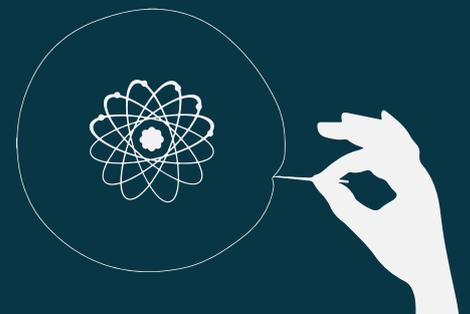


June 2022

Unburnable Carbon: Ten Years On

The financial markets are still enabling a carbon bubble



About Carbon Tracker

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

www.carbontracker.org | hello@carbontracker.org

About the Authors

Thom Allen – Oil, Gas & Mining Analyst

Thom joined Carbon Tracker 2021 working on the emissions and methane reduction targets of the oil and gas industry, demand scenarios, and the financial risks posed to fossil fuel companies by the energy transition.

Prior to joining Carbon Tracker, Thom worked as an exploration geoscientist for INEOS and as an analyst for Deloitte.

Thom has an MSci in Geology from University College London and an MSc in Petroleum Geoscience from Royal Holloway, University of London.

Mike Coffin – Head of Oil, Gas and Mining

Mike joined Carbon Tracker in 2019, and now leads the oil, gas and mining research team, focussing on identifying transition risk within the oil and gas industry. He has authored reports on transition risk at the company level, alongside writing on company climate ambitions in *Balancing the Budget* and the *Absolute Impact* series. Other research themes include country risk and executive remuneration.

Prior to joining Carbon Tracker, Mike worked as a geologist for BP for 10 years on projects across the upstream value chain, from early access to development. Mike has experience working in petroleum basins across the world, including time spent working in Norway, with expertise in unconventional exploration and in leading technical project teams.

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

Thanks to the wider Carbon Tracker team, Ed Vaughan and FFI Solutions

Table of Contents

01	Key Findings	4
02	Foreword	6
03	Executive Summary	9
04	Introduction	15
05	Impact on Global Temperature Rise	21
06	Transition Risk Exposure	30
07	Paris Alignment	39
08	Recommendations for Stakeholders	42
09	Appendix - Methodology	45

An aerial photograph of a logging operation in a forest. The image shows a dirt road with several large stacks of cut logs on either side. A logging truck is visible on the road, and another truck is parked near a stack of logs. The forest is dense with trees, and the overall scene is in black and white. A large, dark, semi-transparent graphic of the letters 'OT' is overlaid on the right side of the image.

OT

Key
Findings

- ✓ **To limit warming to 1.5°C, 90% of fossil fuel reserves must remain in the ground as unburnable carbon.** We calculate the total carbon potential (embedded emissions) of known fossil fuel reserves as around 3,700 GtCO₂ – over ten times the remaining carbon budget. Limiting to 2°C will need around 60% of discovered reserves to stay in the ground. If all reserves were produced, this would lead to a devastating temperature rise in excess of 3°C.
- ✓ **The majority of this unburnable carbon is held by companies listed in just a handful of global financial centres.** Embedded emissions of companies on Chinese stock exchanges represent over 70% of the remaining global carbon budget to 1.5°C. Partial listings of state-owned companies in Shanghai, Shenzhen and Hong Kong are equal to over 230 GtCO₂. This is followed by the United State of America with around 159 GtCO₂ listed between the New York Stock Exchange (144 GtCO₂) and the NASDAQ (15 GtCO₂).
- ✓ **Adjusting for state/restricted ownership reveals New York, Moscow, Toronto and London as the financial centres with the highest embedded emissions from upstream oil and gas companies over which investors have influence.** Shanghai, Mumbai and Sydney “top” the table in terms of publicly-tradable coal reserves. We calculate that discovered reserves of companies with a public listing are equal to around 1,050 GtCO₂.
- ✓ **Despite some having set “net zero” goals, these financial centres enable the ongoing activities of the incumbent fossil fuel industry, in many cases to a far greater degree than national reserves.** For example, the emissions embedded on the London Stock Exchange (47 GtCO₂) are 30 times greater than those of the UK’s reserves (1.5 GtCO₂). In this light the LSEG’s “net zero” goal is somewhat questionable if the organisation continues to facilitate the activities of companies that are so clearly unaligned with global climate goals.
- ✓ **Listed companies are exposed to significant transition risk.** Over \$1 trillion of upstream oil & gas assets risk becoming stranded; the majority, some \$600 billion, is held by listed companies. Policy action on climate and the rise in alternative energy sources increases the financial risk for the companies listed on these exchanges. As both investor awareness of these risks and the assets under management with exclusionary or alignment mandates grows, share prices may be further impacted with knock-on implications for investors.
- ✓ **Energy transition risks apply not just to producers, but across the full oil and gas value chain (e.g. refiners) as well as a wide range of different financial services providers.** For example, banks, insurers, auditors all derive income from the sector; economies of cities overly reliant on enabling fossil fuel production are exposed to changing demand alongside potential regulatory risk.
- ✓ **Policymakers must view the facilitation of new fossil fuels as contrary to achieving national climate goals.** We outline a series of recommendations for them, regulators and for investors to actively engage with investee companies.

A grayscale photograph of an industrial facility, likely a refinery or chemical plant, with several tall smokestacks emitting thick plumes of white smoke into a cloudy sky. A large, dark blue number '02' is overlaid on the right side of the image, partially obscuring the sky and the top of the smokestacks. The number is bold and sans-serif.

02

Foreword

In the decade since our original Unburnable Carbon report was published, much has changed and yet nothing has changed. The concepts introduced by the report of *unburnable carbon* and the *carbon bubble* are widely acknowledged, while the risks of *stranded assets* are firmly established in financial language and regularly referenced by companies, investors and policymakers. Financial stranding risks are increasingly being recognised outside the upstream oil and gas industry.

The Paris Agreement was signed in 2015 and recommendations by the Task Force on Climate-related Disclosures (TCFD) have gained widespread acceptance as a global standard, and more extensive standards are being developed by the EU, the U.S. Securities and Exchange Commission and the IFRS's International Sustainability Standards Board. There is an ever-increasing desire among asset owners to align their investments with "net zero"; for example, at COP26 the Glasgow Financial Alliance for Net Zero (GFANZ) was launched with \$130 trillion of assets now committed to net-zero investor pathways. Alongside this, a range of climate change disclosure regulations are appearing around the globe. However, our core recommendation from 2011, that the carbon potential of companies' listed reserves be reported, has not been adopted to date.

The science, numbers and expectations have also moved on. In 2011 the focus was on not exceeding 2°C of warming, and the headline remaining carbon budget for staying within 2°C was assessed as 565 GtCO₂ for the 40 years to 2050 at an 80% chance of success. Now, post-Paris and the IPCC's special report on the impacts of global warming of 1.5°C, there is growing ambition to limit global temperature rise to 1.5°C. Accordingly, our focus here is on the remaining carbon budget to 1.5°C, which we assess to be 322 GtCO₂, at a 66% chance of success. Over the past decade, the remaining "safe" carbon budget has nearly halved. By 2021, the global average temperature rise had already reached 1.1°C, with some regions disproportionately impacted.¹

This report shows the absolute urgency for governments to act; for regulators to intervene; and for investors to do their job of analysing and managing risk.

Firstly, governments need to ensure that the debt and equity markets themselves are aligned with net zero and this has to start with no more coal, oil and gas IPOs or bond placements. If the companies already listed in London and New York cannot burn what has already been financed, where is the compelling case to finance even more? An urgent moratorium and then a ban is needed. Secondly, companies of the fossil fuel system are making financial disclosures where the assets of this system are assumed to be "going concerns" with no risk of asset impairment or write-down. Regulators need to urgently give guidance to auditors on this. The presumption must be that the assets of the fossil fuel system, its coal mines, oil wells and so forth, are written down, now, in line with a 1.5°C trajectory. Lastly, sell and buy side analysts depend on outdated financial models and implausible scenarios where the fossil fuel system continues on a "business as usual" path. This must not continue. They need to publish stress tests which show – as the science demands – how a 50% cut in emissions in the next decade will tear apart the architecture of the fossil fuel system and where de-rating is properly reflected in asset prices.

The first carbon bubble report was written as an appeal for regulators to intervene and ensure the world's key capital markets are stable and resilient to the clearly rough times ahead. With the evidence set out in this report, we can be no means certain that - even with excellent initiatives such as the TCFD and GFANZ - that the regulatory course has been corrected for a safe climate outcome.

1 Climate Change 2021: The Physical Science Basis, IPCC (August 2021).

As this report goes to publication, we note that the UN's "Race to Zero", the umbrella organisation for climate initiatives including the Glasgow Financial Alliance for Net Zero (of which I am an Advisory Board member), was "*naming the implicit requirement to phase down and out unabated fossil fuels as part of a global just transition*" and that in practice "*this means corporations and investors must restrict the development, financing and facilitation of new fossil fuel assets, which includes no new coal projects.*" As there is no viable abatement for oil and gas, we need to see this embraced for all fossil fuels. Let's hope that by the time of our next Carbon Tracker bubble review, this has indeed been the case.

Mark Campanale

Founder & Executive Chair

A large-scale mining operation is shown in a black and white photograph. In the background, a massive open-pit mine is visible, characterized by its terraced, stepped walls and a network of conveyor belts and roads. The foreground shows a dirt road with a large dump truck and an excavator. The overall scene is industrial and rugged.

03

Executive Summary

Our original *Unburnable Carbon* report (2011) showed for the first time that there were far more fossil fuel reserves around the world than could be burned whilst meeting global climate goals – with huge implications for financial markets. The report introduced the terms *unburnable carbon*, *stranded assets* and the *carbon bubble* into the lexicon and established finance at the heart of the climate change debate.

Growing awareness of the challenge, yet time is rapidly running out for concrete action

Over ten years on, the Earth's carbon budget is nearly entirely exhausted, and although the shape of the debate has moved substantially – oil companies regularly discuss stranded assets in their reporting, and mandatory carbon disclosure rules are appearing around the world – we find that financial markets are still heavily entrenched in the fossil fuel system.

The quantum of emissions embedded in the Earth's known fossil fuel reserves has increased from 2,800 to 3,700 GtCO₂; that held by companies listed in the world's financial centres has increased from 750 to 1,050 GtCO₂.² Despite growing recognition of the problem, current global actions are implicitly accepting a higher likelihood of ecological disaster.

Global financial centres play a key role in enabling continued fossil fuel production and expansion

The global distribution of fossil fuels – and by implication a degree of responsibility for the resultant emissions – is typically considered by either the geographical location in which they are physically produced or, particularly for national carbon accounting purposes, where they are consumed. In this report, however, we explore the global distribution of fossil fuel reserves by the financial centres in which they are listed³, where cash flows are generated from the global extraction of fossil fuels and valued by investors as a result.

As with the first report, we again highlight the role of listings authorities; the admissions panels of stock exchanges; the bankers who prepare prospectuses; and regulators responsible for overseeing the content of both bond and equity prospectuses.

This approach cuts across traditional narratives of carbon accounting and highlights those financial centres that play an outsized role in bringing this unburnable carbon to market and, in doing so, facilitate their extraction.

To limit warming to 1.5°C, 90% of fossil fuel reserves must stay in the ground as unburnable carbon

At the start of 2022, only 320 GtCO₂ remained of the IPCC's carbon budget for a 66% chance of limiting global warming to 1.5°C above pre-industrial times. With current rates of emissions around 40.5 GtCO₂ year this remaining budget will be exhausted by 2030 - in under 8 years' time.

² 2011 analysis was based on the top 200 listed companies by embedded emissions, the top 200 companies in 2021 accounted for 1,025 GtCO₂ of embedded emissions or 97% of the total.

³ For simplification new we have amalgamated stock exchanges by the financial centres in which they are located, for example, the New York Stock Exchange and the Nasdaq Stock Exchange are both included under the financial centre of New York. See table in Appendix for full listing.

We calculate the total carbon potential (“embedded emissions”) of known fossil fuels, based on Proved Reserves from bp’s Statistical Review of World Energy 2021⁴, as around 3,700 GtCO₂ or over ten times the remaining 1.5°C carbon budget. Limiting to 2°C will need around 60% of discovered reserves to stay in the ground. If all reserves were produced, this is predicted to lead to a devastating temperature rise in excess of 3°C.

The embedded emissions in the reserves of listed companies alone will take the world to 2°C

Staying within the goals of the Paris Agreement will require a large share of already-discovered fossil fuels to stay in the ground. Even the subset of emissions embedded within the reserves of listed companies would take the world far beyond 1.5°C if released - we calculate that discovered reserves and resources of companies with a public listing (1,050 GtCO₂) are similar to the entire remaining 2°C budget (1,070 GtCO₂).

Of course, private and state-owned companies also hold significant reserves too. So, unless new oil and gas production projects are halted and existing coal developments leave resources in the ground, then Paris carbon budgets will be exceeded, with disastrous and costly consequences.

The question for investors in listed companies is two-fold. First, to what extent are those investments facilitating the continued release of CO₂ (and other greenhouse gases) into the atmosphere driving global warming, and does that fit with any investment mandate or is in the interests of beneficiaries? Second, what financial risk does the energy transition – whether driven by policy action on climate, or by rapidly growing non-fossil/renewable energy sources – pose to current (and proposed) business models? How are the value of investments in those companies impacted as a result?

For the financial centres that enable these companies’ activities, these two questions are still highly relevant. For countries seeking to align with Paris’ goals, is it appropriate to be enabling the extraction of fossil fuels in excess of climate limits? What are the risks to financial centres from a global reduction in fossil fuel consumption, not just from reduced investment directly, but across the broader financial services industry that supports the activities of those companies and benefits from the secondary trading of shares?

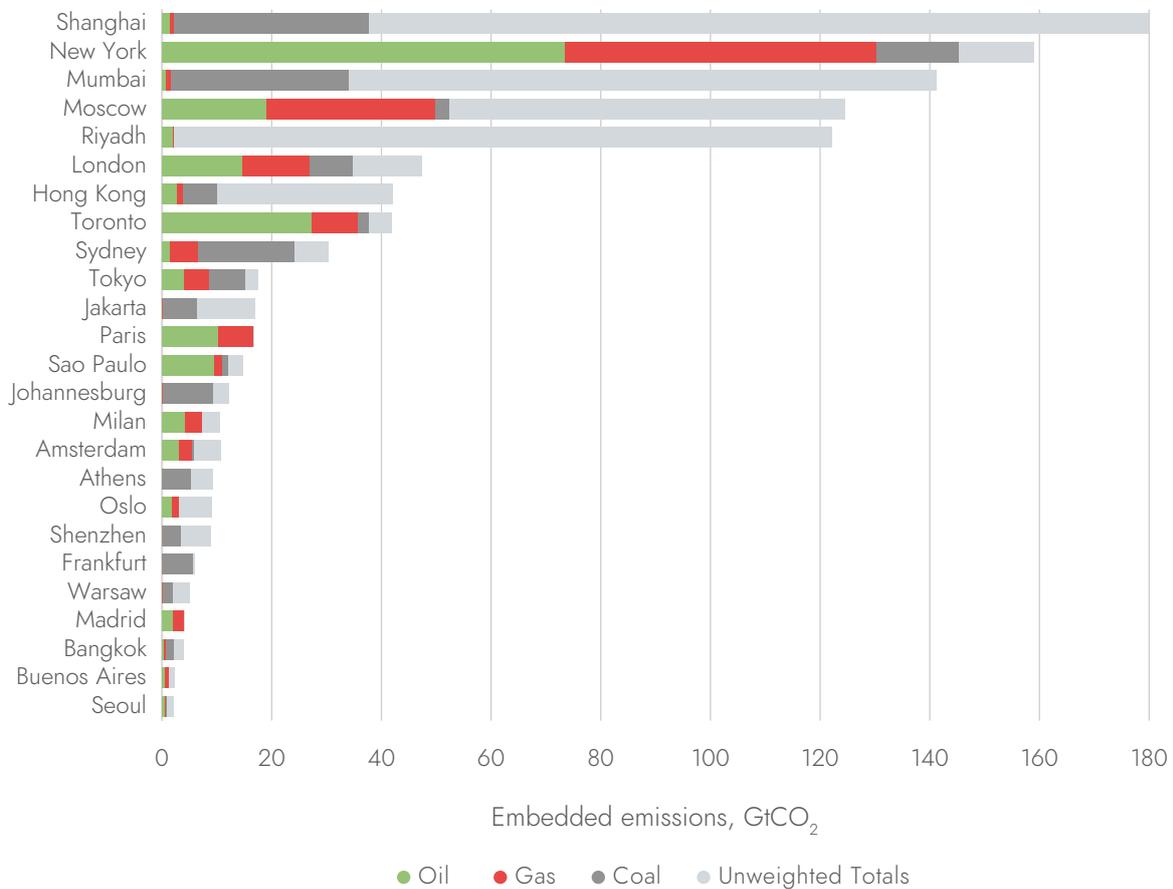
Adjusting for state/restricted ownership reveals New York, Moscow, Toronto, and London as the financial centres with the highest embedded emissions from oil and gas producers

We find that the majority of embedded emissions are listed on the stock exchanges of China, USA, India, Russia and Saudi Arabia where, with the exception of the USA, emissions are dominated by the partial listings of state-owned companies. These listings provide a source of capital and reduce borrowing costs facilitating the development of fossil fuel assets.

Alongside New York, we find that Toronto, London, and Sydney are also shown to have significant embedded emissions within listed companies, particularly when adjusting for the proportion of shares over which investors have an opportunity to influence.

⁴ The embedded emissions of discovered fossil fuels globally are based on proved reserve figures from bp’s Statistical Review of World Energy 2021. These are country-level quantities that “geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions”, but do not necessarily “meet the definitions, guidelines and practices used for determining proved reserves at company level”.

Figure 1: Emissions embedded (GtCO₂) in the reserves of listed and partially-listed companies, by financial centre of primary listing, free-float weighted.



Source: Bloomberg, FFI Solutions, Rystad Energy, Carbon Tracker analysis

Notes: Light grey bars indicate unweighted totals as per Figure 5. Refer to section 5 for more details.

London plays an outsized role in the financing of fossil fuel projects

The embedded emissions within reserves owned by companies listed on the London Stock Exchange were found to be 30 times greater than those of the UK's fossil fuel reserves, and ten times the UK's carbon budget between 2023-2037. London's overweight fossil fuel position also makes the 'financial' transition to a low carbon economy harder and is at odds with the UK's net zero commitments.

The energy transition exposes financial centres to stranded assets

As the world transitions to a low-carbon energy system, falling demand and prices may mean projects fail to deliver the economic returns expected of them at sanction, leading to value erosion for fossil fuel companies and those invested in them. Stock markets and the financial centres around them are exposed to over \$7 trillion USD listed equities with fossil fuel reserves.

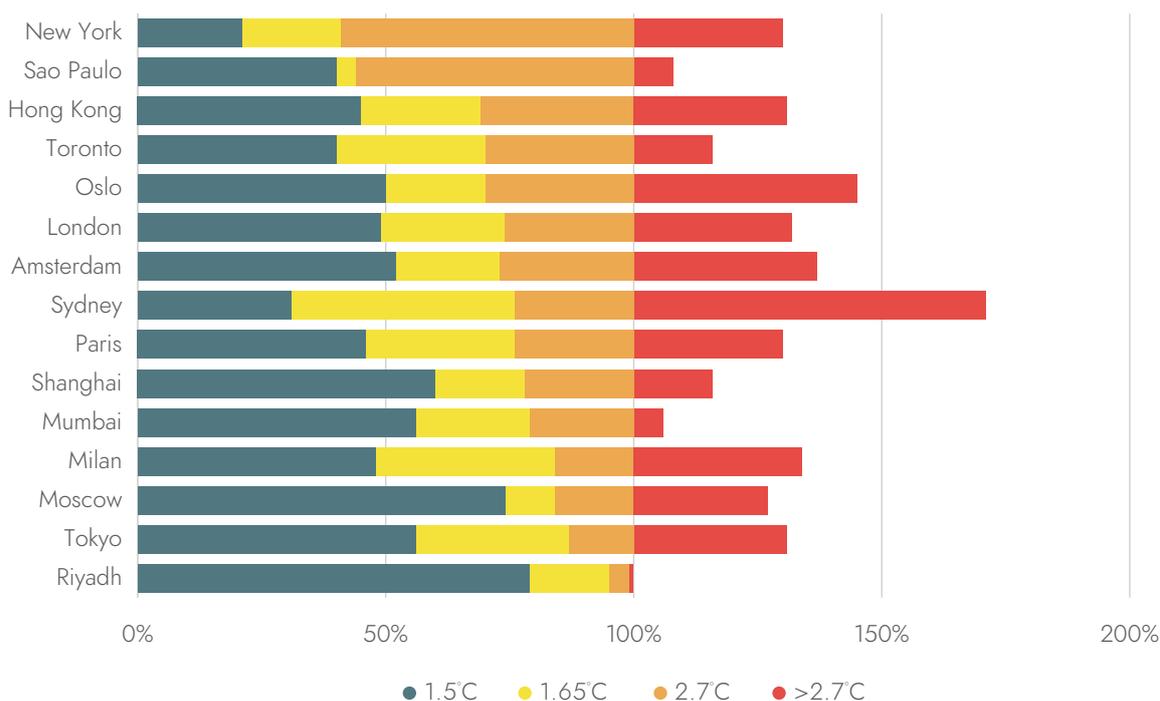
New York and London have the largest free-float weighted market capitalisation associated with fossil fuel reserves, with Moscow, Oslo, and Sao Paulo most exposed as a proportion of total listed market capitalisation.

We quantify stranded asset risk exposure for the oil and gas assets and find over \$1 trillion of oil & gas assets risk becoming stranded, and the majority, some \$600bn, is held by listed companies. In absolute terms, this stranded asset risk is concentrated in the financial centres of New York, Moscow, London, and Toronto.

Figure 2 shows the proportion of new capex that risks being wasted (by being spent on assets that risk becoming stranded if demand falls away) under different temperature outcomes, derived from International Energy Agency (IEA) scenarios – this gives an indication of the relative risk exposure of new investments through the energy transition.

This same data can also be viewed in terms of the degree to which company plans are *aligned* with a given temperature outcome. Through this lens, the companies listed in New York are collectively the least Paris-aligned (considering either a 1.5°C or 1.65°C scenario) than those in other financial centres.

Figure 2: Stranded asset exposure by financial centre shown as upstream oil & gas capex by financial centre, 2021-2030, as % of business-as-usual capex (2.7°C).



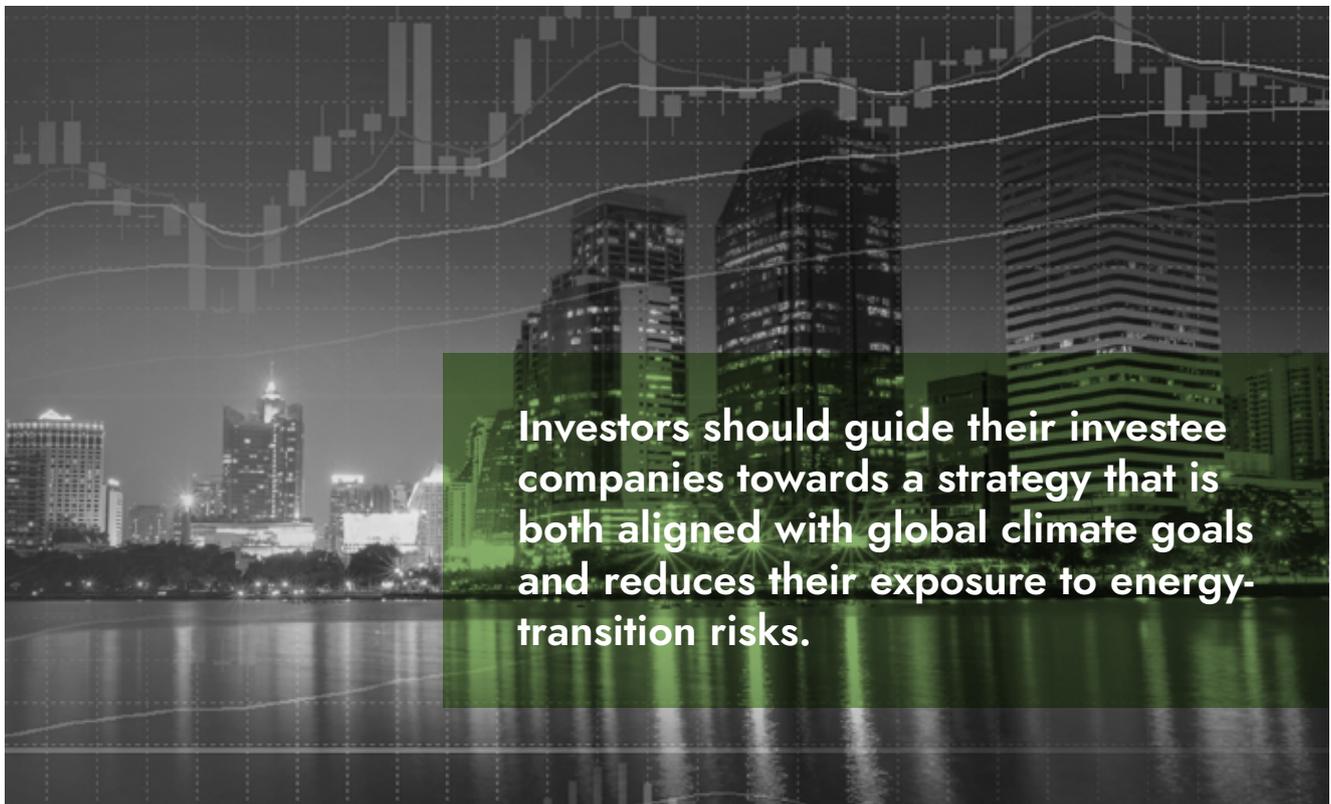
Source: IEA, Rystad Energy, Bloomberg, Carbon Tracker analysis

Note: chart shows the 15 largest financial centres by embedded emissions from oil and gas. 1.5°C scenario shows those projects that have already been sanctioned (post-FID), while coloured bars show the proportion of capex associated with pre-FID projects. Sorted by potential stranded asset exposure under a 1.65°C scenario (IEA’s Sustainable Development Scenario). The IEA’s Stated Policies Scenario is used as the proxy for business-as-usual. Refer to section 6.2 for more details.

Recommendations

We outline recommendations for regulators to set requirements that align financial markets with national climate strategies and provide sufficient disclosures to allow investors to assess financial risk:

- ✓ **Policymakers** must also ensure that the activities of stock markets, and financial centres more broadly, are consistent with stated national climate goals, particularly those “net zero” commitments made in support of Paris Agreement goals.
- ✓ **Regulators** must ensure that disclosure required around material climate-related disclosures, as well as disclosure of other key energy transition risks, is both appropriate and properly enforced.
- ✓ **Investors** should become active owners and guide their investee companies towards a strategy that is both aligned with global climate goals and reduces their exposure to energy-transition risks.



04

WALL ST

Introduction

The world is transitioning towards a carbon-neutral energy system, driven by three things: policy action on climate as governments try to limit global warming; the net zero commitments of asset owners⁵, and; technological innovation meaning that renewable electricity generation already outcompetes electricity from coal in all major markets⁶, with similar implications for gas generation assets⁷.

Geopolitical instability and rising oil and gas prices at the time of writing are leading to, in the short term, greater demand for coal and further investment in oil and gas projects. Governments are scrambling to fill a supply crunch and the capital discipline of companies is being tested by high commodity prices. However, it has also sparked debate about energy security – particularly around gas in Europe – and the diversification away from fossil fuels is likely to accelerate over the medium- to long-term as a result.

Fossil fuels are being displaced by cheaper, more secure sources of energy

The will and resolve of national governments and investors to enact change at a sufficient pace may be debatable and subject to political winds, but the technological revolution that is underpinning this energy transition has an unstoppable inertia all of its own. Increasing deployment is leading to falling costs in key technologies such as renewable energy generation, battery storage and the electrolyzers used to produce green hydrogen.

Irrespective of the driver, fossil fuel demand will peak; long-term prices will fall as a result, increasing the risk of **stranded assets** and potential value destruction for fossil fuel companies, and exposing those invested in them to these same risks. It is no longer a question of whether the transition is underway, but of how fast it is progressing. But time is of the essence, as the speed of the transition must outpace the rate at which the world's remaining carbon budget is being exhausted. Continued over-investment in fossil fuels now risks carbon lock-in and a more expensive transition.

Listed companies play a significant role in global fossil fuel supply

While a significant proportion of fossil fuel reserves are owned by unlisted state-owned companies, or are in private hands, many are held by companies which trade publicly on global stock markets and are thus under the influence of investors.

From an oil and gas production perspective, while the majors' relative contribution has declined over the past decades, the overall emissions from listed companies' production account for nearly half of the total (Figure 3).⁸ The global financial centres that support these companies' activities clearly derive value from these emissions too.

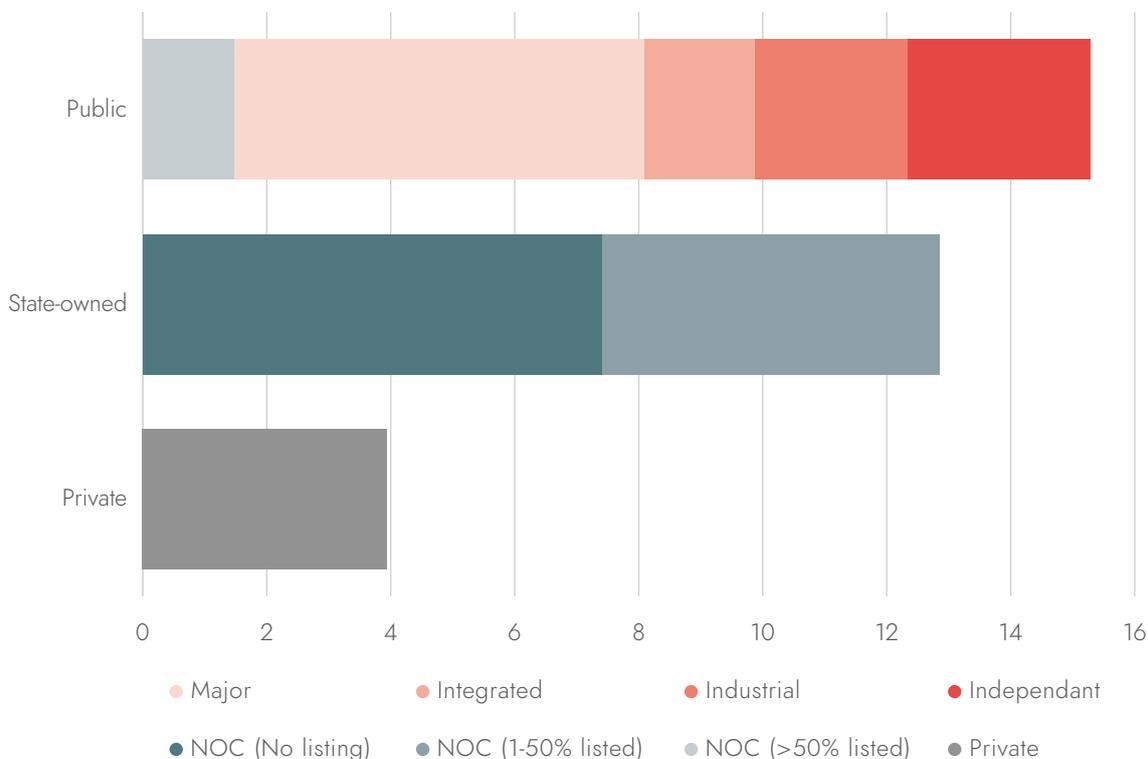
5 Such as those of the UN-convened Net-Zero Asset Owner Alliance (NZAOA) or the Glasgow Financial Alliance for Net Zero (GFANZ), where investors with \$130 trillion are committed to net-zero investor pathways.

6 See Carbon Tracker report, Do Not Revive Coal (June 2021). Available at: <https://carbontracker.org/reports/do-not-revive-coal/>.

7 See Carbon Tracker report, Put Gas on Standby (October 2021). Available at: <https://carbontracker.org/reports/put-gas-on-standby/>.

8 National oil companies with a greater than 50% listing are included with publicly listed companies.

Figure 3: 2019 oil and gas production in terms of emissions (GtCO₂) grouped by majority ownership type.



Source: IEA, Rystad Energy, Carbon Tracker analysis

Note: National oil companies with greater than 50% listing are included with publicly-listed companies.

At current rates, the 1.5 °C carbon budget will be exhausted in 8 years

Since the Intergovernmental Panel on Climate Change (IPCC) published its Special Report on 1.5°C in 2018 (see box) there has been a huge growth in “net zero” commitments by a huge range of organisations, from fossil fuel companies to nation states.

However, while it is estimated that 90% of global GDP is covered by some level of a “net-zero” commitment⁹, reaching net zero is not sufficient, as it is the pace at which the world decarbonises which determines the degree to which the planet warms. For climate targets to link through to global temperature outcomes, they must be associated with a specific emissions reduction *pathway*, such as that in the IEA’s Net Zero Emissions by 2050 Scenario (NZE, 1.5°C by 2100); the same is true of any “Paris-aligned” targets or ambitions¹⁰.

Yet for all the talk of 1.5 °C, the IPCC calculates that for a 66% chance¹¹ of limiting global warming to 1.5°C above pre-industrial times, there is a remaining *Carbon Budget* from the start of 2020 of 400 GtCO₂. With around 78 Gt released over the past two years, this leaves a budget of around 320 GtCO₂ at the start of 2022¹²; at current rates of fossil fuel production, this budget will be exhausted by 2030 – two decades ahead of the much-heralded 2050 net zero target.

9 <https://zerotracker.net/> - Country-level coverage, GDP based on purchasing power parity.

10 Referring to the Paris Agreement goal of limiting warming by 2100 to “well-below 2°C” above preindustrial times.

11 Many reports will discuss a carbon budgets based on a 50% probability of limiting temperatures rise to any given level. In no other walk of life would be accept a 50-50 chance with such devastating consequences, so accordingly we use 66% probabilities in this report. For comparison with the 2011 budgets, we note that a 322 GtCO₂ budget at 66% chance of success is comparable with to c.222 GtCO₂ at 83% chance of success).

12 See Carbon Tracker report, Absolute Impact 2022 (May 2022). Available at: <https://carbontracker.org/reports/absolute-impact-2022/>

Emissions therefore must fall significantly this decade if the world is to stand a chance of containing global temperature rises to 1.5°C, without the requirement to deploy negative emissions technologies on a truly massive scale in an attempt to reverse temperature *overshoot*. Limiting temperature rise to 2°C will also require rapid reductions in fossil fuel usage starting this decade.

The imperative of limiting global temperature rise

The world is already at 1.1°C and in the past year has experienced extreme heat events in India and Pakistan, devastating wildfires in America, Australia and Siberia, and extreme floods in Australia, China, and Europe (Germany & Belgium). With each incremental increase in temperature comes ever more extreme impacts; the IPCC's Special Report on 1.5°C found robust and substantial differences in the impacts between 1.5°C and 2°C.

At 1.5°C sea levels are predicted to rise by 40-80cm, sufficient to flood low lying island nations such as the Maldives. As much as 70-90% of coral reefs will be lost with devastating impacts on fish stocks, while the probability of extreme heatwaves globally would increase five-fold.

At 2°C nearly all coral reefs will be lost, and sea levels will rise further. The share of the *global population exposed to severe heat waves* would rise *threefold* to 37%, with an additional 420 million people exposed to extreme heat events. Sea level rises and lost agriculture would lead to forced migration.

However, the world is potentially on track for a global temperature rise in excess of 3°C, this would likely result in large parts of the tropics becoming effectively uninhabitable, whilst the risk of crossing climatic tipping points become palpable: the collapse of the rainforests, the loss of the ice sheets in Antarctica and Greenland, or a catastrophic breakdown of the global ocean circulation system. Sea level rise would be measured in meters and crop failures risk becoming common place.

It's not just the impacts that increase exponentially with rising temperatures, the cost of adaptation also increases. The World Meteorological Organization forecasts a one in five chance that temperatures will exceed 1.5°C in a given year before 2024. Bringing temperatures back in line to 1.5°C by 2100 is likely only possible through costly negative emissions technologies. The further the temperature overshoot, the harder and ever-more costly this will become.

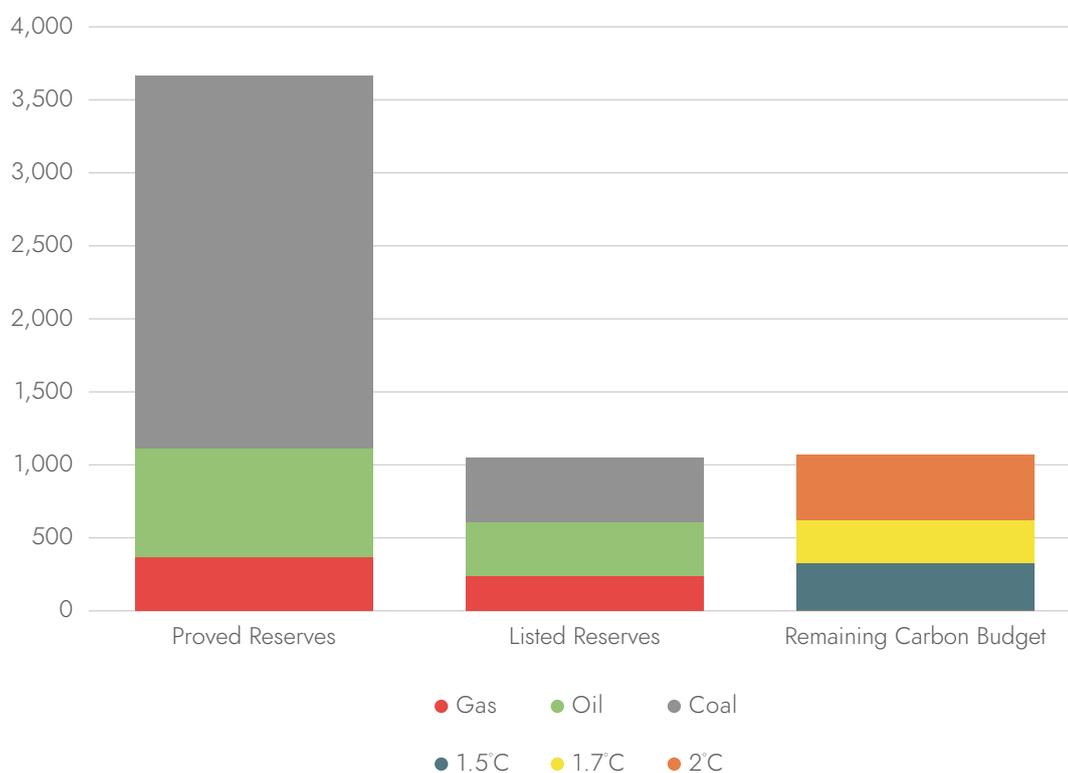
There are also benefits to be gained from transitioning to a carbon-neutral energy system. Research by Oxford University's *Institute for New Economic Thinking* found that \$26 trillion could be saved by 2070 through a fast transition versus no transition.

Only 10% of reserves can be produced to stay within the 1.5°C budget

The total carbon potential of the Earth’s known fossil fuel reserves¹³ is around 3,700 GtCO₂ – 70% from coal, 20% from oil and 10% from gas (Figure 4). This means that to stay within the 1.5°C carbon budget just a tenth of these total fossil fuel reserves can be burned¹⁴; the remaining 90% is **Unburnable Carbon**. Limiting to 2°C will see around 60% needing to remain in the ground, while if all reserves are produced, this will lead to devastating temperature rise, likely well in excess of 3°C.

Put simply, to stand a chance of limiting global warming to 1.5°C, production volumes need to fall rapidly, and a significant proportion of these reserves cannot see the light of day; existing production facilities – particularly for coal – would need to close early. Of course, which fossil fuels are produced, or rather who should get to monetise them, is not straightforward and creates transition risk for fossil fuel producers.

Figure 4: The carbon potential of discovered fossil fuels exceeds the remaining budget.



Source: BP, FFI Solutions, Rystad Energy, IPCC, Global Carbon Project and Carbon Tracker analysis

Notes: Definition of “reserves” varies between sources – see text for detail. Remaining carbon budget bar shows the incremental differences between temperature outcomes.

13 Embedded CO₂ emissions calculated from ‘proved’ fossil fuel reserves from Statistical Review of World Energy 2021. Note: excludes other greenhouse gases, eg., methane.

14 This is a simplistic (and generous to the fossil fuels industry) calculation that assumes the entire carbon budget is reserved for end-use CO₂ emissions from fossil fuels.

Listed company reserves alone lead to 2°C

Figure 4 also shows the embedded emissions within the reserves and contingent resources of publicly-listed companies; together these amount to around 1,050 GtCO₂¹⁵, well in excess of both 1.5°C and 1.7°C carbon budgets. This calculation assumes that no further exploration and discovery occurs, which is contrary to the strategies currently pursued by most companies.

The emissions of discovered fossil fuels globally are based on proved reserve figures from bp's Statistical Review of World Energy 2021. These are country-level quantities that "geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions", but do not necessarily "meet the definitions, guidelines and practices used for determining proved reserves at company level".

For the listed companies, we use company-level estimates for embedded emissions in coal reserves from FFI Solutions that are based on economically extractable reserves by mine. For oil and gas reserves we use Rystad Energy discovered resource estimates, which are an estimate of the expected remaining recoverable economical volumes at an individual project level. Again, these do not necessarily meet strict definitions and are a more expansive estimate than that of currently economical proven reserves (e.g., 1P) used for company reports.

Financial centres are key enablers for the fossil fuel industry

Fossil fuel companies are reliant on equity and debt markets for the financing of capital-intensive projects, both to raise capital to finance new investments, but also to maintain existing production facilities. Financial centres facilitate, and profit from, both the primary equity raising and ongoing finance requirements for these companies, as well as secondary trading activities.

Thus, stock markets, and the industry around them such as the asset owners, assets managers, custodian banks and central securities depositories, are:

- a. enabling the production of fossil fuels beyond climate limits
- b. exposed to transition risk, and
- c. potentially failing to achieve their own ambitions of Paris-alignment

Having shown that a significant proportion of fossil fuel reserves – and thus embedded emissions – are held by listed companies, in this note we explore the implications for those global financial centres which enable these companies' activities. As well as those for a broader set of enabling stakeholders who currently profit from supporting these industries either directly or indirectly. This report is a companion to *Taking Stock of Coal Risks*, released by our Power and Utilities team in November 2021, considering the stranded asset risk of Asian utility companies.¹⁶

We first look at the geographical distribution of the ownership of reserves – i.e. which financial centres are the major enablers of these reserves being produced and the emissions that result – before then exploring the geographical distribution of transition risk in these same financial centres. Having considered these lenses, we then consider the implications for a broad range of investors, financial services companies and policymakers.

¹⁵ This includes partially listed state-owned companies

¹⁶ Carbon Tracker report, "Taking Stock of Coal Risks", November 2021. Available at: <https://carbontracker.org/reports/taking-stock-of-coal-risks/>



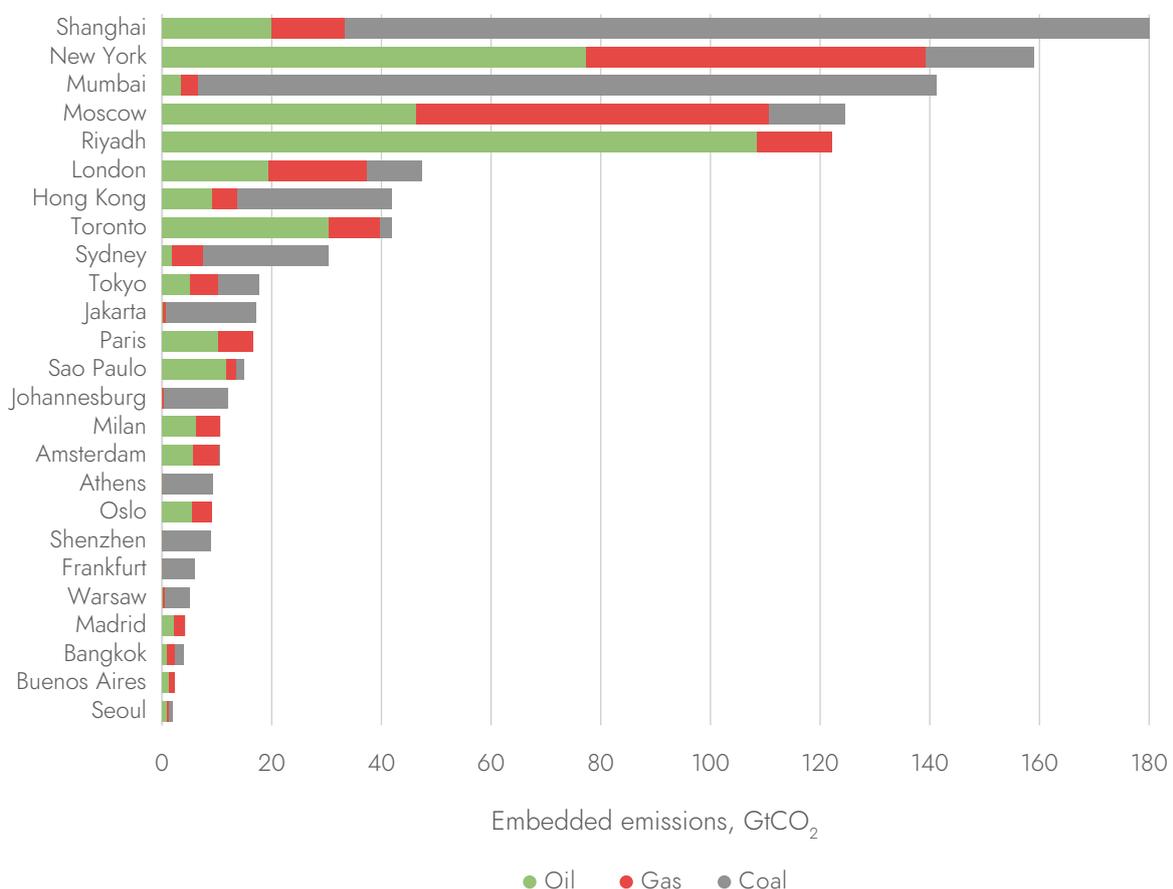
05

Impact on Global
Temperature Rise

Our focus in this note is on the role that financial centres play in enabling the continued extraction of fossil fuels, and we here consider reserves not in terms of traditional measures – such as volume, weight, or energy content – but in terms of the CO₂ emissions embedded within them, and thus the future impact they would have on global warming if produced and combusted.¹⁷

Figure 5 shows the CO₂ emissions embedded within the oil, gas and coal reserves of both listed and partially-listed companies, amalgamated by the location of their primary stock exchange. This figure includes the 25 largest financial centres in terms of their embedded fossil fuel emissions, these same financial centres are used throughout the report; reserves of dual listed firms are split between exchanges based on their share split.

Figure 5: Emissions embedded (GtCO₂) in the reserves of listed and partially-listed companies, by financial centre of primary listing.¹⁸



Source: Bloomberg, FFI Solutions, Rystad Energy, Carbon Tracker analysis

Notes: Emissions from those state-owned companies with less than a 1% listing, and privately-held companies, are not included.

We see that the embedded emissions of listed firms are dominated by those listed on the stock exchanges of financial centres in China (Shanghai, Hong Kong & Shenzhen), the United States of America (New York & the Nasdaq), India, Russia and Saudi Arabia. The embedded emissions of companies on the three Chinese stock exchanges alone amount to over 230 GtCO₂, 70% of the

¹⁷ We use standard conversion factors to estimate how much carbon dioxide would be released by the complete combustion of fossil fuel reserves. It excludes operational emissions (such as the carbon footprint of infrastructure and energy used for extraction/ processing), land-use changes and other greenhouse gases (such as methane) released from fossil fuel operations or incomplete combustion.

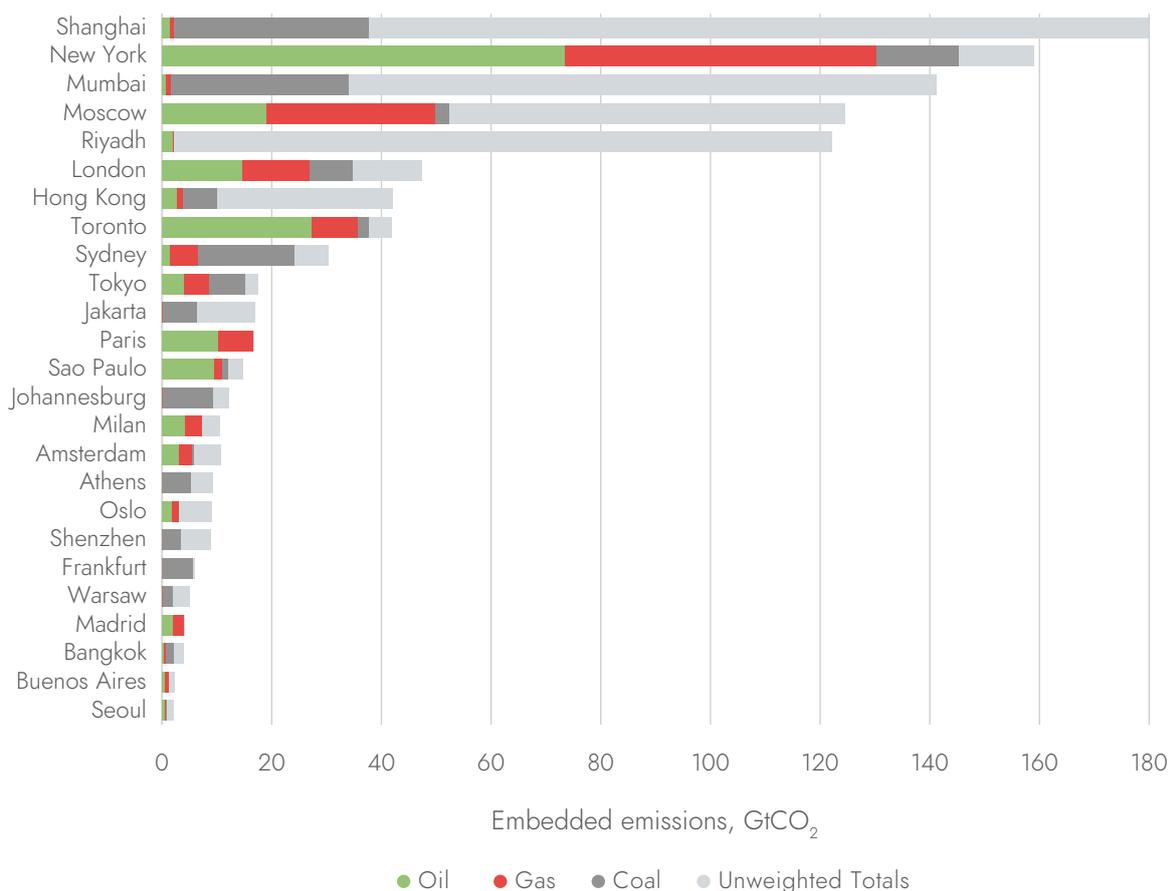
¹⁸ Companies with a dual primary listings are divided between exchanges based on the proportion of shares.

remaining global 1.5°C carbon budget¹⁹. This group of financial centres is heavily influenced by the partial listing of majority state-owned behemoths, particularly Chinese and Indian coal giants (such as China Coal Energy and Coal India), state-controlled oil and gas companies in Russia (Gazprom, Rosneft and Lukoil), and Saudi Aramco’s partial listing on the Saudi Stock Exchange.

Adjusting for state ownership reveals New York, Moscow, Toronto, and London as the financial centres with the highest levels of embedded emissions from listed oil and gas producers

As minority investees often have limited influence in such state-owned enterprises (SOEs), in Figure 6 we have applied a free-float weighting²⁰ to the data shown in Figure 5, to show the proportion of these embedded emissions associated with freely tradable shares.

Figure 6: Emissions embedded (GtCO₂) in the reserves of listed and partially-listed companies, by financial centre of primary listing, free-float weighted.



Source: Bloomberg, FFI Solutions, Rystad Energy, Carbon Tracker analysis

Notes: Light grey bars indicate unweighted totals as per Figure 5

¹⁹ IPCC budget for 66% chance of limiting global warming to 1.5°C

²⁰ We used Bloomberg financial data to determine the percentage of company stock that can be publicly traded and is not held by insiders or governments.

In adjusting for state ownership, New York is clearly highlighted as the financial centre with the greatest embedded emissions listed on its two major stock exchanges (New York and the Nasdaq), with a large number of publicly listed fossil fuel producers, including the reserves of US giants such as ExxonMobil, Chevron, ConocoPhillips, and that of the extensive domestic shale industry.

On this basis, Moscow, Toronto, London, and Sydney also stand out as important centres for the financing of upstream oil and gas companies where investors have a significant impact. Even with a free-float weighting applied, the financial centres of Shanghai and Mumbai have respectively the third and sixth largest accumulations of embedded emissions driven by coal companies.

Emissions embedded on the London Stock Exchange are 30x those of the UK's fossil fuel reserves

While in a global context the UK has relatively modest fossil fuels reserves of 1.5 GtCO₂, yet reserves listed on the London stock exchange add up to 47 GtCO₂. To put this in context, the UK's legally binding carbon budget for the 15yr period 2023 to 2037 is 4.7 GtCO₂.

Although the UK's official carbon footprint excludes such emissions embedded in investments and trade flow, it is important to recognise the role its financial centre plays in the continued financing of fossil fuel extraction around the world. London's overweight fossil fuel position also make the 'financial' transition to a low carbon economy harder. Production assets may be located overseas, and fuels consumed elsewhere, but the financial risks reside with both investors and the financial services sector, who are predominantly located in the UK.



London's overweight fossil fuel position makes the 'financial' transition to a low carbon economy harder.

Can a stock market be “net zero” aligned if it continues to facilitate new fossil fuel investment?

London Stock Exchange’s Race to Zero

The London Stock Exchange Group plc (LSEG) announced in February 2021 that it has become the first exchange group to commit to net zero through the ‘**Business Ambition for 1.5°**’ Science Based Targets initiative, and in doing so has become a member of the United Nations Climate Change ‘Race to Zero’.

But what does this mean and how does it relate to ~47 GtCO₂ embedded in the reserves of companies listed on the exchange?

The target relates to LSEG’s emissions as a company, but it does not apply to the companies listed on the London Stock Exchange.

To LSEG’s credit they have committed to halve their emissions (scopes 1, 2 & 3) and to become net zero in terms of operational emissions by 2040 and more companies should follow their lead; yet LSEG’s annual emissions are a fraction of those it enables through the companies listed on its exchange.

More substantially, LSEG has launched a Transition Bond segment and is ‘encouraging’ issuers to report against Task Force for Climate-related Financial Disclosures (TCFD) guidelines through reporting guidance. Disclosing climate-related information along the TCFD guidance is not currently mandatory, although the Financial Conduct Authority (FCA) is tightening the rules and the UK Government intends to introduce climate disclosure rules for larger companies, known as the Sustainability Disclosure Requirements (SDR). These are all steps in the right direction, but are they enough?

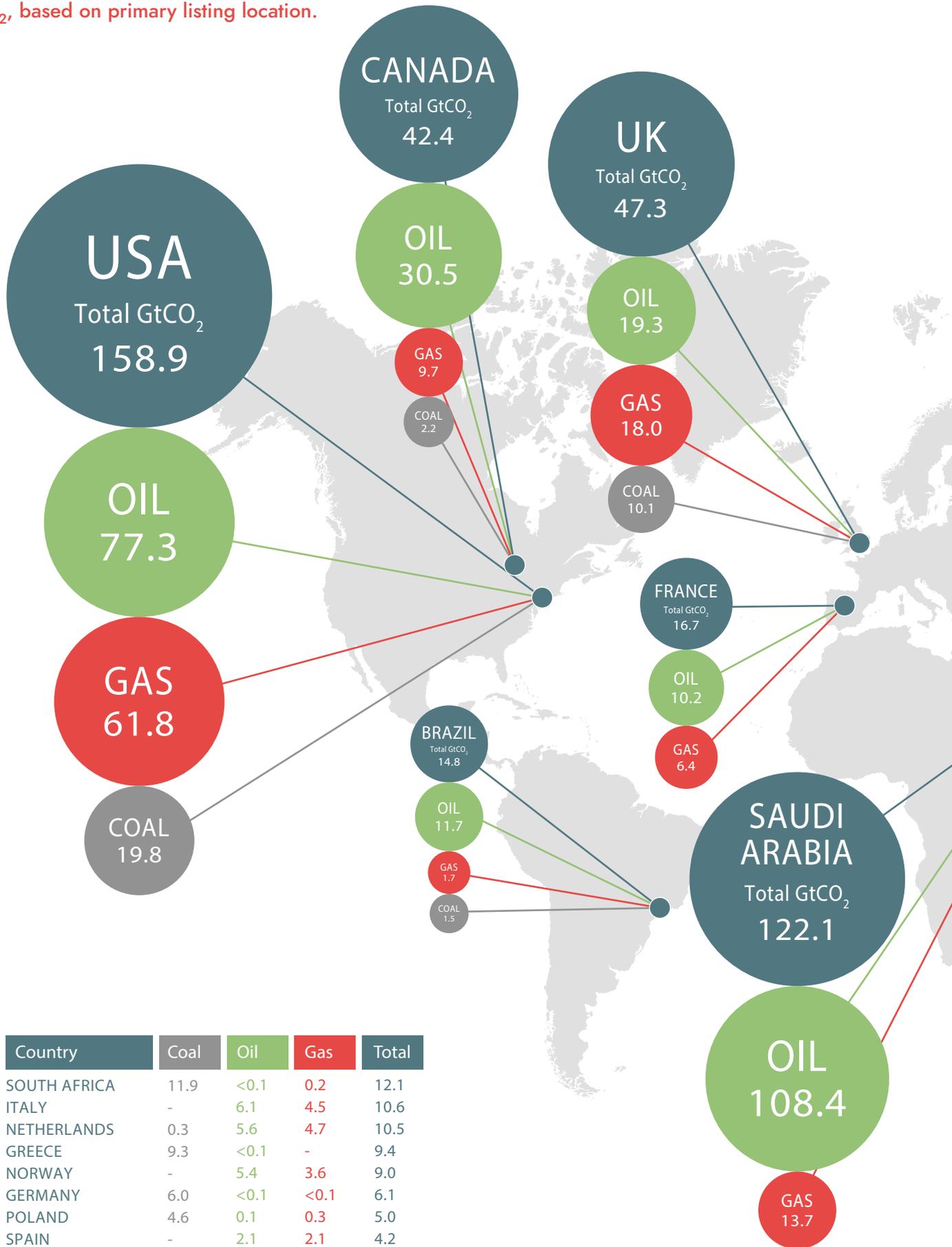
Financial market participants cannot ignore state ownership

However, a lack of influence over SOEs does not absolve investors from a share of responsibility for those reserves under state ownership. A partial listing of a state-owned giant provides a source of capital that facilitates developments across the company’s entire portfolio; both exchanges and the investors that purchase shares on the open market help facilitate company activities.

Further, the market capitalisation of state giants also strengthens national accounts, helping to improve credit ratings and lowering the cost of capital through sovereign and corporate bond markets, in turn helping to finance further development of fossil fuel assets. Reserves are often so significant that even the partial listing of a state giant can add significant embedded emissions to the market, and thus increase the impact of any given financial centre on global temperature.

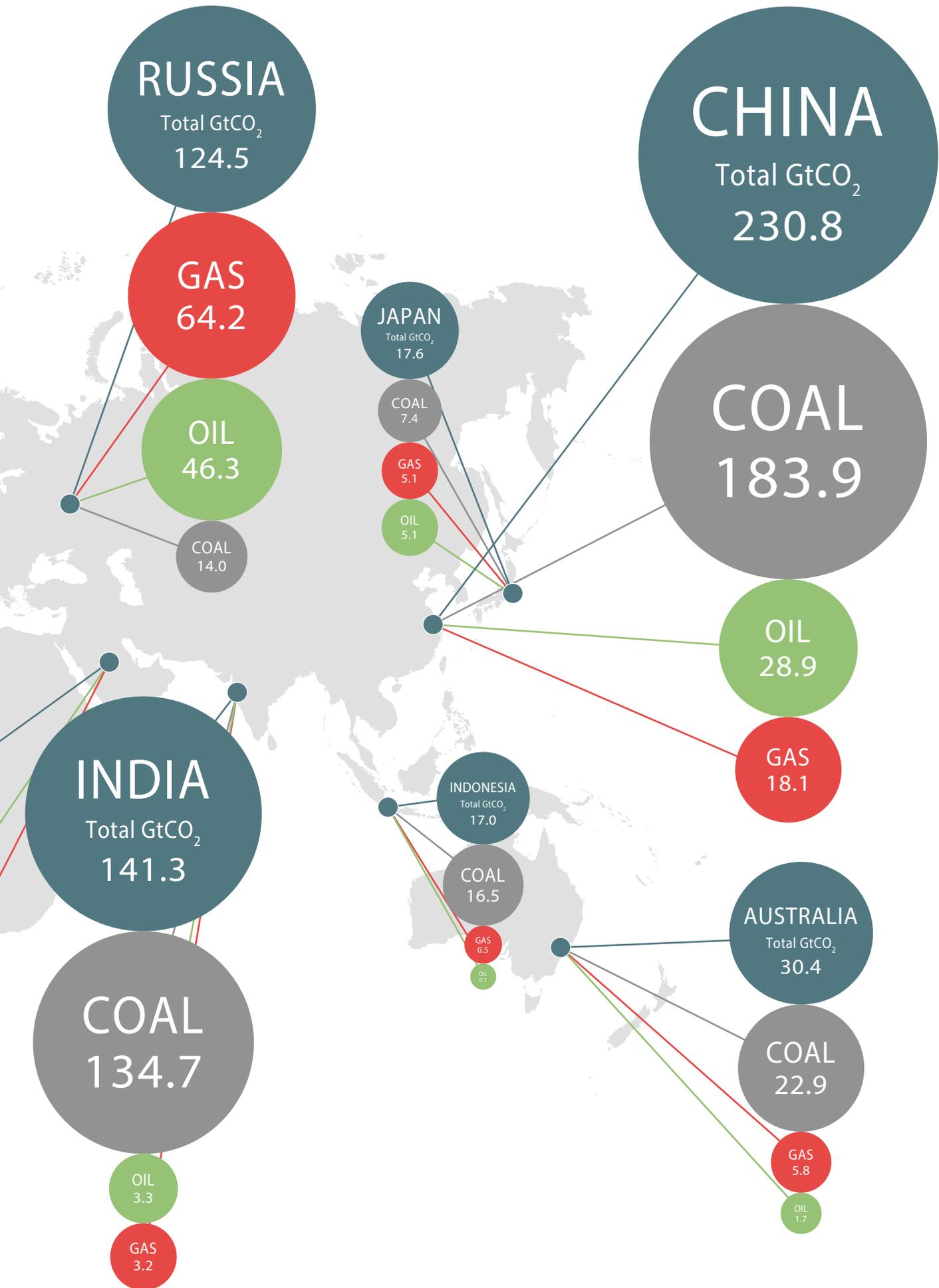
The following map shows the distribution of embedded emissions globally, based on their primary listing location.

Global distribution of embedded emissions, GtCO₂, based on primary listing location.



Country	Coal	Oil	Gas	Total
SOUTH AFRICA	11.9	<0.1	0.2	12.1
ITALY	-	6.1	4.5	10.6
NETHERLANDS	0.3	5.6	4.7	10.5
GREECE	9.3	<0.1	-	9.4
NORWAY	-	5.4	3.6	9.0
GERMANY	6.0	<0.1	<0.1	6.1
POLAND	4.6	0.1	0.3	5.0
SPAIN	-	2.1	2.1	4.2
THAILAND	1.7	0.8	1.5	4.0
ARGENTINA	-	1.1	1.1	2.2
SOUTH KOREA	0.8	0.8	0.5	2.1

Table of countries 10-20, with Top 10 shown on the map



The potential impact of listed companies has increased over the past decade

Compared to the results from our 2011 report, the listed companies embedded emissions in oil reserves have fallen, whilst those associated with gas reserves have uniformly risen as oil and gas companies have progressively pivoted towards gas, many buying into the notion of gas as a “transition” or “bridge” fuel. A key exception to this is the impact of the listing of oil-heavy Saudi Aramco on the Saudi Stock Exchange in 2019.

The listing of embedded coal emissions has shifted from the West to the East, as the diversified miners have divested coal assets, particularly in thermal coal, whilst Asian coal companies have been increasing listed on domestic exchange – for example, Coal India listed a further 10% stake in 2015. Meanwhile, the Rio Tinto Group (listed on the London Stock Exchange and the Australian Securities Exchange in Sydney) became the first of the big miners to fully exit coal after selling its last coal mine in 2018. In Russia, we see that coal reserves have continued to move into private hands.

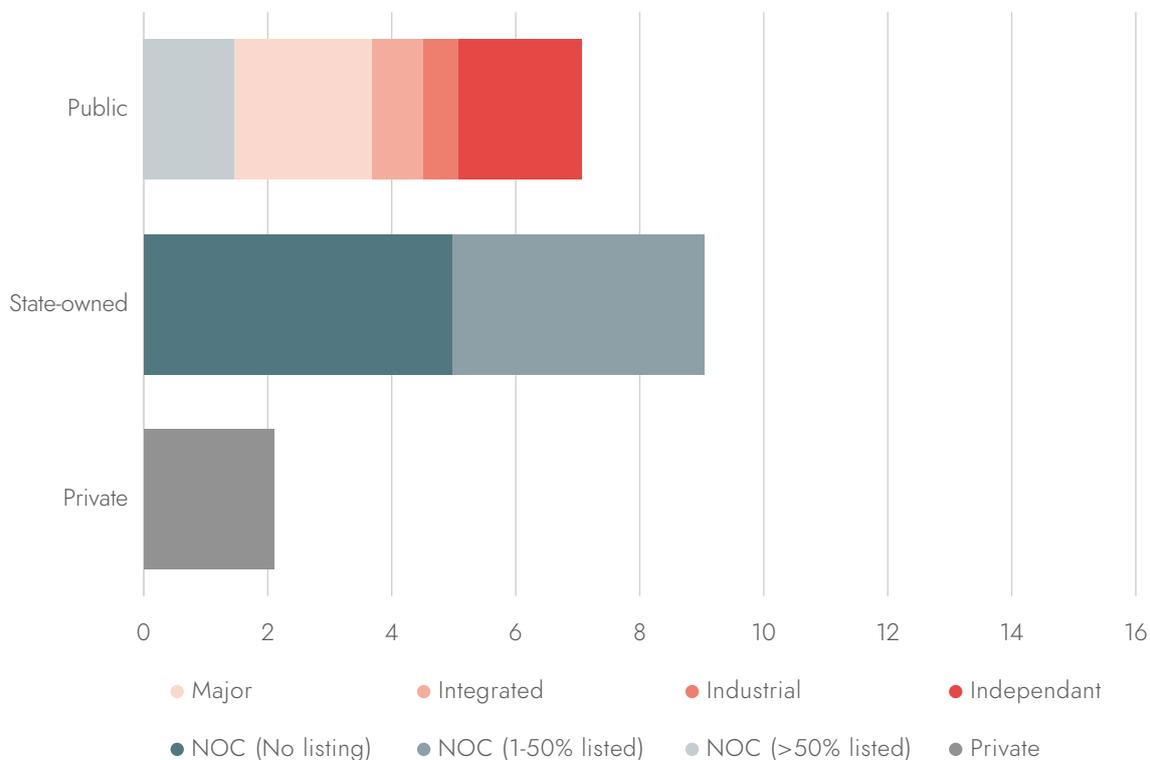
Overall, the level of emissions embedded within reserves listed on the exchanges of India, Canada, Australia, and Japan have increased. Whilst those listed in the USA remain at similar levels, and despite its oversized listing of fossil fuels, the level of embedded emissions listed in the London has reduced, through the divestment of coal assets by some of the diversified miners, and through the shifting of the portfolios of the oil and gas majors bp and Shell.

Future trends

The growing awareness of both the need to act on climate and the financial challenges the energy transition poses to the oil and gas industry may see increased asset divestments from fossil fuel companies over the coming decade. These assets are likely to be picked up either by private companies or SOEs, both those that are partially-listed, and those that are unlisted. While this may reduce the exposure of investors in listed equities, many of the same financial centres are likely still to facilitate those purchasers’ activities, particularly from a capital-raising perspective.

In terms of oil and gas production volume then we expect to see a shift from public companies to the often lower-cost reserves of NOCs (Figure 7), particularly if the world does follow a low-carbon pathway and the level of project sanctions.

Figure 7: 2021-2040 average annual oil and gas production in terms of emissions (GtCO₂) grouped by majority ownership type in a well below 2°C scenario.



Source: IEA, Rystad Energy, Carbon Tracker analysis

Notes: The IEA's Sustainable Development Scenario is used as the "well-below 2 degrees" scenario. National oil companies with greater than 50% listing are included with publicly-listed companies.

Conversely, high commodity prices have the potential to drive an investment supercycle, which may lead to a significant increase in investments that run the risk of becoming stranded through the energy transition. As we wrote about in *Managing Peak Oil* companies taking long-term investment decisions based on short-term pricing may be exposing investors to significant potential value loss.



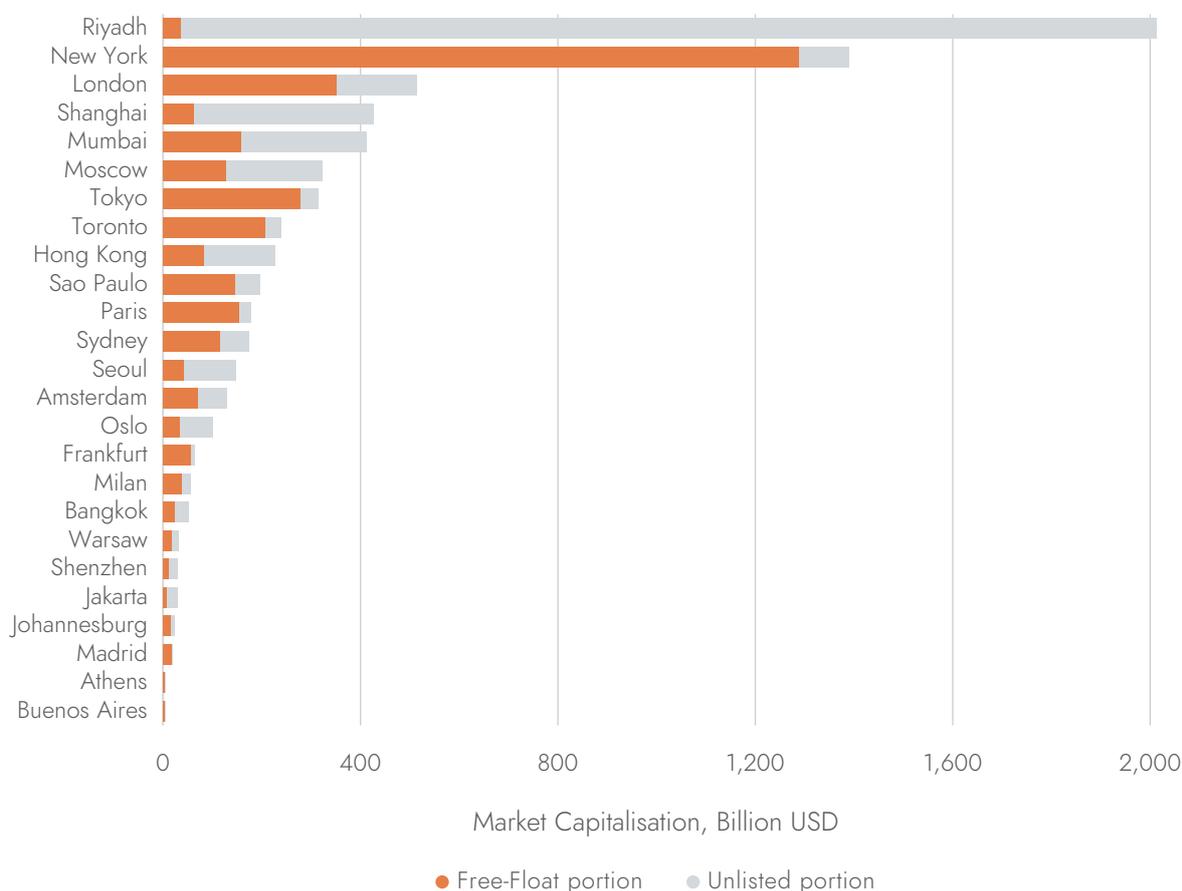
Transition Risk Exposure

6.1 Financial centre exposure to fossil fuels

Having reviewed the extent to which financial centres facilitate – and in some ways could be viewed as being complicit – in taking the world beyond climate limits, we now turn to some of the transition risks that financial centres are exposed to. Irrespective of the drivers of the transition, at least some proportion of the discovered hydrocarbons held by listed oil and gas companies will likely not be needed. Depending on the pace of the transition, this could be the significant majority.

To understand the potential risk exposure of financial centres to a reduction in fossil fuel usage, we first need to review the current weighting of fossil fuel producers by centre. We do this both in the absolute terms (Figure 8), and as the relative proportion this represents of each exchange’s total market (Figure 9).

Figure 8: Market capitalisation of companies with fossil fuel reserves, in millions USD.



Source: Bloomberg, Carbon Tracker analysis

Notes: Market capitalisation, as of 22nd February 2022, for those listed and partially-listed companies holding the fossil fuel reserves shown in Figure 5, amalgamated by financial centre. 25 largest financial centres by embedded emissions. Free-float weighted portion shown in orange.

The value of listed equities with fossil fuel reserves is over \$7 trillion

We calculate the total market capitalisation of listed equity of the companies that hold fossil fuel reserves as being \$7.1 trillion USD²¹. Riyadh tops the list, illustrating the huge apparent valuation of Saudi Aramco from its partial listing on the Saudi Stock Exchange. Adjusting for both state ownership and restricted shares reveals New York and London as having the greatest total valuation of companies with fossil fuel production businesses.

It is beyond the scope of this report to accurately estimate the proportion of each company's value derived from its reserves, so we note that these figures show the full market capitalisation for companies' fossil fuel production assets. It includes both the value of downstream businesses of integrated companies as well as business not directly connected to fossil fuels, such as the convenience stores of large integrated energy companies and the full value of diversified miners which, in many cases, are well-positioned to benefit from providing metals and minerals essential for the energy transition. Nonetheless, we believe this approach is valid to highlight the financial centres in which these risks are concentrated.

We also acknowledge of course that equity valuations are particularly volatile at present. The date of these charts is shortly before the Russian invasion of Ukraine and reflects the strong commodity prices in early 2022 but not the disruptions since. Moscow is notably exposed, in light of the current conflict, with nearly half of the market capitalisation (48%) linked to companies with fossil fuels reserves prior to its invasion of Ukraine. Such companies benefited from strong commodity prices, in part in anticipation of conflict, but are likely to suffer in the medium to long term from restrictions in finance and loss of markets.

Riyadh, Moscow, Oslo and Sao Paolo are heavily exposed

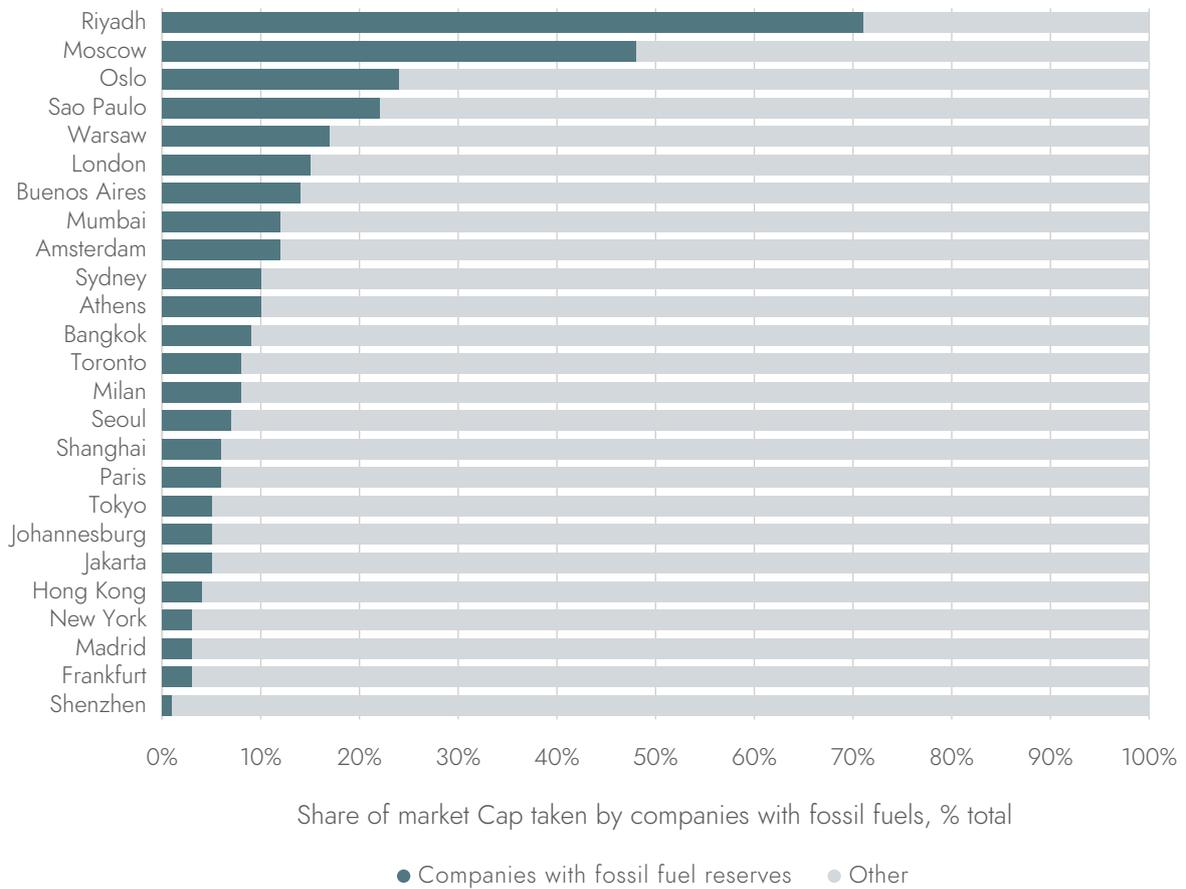
However, considering the total market capitalisation is only one aspect of risk concentration. When considering the share of an exchange's market capitalisation taken by companies with fossil fuel reserves (Figure 9), a different picture emerges.

New York is positioned towards the bottom of the table with only 3% of the combined market capitalisation of the New York and Nasdaq stock exchanges linked to fossil fuel reserves. This, despite the domestic shale industry revolution, illustrates the fossil fuels industry's waning importance compared the other sectors such as the listings of tech giants such as Apple, Microsoft, Alphabet, Meta and Amazon. The Chinese financial centres of Shanghai, Hong Kong and Shenzhen also have comparatively low equity exposure to fossil fuel reserves.

London, by comparison, which also has a large fossil fuel industry but lacks the listing of comparable tech giants, is far more exposed with around 15% linked to companies with fossil fuel reserves.

21 Source: Bloomberg Terminal 22 February 2022

Figure 9: Financial centre exposure to fossil fuel producers by market capitalisation.



Source: Bloomberg, Carbon Tracker analysis

Notes: Market capitalisations cover the entire value of companies with fossil fuel reserves, not just the upstream/fossil fuel segments. 25 largest financial centres by embedded emissions.



A partial listing of a state-owned enterprise provides a source of capital that facilitates developments across the company's entire portfolio.

A lack of influence over SOEs does not absolve investors from a share of responsibility for those emissions.

A debt mountain

These figures illustrate just part of the full potential extent of the Carbon Bubble. Carbon Tracker research in 2021 identified \$18tn USD²², 25% of all listed equities, with significant links to the fossil fuel system. This included services companies like Schlumberger and Halliburton, fossil fuel-dominated utilities, and the chemicals industry. The web of the carbon bubble stretches even further when you consider the companies and sectors that include this extended ecosystem as significant clients such as financial services, insurance and legal. And this is just listed equity.

The same research identified \$8tn USD of non-financial corporate bonds issued by companies in fossil fuel supply and demand linked sectors, over half the amount tracked by Bloomberg. These are bonds primarily issued by companies with listed equities, but private companies are also often heavily reliant on debt to raise capital. The total amount of fossil fuel sector-related debt including syndicated loans and untracked bonds was estimated to be much larger.

Much of this debt is owed to banks and the risk is that the banking sector is lending to fossil fuel projects based on outdated assumptions of continuously rising demand. As the world moves toward net-zero, banks could face higher defaults and lower recovery rates, coupled with an evaporating market for this debt, as others seek to reduce exposure, and there are the makings of a Minsky Moment in fossil fuel debt.

6.2 Stranded Asset Risk

Falling demand for coal, oil and gas, will lead to fewer volumes being needed, but crucially lower long-term commodity prices, making many projects unable to make a value-creative return on the capital deployed. This gives rise to significant stranded asset risk to companies as those companies planning on developing projects in a business-as-usual way risk committing huge amounts of capital on projects that are ultimately not needed.

Through our '2 Degrees of Separation' series of reports, Carbon Tracker has developed its least-cost approach to assessing the relative stranded asset risk for oil and gas producers.²³ The modelling considers the proportion of new developments that would go ahead under business-as-usual²⁴ that are at risk of becoming stranded assets under future low-carbon scenarios.

Notwithstanding a just transition and environmental considerations, on a purely economic basis, the projects with the lowest break-even prices that will be the most robust to future low-demand scenarios would be the ones to proceed first. The results are expressed in terms of capital expenditure (capex) associated with those at risk projects as a proportion of business-as-usual company capex plans.²⁵

Investors with equity stakes in these companies are thus exposed to these same risks; the magnitude of potential losses for investors is clearly a function of how much of this risk is already priced into market valuation of fossil fuels companies - it is up to individual institutions to assess how the transition will pan out, and their risk exposure as a result. And these risks are not limited to equity investors in oil and gas producers; these same risks could impact those downstream in the oil and gas value chain as well as a whole range of enabling financial services companies.

²² Carbon Tracker report, "Decline and Fall", June 2020. Available at: [Decline and Fall: The Size & Vulnerability of the Fossil Fuel System - Carbon Tracker Initiative](#)

²³ Carbon Tracker report, Adapt to Survive (Sept 2021). Available at: <https://carbontracker.org/reports/adapt-to-survive/>

²⁴ We use the International Energy Agency's Stated Policies Scenario (STEPS) as a proxy for business-as-usual behaviour.

²⁵ For further detail on Carbon Tracker's approach, see the methodology appendix to Adapt to Survive, and the methodology document for Breaking the Habit (Sept 2019). Available at: <https://carbontracker.org/wp-content/uploads/2019/09/Breaking-the-Habit-Methodology-Final-1.pdf>

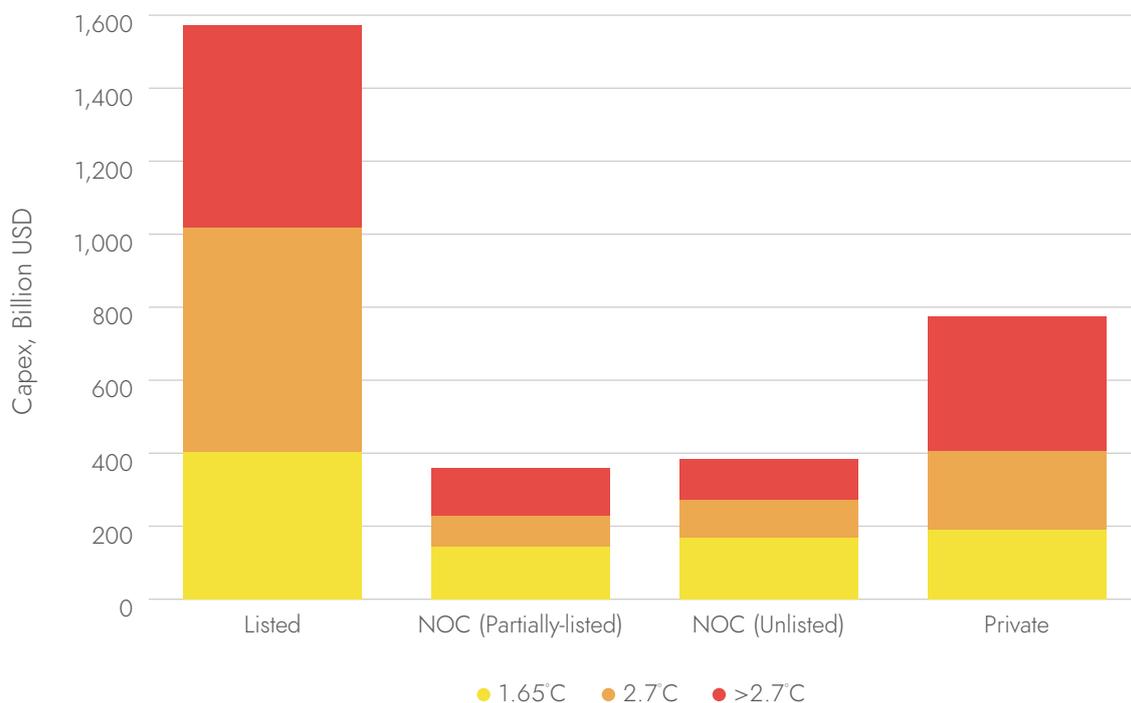
The majority of stranded asset risk exposure is held by listed companies

Our modelling identifies significant stranded asset risk for the oil and gas industry over the next decade, finding that if business-as-usual investment behaviour continues then \$1tn in capital would potentially be spent on new projects that are incompatible with a Paris scenario, and are thus at risk of delivering reduced returns if society does succeed in limiting global temperature to well-below two degrees. Under the “no new projects” assumption of the NZE this rises to \$1.9tn.

Despite large amounts of oil & gas being in private hands, an oversized proportion of this \$1tn risk resides in publicly-listed companies, with partial listings of giant State-Owned Enterprises (SOEs) including National Oil Companies (NOCs) further increasing the exposure to financial markets. This is shown in Figure 10, where the capex associated with unsanctioned (final investment decision yet to be taken) oil & gas projects held by companies is shown by company-ownership type. The colours of the bars indicate the proportion invested in projects that remain economic under different decarbonisation scenarios, and thus different temperature outcomes.

Figure 10: Capital expenditure on unsanctioned upstream oil & gas projects, 2021-2030, in billions USD, by company type.

Source: IEA, Rystad Energy, Carbon Tracker analysis



Notes: NOC (Partially-listed) includes National Oil Companies (NOCs) with a public listing of between 1-50%. NOCs with a >50% listing are included under 'Listed' companies. Colours refer to projects that remain economic under different temperature scenarios. Capex on existing projects not shown.

How to interpret these charts

The capex bars in Figures 10-12 are coloured based on our analysis of project economics under different demand scenarios:

Blue – sanctioned projects, including both existing producing assets and those under development²⁶. We see this set of projects as broadly consistent with those compatible with the IEA's 1.5°C Net Zero Emissions by 2050 Scenario (NZE). Not shown in Figure 10.

Yellow – new projects with some of the lowest breakeven prices, potentially resilient to lower fossil demand under a Paris-aligned ('well below 2°C') scenario, but at risk of becoming stranded under faster transition scenarios. We use the IEA's Sustainable Development Scenario (SDS, 1.65°C), as this Paris-aligned scenario.

Orange – new projects with comparatively higher breakeven prices, which we see as likely to go ahead under a 'business as usual' scenario, but at risk of becoming stranded if a Paris-aligned pathway is achieved (SDS). We use the 2.7°C IEA's Stated Policies Scenario (STEPS), as a proxy for business-as-usual behaviour.

Red – the highest-cost project options that we assess as potentially uneconomic even under a business-as-usual scenario, and if sanctioned then would be highly vulnerable to becoming stranded. Companies developing projects in this band are effectively betting on complete failure of society to achieve global climate goals.

A significant proportion of this risk lies with companies listed in New York

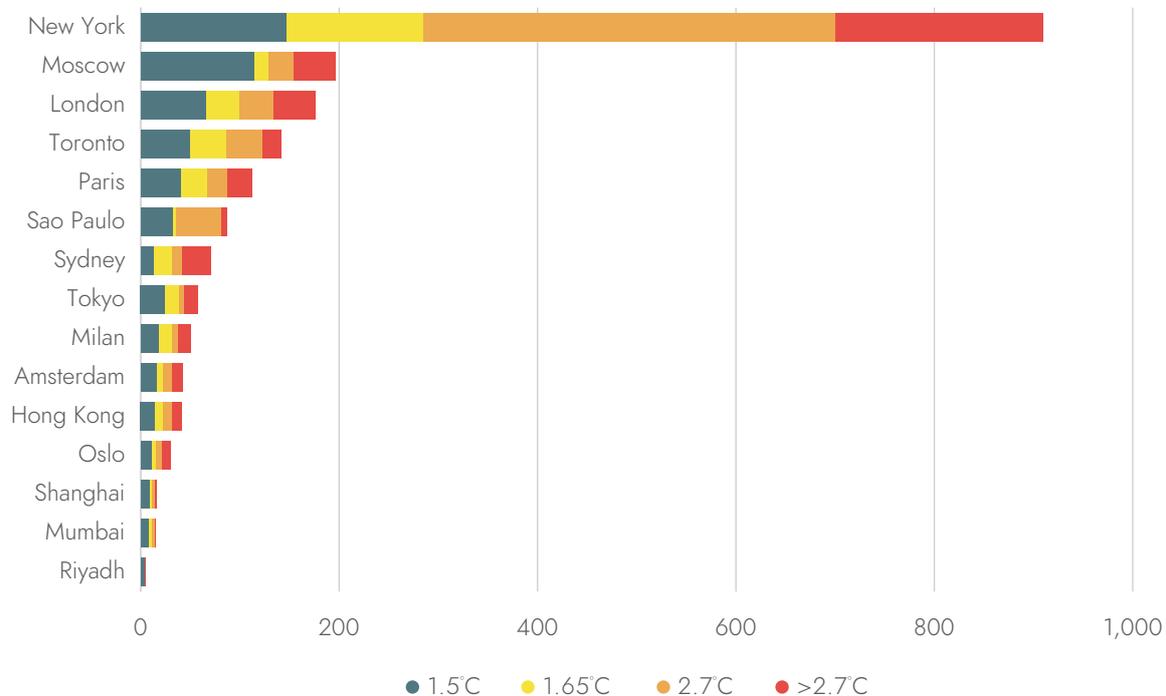
Riyadh and its Saudi stock exchange have unsurprisingly, the largest share of its market capitalisation linked to fossil fuel reserves. But is it the most exposed to the energy transition? As is hinted at by the valuation of Saudi Aramco, risks from the energy transition are not spread evenly, with companies that have access to low-cost projects likely to be more resilient to falling demand and prices. Here, we seek here to identify the geographical distribution of that risk by financial centre by aggregating company capex by the stock exchange of each company's primary listing.

Figure 11 shows the future potential total²⁷ capex over the next decade, adjusted for restricted stock/state ownership by applying a free-float weighting, showing the top 15 financial centres by embedded emissions within oil and gas reserves.

²⁶ Post-FID projects as of March 2021. Under the NZE, no new oil and gas development are required beyond 2021.

²⁷ Capex for both already-sanctioned (post-FID) projects and future project options.

Figure 11: the largest concentration of oil and gas projects by potential 2021-2030 capex (billions USD) aggregated by financial centre, free-float weighted.



Source: IEA, Rystad Energy, Bloomberg, Carbon Tracker analysis

Note: chart shows the 15 largest financial centres by embedded emissions from oil and gas.

New York once again dominates; on a free-float adjusted basis, a business-as-usual scenario would see listed companies spend \$700 billion over the next decade, the significant majority of this on new projects.

This reflects both the expansive portfolios of large companies such as ExxonMobil, Chevron, ConocoPhillips, and Occidental Petroleum on the New York Stock Exchange, and Apache (APA Corp), Diamondback Energy and Chesapeake Energy listed on the Nasdaq Stock Exchange, but also the sheer number of companies – with 79 upstream oil and gas companies listed across the two exchanges in our dataset.

Moscow has the second largest total spend, albeit with a large share on already-sanctioned projects. However, our analysis pre-dates the Russian invasion of Ukraine. With Urals crude currently trading at a discount and the EU's plans to reduce its reliance on of Russian oil and gas, many of these existing projects may return lower revenues in the medium- to long-term. Access to capital to supporting this ongoing investment may be challenging.

London, which has 59 listings of oil and gas producers, including the majors BP and Shell²⁸, has the third largest future capex. Toronto with tar sand companies such as Suncor, Canadian Natural Resources and Cenovus Energy listed on the Toronto Stock Exchange, follows in fourth.

²⁸ Companies were assigned to stock exchanges based on their listing status as of 28th September 2021, prior to Shell implementing its simplified share structure. Therefore, in our analysis, Shell is divided between the financial centres of London and Amsterdam.



07

Paris Alignment

In the previous section, we looked at companies' business-as-usual capex plans through a transition risk lens. This same data can alternatively be viewed as indicating the degree to which plans are aligned – or not – with the global climate goals.

The IEA has been clear that under its 1.5°C scenario (NZE) there is no need for new oil and gas projects to be developed; thus, companies and investors alike looking to be aligned with 1.5°C cannot credibly continue to support the development of new oil and gas. Under other “well below 2°C” scenarios, only a small number of new oil and gas projects can go ahead.

As we have written about in our ‘2 Degrees of Separation’ series of reports, those companies which are continuing to invest in projects that are not needed in a low-demand world cannot be viewed as “Paris-aligned” (or “net-zero” / “1.5°C” aligned).

Business-as-usual activity of listed companies is far from Paris-aligned

Interpreting this data through an alignment lens, we see that together, listed companies' business-as-usual plans for new investment in new projects are far from aligned with Paris' goals. This is shown by the size of the orange bars in Figure 12 (the same data as in Figure 11 redrawn as a % of business-as-usual capex)²⁹.

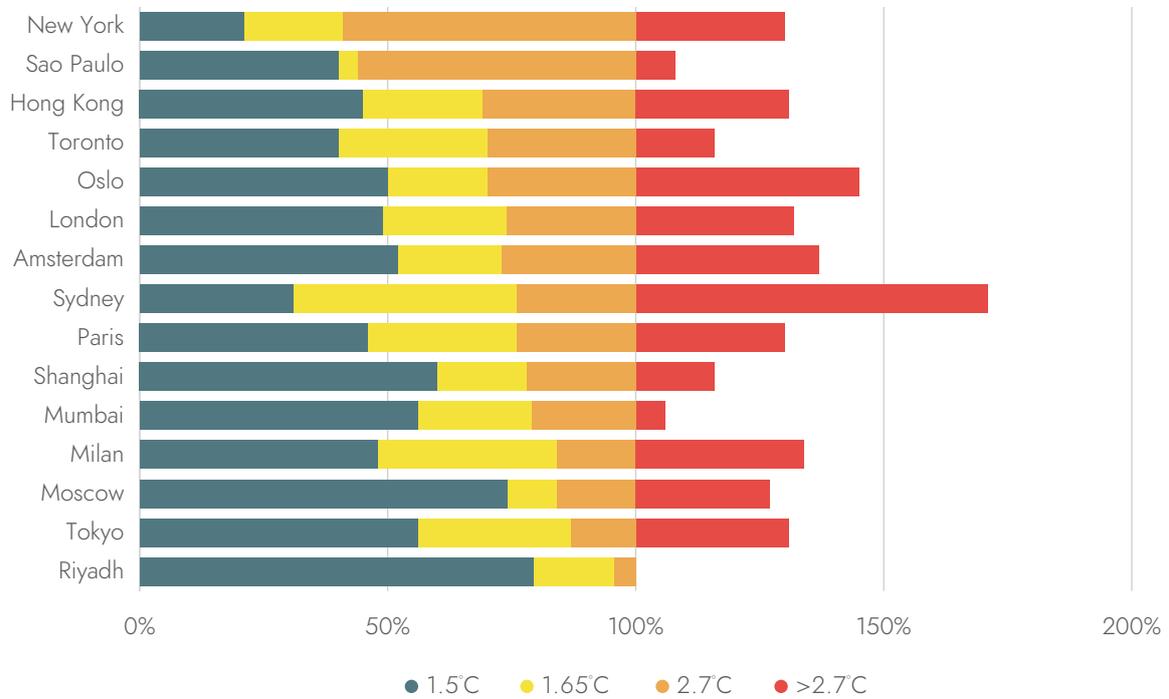
Companies listed in New York collectively have investment plans that are the least aligned with a 1.65°C scenario, with around 60% of total future capex falling outside this, and around 80% not aligned with 1.5°C (the blue bars). This is in part due to the nature of the shale industry and the need to continuously drill new wells to sustain production, whereas Riyadh at the bottom of the chart is heavily weighted towards Saudi Aramco's continued development of existing giant fields already under production.

Sao Paulo is the next least aligned, with a notably low share of new projects that fall within a 1.65°C scenario. This reflects the relatively high cost of the deepwater offshore project options of Petrobras, the principal oil and gas listing on the Brasil, Bolsa, Balcão (B3) stock exchange.

Sydney is also notable both for having the second lowest degree of alignment under a 1.5°C scenario, but also for having a particularly large share of capex outside of a 2.7°C scenario. In this case, this reflects a high proportion of comparatively high-cost projects options that are owned by Australian listed companies. This includes some large, capital-intensive LNG projects that will take many years to start producing and exporting gas, potentially into a market that is rapidly switching to alternative energy sources.

²⁹ The collective level of alignment amongst new projects can also be seen in Figure 10 by comparing the size of the orange bars to the total of the yellow and orange bars. For listed companies, 60% of potential business-as-usual capex on new projects (the orange bar) is not aligned with a 1.65°C “Paris” scenario.

Figure 12: Stranded asset exposure by financial centre shown as upstream oil & gas capex by financial centre, 2021-2030, as % of business-as-usual capex (2.7°C).



Source: IEA, Rystad Energy, Bloomberg, Carbon Tracker analysis

Note: chart shows the 15 largest financial centres by embedded emissions from oil and gas. 1.5°C scenario shows those projects that have already been sanctioned (post-FID), while coloured bars show the proportion of capex associated with pre-FID projects. Sorted by potential stranded asset exposure under a 1.65°C scenario (IEA's Sustainable Development Scenario). The IEA's Stated Policies Scenario is used as the proxy for business-as-usual.



Recommendations for Stakeholders

8.1 Recommendations for policymakers and regulators

The industrial revolutions of the past two centuries, built on the consumption of fossil fuels, have brought wealth and prosperity to much of the world. But continued development has run up against the buffers of the Earth's carbon budget, and for economies to continue to progress, the world must transition to a new energy system.

We contend that current financial market regulation is not fit for purpose overall as it is failing to protect investors from the systemic risks posed by climate change. As a result, financial markets continue to enable the extraction of fossil fuels beyond climatic limits, which will increase future losses from stranded assets. The current environment of high commodity prices, and a focus on securing fossil fuel supplies in the wake of the Russian invasion of Ukraine, risks amplifying the *carbon bubble* in financial markets through further investment in fossil fuel projects that are not needed in the medium to long term.

Governments and policymakers ought therefore to reflect on what this research tells them about how financial centres are both enablers of ongoing investment in fossil fuels and the risks they carry in their exposure to the fossil fuel system; and whether policy in this area is really aligned with their climate change and energy transition objectives.

Policymakers and regulators must set requirements that align financial markets with these national climate strategies and provide sufficient disclosures to allow investors to assess financial risk. As we have written about in "Flying Blind", the impacts of such risks are not being properly disclosed by companies in their financial statements and other reporting³⁰.

Increased regulatory oversight is required to enforce existing accounting and auditing requirements for climate-related disclosures. In particular, there should be a focus on requirements for financial statements to include the relevant quantitative assumptions and estimates used in the assessment of climate-related matters. Consistency across a company's climate reporting narrative is also essential.

We outline these specific recommendations for policymakers and/or regulators, as appropriate to consider:

- Increase regulatory oversight and enforcement of existing accounting and auditing requirements for climate-related considerations and relevant disclosures.
- Introduce rules that go beyond the TCFD³¹ recommendations, such as those being developed by the IFRS Foundation's *International Sustainability Standards Board*, or the SEC's proposed *climate change risk disclosure rules*, which would require the disclosure of Scope 3 emissions where material.
- Require companies with fossil fuel reserves to additionally disclose the carbon potential of their reserves and resources (i.e., their embedded emissions).
- Extend these requirements to disclosures in prospectuses of those looking to raise new or additional capital through equity or debt offerings. New listings or share offerings of fossil fuel companies should be required to explain why their reserves are necessary or will be developed in addition to those of other, already listed, fossil fuel companies.

30 See Carbon Tracker's report, *Flying Blind: The glaring absence of climate risks in financial reporting* (September 2021). Available at: <https://carbontracker.org/reports/flying-blind-the-glaring-absence-of-climate-risks-in-financial-reporting/>

31 Task Force on Climate-related Financial Disclosures

8.2 Recommendation for investors

Universal owners, such as institutional investors with a representative slice of the economy, should consider how the impact and costs of climate change to their entire portfolios might be weighed against pursuing the remaining profits from fossil fuel companies.

Investors with a more focused portfolio, or with a shorter time horizon, must still consider the risks facing the sector. Although fossil fuel shares have recently performed well, the long-term trend is clear: as the energy transition unfolds, demand for oil and gas will fall, with potential significant value loss for those invested in companies that did not show adequate foresight in their corporate strategy to transition away from fossil fuels.

We urge all investors to be **active owners** and:

- Require companies to adopt decarbonisation strategies and climate targets that fit within a Paris-aligned scenario, using initiatives such as *Climate Action 100+* to assess companies' targets and financial disclosures.
- Scrutinize companies' investment plans to ensure they are aligned with stated transition goals, particularly regarding capital investment in low carbon businesses relative to fossil fuel production investment.
- Insist that capex is not wasted on further fossil fuel exploration given that embedded carbon within discovered resources is already far in excess of Paris carbon budgets.
- Require that the emissions targets of fossil fuel companies meet our *Hallmarks of Paris Compliance*³². These are the three pre-conditions that we believe should be satisfied, as a minimum, for targets to be considered "Paris-compliant".
- Demand executive compensation is aligned with progress on climate targets, that it does not incentivise increased production, and that board members have the required expertise for assessing and managing climate-related risks and disclosures.
- Use all the tools at their disposal to bring about required changes at investee companies, including supporting shareholder action, voting against remuneration packages, and where necessary voting against the re-election of directors.

For those companies who fail to readily align their business plans with a 1.5°C trajectory, even after extensive 'engagement,' shareholders always have the option of switching their capital allocation from fossil fuels to alternatives including renewable energy. Divestment should always be a tool in the investor toolbox.

32 As outlined in our Absolute Impact series of reports.



09

Appendix & Methodology

9.1 Embedded emissions

The term 'embedded emissions' is used throughout the report to refer to the carbon dioxide (CO₂) potential from combustion of discovered fossil fuel reserves. It excludes emissions from other greenhouse gases, fugitive emissions and any associated land use changes. When considering all fossil reserves on a global basis, operational CO₂ emissions from extraction, processing, and transportation are accounted for, however on an individual basis (e.g., for a given financial centre) the total carbon footprint may be larger.

Embedded emissions were calculated using the latest *IPCC Guidelines for National Greenhouse Gas Inventories* as a methodological framework.

Embedded emissions in oil and gas reserves were calculated using Rystad Energy reserves data at individual asset level. Reserves were subdivided by type (Bitumen, synthetic crude, extra heavy oil, heavy oil, sour, regular, light, condensate, natural gas liquids and gas) and multiplied by CO₂ emissions factors assuming 100% combustion.

Embedded emissions in coal reserves of publicly-listed companies were provided by *FFI Solutions* from their *The Carbon Underground 200* (CU200) – a database developed and expanded from the original top 200 fossil fuel reserves owners identified in Carbon Tracker's 2011 Unburnable Carbon report. FFI Solutions subdivide coal reserves into anthracite, bituminous, sub-bituminous, and lignite. A detailed methodology can be downloaded from their website: [TCU-Methodology-2020-Factsheet-DEC.pdf](https://www.ffisolutions.com/TCU-Methodology-2020-Factsheet-DEC.pdf) ([ffisolutions.com](https://www.ffisolutions.com))

Global embedded emissions for all known fossil fuel reserves used in Figure 4 were calculated from 'proved' fossil fuel reserves from BP's Statistical Review 2021. Reserves were split into Anthracite and bituminous coal, sub-bituminous coal and lignite, oil, and gas and country level and multiple by standard CO₂ emissions factors assuming 100% combustion.

9.2 Reserves classification

Throughout this report we use 'reserves' to refer to discovered and recoverable reserves and contingent resources of fossil fuels. Prospective and inferred resources were excluded.

The coal reserves provided by FFI Solutions are the sum of economically extractable reserves based on the last reported reserves amount by mine. Reserves are allocated to listed companies based on percentage ownership of individual mines. Coal reserve data is dated 30th September 2021.

For oil and gas reserves we used Rystad Energy Pmean resource base - an estimate of the expected remaining recoverable economical volumes. This is a larger estimate than the strict 1P or 2P currently economical reserves estimates required under company disclosure rules. Oil and gas reserves data is dated 11th March 2021.

9.3 Financial centre assignment

Throughout this report, we consider embedded emissions and financial risk by 'Financial Centre' which is taken to be the host city of different stock exchanges. We have chosen financial centres as we wanted to both encapsulate the risk and impacts of the wider financial industry around each stock exchange and simplify the language of the report. It also allows us to group several exchanges together, often grouping a smaller exchange with a main stock exchange.

We amalgamate the reserves, market valuation, and stranded assets risk (in terms of future potential capex) of listed companies by the stock exchange of their primary listing. Companies with dual primary listings such as Shell prior to simplifying its share structure and companies with 'H-shares' in Hong Kong and 'A-shares' in Shanghai are split between exchanges based on the proportion of shares associated with each exchange. Depository receipts and over-the-counter trading were excluded from our analysis. Companies were assigned to stock exchanges based on their listing location as of 28th September 2021.

Table 1 below shows the exchanges and associated financial centres that include listings from the universe of companies with fossil fuel reserves used in our analysis.

Table 1: Financial centres and associated stock exchanges used in the analysis

Country	Financial Centre	Exchange	Embedded Emissions, GtCO ₂
Argentina	Buenos Aires	BYMA Floor	2.2
Australia	Sydney	Australian	7.5
		Australian Securities	22.9
Austria	Vienna	Wiener Boerse	1.5
Brazil	Sao Paulo	B3 Day	13.4
		BM&F BOVESPA	1.5
Canada	Toronto	Canadian Securities	<0.1
		Toronto	41.8
		TSX Venture	0.6
Chile	Santiago	Santiago	0.3
China	Hong Kong	Hong Kong	42.0
	Shanghai	Shanghai	180.0
	Shenzhen	Shenzhen	8.8
Colombia	Bogota	Bolsa Colomb	1.4
Denmark	Copenhagen	Copenhagen	<0.1
France	Paris	EN Paris	16.7
Germany	Frankfurt	Deutsche Boerse AG	6.0
		Xetra	0.1
		Hamburg	0.1
Greece	Athens	Athens	9.4
Hungary	Budapest	Budapest	0.4
India	Mumbai	BSE India	35.5
		NSE India	105.8
Indonesia	Jakarta	Indonesia	17.0

Ireland	Dublin	Euronext Dublin	<0.1
Israel	Tel Aviv	Tel Aviv	1.3
Italy	Milan	Borsa Italiana	10.6
Japan	Tokyo	Tokyo	17.6
Kuwait	Kuwait City	Kuwait	<0.1
Malaysia	Kuala Lumpur	Bursa Malays	0.4
Mexico	Mexico City	BMV Mexico	<0.1
Mongolia	Ulaanbaatar	Mongolian	0.2
Netherlands	Amsterdam	EN Amsterdam	10.5
New Zealand	Wellington	NZX	<0.1
Nigeria	Lagos	Lagos	0.3
Norway	Oslo	Oslo	9.0
Pakistan	Karachi	Pakistan	0.9
Philippines	Manila	Philippine	0.2
Poland	Warsaw	Warsaw	5.0
Portugal	Lisbon	Euronext Lisbon	0.9
Romania	Bucharest	Bucharest	0.3
Russia	Moscow	Moscow	124.5
Saudi Arabia	Riyadh	Saudi	122.1
Singapore	Singapore	Singapore	0.4
South Africa	Johannesburg	Johannesburg	12.1
South Korea	Seoul	Korea	2.1
Spain	Madrid	Soc.Bol SIBE	4.2
Sweden	Stockholm	Stockholm	0.5
Taiwan	Taipei	Taiwan	<0.1
Thailand	Bangkok	Thailand	4.0
UAE	Abu Dhabi	Abu Dhabi	0.6
United Kingdom	London	London	47.3
		NASDAQ	14.6
United States of America	New York	New York	143.9
		NYSE American	0.4
Zambia	Lusaka	Lusaka	0.2

Disclaimer

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