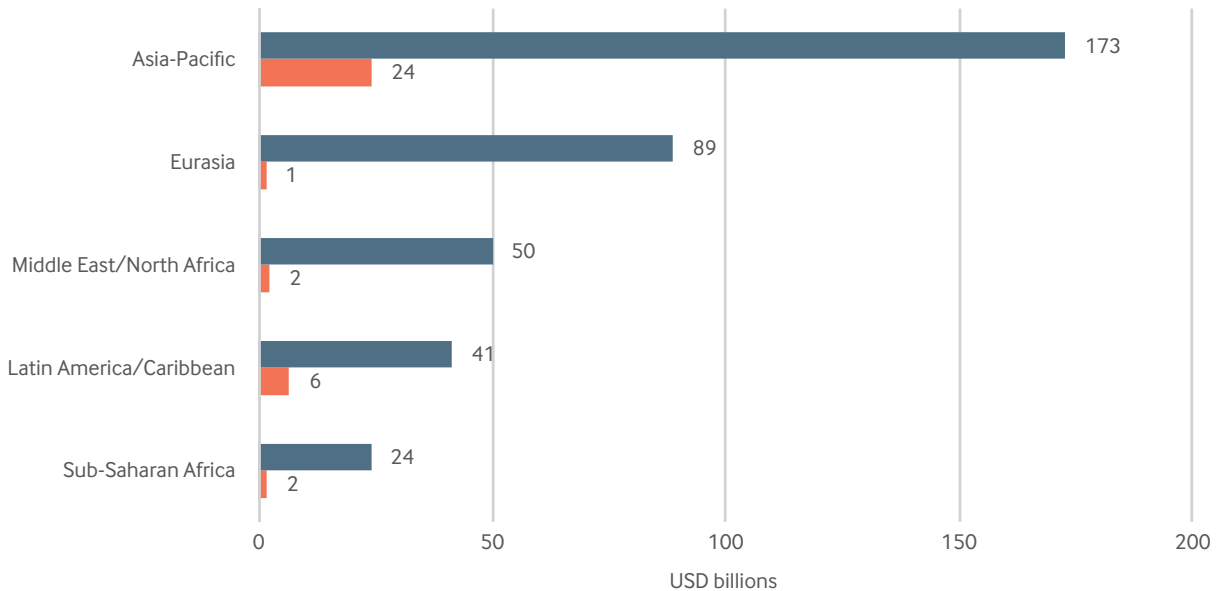
Our analysis shows that project viability is highly sensitive to taxation. At least during the operational phase of projects, taxes and other payments to governments like production shares are often larger than payments to suppliers and other costs.⁵⁰ Therefore, cutting taxes can significantly reduce a project’s break-even price. Figure 6 shows that if the government did not tax oil production, and simply left companies to distribute the proceeds, almost all projects break even when the price of oil is \$40.

Taxes could fall in two ways. Most tax regimes have some level of “progressivity” – the tax burden rises and falls as a project’s profits rise and fall. Russia

levies a relatively progressive tax regime on oil and gas projects. Many other governments, particularly those in poorer countries, use less progressive regimes. Often, these countries have production sharing arrangements based on the quantity of oil produced, or levy high fixed rate taxes such as royalties. Neither are progressive with respect to profits. In these countries, the automatic fall in taxes as the oil price falls will be relatively insignificant.⁵¹

The other way that taxes will fall is if NOCs and IOCs lobby governments to accept lower tax returns to avoid stranding reserves. For NOCs, this could involve requests for governments to lower income tax rates, dividend payouts or the transfer of proceeds from the sale of state oil.

Figure 6. Value of NOC capital expenditure that would fail to break-even under the central scenario, pre- and post-tax⁵²



50 David Manley, Anna Fleming and David Mihalyi, *A Race to the Bottom and Back to the Top: During Oil and Gas During and After the Pandemic* (Natural Resource Governance Institute, 2020), resourcegovernance.org/analysis-tools/publications/race-bottom-taxing-oil-gas-coronavirus-pandemic.

51 Philip Daniel, Natural Resource Governance Institute Advisory Council meeting, Zoom call, 15 October 2020.

52 Authors’ calculations using Rystad Energy UCube. Projects estimated to have negative tax payments (e.g. subsidies) are cut from the sample.

Tax breaks for national oil companies would not save oil-producing governments from the energy transition. They merely shift the burden to governments.

However, tax breaks for NOCs would not save oil-producing governments from the energy transition. They merely shift the burden to country governments. A tax break on an NOC's oil projects impedes government's ability to shift money out of the oil sector and into non-oil sectors. It allows the NOC to make larger returns (or smaller losses) on the public capital invested, but this does not ultimately benefit the public. Giving the NOC a tax break to help the project break even increases the returns the public ultimately might get from the NOC in the form of dividends (or equivalent transfer) if the NOC profits in the future. However, it reduces tax revenues. For the public, ultimately, the two cash flows are fungible: the combined amount is important.

Furthermore, some of the largest payments to governments—such as production shares and royalties—are from taxes levied on projects, not companies themselves. In many projects worldwide, NOCs take minority positions. Reducing taxes on projects is therefore a particularly costly way to save an NOC. It effectively means the state giving up a revenue source from the private capital invested in order to allow the public capital to make a return.

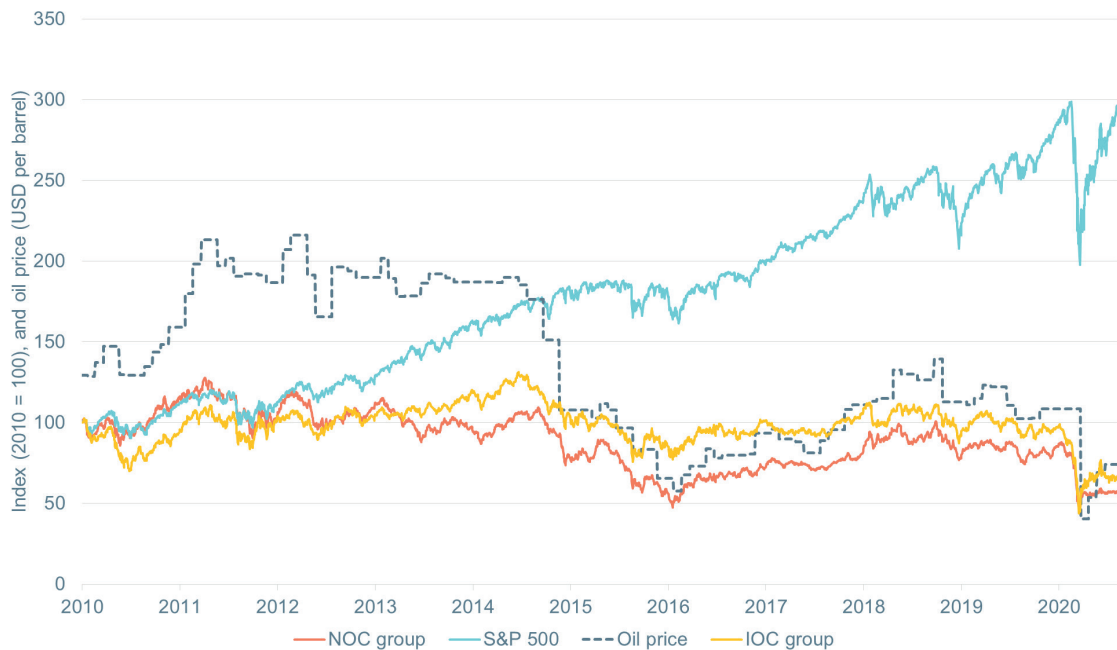
We discuss tax policies government might use to influence how NOCs make investment decisions in section 5.

2.2 PAST NATIONAL OIL COMPANY PERFORMANCE

In the previous section, we showed that a number of NOCs might invest in high cost projects that may not generate sufficient returns. That is one risk that governments face when investing in NOCs. Another may have to do with NOC performance more generally. Past success does not guarantee that NOCs will perform well in the future. Similarly, poor performance also does not indicate that NOCs will fail in the future. However, it stands as a warning for governments that the financial returns on NOC investment have often disappointed.

Figure 7 on the next page shows the twelve NOCs that currently have shares traded on public exchanges.⁵³ We created an unweighted index of their shares, and found that this index lost 46 percent of its value between 2010 and 2020. Tracking the share price of listed NOCs over the last decade suggests that state shareholders lost out by investing their money in these companies. Along with many other fossil fuel companies, the share prices of listed NOCs have lost substantial value.

⁵³ These are CNOOC Limited (headquartered in China), Ecopetrol (Colombia), Equinor (Norway), Gazprom (Russia), ONGC (India), Petrobras (Brazil), PetroChina (China), PTT (Thailand), Rosneft (Russia), Saudi Aramco (Saudi Arabia), Sinopec Corp. (China), TAQA (United Arab Emirates), and YPF (Argentina).

Figure 7. Share price indices of listed NOCs and IOCs compared with the S&P 500 index⁵⁴

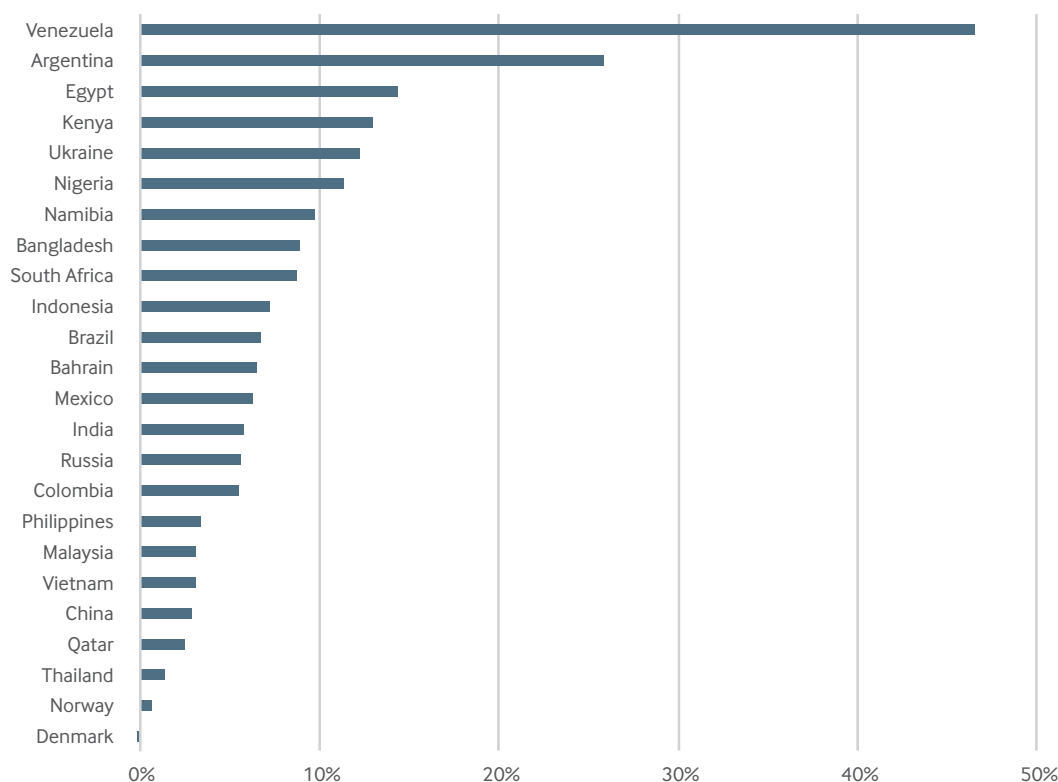
We created another index of IOCs—labeled above as “IOC group”—comprised of BP, Exxon, Chevron and Total. As of October 2020, this IOC index is slightly higher than the NOCs, but performance is similar. This, however, should not be much comfort to NOCs and their owners. Investors in any of these oil companies – NOC or IOC – could have done better investing elsewhere. For example, a government of one of these NOCs could have tripled its money by investing in an S&P 500 index fund. On average, a government could have done financially better by investing in one of these funds—perhaps as part of their sovereign wealth fund—rather than investing in their NOC.

Another alternative to investing public money in NOCs is to pay down sovereign debt. Governments would have done better financially doing this as

well. Figure 8 on the next page shows the current yields on sovereign debt held by the governments that own NOCs. The yield is one way of showing the cost of debt as a percentage of the debt value. The mean yield is nine percent; the median yield is six percent. Given that our NOC share index actually lost value over the decade, governments on average appear to have borrowed money costing six percent a year, and invested in assets that lost money. They could have done better by paying down their debt and saving on interest payments.

We do not have the data to confirm whether these sovereign debt yields had been similar in the past. However, the NOC share index suggests that the capital gain on public money invested in NOCs would be much worse than six percent. In some countries, notably Venezuela and Argentina, which

⁵⁴ Yahoo finance, via quantmod R package, and authors' calculations. Data collected in October 2020. IOC group index comprises of BP, Exxon, Chevron and Total. We acknowledge the selection bias at play here. The constituents of the S&P 500 index over time are rebased, with the worst performing companies falling out of the index, and new, high-performing companies entering the index.

Figure 8. Yields on 10-year sovereign debt⁵⁵

have debt yields over 20 percent, there is little room for doubt. Investing public money in the oil and gas business yielded far lower returns than the cost of servicing these countries' debt.

If oil prices structurally decline, this situation might worsen. Not only would the return on oil assets fall, but also because of the worsening fiscal position of the government, debt yields would likely rise.

Our results only show the stock performance of listed NOCs. It is unclear whether non-listed NOCs would have performed better. On the one hand, the listed NOCs have higher average production costs

than other NOCs, and Rystad Energy indicates that their costs will rise faster in the future than other NOCs.⁵⁶ On the other hand, NRGi research suggests listed NOCs tend to perform better financially than non-listed NOCs, both because of the increase in the quality of corporate governance that often goes along with listing, and the self-selection in listing – companies that have started to perform well are more likely to be able to raise equity capital. NRGi's research has also shown that listed NOCs are significantly more likely to pay dividends than their unlisted counterparts are, and that these companies produce oil more efficiently on a production-per-employee basis.⁵⁷

55 Damodaran Online, *Costs of Capital by Industry Sector*, 5. *Global and World Government Bonds, 10Y Bond Yield*.

56 Authors' calculations and Rystad Energy UCube.

57 Heller and Mihalji, *Massive and Misunderstood*, pp. 37, 44-46.

3. Some oil-dependent countries cannot afford to make big bets

We have argued that NOCs' investments are betting with public money. Some of these bets may make money, but the risk that they will lose money is significant and is quickly increasing. As this risk grows, how much of the public's money should NOCs be betting with? Good gamblers know how much money to risk: not so much that it leaves them ruined if they lose the game. In contrast, governments with economies that are poorly diversified that are dependent on income from an NOC are more vulnerable to NOC spending on projects that fail to break even. In these places, the consequences of losing these bets is economic hardship for the country's citizens.

We examine this risk in two ways. First, we consider which countries can afford for their NOCs to make large, risky bets by measuring how diversified the NOCs, governments and economies are. Second, we look at public risk in places where NOCs raise capital from other sources than their government. We examine the factors that drive governments to bail out highly indebted NOCs, thus putting more public money into the industry.

3.1 DEPENDENCY OF PUBLIC FINANCES AND ECONOMIES ON NATIONAL OIL COMPANIES

Experts in oil and gas governance have long argued that governments dependent on oil and gas revenues should diversify their economies.⁵⁸ Few have succeeded in doing so.⁵⁹ This matters because the more dependent a country is on the oil and gas sector—and on revenues that flow through the NOC—the greater the economic fall-out will be if NOC investments fail to break even.

Countries are not equally dependent. As governments and NOCs investigate their risk exposure from the energy transition, we recommend that they

ask three questions about their dependence on risky projects and the potential reverberations of failure.

How concentrated is public capital in the NOC?

The more concentrated public capital is in the NOC, the greater the consequences of NOC failure. This concentration is much higher than that of the typical investor in an IOC. The typical shareholder in an IOC like ExxonMobil holds only a small part of their entire wealth in the company. Thousands of shareholders own ExxonMobil. As of March 2019, 56 percent of the company was owned by institutional investors, with the largest shareholders being the Vanguard Group (8 percent), BlackRock (7 percent) and the State Street Corporation (5 percent). These shareholders in turn derive their money from thousands of pension holders and retail investors. These individuals own a variety of assets, not just ExxonMobil. For instance, the oil and gas industry constitutes just three percent of the United States' S&P 500 index.

Contrast this with the state shareholders of NOCs. Some NOCs list some of their shares on public stock exchanges. But most are entirely owned by the state, usually holding shares on behalf of the public. These governments and the public are more exposed to the fortunes of their NOC than the average investor is to ExxonMobil. It is for this reason that preparing for the energy transition along the lines we discuss in this report matters much more for governments and the public in oil and gas-dependent countries than it does for the average investor from Shanghai, Paris or New York.

People in most of the countries with an NOC are also poorer, so they have fewer assets in general. They are also less likely to own foreign assets so are less able to diversify their own wealth. Furthermore, the fortunes of an oil-dependent country are more correlated with the fortunes of the

58 Natural Resource Governance Institute, *Natural Resource Charter 2nd edition*, (2014), resourcegovernance.org/analysis-tools/publications/natural-resource-charter-2nd-ed.

59 Anthony J. Venables, "Using Natural Resources for Development: Why Has It Proven So Difficult?" *Journal of Economic Perspectives* 30, no. 1 (2016), doi.org/10.1257/jep.30.1.161.

oil market. Thus, the assets they do have are more likely to be correlated to the fortunes of the NOC.

These investors also have fewer chances to diversify. Most NOCs invest only in their home country, so have fewer investment options than even IOCs. Further, it is easy for any retail investor to divest from ExxonMobil, and it is their choice. A citizen of a country with an NOC has almost no power to divest their share of public wealth from the country's NOC.

How dependent is government revenue on the NOC?

If the NOC incurs significant losses or lowers the transfers it makes to the treasury, then an oil-dependent government will not be able to maintain public programming. Table 5 provides one snapshot of the potential scope of these impacts. It lists the amounts from Table 4 above—the amounts of NOC capital expenditure that would fail to break

Table 5. NOC capital expenditure that would fail to break even as a proportion of annual general government expenditure, under the central scenario⁶⁰

Country	Value at risk as % of government expenditure
Mozambique (ENH)	179%
Azerbaijan (SOCAR)	157%
Oman (OOC)	61%
Nigeria (NNPC)	53%
Congo (Rep.) (SNPC)	42%
Turkmenistan (Turkmengaz)	41%
Algeria (Sonatrach)	36%
Qatar (Qatar Petroleum)	31%
UAE (ADNOC, ENOC)	30%
Malaysia (Petronas)	29%
Russia (Gazprom, Rosneft)	27%
Colombia (Ecopetrol)	21%
Ghana (GNPC)	18%
India (ONGC)	16%
Brunei (PetroleumBrunei)	14%
Norway (Equinor)	12%
Vietnam (PetroVietnam)	10%
Kazakhstan (KazMunayGas)	10%
Angola (Sonangol)	9%
Ukraine (Naftogaz)	8%
China (CNPC, CNOOC, Sinopec)	7%
Mexico (Pemex)	7%
Chad (SHT)	6%
Sudan (Sudapet)	6%
Tunisia (ETAP)	5%
Venezuela (PDVSA)	5%
Brazil (Petrobras)	5%
Iraq (Basra Oil Company)	5%

Country	Value at risk as % of government expenditure
Cameroon (SNH)	5%
Gabon (Gabon Oil Company)	5%
Ecuador (Petroamazonas)	4%
Iran (NIOC)	4%
Indonesia (Pertamina)	3%
Bangladesh (Petrobangla)	2%
Kuwait (KPC)	2%
Equatorial Guinea (GEPetrol)	1%
Thailand (PTT)	1%
South Africa (PetroSA)	1%
Myanmar (MOGE)	1%
Cote d'Ivoire (Petroci)	1%
Egypt (EGPC)	1%
Argentina (YPF)	1%
Dem. Rep. of Congo (Sonahydroc)	0%
Saudi Arabia (Saudi Aramco)	0%
Bahrain (BAPCO)	0%
Bolivia (YPFB)	0%
Cuba (CUPET)	0%
Jamaica (PCJ)	0%
Kenya (National Oil Kenya)	0%
Liberia (NOCAL)	0%
Namibia (NAMCOR)	0%
Philippines (PNOC)	0%
South Sudan (Nilepet)	0%
Tanzania (TPDC)	0%
Timor-Leste (Timor GAP)	0%

■ This figure exceeds average annual public spending on health

60 Rystad Energy UCube and authors' calculations. General government expenditure data from International Monetary Fund, "General government total expenditure," *World Economic Outlook*, last updated October 2020, www.imf.org/en/Publications/WEO/weo-database/2020/October/download-entire-database. We take the average government expenditure from 2014 to 2018. The IMF database does not have expenditure data for Libya and Yemen. We show the results from assuming NOCs invest assuming a price of \$70, but actual long-term price is \$40. Development capital expenditure on projects expected to start between 2020 and 2030 under Rystad Energy's baseline price scenario.

Governments that make risky investments in oil production do so by foregoing public spending in other domains.

even under our central scenario where NOCs invest on the assumption of a long-term price of \$70 as a percentage of today's general government expenditure in each country. For countries where this figure is particularly high, wasted spending by the NOC carries a high opportunity cost.

Mozambique and Azerbaijan stand out for risking a large value as a share of their government expenditure. These high proportions may derive from a lack of disaggregation in Rystad Energy's reporting of the data – it is possible that a share of what Rystad Energy projects as the Mozambican ENH's upcoming capital expenditure will be “carried” by the company's partners rather than drawing upfront on the public purse. (See Box 4 for a discussion of carried stakes.) New producers (such as Mozambique) that produce little oil now but have ambitions to produce more in the future most often use carried interest arrangements. In these countries, if oil investments succeed, then over time, government revenues would rise, and these percentages would come down.

Governments that make such risky investments in oil production do so by foregoing public spending in other domains. If they follow the investment levels projected by Rystad Energy, the governments at the upper end of this scale would devote significantly more public revenues to these high-cost NOC projects than they spend on public health or education. These risks can be significant even for countries in the middle range of Table 5. To put some figures in context, the at-risk capital expenditure on oil projects anticipated for Angola's

Sonangol (9 percent of general government expenditure), Ukraine's Naftogaz (8 percent) and Chad's SHT (6 percent)—among others—is equal to or greater than average annual public spending on health in these countries.⁶¹

How dependent is the economy on oil and gas exports?

The more dependent a country is on oil and gas exports, the greater the potential for broad-based disruption if NOCs fail to generate expected revenues and returns. In Figure 9, we compare the share of fossil fuel exports to total exports against the average break-even price of projects owned by NOCs in each country. The figure covers the break-even prices of the projects in each NOC's current portfolio. This includes currently operating assets, and expected upcoming developments, weighted by production. NOCs' choices will therefore determine whether this figure rises or falls.⁶²

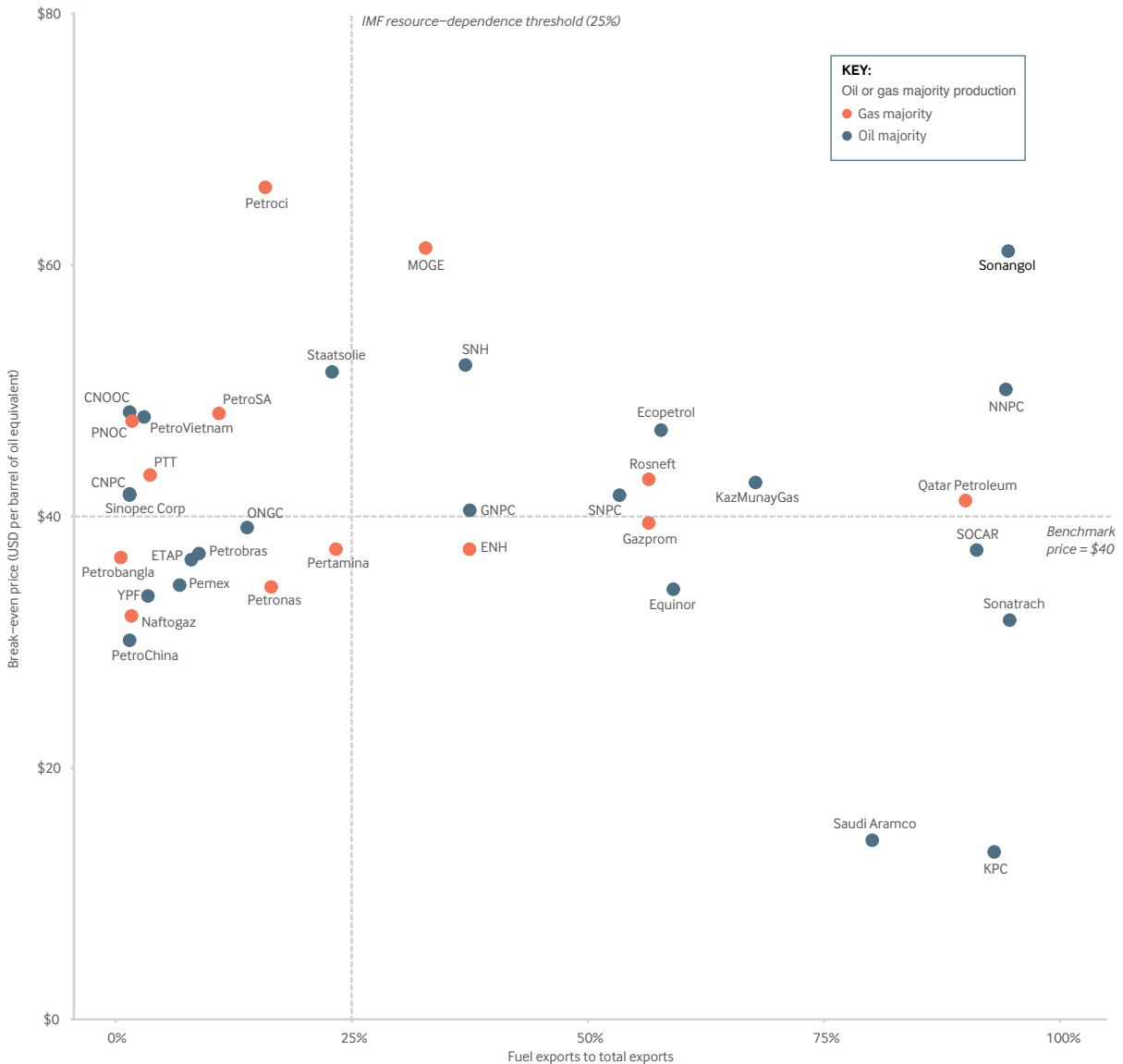
Spending on new high-cost projects is particularly risky in countries that are highly dependent on oil and gas, and in countries where the NOC's current average break-even price is already high. This is because these companies have less recourse to low-cost existing projects to bolster their business if new projects fail.

We also separate countries by whether they produce a majority of oil or gas, as measured by energy equivalent barrels of oil. As we discussed in Box 1, it is unclear whether holding gas assets will be less risky than oil assets as the global economy decarbonizes, however, the futures of these two fuels are at least different, so separating the results is useful.

61 Data on domestic general public health expenditure as a percentage of general government expenditure from World Bank, *Health, Nutrition and Population Statistics*, last accessed 8 January, 2021, databank.worldbank.org/source/health-nutrition-and-population-statistics#. Average health expenditure for 2011 – 2018 was 4.7 percent of general government expenditure in Angola, 8.1 percent in Ukraine and 4.9 percent in Chad.

62 Future research could examine the average break-even price of all assets in NOC's projected 2030 portfolio, instead of departing from the 2020 portfolio. The available data to which the authors had access did not enable us to take this further step for this report.

Figure 9. Comparison of estimated break-even prices of NOCs' global portfolio and country share of fuel exports to total exports⁶³



63 Rystad Energy UCube, World Bank, "Fuel exports (% of merchandise exports)," *World Development Indicators*, data.worldbank.org/indicator/TX.VAL.FUEL.ZS.UN; NRG1, *The National Oil Company Database*, last updated May 2020, www.nationaloilcompanydata.org; and authors' calculations. Breakeven prices for NOCs in their entirety in 2020. This is a production-weighted average of the underlying projects owned by each NOC. Assuming NOCs invest according to Rystad Energy's baseline scenario. Threshold for fuel export dependency is 25 percent, based on the IMF's definition of a country that is "resource-dependent." In cases in which there are multiple NOCs at home in a country, points denote an average of each NOCs' breakeven price. As a benchmark to determine dependency, we follow the IMF. They define an economy that is dependent on oil and gas as any economy whose exports from oil and gas constitute at least 25 percent of total exports. This includes oil and gas exports that may not be from an NOC, but the measure broadly indicates how dependent the economy in general is on the oil and gas industry.

A decline in oil and gas exports can mean fewer jobs and less foreign exchange.⁶⁴ Usually, a dependent economy and a dependent government go hand in hand, but not always. For example, the oil and gas sector makes up only 6 percent of the Nigerian economy and contributes few jobs, but constitutes 90 percent of the country's exports and 75 percent of the government's revenues.

3.1 GOVERNMENT BAILOUTS OF NATIONAL OIL COMPANIES

Rather than using solely public funds, NOCs can raise capital from other investors. However, NOCs borrowing funds from other investors, such as banks, still puts public capital at risk. Therefore, governments and NOCs should ask an additional question: if the NOC fails, will the government be compelled to devote public funds to bail it out?

Three recent examples of governments bailing out NOCs are Mexico's PEMEX (see Box 5), Venezuela's PDVSA and Kazakhstan's KMG. Even before NOCs reach a critical indebtedness, a government may help out a company by giving a tax break. Whatever the means, the result effectively draws in and keeps public money within the NOC. This may be in the interests of the country, or driven by a desire to maintain state control of the sector despite the risks.

Box 5. The PEMEX bailouts

The highly indebted Petróleos Mexicanos (PEMEX) has required rounds of tax breaks and bailouts from the Mexican government in recent years, as the government seeks to help the company meet obligations, manage relationships with creditors and arrest declines in production, revenues and investment. In September 2019, the government approved a \$5 billion bailout package, referring to it as a "one-of-a-kind transaction" to give the company "breathing space."⁶⁵ Mexico has also reduced Pemex's taxes multiple times, with a significant reduction in its profit-sharing duty in 2019 followed by another package designed to reduce the company's fiscal burden by a further 80 percent amidst the coronavirus pandemic of 2020. These calls on public resources to bolster the flagging NOC have been publicly justified in part with a Pemex-centric view of national development and in part by fears that the company's failure would jeopardize the national economy.⁶⁶

As of March 2020, Pemex owed \$172 billion in debt. Forty percent of this debt was in the form of pension liabilities owed to its nearly 300,000 staff and pensioners.⁶⁷ This has made ensuring Pemex's survival all the more important, as the default on pension liabilities would hurt ordinary Mexicans and cause intense public dissatisfaction.

64 Although, as oil and gas prices fall, other sectors of each economy are likely to change. The Dutch disease theory suggests that other exporting sectors will become more competitive, but we have not considered this further.

65 Deputy Finance Minister Gabriel Yorio, as cited by Reuters staff, "Mexico's \$5 billion debt bailout for Pemex a 'one-off' – deputy minister," Reuters, 12 September 2019, www.reuters.com/article/uk-mexico-pemex/mexicos-5-billion-debt-bailout-for-pemex-a-one-off-deputy-minister-idUKKCN1VX0PI.

66 Jude Webber, "Mexico's Pemex: from Cash Cow to Resource Drain," *Financial Times*, May 5 2020, www.ft.com/content/4958eef9-7ce7-41c1-b2ff-8ea30ab0082b; Reuters, "Mexico Central Bank Warns Pemex Challenges Could Put Stability at Risk," 11 April 2019, www.reuters.com/article/us-mexico-economy/mexico-central-bank-warns-pemex-challenges-could-put-stability-at-risk-idUSKCN1RN28Z.

67 Stefanie Eschenbacher, "'Unsustainable': Mexico's Pemex buckling under crushing pension debt," Reuters, 6 March 2020. www.reuters.com/article/us-pemex-pension/unsustainable-mexicos-pemex-buckling-under-crushing-pension-debt-idUSKBN20T0K1

Reasons that governments bail out NOCs

The imminent collapse of an NOC has repercussions that a government will want to avoid. In some limited cases, in which NOCs have work forces numbering in the tens or even hundreds of thousands), and their collapse could cause widespread unemployment.⁶⁸ Alternatively, the NOC could default on debts and cause further financial worries for domestic financiers and the government.

This second reason partly depends on how much non-state investors in the country have invested in the oil and gas sector. If an NOC defaults on debt held by these domestic investors, investors in turn may have to rein in spending, call in loans from other borrowers, or sell assets to raise cash. Data on how entrenched NOCs are within their domestic financial systems is difficult to obtain. One study showed that in the 2000s, banks in Arab countries contributed a third of total oil and gas financing in the region. The study also measured bank lending to sectors negatively affected by the energy transition. On average, 12 percent of bank loans were made to these sectors.⁶⁹

The complexity of financial transactions may be problematic. In many countries – particularly in emerging and developing economies – governments hold debt issued by their state-owned enterprises (SOEs), which include NOCs. In turn, state banks, other SOEs and the wider financial sector holds substantial amounts of government debt. SOEs can also hold each other’s debt. In Gambia, for example, SOE-to-SOE lending comprised almost half of total domestic lending.⁷⁰ In these situations, the liability of one entity is the asset of another. The network of domestic banks, and other entities that hold NOC debt and equity, can propagate an oil price shock throughout the economy.

A government may ultimately be obligated to pay lenders on the debts that its NOC incurred, even if the government did not formally guarantee the debts. These debts are also treated inconsistently in public reporting. For example, public debt figures for Mexico and Venezuela include the debts of their NOCs but Bolivia or Brazil usually do not.

68 For data on the size of workforces of NOCs, see Natural Resource Governance Institute, *National Oil Company Database*.

69 Banks contributed 33.8 percent of the financing for Arab oil and gas between 1998 and 2003, compared with 48.1 percent by sponsored/self-finance and 18.3 percent by foreign capital. Randa Alami, *Changing Financial Structures in the Arab World: Some Implications for Oil and Gas*, Oxford Institute for Energy Studies (2005), www.oxfordenergy.org/publications/changing-financial-structures-in-the-arab-world-some-implications-for-oil-and-gas.

70 International Monetary Fund, “Chapter 3 State-Owned Enterprises: The Other Government,” in *Fiscal Monitor Update* (April 2020), www.imf.org/en/Publications/FM/Issues/2020/04/06/fiscal-monitor-april-2020.

A government's fear of NOC failure might in turn encourage the NOC to take larger risks or encourage greater lending to the NOC. This is called a "moral hazard," and it may occur in cases in which the NOC can freely borrow, and the government deems the NOC to be too big to fail. The NOC may borrow more heavily, and at cheaper rates, as both NOC and lenders assume the government will bail out the NOC if necessary.⁷¹

The lack of information about NOC debts, and the accompanying fear that an NOC could bring down a country's financial system, might strengthen a government's resolve to bail out the NOC as a precautionary measure. The oil price crash in 2020 showed how NOCs provide a secondary source of worry for governments. Not only did government revenues fall across oil-producing countries, the profits of their NOCs fell too. In some cases, such as in Colombia, NOC profits fell at a greater rate than government revenue. This matters, because the decline in NOC profits is effectively an additional decline in government revenues, but one that is not immediately reported, nor consistently categorized as such.⁷²

Measuring NOC indebtedness

A structural decline in the oil price should be most worrying for NOCs with both high costs and high debt. Debt is particularly risky when prices decline because debt payments remain constant while borrowers' ability to pay worsens. There are various ways to measure indebtedness and the risk of default. Each produce slightly different results. In Figure 10, we show just one.

We compare the aggregate break-even prices of projects in the NOCs' current portfolios with NOCs' long-term debt as a proportion of general government revenue. This indicates how much of a burden on the government it would be for the government to have to pay off NOC debts.⁷³ As a benchmark, we show the median debt ratio for all NOCs, which is about five percent.

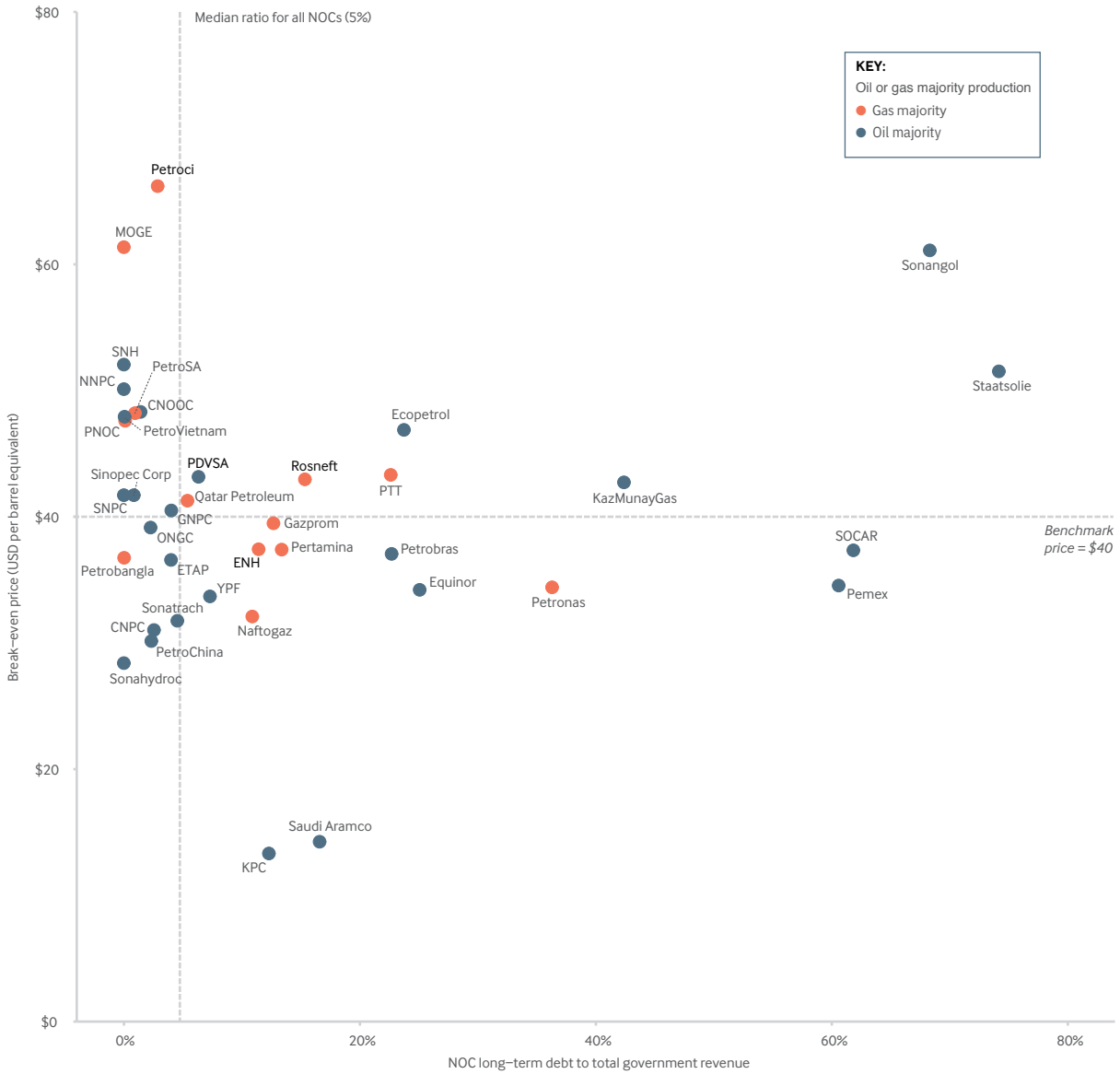
As with the last measure, NOCs in the top right corner of this chart represent the biggest risk to their state owners. They have the highest costs in their existing portfolios, so their profits will fall proportionally faster if prices decline and/or new projects fail to generate positive returns. Their debts are large relative to the ability of their governments to bail them out.

71 The phenomenon of moral hazard associated with bailouts has been extensively researched with regards to other sectors. See, e.g., Jong-Wha Lee and Kwanho Shin, "IMF Bailouts and Moral Hazard," *Journal of International Money and Finance* 27, no. 5 (2008): 816–30, papers.ssrn.com/sol3/papers.cfm?abstract_id=640388. Lee and Shin find that sovereign risk-taking was higher among countries that anticipated that the IMF would bail them out in the event of distress. Giovanni Dell'Ariccia and Lev Ratnovski, "Bailouts and Systemic Insurance," *Journal of Banking & Finance* 105 (2019): 166–77, ideas.repec.org/a/eee/jbfina/v105y2019icp166-177.html. They find that bailout expectations increased risk taking by banks. Lammertjan Dam and Michael Kotter, "Bank Bailouts, Interventions and Moral Hazard," *The Review of Financial Studies*, vol. 25, no. 8. (August 2012), papers.ssrn.com/sol3/papers.cfm?abstract_id=2794065. They find that risk-taking in German banks increased when they anticipated capital preservation support from the state.

72 The IMF provides ambiguous guidance about whether to include NOC revenues under general government revenues. It recommends including state-owned companies only when they are not run as commercial entities. In practice, however, this distinction has been difficult to interpret consistently. For more discussion, see Heller and Mihalyi, *Massive and Misunderstood*, 19-20.

73 Another similar measure is comparing NOC breakeven prices with NOC debt to total government debt.

Figure 10. Comparison of estimated break-even prices of NOCs' current global portfolio, and NOCs' long-term debt as a proportion of general government revenue⁷⁴



74 NRG National Oil Company Database, Rystad UCube, and authors' calculations. Break-even prices are the average for the NOC's global portfolio. Debt and government revenue values are averages from the years 2014 to 2018.

Even if a national oil company raises funds from other investors, the public should still be interested in the company's finances. Some bailouts have cost the public billions of dollars.

Figure 10 shows that most NOCs currently hold long-term debts worth less than 20 percent of their government's annual revenues, with a large number of NOCs clustered around 5 percent. However, some are highly indebted in proportion to their government's ability to pay. NOCs such as Sonangol (Angola), Staatsolie (Suriname), SOCAR (Azerbaijan) and Pemex (Mexico) appear to represent a significant risk to their governments.⁷⁵

Indeed, the Mexican government has already bailed out Pemex. Also in Latin America, Petróleos de Venezuela, S.A (PDVSA) has a low debt-to-asset ratio, but most of those assets are in oil underground. Due to PDVSA's poor production rate and the combined impact of an economic crisis and sanctions, PDVSA cannot extract these resources quickly. A decline in oil

price would also make those assets worth much less, even as the company's debts stay the same. Consequently, PDVSA is currently unable to service part of its \$35 billion in debt—worth over 20 percent of Venezuela's economic output.⁷⁶

Highly indebted NOCs are a risk to their governments. Even if NOCs raise funds from other investors, the public should still be interested in the NOCs' finances. Some bailouts have cost the public potentially billions of dollars. There are various ways to measure NOC indebtedness and the risk of financial troubles if prices fall. The measure we have chosen is one way, but further research can help identify the most reliable measure that NOCs and their government might use to monitor their exposure.

75 Although we did not show it here, using debt as a proportion of total assets instead of as a proportion of general government revenue shows most of the same NOCs plus Petróleos de Venezuela, S.A (PDVSA), and Ecopetrol and Petrobras.

76 David Manley, David Mihalyi and Patrick R. P. Heller, "Hidden Giants," *Finance and Development* 56, no. 4 (December 2019), www.imf.org/external/pubs/ft/fandd/2019/12/national-oil-companies-need-more-transparency-manley.htm.

4. National oil companies will struggle to manage energy transition risk on their own

We have argued that some NOCs are investing in assets that will not generate returns if prices decline. These risks are especially concerning for those countries that also highly dependent on the oil and gas sector and their NOC. Will these governments and NOCs change their approach to the sector to manage this risk?

There is huge variety among NOCs – ranging from industry-leading giants such as Saudi Aramco to small, non-operating companies such as Timor Leste’s TIMOR GAP. Still, some common traits of government-NOC relationships will likely exacerbate excessive or risky company spending, making managing risk difficult. In this section, we discuss these governance risks, to set the stage for a discussion of practical responses in section 5.

4.1 MANY RESPONSIBILITIES

Many governments have situated their NOCs as central players in a social contract predicated upon large oil revenues to spend on public policy and political goals. NOC roles vary widely: from managing the oil sector, to building public infrastructure, to subsidizing fuel sales. But the combination of roles makes it harder for NOCs and their shareholders to define measures of success, and for citizens to hold NOC leaders accountable according to these measures.⁷⁷ Multiple roles have also been used to justify large and risky spending, including on projects of purported strategic interest.⁷⁸ Some NOCs are particularly susceptible

to being used to advance the positions of political leaders because these companies control huge flows of revenues, often with extensive discretion, and because they sit at the intersection of commercial activity and public rent-allocation power.⁷⁹

The combination of commercial and non-commercial activities distinguishes NOCs from private oil companies. In many countries, public policy goals will be an important driver for NOCs to deliver value to their citizens in the future. As a potential structural decline in price affects the prospects for sustained large revenues in the future, however, the governments and people will feel these trade-offs among these myriad activities more acutely.

4.2 OUTSIZED CONTROL OF PUBLIC MONEY

Much government income in oil-producing countries comes from the NOC, which often sells the state’s share of production from oil projects.⁸⁰ NRG research revealed that during the oil boom of 2013, at least 25 countries worldwide had NOCs that collected revenues equivalent to more than 20 percent of total government revenues.⁸¹ The typical NOC spends most of the money that it collects, before it ever reaches the treasury. In 2018, the median NOC in NRG’s National Oil Company Database transferred only 22 percent of its gross revenues to government in taxes, dividends and other transfers, with significant

77 For a discussion of the challenges associated with this multiplicity of NOC roles, 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); Valerie Marcel, Donald Painter, and Patrick Heller, *Benchmarking the Performance of African National Oil Companies*, African Development Bank, forthcoming.

78 Examples of this include the Lobito refinery project by Angola’s Sonangol.

79 For an extensive discussion of the modes by which NOCs are used as vehicles for public corruption, see Alexandra Gillies, *Crude Intentions: How Oil Corruption Contaminates the World* (Oxford: Oxford University Press, 2020.)

80 Oil, gas and associated product sales represent a major share of total fiscal revenues in a number of countries. NRG researchers found public information on the value of these sales in 2016 for NOCs from 35 countries. Among these countries, oil sales were equal to 22 percent of the total government revenues the countries collected that year. See Alexander Malden and Joseph Williams, *Big Sellers: Exploring the Scale and Risk of National Oil Company Sales* (Natural Resource Governance Institute, 2019), resourcegovernance.org/analysis-tools/publications/big-sellers-exploring-scale-and-risk-national-oil-company-sales.

81 Heller and Mihalyi, *Massive and Misunderstood*, 18-20.

In extreme cases, the NOC can become a “state within a state,” responsible for huge shares of public spending – both inside and outside the oil sector.

variation among NOCs.⁸² NOCs spend most of their funds on operations and investments, and deduct this spending from tax and other profit-based obligations to the state.

At the core of this situation is a principal-agent problem, a situation in which the incentives for NOCs may not match the long-term interests of citizens. This is often especially true for those interests related to the division of public capital between the NOC and other potential uses. Like IOCs, NOCs – sometimes at the direction of government or political leaders – may have an incentive to spend as much as they can in the pursuit of the company’s or politicians’ own goals. These choices may deviate from the public’s best interest.

In extreme cases, the NOC can become a “state within a state,” responsible for huge shares of public spending – both inside and outside the oil sector. Venezuela’s PDVSA is perhaps the highest-profile example of this phenomenon. At the height of the Chavez-era oil boom, the company was spending tens of billions of dollars per year on a mix of oil-sector operations and social projects such as schools and health clinics.⁸³

Even in less dramatic cases, we have observed a persistent dynamic in our work in oil-rich states, whereby officials from ministries of finance and other central economic agencies with a broader whole-of-economy view express concern about the level of de facto spending power that NOCs enjoy, often with relatively little scrutiny.⁸⁴ This trend

indicates that many NOCs may continue spending big, because it suits the interests of their own management or the political leadership rather than the expected commercial return from these outlays.

4.3 EXPANSIONIST AGENDAS

The expansionist agenda of many NOCs is another obstacle. The most common public rationale for state investment in an NOC includes rhetoric on the importance of the state capturing a large slice of the growing proceeds of oil. For example, Sonangol’s mission is, “To contribute to the sustainability and growth of the national oil industry, in order to guarantee a greater return to the Angolan state, supporting the participation of companies and national staff in the sector’s activities for the socio-economic development of Angola.”⁸⁵

Such ambition drives the strategies of many NOCs, and ministries of petroleum and energy. An expansionist orientation tends to permeate the visions of NOCs big (Qatar Petroleum’s is “to become one of the best NOCs in the world”) and small (the Ghana National Petroleum Corporation’s is “to become a leading global oil and gas company”).⁸⁶

An expansionist agenda appears common amongst state-owned companies in general. One study finds a tendency across sectors for SOEs to “value an expanded operating scale for its own sake,” even at the expense of profitability, including by discounting the costs and risks associated with

⁸² *Ibid.*

⁸³ For a discussion of PDVSA’s role in the boom-and-bust cycle in Venezuela, see Francisco Monaldi, *The Impact of the Decline in Oil Prices on the Economics, Politics and Oil Industry of Venezuela* (Columbia University Center on Global Energy Policy, 2015), energypolicy.columbia.edu/sites/default/files/Impact%20of%20the%20Decline%20in%20Oil%20Prices%20on%20Venezuela_September%202015.pdf

⁸⁴ Countries where a version of this tension between NOCs and central economic authorities has made its way into the public discourse include Mexico (see Reuters, “Mexico Central Bank Warns Pemex Challenges Could Put Stability at Risk,” Reuters, 11 April 2019) and Malaysia (see Niluksi Koswanage and Emily Kaiser, “The Polite Rebellion of Malaysia’s Piggy Bank,” Reuters, 2 July 2012, graphics.thomsonreuters.com/12/07/Petronas.pdf).

⁸⁵ Sonangol, “Strategic Objectives,” accessed 24 July 2020, www.sonangol.co.ao/English/AboutSonangolEP/MissionAndValues/Pages/Mission-and-Values.aspx.

⁸⁶ Qatar Petroleum, “Strategy and Values,” accessed 24 July 2020, qp.com.qa/en/AboutQP/Pages/StrategyAndValues.aspx. Ghana National Petroleum Corporation, “About Us,” accessed 24 July 2020, www.gnpcghana.com/overview.html.

Of the 52 national oil companies featured in the Resource Governance Index, 62 percent demonstrated “weak,” “poor,” or “failing” performance on public transparency.

that expanded output.⁸⁷ This tendency can play out in the oil sector through incentives that reward management for expanding the scope of projects (including new exploration and other unproven investments) to bolster the influence of NOC leaders and company’s bona fides as a national champion.

This expansionist view made more sense during the years that most NOCs were founded. Indeed many, such as Sonangol and Azerbaijan’s Socar, grew tremendously over recent decades, and therefore expansionism is engrained in their institutional culture. However, this approach is at odds with the current oil market and its likely eventual decline, which calls for much more measured approaches unfamiliar to most NOCs.

4.4 WEAK ACCOUNTABILITY

Several factors prevent governments from holding NOC leaders to account. Some are inherent to state-owned enterprises across a variety of sectors – they can be called upon to mix commercial and non-commercial mandates, struggle to prioritize among various key performance indicators, and the phenomenon of being “too big to fail” insulates them from market pressures to perform.⁸⁸ NOCs face particular challenges because of the complexity of the industry in which they operate and their central role in their economies, as discussed above. In other cases, top government officials benefit from weak NOC governance, such as if NOC spending fuels the patronage networks that help keep them in power. In either case, the NOC’s public accountability is weak.

Many NOCs have strong corporate governance and benchmarking, and report extensively to their citizen shareholders – among them Colombia’s Ecopetrol and Norway’s Equinor. Many others, however, exhibit substantial shortcomings when it comes to public accountability. Of the 52 NOCs featured in the 2017 Resource Governance Index, 62 percent demonstrated “weak,” “poor,” or “failing” performance on public transparency, with NOCs in the Middle East/North Africa and sub-Saharan Africa, on average, showing the largest shortcomings.⁸⁹ This absence of transparency and accountability could enable NOCs to make irresponsible choices.

As the global energy transition introduces new complexities into the industry, the cost of deficiencies in accountability and public reporting rises.

87 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 Behaviour and Public Enterprises*, ed. R. Richard Geddes (Hoover Institution Press, 2004).

88 OECD, *Guidelines on Corporate Governance of State-Owned Enterprises* (2015), www.oecd.org/corporate/guidelines-corporate-governance-SOEs.htm.

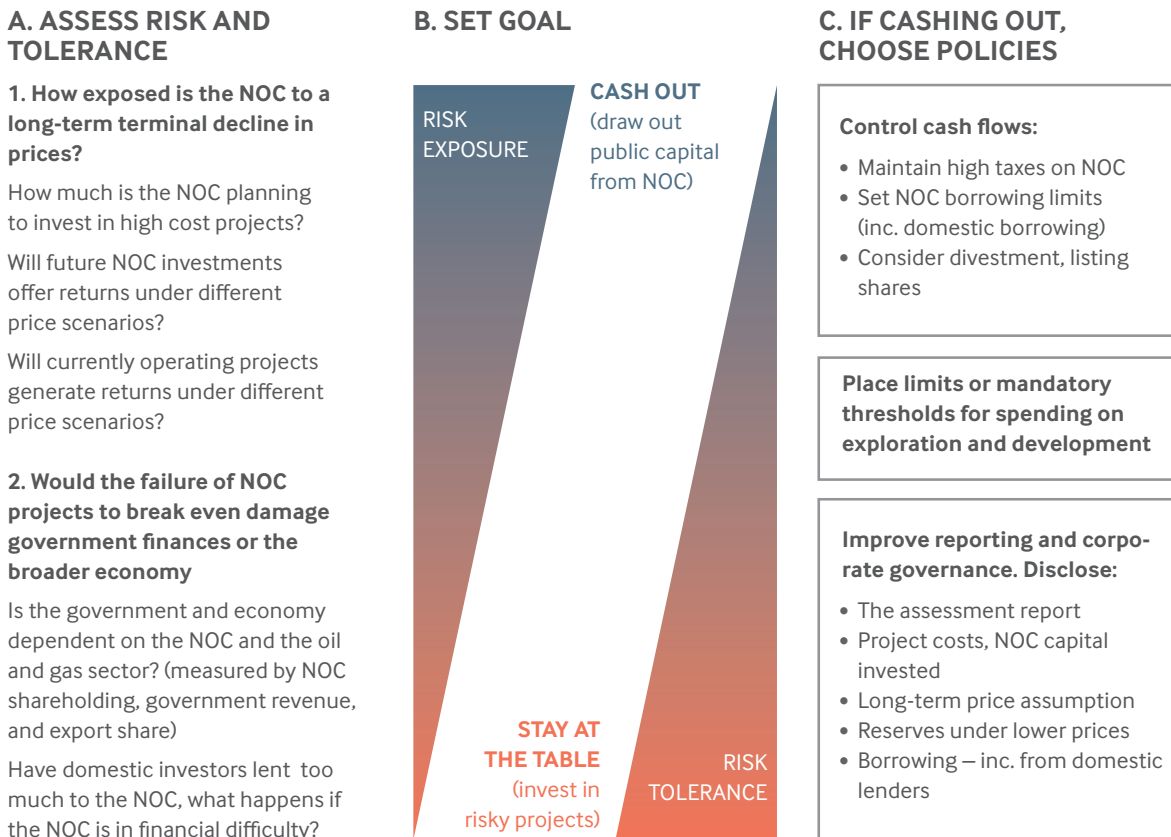
89 Natural Resource Governance Institute, *Resource Governance Index* (2017), resourcegovernanceindex.org/.

5. Recommendations

As the energy transition progresses, governments and people in oil-dependent countries should question the strategy of spending today to build to an oil-dominated future. In this section, we examine policies that governments and NOCs could

implement to optimize the allocation of public capital in the context of the energy transition. In Figure 11, we propose three steps to alter the status-quo approach to NOC investment.

Figure 11. Assessing and responding to NOC energy transition risk



Governments can no longer leave decisions on national oil company spending and borrowing entirely to the companies or petroleum ministries alone.

5.1 ASSESS COUNTRIES' EXPOSURE TO ENERGY TRANSITION RISK

The most important conclusion of our analysis is that oil and gas-producing countries—particularly those most exposed to the transition risks discussed in sections 2 and 3—should undertake systematic assessments of NOC transition risk and its broader economic implications, and mitigate risks they cannot afford. Governments—the departments responsible for decisions across the economy such as ministries of finance—can no longer leave decisions on NOC spending and borrowing entirely to NOCs or their petroleum ministries alone. Rather, governments need a systematic approach led by ministries of finance or public entities with a broad economic view, including substantial input from NOC leadership but also and rigorous public dialogue.

Such a process should begin by examining the break-even prices of projects across the NOC's portfolio, as well as the costs and likelihood of success of new exploration efforts. This will inform an analysis of how robust investments in these projects would be against a range of long-term price scenarios. Government leaders would then assess the impacts of any risks on the long-term resilience of the economy, including by asking the questions we identify in section 3, above.

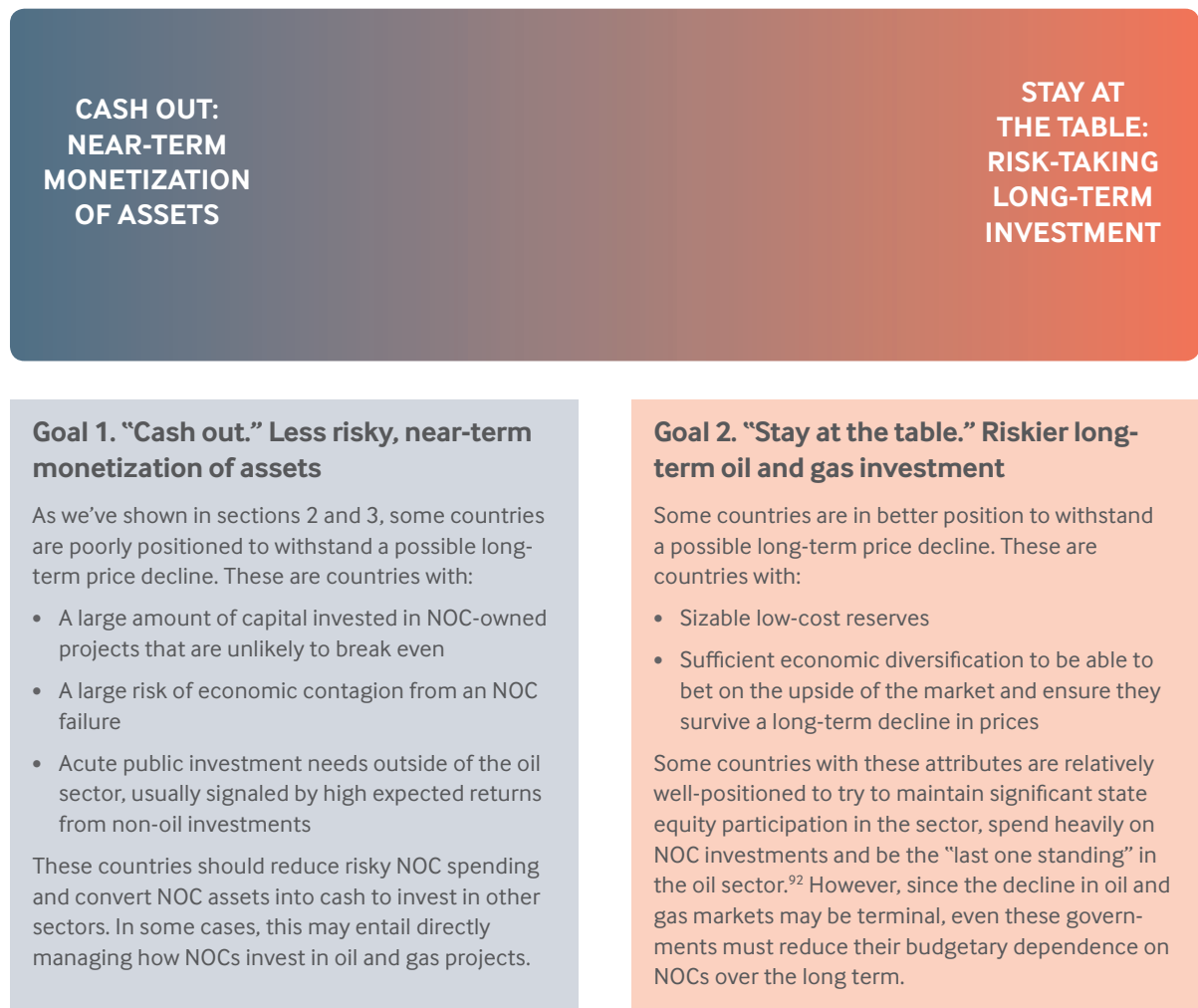
This process should incorporate the country's commitment to the Paris Agreement and any other efforts to lower its fossil fuel production. One hundred eighty-nine countries have ratified the Paris Agreement, which commits them to make nationally determined contributions toward a global effort to hold global temperature rise “well below 2 °C above pre-industrial levels.”⁹⁰ Most nationally-determined contributions from fossil fuel producers contain little or no commitment to limit supply, and various experts have argued, alternatively, that a separate supply-side treaty is necessary to limit fossil fuel production. Some experts also argue that it is inequitable to require developing- and middle-income producers to limit their production in the absence of more serious commitments from the industrialized world.⁹¹ Nonetheless, given the global significance of the issue and its political salience across producer countries, a serious discussion inside and outside of government about the climate implications of further development and its coherence with the country's climate commitments is an important component of the assessment process, alongside the economic analysis.

A risk assessment can help a government reassess the goals for the oil sector, the NOC and the economy in general, and the risks the government is willing to incur in striving for this goal. Governments would decide where the NOC should sit on the stylized spectrum illustrated in Figure 12, between two archetypical goals.

90 United Nations Framework Convention on Climate Change, *Paris Agreement*, 2015, unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf.

91 See, e.g., G. B. Asheim et. al, “The Case for a Supply-Side Climate Treaty,” *Science* 365, no. 6451 (2019); Sivan Kartha, Michael Lazurus, Kate Tempest, *Fossil Fuel Production in a 2°C World: The Equity Implications of a Diminishing Carbon Budget*, Stockholm Environment Institute (2016), www.sei.org/publications/equity-carbon-budget/.

Figure 12. Spectrum of sector goals



92 Subject to any public policy decision to reduce upstream spending in support of the country’s Paris Agreement commitments.

The decision that a government makes about where to sit on the spectrum illustrated in Figure 12 will inform how much public money a government should start pulling out of the NOC. In the next section, we focus on actions for countries on the left-hand side of the spectrum, with high risks and limited ability to bear those risks without imperiling the economy.

5.2 CONTROL CASH FLOW INTO AND OUT OF THE NOC

If the risk assessment leads the government to move toward a “cashing out” strategy of near-term monetization of NOC assets, the state could take several policy measures. Many of these measures affect the allocation of public capital between the NOC, government and other investors; and within different enterprises.

Taxes, dividends and other transfers from the NOC to the state

NOCs transfer money to the state as taxes, dividends and other types of transfers. In some cases, all oil money first goes to the state, and then the government allocates some to the NOC. We call this system of transfers the “NOC tax system.” Changes in the NOC tax system are one way for governments to accelerate monetization of oil assets and reinvest in other parts of the economy.

We argued in section 2 that governments may face calls to lower taxes on NOCs as prices decline.⁹³ Governments that want to “stay at the table” may allow an NOC to take commercial risks, develop a long-term investment strategy and reap any returns from future projects. Governments that pursue a “cash out” strategy, by contrast, might increase the required NOC transfers to the state. Such an approach reduces the opportunity for NOCs to spend.

Some governments may find the potential benefits of “cashing out” compelling. Governments could make a larger share of oil revenues available in the short term to finance investment in other sectors and bolster diversification efforts, while reducing the incidence of public spending on high-cost projects that may ultimately fail to break even.

Borrowing limits

Another approach to reallocating capital involves limiting how much NOCs borrow. We argued in section 3 that the risks that NOC debt imposes on their home economies are growing more severe as the energy transition threatens NOCs’ abilities to repay their loans. This is particularly true where the expectation of a bailout creates a moral hazard that encourages an NOC to borrow more than it otherwise would.

As such, governments facing severe transition risk may want to place limits on their NOC’s ability to borrow. This could take several forms, each with its advantages and disadvantages:

- Overall ceilings on allowable borrowing. Either in overall dollar terms or as a function of debt sustainability ratios. For example, debt as a share of operating cash flow
- Requirements of government approval of NOC borrowing above a threshold
- A weaker form of limit than a strict ceiling
- Limits on borrowing from domestic lenders or state-owned banks. Where domestic investors have already invested heavily in oil and related sectors or the risks of contagion across the domestic economy are high
- Restrictions on the terms of borrowing. To which NOCs are allowed to agree, in order to limit the risk of burdensome repayment terms

93 Mexico’s response to the coronavirus market crash offers a case in point that may be replicated in other contexts with a long-term decline. See Sheky Espejo and Gary Gentle, “Mexico Cuts Pemex Taxes to Cope with Crisis,” *S&P Global Platts*, 2 April 2020.

Divestments

The sale of shares of the NOC or specific NOC assets is a third way to control how much public capital sits in the oil industry. Going forward, countries with upstream assets at risk of not breaking even may consider requiring their NOCs to divest shares and assets to investors and partners able to tolerate greater risks.

Selling shares of the NOC is a direct way to sacrifice a portion of potential future profits in return for a payment today. As is noted above, twelve NOCs today trade shares on public exchanges. Saudi Aramco—better positioned in the oil market than any other NOC—has recently entered this club. In 2019, it listed 1.7 percent of its shares on the Tadawul, the Saudi Stock Exchange; a small amount that may pave the way for greater divestment.

Listing shares on a stock market can also strengthen the governance of an NOC, which can help the NOC during the energy transition.⁹⁴ Partial privatization is no panacea for governance challenges, however, as the Petrobras corruption scandal illustrates powerfully. Nor is selling shares viable everywhere.⁹⁵

As an alternative, some NOCs sell subsidiaries or specific assets— of their own volition or under pressure from their governments. During the price downturn of 2014 to 2016, NOCs,

including Colombia’s Ecopetrol, sold assets in non-core businesses and farmed out uncompetitive production assets.⁹⁶ In 2020, in the face of severe financial pressures, Angola’s Sonangol began selling shares from 81 companies it owns (some of which are in non-oil assets such as hotels and aviation).⁹⁷ Some of the major IOCs, ExxonMobil especially, are also following a similar strategy: selling assets in high cost, maturing or political risky areas to focus on a smaller set of mainly large projects.⁹⁸

5.3 MANAGE OR INCENTIVIZE NATIONAL OIL COMPANY INVESTMENT DECISIONS

In addition to adjusting taxes, limiting borrowing and divestments, government can also influence how much the NOC spends on various oil projects. A government has two options: impose additional rules on the NOC, or incentivize NOC management to change behavior but otherwise allow management to make its own decisions. It is not a straightforward choice. Increased government influence on these decisions carries risks. Experts have long emphasized that commerciality and efficiency should be the principal drivers of NOC decision-making. They have counseled that excessive government influence over operational decisions impedes performance and exacerbates governance risks.⁹⁹ Therefore, we do not advise that government leaders directly involve themselves in

94 Patrick Heller, Paasha Mahdavi, Johannes Schreuder, *Reforming National Oil Companies: Nine recommendations*, Natural Resource Governance Institute (2014), resourcegovernance.org/sites/default/files/documents/nrgi_9recs_summary_web1.pdf.

95 In some countries such as Mexico – where public ownership of the oil sector is built into the constitution – privatization is a complete non-starter politically. In others, the cost and complexity of listing shares represent burdens that governments are unable or unwilling to bear. Most NOC privatizations have taken five to ten years to achieve. See Christian Wolf and Michael Pollitt, “Privatising National Oil Companies: Assessing the Impact on Firm Performance,” *Cambridge Working Papers in Economics* 0811 (2008): 11.

96 David Biller and Andrew Wills, “Colombia’s Ecopetrol May Farm Out Oil Production Stakes in 2015,” *World Oil*, 20 April 2015, www.worldoil.com/news/2015/4/20/colombia-s-ecopetrol-may-farm-out-oil-production-stakes-in-2015.

97 Noah Browning, “Angola’s Sonangol to Begin Selling Assets in April,” Reuters, 28 February 2020, www.nasdaq.com/articles/angolas-sonangol-to-begin-selling-assets-in-april-2020-02-28.

98 Kathy Hipple and Tom Sanzillo, *ExxonMobil’s Planned Assets Sales: Another Strategic Misstep*, Institute for Energy Economics and Financial Analysis (2020), ieefa.org/wp-content/uploads/2020/04/ExxonMobil-Planned-Assets-Sales-Another-Strategic-Misstep_April-2020.pdf. Jordan Blum, “Big Oil majors looking to sell \$27 billion in assets worldwide,” *Houston Chronicle*, 18 November 2019, www.houstonchronicle.com/business/energy/article/Big-Oil-majors-looking-to-sell-27-billion-in-14842981.php.

99 See, e.g., OECD, *Guidelines on Corporate Governance of State-Owned Enterprises*. This emphasizes the need for independent commercial decision-making free from political or bureaucratic interference. See also David R. Hults, “Hybrid governance: state management of national oil companies,” in *Oil and Governance*, ed. David G Victor, David R. Hults, Mark C. Thurber, 62-120 (Cambridge: Cambridge University Press, 2011). This work emphasizes the consequences of excessive state ex ante control over decision-making.

project-level decisions. Governments do, however, play a central role in setting the strategic priorities of their NOCs, and as such have an important role to play in defining limits. In addition, governments may want to set clear thresholds to which NOC leaders must adhere in making investment decisions. Here we discuss the three main areas in which governments could act.

Limiting state equity in projects, or prioritizing carried interest arrangements

Governments and NOCs pursuing the development of new oil projects decide whether the NOC should take an equity stake—and if so, how large it should be—or to leave the project in the hands of IOCs. (See Box 4 for various forms of IOC-NOC cooperation.) The prospect of structural decline makes state participation in projects riskier, and a government that decides to pursue a “cashing out” strategy should consider avoiding equity in new projects and/or reducing equity in existing projects. This may reduce the share of upside that the state and the NOC may capture if long-term prices exceed expectations, but it also reduces the state’s exposure to downside risks.

Alternatively, states may prioritize carried interest arrangements for their equity stakes. Many NOCs pay for the contributions to project investment by agreeing carried interest arrangements with their IOC partners. Effectively, the IOCs lend the NOC money to pay for NOCs’ share of capital. The IOCs “carry” the NOCs’ shares.

Governments could encourage or even require NOCs to use rely more on carried interest arrangements, as they often shift risk to IOCs. Such arrangements limit the NOC’s (and therefore the country’s) risk of spending money upfront on projects that ultimately fail to break even. As such, governments can use them to limit how much NOCs are exposed to a structural decline in prices.

Increasing the share of projects financed with carried interests will not be easy for governments to achieve. Increasingly, IOCs are encouraging NOCs to pay for their positions from cash, without any carried arrangement. And IOCs are likely to encourage greater equity participation from governments as the oil sector evolves as the risk facing IOCs increases.¹⁰⁰ This helps IOCs in two ways. First, because in return for NOCs taking larger equity positions, IOCs may be able to be able to negotiate lower taxes. IOCs are likely to prefer this because most taxes have to be paid before dividends are paid to shareholders. Second, having governments as equity partners, they may offer a cheaper form of equity capital than other investors who may demand greater governance standards and dividends.

Carried interest arrangements are no cure-all, and can end up being costly for a country. This is because the NOC usually pays back the carried interest by deducting amounts from IOCs’ production share or other payments to the NOC. These are paid only once the project is producing. IOCs seek compensation for this extra risk by increasing the effective interest rate. These payments may be senior to some other tax obligations, and could therefore result in the government receiving much less revenue after first paying off the carried interest. This can be problematic, as there has long been a tendency for new producers to over-estimate the revenues likely to come in from oil, only to find that actual revenues are smaller and later than they had anticipated.¹⁰¹ The prospect of a structural price decline raises these “presource curse” risks, especially if NOCs spend or borrow in anticipation of returns from projects that ultimately prove unsuccessful.

¹⁰⁰ Pedro van Meurs, “The Future of Petroleum Contracts,” *Chatham House/NRGI New Producers Group*, 29 October 2020.

¹⁰¹ David Mihalyi and Thomas Scurfield, “How Did Africa’s Prospective Petroleum Producers Fall Victim to the Presource Curse?” World Bank, Policy Research Working Paper, no. 9384 (2020), openknowledge.worldbank.org/handle/10986/34470.

There is more than enough oil and gas already discovered to burn far past the world's carbon budget, and more than enough even to meet projected demand up until 2040.

Exploration

There is more than enough oil and gas already discovered to burn far past the world's carbon budget, and more than enough even to meet projected demand up until 2040.¹⁰² This has prompted some countries to ban further exploration.¹⁰³ In the midst of the coronavirus pandemic and with the potential for long-term price decline, many oil companies have cut exploration spending significantly.

Despite these factors, even if there is no environmental justification, companies may continue to engage in exploration for commercial reasons. A great deal of the discovered resources are in fields that are costly to develop, so oil companies want to find cheaper ones.¹⁰⁴ Internationalized NOCs, such as Petronas and Qatar Petroleum, are increasing their participation in international exploration partnerships as they seek economic resources beyond their shores. Other NOCs are seeking cheaper assets at home to bring down their future development costs.

Over the past five years, about five percent of NOCs' total capital expenditure has been on exploration, and NOCs have contributed only 19 percent of global exploration expenditure.¹⁰⁵ However, this spending is the riskiest kind of investment companies make. Geological risk means that most exploration efforts do not result in a discovery. For example, only one in ten wells drilled results in a commercial find.¹⁰⁶ Even when a company does find oil or gas, it takes many years to make a return.

The economic impacts of exploration risk may be particularly severe for new producer countries or countries that produce relatively small amounts of oil, because a small number of exploration failures can consume a significant share of today's revenues. Ghana National Petroleum Corporation (GNPC), for example, earmarked fifteen percent of its 2018 budget for "exploration and appraisal projects." This included efforts by GNPC to find new onshore petroleum and to build toward a goal of becoming an independent operating company.¹⁰⁷ GNPC is pursuing this goal at the government's direction, in order to learn by doing and build toward becoming an industry leader. However, if time is running out for the oil industry in general, is it worthwhile for GNPC and similar NOCs to develop their expertise?¹⁰⁸

As governments and NOCs consider spending on exploration, significant scrutiny is warranted on four fronts: 1) the likelihood of exploration success in light of geology, 2) the expected revenues from discoveries under various price and production scenarios, 3) the NOC's and government's tolerance (both political and economic) for potential failure, and 4) the opportunity cost of these efforts. The last is perhaps the most important consideration: the government must ask whether it can afford to spend public money on high risk experiments when there are many other useful ways to spend the money.

102 Christopher McGlade and Paul Etkins, "The geographical distribution of fossil fuels unused when limiting global warming to 2 °C," *Nature* 517 (2015): 187-190, doi.org/10.1038/nature14016; Wood Mackenzie, *Exploration's future in a low-cost, low-carbon world*, 4.

103 Though the most prominent examples are Ireland and New Zealand, which have less prospective geology and less need for the extra income.

104 Wood Mackenzie, *Exploration's future in a low-cost, low-carbon world*, 4.

105 Authors' calculations based on Rystad Energy UCube.

106 Daniel Fletcher, BP, *Executive Course on Oil, Gas and Mining Governance*, 10 September 2019.

107 Ghana Public Interest and Accountability Committee, *Annual Report on the Management and Use of Petroleum Revenues for the Period 2018* (2019): 92 – 94, www.piacghana.org/portal/files/downloads/piac_reports/piac_2018_annual_report.pdf.

108 While exploration will continue, hiring private companies to take manage this risk may be more appropriate for most NOCs. Even hiring others to explore carries risk, however, where the NOC is contributing financially to the efforts. 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)

Project development

About 80 percent of capital in the oil and gas industry goes into developing projects.¹⁰⁹ These are the most critical projects for most governments to examine and to assess whether future prices will clear the break-even price. High-cost projects that are yet to be developed, and so will run furthest into the future, are most exposed to a structural decline in prices. Investments in currently-operating projects are sunk. To recover its capital, an NOC must hope that the project returns enough or it must sell the project to another company. Instead, governments have some control over investments in new projects. Thus, government and NOC scrutiny should focus on NOC plans to develop the next generation of oil and gas projects.

To systematize this scrutiny, a government could select a threshold break-even price or investment hurdle rate based on the risk assessment described in section 5.1, and prevent the NOC from embarking upon new investment in projects that do not meet the prescribed thresholds. A slightly more flexible option would be to allow NOCs to spend on projects with break-even prices above the threshold, but only upon a detailed explanation of their economic rationale following a standard format. Creating such a system would be complicated—not least, because many development projects are subject to contractual obligations with IOC partners—and requires additional research and consultation. But for countries facing severe risks, the status quo approach to project spending is no longer viable, so thorough examination of new approaches is essential.

While we have focused on NOCs' investments, the operating expenses is also a significant area in which NOCs spend money, and could be reduced.

5.4 BENCHMARK PERFORMANCE AND IMPROVE CORPORATE GOVERNANCE

A strong commitment to transparency and corporate governance underpins all of these policies. Opacity and poor governance have long impeded the performance of many NOCs, limiting the returns they generate for the public. Of the 52 NOCs studied in the 2017 Resource Governance Index, 62 percent exhibited “weak,” “poor” or “failing” performance on public transparency.¹¹⁰ Disclosures around NOC expenditures are particularly weak, with fewer than half of the 71 NOCs included in the National Oil Company Database publishing sufficient data on their capital expenditures.¹¹¹

During boom times, poor governance often goes unnoticed, and high prices help governments paper over the public resources being wasted. However, if the energy transition progresses in line with the Paris Agreement and the oil and gas sector faces declining profits, then inefficiency, waste and unaccountable risk-taking become even harder for the country to afford. The key tools for NOC governance are well established, if not always used: a clearly defined mandate for the company, clear investment criteria, accurate and timely reporting, well-qualified and independent boards and strong management accountable for their performance against clear benchmarks.¹¹²

¹⁰⁹ Based on average of projects globally, using Rystad Energy UCube.

¹¹⁰ Natural Resource Governance Institute, *Resource Governance Index 2017*.

¹¹¹ Heller and Mihalyi, *Massive and Misunderstood*, 55.

¹¹² Glada Lahn, Valérie Marcel, John Mitchell, Keith Myers and Paul Stevens, *Good Governance of the National Petroleum Sector*, Chatham House (2007), www.chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20and%20Development/gginterim_report.pdf; OECD, *Guidelines on Corporate Governance of State-Owned Enterprises*; and Patrick Heller, Paasha Mahdavi, Johannes Schreuder, *Reforming National Oil Companies*.

The additional risks of the energy transition amplify the importance of strong corporate governance. The foregoing analysis illustrates the central impact that NOC capital allocation decisions will have on the long-term resilience of their nations. Many governments are endowing their NOCs with new roles, including in the generation and distribution of clean energy.¹¹³ As a company takes on new roles, goals and benchmarking will remain muddled without rigorous efforts to define the company's responsibilities and limits, and to establish clear measures of success.

What NOCs report to the government, their boards and the public is important. Public reporting, including on spending, at a level of detail sufficient to enable governments, legislators and citizens to scrutinize NOC leadership for their actions – is critical element.¹¹⁴ Much of this kind of reporting is almost unheard of today among most NOCs, and rare even among IOCs.

As some IOCs assume lower oil prices and announce write-downs in the value of their assets, NOCs may have to do the same. Disclosing

information on the assumptions underpinning the valuation of NOC assets, most of which are usually reserves, is crucial here. This includes:

- Company long-term price assumptions and scenarios
- Break-even prices for upstream projects (current and projected)
- Carbon intensity of production (including flaring and venting) – the NOC's scope 1, 2, and 3 emissions¹¹⁵

More detailed expenditure reporting is another element:

- Expenditure on exploration (current and forecasts of required or projected future spending)
- Expenditure on appraisal and development of pre-production assets (current and projected)
- Expenditure on brownfield sites
- Expenditure on refineries, pipelines and other infrastructure linked to assumptions about future production (current and projected)¹¹⁶

113 Valérie Marcel, "National Oil Companies of the Future," *Annales des Mines – Responsabilité et Environnement* 95 (2019), 133 – 136.

114 Looking across NOCs, David Hults found that ex-post scrutiny of NOC actions, combined with clear benchmarking standards, is a more effective tool for NOC performance against public goals than extensive government or public involvement in decision-making. David R. Hults, "Hybrid governance: state management of national oil companies." For a more detailed discussion of potential transparency measures that could enhance public accountability of NOC climate-related financial risk, see Sian Bradley, *Transparency in Transition: Climate Change, Energy Transition and the EITI*, Chatham House (2020), www.chathamhouse.org/publication/transparency-in-transition-eiti-bradley.

115 Hans Hoogervorst, "Speech: IASB Chair on what sustainability reporting can and cannot achieve," Climate-Related Financial Reporting Conference, Cambridge University, U.K., 2 April 2019, www.ifrs.org/news-and-events/2019/04/speech-iasb-chair-on-sustainability-reporting.

116 Carbon Tracker, *Reporting for a Secure Climate: A model disclosure for upstream oil and gas*, 2019, carbontracker.org/reporting-for-a-secure-climate-a-model-disclosure-for-upstream-oil-and-gas.

Conclusion

No one knows how the energy transition will unfold. But evidence of a growing transition away from fossil fuels continues to mount. This transition may take much of this century, allowing oil-producing countries and their NOCs to continue making money on the next round of investment. Or the transition could be much quicker, with a decline in prices that kills the returns on companies' next round of investments. Our analysis indicates that the risk of a fast transition and its impact on producing countries is significant. NOC managers and government officials should be concerned, as their counterparts at some IOCs increasingly are.

NOCs play multifaceted and complex roles in their economies, from managing IOC contractors to serving as quasi-regulators to providing public services. The prospect of structural decline poses particular challenges in their roles investing in commercial projects and spending public revenues in the upstream. Over the next decade, if NOCs are particularly optimistic about the future, they might invest more than \$400 billion in new, high-cost projects. These projects will only generate a return if fossil fuel consumption remains high enough that global emissions far exceed the world's carbon budget—the level required to meet the Paris Agreement and keep the global temperature rise well below 2°C.

There is still time for governments to change course. We detailed policies ranging from controlling cash flows in and out of the NOC to reducing state equity to imposing closer limits on specific investments by NOCs. Some countries must react more significantly than others. Our study suggests that in absolute terms, NOCs from China, Russia and India are most exposed. These NOCs would spend more than half of the potential capital from all NOCs that would fail to break even in lower-price scenarios.

Analyzing the risks associated with NOC investment portfolios requires examining the size and costs of their upcoming investments, their

indebtedness and the dependency of governments on their revenues. By these measures, countries and their NOCs in Africa, Eurasia and Latin America are most exposed to the energy transition. In terms of the next generation of oil and gas investment, NOCs in the Middle East are the safest from a cost perspective. Unfortunately, governments in this region are also the most dependent on oil revenues, so countries there must still contend with the energy transition. South and Southeast Asian countries and their NOCs do not appear to be as exposed as others.

The potential failures of NOCs matter most for the governments that are most dependent on their NOCs for revenue. To fulfill their ambitions to grow their NOCs or even to maintain production, some African countries are in a particularly concerning position: Algeria, Angola, Mozambique and Nigeria, and to a lesser extent Ghana and Tunisia. Some countries are also weighed down by high debts. Mexico's Pemex one of the most indebted without having particularly low-cost oil. Other Latin American NOCs—Ecopetrol and Staatsolie—are also exposed in this way.

By themselves, it is unlikely that NOCs will manage the risk that the energy transition poses to their economies as currently structured. However, in many cases, the decision of how much public money is invested in oil is made by NOCs themselves, not the government nor the public. Instead, the task of breaking out of the status quo falls to government—presidential offices, ministries of finance and planning—and public accountability bodies.

Further research will be key to understanding the coming effects of the energy transition, the differential exposure of oil and gas assets, as well as the dynamics of taxation and costs. However, it is clear that governments and the public must act now to change their relationship with their national oil companies.

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Correction notice: In a previous version of this report, we stated we used a ten year government expenditure figure to calculate the Value at Risk as a % of Government Expenditure, shown in table 5. This is incorrect. We used a one year government expenditure figure.

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