

Ownership of power plants stranded by climate mitigation

Received: 12 February 2025

Accepted: 30 October 2025

Published online: 11 December 2025

 Check for updates

Robert Fofrich Navarro¹✉, Lauren Liebermann², Frances C. Moore³,
Christine Shearer⁴ & Steven J. Davis⁵

Existing fossil-fuel-burning power plants must be retired (or retrofitted with technology to capture and store CO₂ emissions) before the end of their operating lifespans to achieve the most ambitious international climate goals (around 2 °C). Abbreviated power-plant lifespans, costly retrofits and lost revenues to power-plant owners in turn represent stranded assets, namely investments that can no longer earn a viable return because of climate policies. Here we use detailed data of power plants worldwide to evaluate the scale of financial risks by region, generator type and corporate ownership. We find that of the 100 companies that own the most stranded assets by value, the very largest are state-owned and the top 25 companies cumulatively hold upwards of US\$770 and US\$224 billion in stranded assets under a 1.5 °C scenario and 2.0 °C, respectively. Our findings reveal the power-plant owners most exposed to financial risks linked to the shift away from fossil fuels, as well as the concentration of financial interests adverse to rapid decarbonization.

International climate goals to limit anthropogenic warming to 2 °C or less aim to avoid severe climate impacts on natural and human systems in the coming decades^{1–10}, but such goals entail a rapid reduction in carbon dioxide (CO₂) emissions by transitioning away from fossil sources of energy and fossil-fuel-burning power plants in particular^{11,12}. Policies aligned with international climate targets will effectively impose higher costs on emitting infrastructure^{13,14}, leaving the owners of fossil-fuel-burning power plants to adapt and transition away from high-carbon-emitting technologies, absorb substantial financial losses or pass related costs on to consumers. However, the magnitude and distribution of company-level financial risks in the global power sector have not been systematically evaluated, even though understanding such risks is crucial for accurately anticipating broader economic implications and allowing companies, investors and policy-makers to plan for and manage projected financial losses^{15–18}. In this study, we assess stranded power-plant assets at the company level and by region with the hope of informing financial investors and energy-related decision-makers.

Previous research has shown that achieving ambitious climate goals requires the early retirement of fossil-fuel-burning power plants^{2,11,19,20} in the absence of retrofitting these plants with carbon capture technology, resulting in substantial forgone revenues. Other studies have estimated potential economic losses across the power sector^{13,14,21–23} or quantified stranded power-plant assets on a national level^{14,24}, but most have not quantified the financial exposure of individual companies. For instance, ref. 24 calculated the proportion of operating fossil-fired electricity-generating capacity that exceeds climate-compatible levels under a 2 °C scenario and estimated stranded assets based on unrecovered capital costs from premature decommissioning. Similarly, ref. 25 quantified stranded assets using overnight capital costs and the unfulfilled portion of the expected lifetime of a coal plant under a 1.5 °C pathway. Meanwhile, ref. 14 estimated stranded assets in oil and gas production as the net present value of foregone profits under climate policy scenarios and aggregated from the asset level to firms and countries. In contrast, we evaluate foregone operating income of existing fossil-fuel-burning generators under carbon pricing

¹Institute of the Environment and Sustainability, University of California, Los Angeles, Los Angeles, CA, USA. ²Department of Civil and Environmental Engineering, University of California, Irvine, Irvine, CA, USA. ³Department of Environmental Science and Policy, University of California at Davis, Davis, CA, USA. ⁴Global Energy Monitor, Covina, CA, USA. ⁵Department of Earth System Science, Stanford University, Stanford, CA, USA.

✉e-mail: robertfofrich@ucla.edu

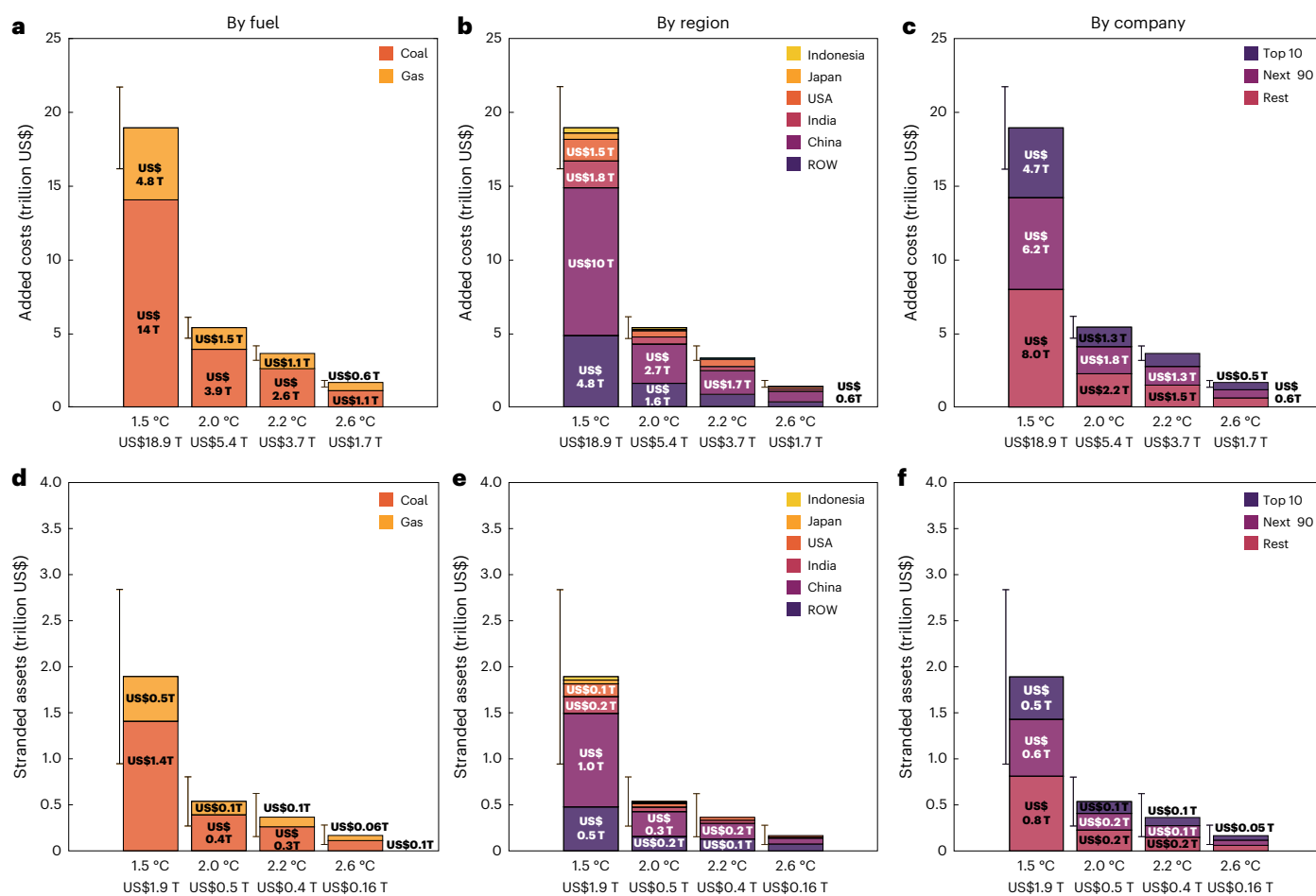


Fig. 1 | Value of fossil-fired electricity generators worldwide stranded under lower climate mitigation scenarios. a–c, Stacked bars show the additional costs to fossil-fuel-fired electricity generators resulting from median regional carbon prices ($n = 25$ per region) under scenarios that limit the increase in global mean temperature to 1.5 °C, 2.0 °C, 2.2 °C and 2.6 °C. Bars represent median values, with error bars showing the range of stranded assets using minimum and maximum carbon prices within each region. Roughly 75% of the total added costs are related to coal-fired generators (a), more than half of the total are attributable

to China (b) and more than a quarter are associated with power plants owned by just ten companies (c). d–f, The stranded-asset amounts under the same carbon pricing scenarios, assuming a 90% pass-through rate, with error bars showing the range of results calculated with pass-through rates of 85% and 95%. Coal power operators stand to lose around US\$1.4 trillion over the operational lifespans of their plants (d). Similarly, China is projected to lose around US\$1 trillion (e) and just ten companies could collectively lose half a trillion dollars (f) under a 1.5 °C scenario. ROW, rest of world; T, trillion.

estimates associated with lower climate policy scenarios, aggregate these losses to the company and identify and name companies with the largest financial exposure. While financial institutions, investors and policy-makers are generally aware of the financial risks associated with climate policies^{26,27}, the scale and distribution of economic exposure among companies with emission-intensive power-plant assets is not clear. Therefore, this study assesses the financial implications of carbon pricing on fossil-fuel-burning power plants and reports the potential economic losses incurred by individual companies.

An asset is stranded when changes in technology or policy sharply reduce its value. Here we estimate differences in operating income of 16,438 fossil-fired power generators assuming either no carbon price or carbon prices consistent with lower warming targets (1.5 °C, 2.0 °C, 2.2 °C and 2.6 °C) and aggregate these losses on a company and country level. To isolate the financial impact of carbon pricing on generator revenues, we hold electricity generation constant at historical levels across climate policy scenarios and allow generators to pass on 90% of the added carbon costs to the rate-paying consumers. Our default model uses a geographically uniform discount rate, consistent with the parameters widely used by models that generate the carbon prices listed in the shared socioeconomic pathways database^{28–30} (Supplementary Tables 1–4). Further details of our approach are

described in Methods. It should be noted that, although our model represents climate mitigation policy in terms of carbon prices, such prices may reflect a multitude of specific policies that are more regionally scaled and not fully captured by our model. Thus, our results are not intended as financial projections for individual companies but rather as a relative indicator of which companies have the highest financial risks under climate policies aligned with international targets if governments do not implement compensatory policies for asset owners.

Results

Figure 1 illustrates the net present value of the added operating costs and foregone operating income from existing fossil-fuel-burning power plants worldwide under carbon pricing scenarios consistent with limiting global mean temperature increases to around 2 °C, assuming each plant continues to operate under its historical conditions into the future. Under these scenarios, the total added costs to fossil fuel power-plant operators are US\$18.9 trillion (US\$16–21.7 trillion), US\$5.4 trillion (US\$4.6–6.1 trillion), US\$3.7 trillion (US\$3.2–4.2 trillion) and US\$1.7 trillion (US\$1.5–1.9 trillion) based on the median carbon price for each climate policy trajectory, respectively (Fig. 1). Coal-burning power-plant operators would incur 75% of the total costs under a 1.5 °C climate mitigation scenario (Fig. 1a). More than half these

costs are concentrated among power-generating companies in China and a substantial share of the costs are borne by companies in India (9.6%), the USA (7.3%) and Indonesia (2.0%) (Fig. 1b). Added costs are highly concentrated amongst countries and companies: 10 companies would be responsible for 24.0% of the total, 90 other companies would bear 33.7%, with the remainder of these costs being divided among 4,851 companies (Fig. 1c). In the absence of strict regulation, power companies are likely to pass through a large share of carbon-related operating cost increases to rate payers, thereby reducing their own financial exposure. However, the portion of costs not passed through by the utility operator would ultimately be absorbed by the company as a loss to operating income (stranded assets). Consequently, the magnitude of financial losses to companies will not only depend on the stringency of climate policy, but also on the proportion of costs passed through to electricity rate payers and the discount rates used to value foregone revenues. We find that stranded assets total US\$1.9 trillion, US\$0.5 trillion, US\$0.4 trillion and US\$0.16 trillion under scenarios in which power-generating companies are permitted to pass through 90% of their increased operating costs associated with carbon prices consistent with 1.5 °C, 2 °C, 2.2 °C and 2.6 °C climate targets, respectively, while discount rates are held constant across nations (Fig. 1d). However, revenue losses to fossil power generators are highly sensitive to the share of costs passed on to rate payers, ranging from approximately US\$0.9 trillion to US\$2.8 trillion under pass-through assumptions of 95% to 85%, respectively, in the 1.5 °C scenario alone. By comparison, stranded assets increase by 25% to 60% when adopting lower and more geographically differentiated cost of capital estimates (Supplementary Table 5), as lower discount rates in many major economies raise the present value of foregone revenue (Supplementary Fig. 1). Although the absolute value of stranded assets increases under more ambitious climate scenarios and under lower-pass through or discount rates, the proportional concentration among power-generator operators (for example, fuel, region and ownership) of these assets remains relatively unchanged (Supplementary Fig. 1), indicating that these financing assumptions strongly affect magnitude but not the relative distribution of risks. Not shown in the figures, a well-known metric of market concentration, the Herfindahl–Hirschman index (HHI), indicates that ownership of stranded coal plants is substantially more concentrated (0.0142) than natural gas plants (0.0048; Methods).

Of the 100 companies that own the most stranded assets by value, the very largest are state-owned (denoted by an asterisk below) and the top 25 companies cumulatively hold upwards of US\$770 billion in stranded assets and are responsible for emitting 4.0 GtCO₂ per year—nearly 11% of global CO₂ emissions in 2024. Among coal plants, these companies include China's five largest power producers: Huaneng Group*, Datang Corporation*, Huadian Group*, China State Power Investment Corporation* and China Energy Investment*, which cumulatively account for US\$79 to US\$134 billion of coal assets stranded by the 2.0 °C scenario (Fig. 2a and Supplementary Fig. 2a). Beyond China, NTPC Limited* (owned by India's Ministry of Power), Korea Electric Power* (South Korea), Perusahaan Listrik Negara* (Indonesia) and Adani Enterprises LTD (India) also hold around US\$22 to US\$33 billion in stranded coal-burning assets (Fig. 2a and Supplementary Fig. 2a). Stranded coal assets in China and India are large primarily because these countries are operating relatively new power plants: in both countries, the capacity-averaged age of coal-burning power plants is <15 years (Fig. 2b). The largest owners of stranded gas- and oil-burning plants include Egyptian Electric Holdings* (Egypt), Saudi Electricity* (Saudi Arabia), Nextera Energy (USA), Ministry of Electricity Iraq* (Iraq), Korea Electric Power (South Korea), Calpine (USA), CLP Group (China) and Engie S.A. (France; Fig. 2c). These companies operate large and/or young fleets of power plants (Fig. 2d).

The degree to which ownership of stranded fossil-fuel-burning power-plant assets is concentrated is shown in Fig. 3, which shows the share of fuel-specific emissions related to generators stranded

under a carbon price consistent with a 2.0 °C scenario. Roughly 30% of CO₂ emissions from coal plants are attributable to power plants owned by 10 companies (Fig. 3a,c) and more than half of CO₂ emissions are from 50 companies. Ownership of stranded gas-burning power plants is more evenly distributed, with 100 companies owning gas-fired generators that emit half the emissions from natural gas- and oil-burning power plants (Fig. 3b,d). Some key assumptions underlying our engineering-based estimates of stranded assets include the operational capacity factor of individual fossil-fuel-burning power plants, carbon price trajectories, cost of capital estimates and pass-through rates. We test our results using lower and more granular cost of capital estimates (Supplementary Table 5) and observe an increase in stranded assets, but the relative patterns of stranding across firms, fuels and regions remain largely consistent (Fig. 3 and Supplementary Table 6). Figure 4 illustrates how estimated stranded-asset values vary under different power-plant operating conditions and various carbon pricing scenarios. We find that higher carbon prices (more stringent climate policies), extending fossil-fuel-burning power-plant lifespans and increased capacity factors all raise the value of stranded assets, but the relative importance of these variables is somewhat different for fossil-fuel-burning power plants burning different fossil fuels (Fig. 4). Coal-burning plants are the most sensitive to carbon price as they generally release more CO₂ per unit of electricity generated and natural gas power plants are more evenly sensitive to both carbon prices and capacity factor (Fig. 4a,b). Similar patterns are observed with respect to power-plant operational lifespans, where carbon prices have a more pronounced impact on the stranded-asset values of coal power generators compared with gas-fired plants (Fig. 4d,c). Despite modeling assumptions, we observe that the distribution of stranded-asset risks among regions and companies remains largely consistent and companies with the greatest risk of stranded assets are those that have invested in and deployed the most fossil-fuel-burning power-plant capacity most recently.

Discussion

Uncertainties as to the timing and stringency of climate policies have encouraged continued investments in fossil-fuel-fired electricity generation, even as international climate goals (for example, limiting the increase of global mean temperature to around 2.0 °C) would entail the costly early retirement of a substantial portion of existing fossil infrastructure^{2,19,29,31}. Here we develop an engineering-based estimate of stranded assets for the power sector and estimate the global total to be in the trillions of dollars over the next 40 years, more than half of which is owned by just 100 companies. Previous studies have estimated the economic impacts of stranded fossil fuel assets at national or global scales, reporting losses ranging from approximately US\$500 billion to over US\$4 trillion, depending on the stringency and timing of the implemented climate policy^{14,22–25,32}. Our results are broadly consistent with these estimates, despite differences in methodological approach and the framing of stranded assets. Where previous studies assess stranded assets at the sector, country or financial system levels, our analysis identifies stranded assets at the company level and reveals that financial exposure is concentrated among a relatively few firms, particularly those with substantial investments in coal-fired power generation. While our estimates provide a benchmark for financial exposure under stringent climate policy, real-world asset stranding is likely to unfold in a more uneven environment, due to regional differences in policy, electricity market structures and financing conditions and thus may be more regionally differentiated than what is observed here. Still, our results may be useful for the growing number of investors and regulators interested in assessing policy-related transition risks^{18,33}. In contrast to general statements about the potential costs of climate and energy policies, such as those made pursuant to the requirements of the Task Force on Climate-Related Financial Disclosures³⁴, we have quantified the value of the assets of companies at risk of being stranded

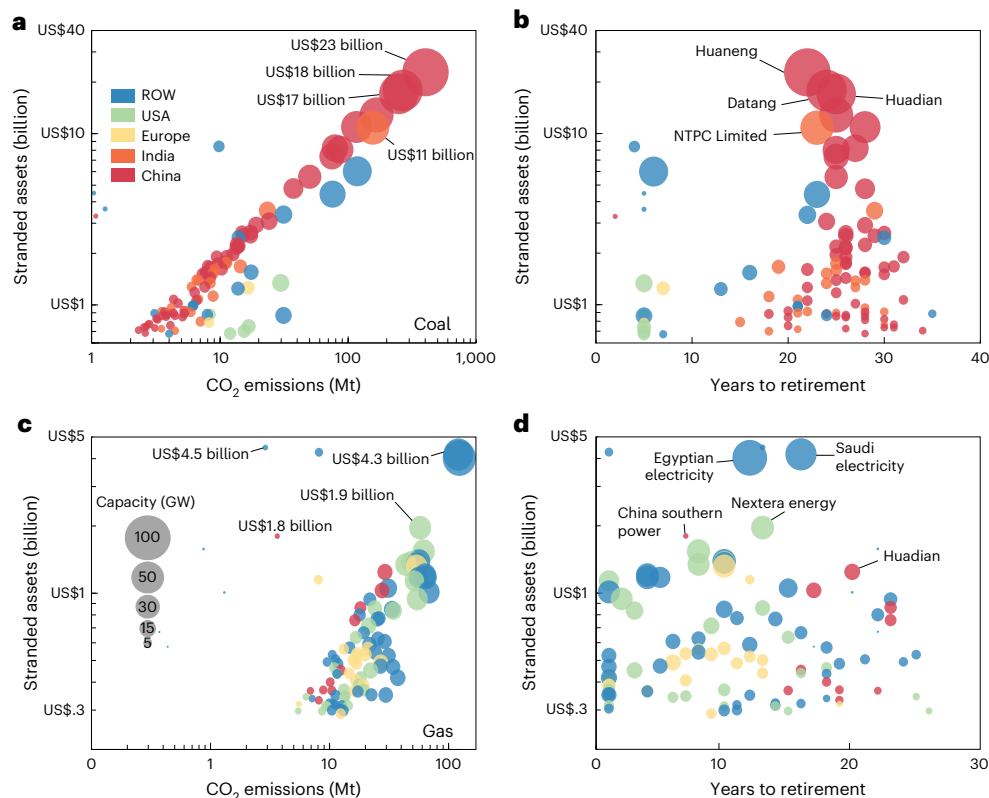


Fig. 2 | Top 100 companies by stranded-asset value in the 2.0 °C scenario.

Circles show the value of stranded generation assets and related annual emissions for each of the 100 companies with the greatest total value of stranded assets, separated according to the type of fossil fuel burned by generators (rows). The size of the circles further indicates the fossil-electricity-generation capacity

of each company and colours denote the country or region. **a,c**, Comparing the stranded assets of each company with the annual emissions from its power plants for coal (**a**) and gas (**c**). **b,d**, The average remaining operating life of those coal (**b**) and gas (**d**) plants until retirement.

under different climate goals using publicly available information and transparent assumptions.

Under the most ambitious climate mitigation scenarios, we find stranded assets increase in companies whose power holdings have capacity-weighted average operational life of less than 20 years, most of which are owned and operated by China's big five energy-generating companies—China Huaneng Group corporation[†], China Datang Corporation[†], China Huadian Corporation[†], China Energy Investment[†] and China State Power Investment Corporation[†]. These state-owned enterprises are managed by the State Asset Supervision and Administration Commission (SASAC) and have been at the forefront of China's energy and economic growth in recent decades. Cumulatively, SASAC manages 331 GW and 49 GW of coal- and gas-fired capacity, respectively (around 28.1% of China's total electricity-generating capacity) and together, the power plants owned by these companies produce roughly 15% of the committed emissions of the global power sector. Consequently, China's state-owned power infrastructure presents a unique opportunity and challenge for global decarbonization efforts as state-owned enterprises are largely incentivized by public service mandates rather than typical economic frameworks and are therefore more insulated from broader market forces^{35,36}. Thus, the economic structure of state-owned enterprises can ultimately hinder or propel green technology investment relative to private firms, but is largely dependent on the regulatory directives of the state. Still, additional costs to state-owned power-generating enterprises constitute a public policy problem for national governments. Depending on the public objectives of those entities, costs may not be borne entirely by the enterprise itself but might be redistributed more generally across the population. While there is some evidence suggesting that state-owned enterprises may be more inclined than private firms to adopt environmentally friendly

policies, the degree to which governments pursue policies counter to their economic objectives is relatively unknown and warrants further investigation^{35,37}, particularly given that the scale of potential financial losses can also create strong incentives to resist more stringent climate policy. Given its notable role as a global producer of consumer goods³⁸, the sudden financial collapse of the power infrastructure overseen by SASAC could have extensive financial implications beyond China's borders and thus merits special consideration. By comparison, in Western economies, corporate power-generating entities and public utilities have largely lowered annual CO₂ emissions by heavily investing in natural gas-fired power generation³⁹. However, the substitution of aging coal-fired power generators with newer gas-fired power infrastructure has not substantially reduced cumulative emissions and has instead increased the transition risks for power-generating firms in the USA³⁹ and European Union.

Limitations

While our findings offer valuable insights into the risks faced by specific companies, they are subject to several important caveats and limitations. First, our estimates of stranded assets are a result of financial conditions and policy trajectories that vary across countries and are likely to evolve over time, including climate policy (carbon pricing consistent with a specific warming target), cost of capital and the proportion of costs absorbed by individual companies. To the extent that the stringency of global climate policy is insufficient to meet lower warming targets, then our estimates will be correspondingly smaller. Similarly, our valuation of stranded assets is based on the assumption that fossil fuel power generators will continue to operate to the end of their working lives. While this assumption provides a useful upper bound for estimating stranded assets, it may overestimate operational persistence.

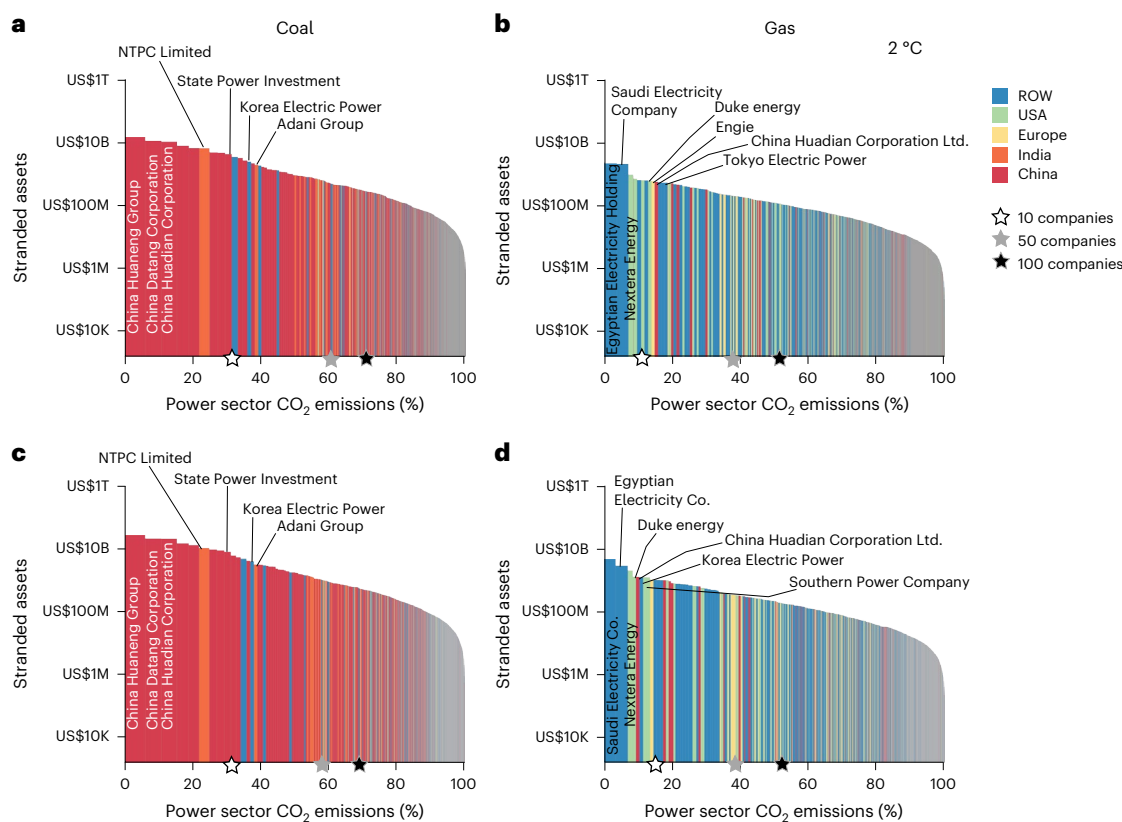


Fig. 3 | Corporate stranded assets by fuel and emissions. We organize stranded power-generating assets by value and show total power-sector emissions (x axis) by fuel (columns) and region (colours). The height of each bar represents the total stranded assets of each parent company under a 2 °C scenario, while the width of the bar indicates the proportion of the emissions of a company in

relation to the total CO₂ emissions from the power sector for a given fuel class. **a, b**, Stranded-asset values for coal (**a**) and gas (**b**) using a uniform global discount rate. **c, d**, Results derived using country-specific cost of capital estimates for coal (**c**) and gas (**d**). B, billion; K, thousand; M, million.

In practice, there is considerable variation in power-plant lifespans due to regulatory design, maintenance requirements and economic conditions, which can lead to the early retirement of younger, more efficient generators or the extended operation of older plants^{40,41}. Thus, to the extent that financial markets or asset owners already anticipate some tightening of climate policy over the lifetimes of assets or, conversely, reflect scepticism about the realization or stringency of climate policy, elements of this risk may already be priced into assets or appear on company balance sheets and thus be reflected in their current market valuation. Furthermore, substantial changes in fuel prices, evolving economic pressures or technological advancements may prompt earlier-than-expected retirements of fossil-fired-generating assets even in the absence of carbon pricing or climate-driven mandates. Therefore, given the complex and evolving factors driving stranded assets, our results should not be interpreted as forecasts for corporate revenues, investment returns, market capitalization or current stock valuation. Nor should our estimates be interpreted as unrealized capital that would automatically accrue to firms if more ambitious climate policy efforts were ultimately abandoned, as current company valuations already embed expectations about future profitability amid evolving macro-economic conditions. Nonetheless, our results consistently show that the same companies hold the largest share of stranded assets across various climate mitigation policy trajectories and financing assumptions, indicating that these entities are most at risk of asset stranding.

It should also be noted that we assume companies will internalize some of the costs associated with carbon pricing, rather than transferring all additional expenses to their rate payers. In some cases, only a smaller portion of the carbon costs will be passed on to consumers, while in less competitive markets, all these costs can be passed through to rate

payors⁴². The degree to which companies can pass costs on to consumers will depend on the development of carbon-free power generation, consumer demand response to increasing energy prices and regulatory processes that determine local electricity rates^{43,44}. Our analysis attributes the added costs from carbon pricing as stranded-asset exposure to corporate owners, although we recognize that this does not fully capture the distribution of financial risk or liability. Utilities frequently use risk-sharing strategies, such as project-level non-recourse debt, leasing structures or regulatory cost of service frameworks, which shift financial exposure to lenders, lessors or consumers. However, these arrangements are often private and inconsistently disclosed, making them difficult to incorporate into asset-level modelling. Additionally, the timing at which carbon pricing is implemented also influences our results, as the financial risk of a company diminishes as its fossil-fired power fleet ages and increases as new carbon-emitting power plants come online. Consequently, the scale of stranded assets held by each corporate entity is likely to fluctuate over time. Although many countries, such as China and India, have nascent carbon pricing mechanisms, others, including the USA, lack such programmes at the national level.

Additionally, carbon policies that are more substantially geographically differentiated than the regional estimates used here, for instance, to reflect the differentiated responsibility of individual countries as opposed to economic regions, would produce different geographic distributions of stranded assets. Nonetheless, the carbon price schedules we adopt reflect cost-minimizing pathways for achieving more ambitious climate mitigation targets and the central pass-through rates used in this study are representative of those observed in more-established carbon markets within the electricity sector. If, instead, countries implement non-price instruments to

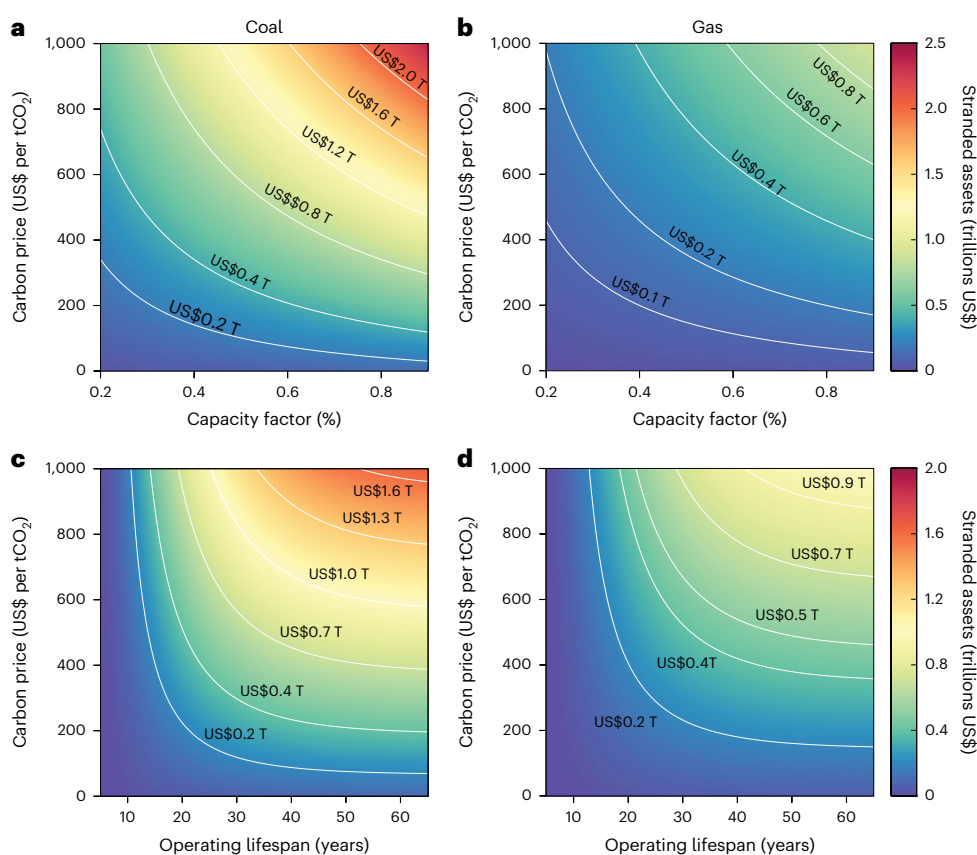


Fig. 4 | Sensitivity of stranded assets to assumed carbon prices and power-plant operating conditions. Contours show how the value of stranded coal and gas power plants changes under various global carbon pricing scenarios which extend beyond the values used in lower warming scenarios. Carbon prices

reflected on the y axis represent the maximum carbon price achieved under each case. **a,b.** The influence of the capacity factor (x axis) on stranded-asset values for coal (**a**) and gas (**b**). **c,d.** Illustrating how our estimates of stranded assets change under different power-plant operating lifespans (x axis) for coal (**c**) and gas (**d**).

achieve their emissions goals, the associated costs and potential for stranded assets will be correspondingly higher. Finally, our analysis is grounded in projections of power-plant revenues and costs based on historical electricity-generation returns. However, projected revenues and input costs are subject to change, with precise operational conditions, maintenance and fuel costs influenced by dynamic future conditions that are unknown and very difficult, if not impossible, to model. Yet changing costs and revenues will probably alter the operating schedules of future power generators.

Conclusions

Our results suggest that a substantial fraction of the existing fossil-fired generating assets of these companies could be stranded under current climate mitigation targets. However, while these costs pose a large financial risk to these companies, the monetary value of these stranded assets pales in comparison to the social and natural damages associated with unmitigated anthropogenic climate warming^{3–6,45–47}. A sudden increase in power-generating costs from the implementation of carbon pricing can result in sizeable financial losses for companies that are heavily invested in carbon-intensive industries⁴⁸. Thus, companies that persistently invest and deploy new CO₂-emitting infrastructure without anticipating future tightening of climate policies face higher financial transition risks and ultimately increase the likelihood of unrecoverable previously anticipated projected returns (stranded assets). While gas-fired generators are likely to play a growing role in the clean energy transition because of their flexibility in supporting variable renewable energy, their profitability would still decline relative to a no-policy baseline as carbon prices rise. Therefore, to reduce stranded-asset exposure and align with climate mitigation trajectories,

power-generating companies should strategically decommission or mothball their existing fossil-fuel-generating fleets.

Methods

We derived the corporate and state owners of 98% of individual operating fossil-electricity-generating plants from the global coal-plant tracker, global oil- and gas-plant tracker and global energy ownership tracker datasets obtained from the global energy monitor database. We omitted power plants from our calculations in the limited cases where the percentage of ownership was not listed within the data. We obtained technology-specific estimates of power-plant operating costs from the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Working Group III (IPCC WGIII) and future carbon prices consistent with lower warming scenarios (1.5 °C, 2.0 °C, 2.2 °C and 2.6 °C scenarios) are obtained from the shared socioeconomic pathways database^{28–30}. All monetary values are expressed in constant US\$(2005), which is consistent with the carbon pricing estimates listed in the shared socioeconomic pathways database. While this approach ensures comparability across countries and time, it does not capture the potential impact of exchange rate fluctuations on historical or projected costs.

To quantify future profits, we project the expected generating income and costs of each power plant (*i*) individually over the anticipated operational life of the plant and assign profits to their respective parent company.

$$\text{Generator profits}_{it} = G_{it}EP_{it} - G_{it}FC_f\theta_i - O\&M_{it} - IC_{it}$$

In our study, generator profits are defined as the operating income earned from electricity generation over a period (*t*), calculated

as power-plant revenue minus the cost of production. Income from production is determined by multiplying the annual electricity generation of each plant (G) with the regional price of electricity (EP) and subtracting the generating costs. Generating costs are calculated by multiplying annual electricity generation (G), global average fuel costs (FC) and a fuel-to-electricity conversion term (θ), in addition to the global operations and maintenance costs (O&M), as well as the investment costs (IC). Global average, technology-specific power-plant operational costs are obtained from the IPCC WGIII report⁴⁹, while regionally distinct electricity prices are obtained from GCAM v.7 and although more granular data could improve accuracy in specific contexts, our approach allows for consistency and comparability across countries. In line with the IPCC approach, we include capital investment costs in our estimates. Although typically considered sunk and not expected to influence operational decisions, these costs reflect ongoing financial obligations that may persist for debt-financed infrastructure. We adopt a geographically uniform discount rate of 10%, consistent with the International Energy Agency (IEA) estimates for a high-risk market^{50–52}, to reflect investor expectations under a riskier operating environment associated with climate policy and given the absence of a globally comprehensive cost of capital dataset. However, to test the sensitivity of our results against more heterogeneous financing conditions, we use lower regional- and country-level discount rates to reflect lower perceived investment risks and financing costs. Country-level cost of capital values are taken from ref. 53, which reports estimates for about 100 countries. These values are aggregated according to the regional classifications used in the carbon pricing data, with regional averages assigned to countries that have missing values. Additionally, as individual power plants age, the operational and maintenance costs typically increase such that these costs are not well covered by the generated revenues, resulting in their closure historically around 30 years for natural gas and 40 years^{12,54–57} for coal-fired power-generating infrastructure. Therefore, we allow for existing power infrastructure to retire in line with their historical norms, except for cases where a projected retirement date is explicitly listed in the power-plant data.

To quantify the impacts of climate mitigation policy on fossil-fired power-plant profits, we first calculate the net present value of these generating assets (i) on the basis of the operating income for each generator. We allow firms to retire these plants following historical conditions and do not explore the ramifications of the financial liabilities this may cause. Additionally, to avoid abrupt retirements of power-generating assets, we gradually raise the annual carbon price on an annual basis in line with the carbon pricing used by IPCC climate projection models, which use the shared socioeconomic framework³⁰ (Supplementary Tables 1–4).

$$NPV_i = \sum_{t=0}^{IT} \frac{\text{Generator profits}}{(1+r)^t}$$

We translate future climate trajectories (1.5 °C through 2.6 °C) into stranded assets by incorporating regionally specific carbon price paths used by integrated assessment models for climate mitigation scenarios⁵⁸. Carbon prices translate directly into increased input costs for fossil fuel plants, diminishing future profit projections. Therefore, we modify power-generator profits by including the additional accrued costs of electricity generation.

$$\begin{aligned} \text{Modified generator profits}_{it} \\ = G_{it}EP_{it} - G_{it}FC_f\theta_i - G_{it}ECP_t(1 - PTR) - O\&M_{it} - IC_{it} \end{aligned}$$

Where E is the total annual emissions for each plant, PTR is the uniform pass-through rates and CP is the regionally based carbon pricing at the time (t), which achieves the climate emission scenario. Since most countries lack established carbon markets, there is limited

empirical evidence available to determine national-level carbon price pass-through rates. Under conditions of perfect competition and full market efficiency, carbon costs would almost certainly be fully passed through to electricity prices, resulting in a 100% pass-through rate and no direct cost burden to fossil fuel generators⁵⁹. In practice, however, observed pass-through rates vary across markets because of various factors such as market structure, regulatory interventions, the availability of alternative generation capacity and uncertainty in emission cost projections^{60,61}. As a result, we adopt a range of 85% to 95% pass-through rates based on values reported in the existing literature^{42,62,63}. Annual emissions are calculated for each individual unit from equations that vary slightly based on their fuel type. We obtain the emission equations from the Global Energy Monitor and IEA estimates.

$$\text{Annual CO}_2 \text{ emissions}_{\text{Coal}} = G_{it} \times HR_t \times EF_t \times C$$

$$\text{Annual CO}_2 \text{ emissions}_{\text{Gas}} = G_{it} \times LCEF_t$$

Where HR is the technology-specific heat rate, EF denotes the emission factor of coal plants and LCEF represents the life-cycle emissions factor associated with natural-gas power plants. In our study, we define stranded assets as the difference in future asset income with and without the implementation of a climate policy that limits warming:

$$\text{Stranded assets}_i = \sum_{t=0}^{IT} \frac{GP_i - \widehat{GP}_i}{(1+r)^t} = \sum_{t=0}^{IT} \frac{G_{it}ECP_t(1 - PTR)}{(1+r)^t}$$

We aggregate unit-level monetary income over the operational lifetime of the power generator and assign these losses to their parent company (corporate or state-enterprise owners) and select the top 100 companies by stranded-asset holdings. To investigate the national economic risk from stranded fossil-fired capacity, we quantify and assign the monetary value of these losses within the borders of each nation. We quantify the concentration of company-level stranded assets using the HHI, calculated as the sum of the squared shares of stranded assets relative to the total stranded assets for each fuel type. The HHI reflects the degree of concentration, with higher values indicating that a greater proportion of stranded assets is concentrated among fewer companies. Our analysis of stranded assets relies on publicly available data used by integrated assessment models for carbon prices^{28–30}, which are commonly used in climate change forecasts and by the broader scientific community and historical average power-plant operating conditions for each individual unit. Nonetheless, we recognize that the value of stranded assets is determined by the carbon pricing amount and is also influenced by the use of power generators. Thus, we test the sensitivity of our results by varying the carbon price trajectory incrementally per year until the maximum price of US\$0 to US\$1,000 per ton is reached and fluctuating the capacity factor from 20% to 90%. We report the implications of these variations on global fossil-fired power-generator stranded assets in our sensitivity analyses. In a separate sensitivity test, we use historical capacity-factor estimates and instead vary the power-generator operating life and report these results. We subsequently repeat our sensitivity test, but instead of gradually increasing carbon prices over time, we apply the maximum carbon prices immediately and uniformly for the entire duration of the lifespans of the power infrastructures and show its effects on stranded-asset values. Overall, our approach enables us to assess the potential economic impacts of stranded fossil-fired power-generation assets, providing valuable insights into the financial risks faced by corporate entities and the challenges associated with transitioning to a low-carbon energy system.

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability

The data used for this study are publicly available. Unit-level power-plant data, power-plant emission factors and heat rates can be found on the Global Energy Monitor website (<https://globalenergy-monitor.org>). While carbon prices can be downloaded from the shared socioeconomic pathways database (<https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=about>). Power-plant generating costs were obtained from the IPCC AR5 report (https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-iii.pdf). Additional data are available via Zenodo at <https://doi.org/10.5281/zenodo.14861495> (ref. 64). All inquiries and requests for materials should be addressed to R.F.N. (robertfofrich@ucla.edu). Source data are provided with this paper.

Code availability

Data processing and analysis were conducted in MATLAB (release R2020b, v.9.9). The MATLAB code used in this study is available via Zenodo at <https://doi.org/10.5281/zenodo.14861495> (ref. 64).

References

- Sanderson, B. M. & O'Neill, B. C. Assessing the costs of historical inaction on climate change. *Sci. Rep.* **10**, 9173 (2020).
- IPCC. *Climate Change 2021: The Physical Science Basis* (eds Masson-Delmotte, V. et al.) (Cambridge Univ. Press, 2021).
- Meehl, G. A. et al. Trends in extreme weather and climate events: issues related to modeling extremes in projections of future climate change. *Bull. Am. Meteorol. Soc.* **81**, 427–436 (2000).
- IPCC: Summary for Policymakers. In *Climate Change and Land* (eds Shukla, P. R. et al.) (IPCC, 2019).
- Carleton, T. et al. Valuing the global mortality consequences of climate change accounting for adaptation costs and benefits. *Q. J. Econ.* <https://doi.org/10.1093/qje/qjac020> (2022).
- Carleton, T. A. & Hsiang, S. M. Social and economic impacts of climate. *Science* **353**, aad9837 (2016).
- Lobell, D. B. et al. The critical role of extreme heat for maize production in the United States. *Nat. Clim. Change* **3**, 497 (2013).
- Nelson, G. C. et al. Climate change effects on agriculture: economic responses to biophysical shocks. *Proc. Natl Acad. Sci. USA* **111**, 3274 (2014).
- Schlenker, W. & Roberts, M. J. Nonlinear temperature effects indicate severe damages to U.S. crop yields under climate change. *Proc. Natl Acad. Sci. USA* **106**, 15594 (2009).
- Urban, D., Roberts, M. J., Schlenker, W. & Lobell, D. B. Projected temperature changes indicate significant increase in interannual variability of U.S. maize yields. *Clim. Change* **112**, 525–533 (2012).
- Fofrich, R. et al. Early retirement of power plants in climate mitigation scenarios. *Environ. Res. Lett.* **15**, 094064 (2020).
- Cui, R. Y. et al. Quantifying operational lifetimes for coal power plants under the Paris goals. *Nat. Commun.* **10**, 4759 (2019).
- Semieniuk, G., Campiglio, E., Mercure, J.-F., Volz, U. & Edwards, N. R. Low-carbon transition risks for finance. *WIREs Clim. Change* **12**, e678 (2021).
- Semieniuk, G. et al. Stranded fossil-fuel assets translate to major losses for investors in advanced economies. *Nat. Clim. Change* **12**, 532–538 (2022).
- Sen, S. & von Schickfus, M.-T. Climate policy, stranded assets, and investors' expectations. *J. Environ. Econ. Manag.* **100**, 102277 (2020).
- Riedl, D. The magnitude of energy transition risk embedded in fossil fuel company valuations. *Heliyon* **7**, e08400 (2021).
- Reboredo, J. C. & Otero, L. A. Are investors aware of climate-related transition risks? Evidence from mutual fund flows. *Ecol. Econ.* **189**, 107148 (2021).
- Battiston, S., Monasterolo, I., Riahi, K. & Ruijven, B. J. Accounting for finance is key for climate mitigation pathways. *Science* **372**, 918–920 (2021).
- Rogelj, J. et al. Energy system transformations for limiting end-of-century warming to below 1.5 °C. *Nat. Clim. Change* **5**, 519–527 (2015).
- Rogelj, J. et al. in *IPCC Special Report on Global Warming of 1.5 °C* (eds Masson-Delmotte, V. et al.) 93–174 (WMO, 2018).
- Lamperti, F., Bosetti, V., Roventini, A. & Tavoni, M. The public costs of climate-induced financial instability. *Nat. Clim. Change* **9**, 829–833 (2019).
- Mercure, J. F. et al. Macroeconomic impact of stranded fossil fuel assets. *Nat. Clim. Change* **8**, 588–593 (2018).
- Kefford, B. M., Ballinger, B., Schmeda-Lopez, D. R., Greig, C. & Smart, S. The early retirement challenge for fossil fuel power plants in deep decarbonisation scenarios. *Energy Policy* **119**, 294–306 (2018).
- von Dulong, A. Concentration of asset owners exposed to power sector stranded assets may trigger climate policy resistance. *Nat. Commun.* **14**, 6442 (2023).
- Edwards, M. R. et al. Quantifying the regional stranded asset risks from new coal plants under 1.5 °C. *Environ. Res. Lett.* **17**, 024029 (2022).
- Sanchez, D., Nelson, J., Johnston, J., Mileva, A. & Kammen, D. M. Biomass enables the transition to a carbon-negative power system across western North America. *Nat. Clim. Change* **5**, 230 (2015).
- FSOC Report on Climate-Related Financial Risk 2021 Report (US Treasury, 2021).
- Gidden, M. J. et al. Global emissions pathways under different socioeconomic scenarios for use in CMIP6: a dataset of harmonized emissions trajectories through the end of the century. *Geosci. Model Dev.* **12**, 1443–1475 (2019).
- Rogelj, J. et al. Scenarios towards limiting global mean temperature increase below 1.5 °C. *Nat. Clim. Change* **8**, 325–332 (2018).
- Riahi, K. et al. The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: an overview. *Glob. Environ. Change* **42**, 153–168 (2017).
- Paris Agreement TIAS No. 16-1104 (UNFCCC, 2015).
- Johnson, N. et al. Stranded on a low-carbon planet: implications of climate policy for the phase-out of coal-based power plants. *Technol. Forecast. Soc. Change* **90**, 89–102 (2015).
- Bolton, P. & Kacperczyk, M. Do investors care about carbon risk?. *J. Financ. Econ.* **142**, 517–549 (2021).
- Goldstein, A., Turner, W. R., Gladstone, J. & Hole, D. G. The private sector's climate change risk and adaptation blind spots. *Nat. Clim. Change* **9**, 18–25 (2019).
- De Kleine Feige, A. I. *State-Owned Enterprises and Climate Action* (World Bank Group, 2021).
- Climate Change and Low-Carbon Transition Policies in State-owned Enterprises* (OECD, 2022).
- Hsu, P.-H., Liang, H. & Matos, P. Leviathan Inc. and Corporate Environmental Engagement. *Manag. Sci.* **69**, 7719–7758 (2021).
- Davis, S. J. & Caldeira, K. Consumption-based accounting of CO₂ emissions. *Proc. Natl Acad. Sci. USA* **107**, 5687–5692 (2010).
- Shearer, C., Tong, D., Fofrich, R. & Davis, J. D. Committed emissions of the U.S. power sector, 2000–2018. *AGU Adv.* **1**, e2020AV000162 (2020).
- Keohane, N. O., Mansur, E. T. & Voynov, A. Averting regulatory enforcement: evidence from new source review. *J. Econ. Manag. Strategy* **18**, 75–104 (2009).
- Rode, D. C., Fischbeck, P. S. & Páez, A. R. The retirement cliff: power plant lives and their policy implications. *Energy Policy* **106**, 222–232 (2017).
- Fabra, N. & Reguant, M. Pass-through of emissions costs in electricity markets. *Am. Econ. Rev.* **104**, 2872–2899 (2014).

43. Sijm, J., Chen, Y. & Hobbs, B. F. The impact of power market structure on CO₂ cost pass-through to electricity prices under quantity competition—a theoretical approach. *Energy Econ.* **34**, 1143–1152 (2012).
44. Sijm, J., Karsten, N. & Chen, Y. CO₂ cost pass-through and windfall profits in the power sector. *Clim. Policy* **6**, 49–72 (2006).
45. Yang, H., Meng, K. C. & Suh, S. Spatial distributions of stranded fossil asset costs and benefits from climate change mitigation. *Environ. Res. Commun.* **5**, 061001 (2023).
46. Quilcaille, Y. et al. Systematic attribution of heatwaves to the emissions of carbon majors. *Nature* **645**, 392–398 (2025).
47. Callahan, C. W. & Mankin, J. S. Carbon majors and the scientific case for climate liability. *Nature* **640**, 893–901 (2025).
48. Gambhir, A. et al. Near-term transition and longer-term physical climate risks of greenhouse gas emissions pathways. *Nat. Clim. Change* **12**, 88–96 (2022).
49. Schlömer S. et al. in *Mitigation of Climate Change* (eds Edenhofer, O. et al.) 1329–1356 (Cambridge Univ. Press, 2014).
50. *Projected Costs of Generating Electricity 2020* (IEA, 2020).
51. *Projected Costs of Generating Electricity 2010* (IEA, 2010).
52. Fishedick, M. et al. in *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* (eds Edenhofer, O. et al.) Ch. 10 (Cambridge Univ. Press, 2011).
53. Calcaterra, M. et al. Reducing the cost of capital to finance the energy transition in developing countries. *Nat. Energy* **9**, 1241–1251 (2024).
54. Davis, S. J., Caldeira, K. & Matthews, H. D. Future CO₂ emissions and climate change from existing energy infrastructure. *Science* **329**, 1330–1333 (2010).
55. Davis, S. J. & Socolow, R. H. Commitment accounting of CO₂ emissions. *Environ. Res. Lett.* **9**, 084018 (2014).
56. Shearer, C., Fofrich, R. & Davis, S. J. Future CO₂ emissions and electricity generation from proposed coal-fired power plants in India. *Earth's Future* **5**, 408–416 (2017).
57. Tong, D. et al. Committed emissions from existing energy infrastructure jeopardize 1.5 °C climate target. *Nature* **572**, 373–377 (2019).
58. *IPCC AR5 Scenarios Database* (accessed, 2021); <https://iiasa.ac.at/models-tools-data/ar5>
59. Bonacina, M. & Gulli, F. Electricity pricing under ‘carbon emissions trading’: a dominant firm with competitive fringe model. *Energy Policy* **35**, 4200–4220 (2007).
60. Jouvet, P.-A. & Solier, B. An overview of CO₂ cost pass-through to electricity prices in Europe. *Energy Policy* **61**, 1370–1376 (2013).
61. Woo, C. K. et al. Carbon trading’s impact on California’s real-time electricity market prices. *Energy* **159**, 579–587 (2018).
62. Kim, W., Chattopadhyay, D. & Park, J.-b. Impact of carbon cost on wholesale electricity price: a note on price pass-through issues. *Energy* **35**, 3441–3448 (2010).
63. Nelson, T., Kelley, S. & Orton, F. A literature review of economic studies on carbon pricing and Australian wholesale electricity markets. *Energy Policy* **49**, 217–224 (2012).
64. Fofrich Navarro, R. A. Ownership of power plants stranded by climate mitigation. *Zenodo* <https://doi.org/10.5281/zenodo.14861495> (2025).

Acknowledgements

The research presented here was primarily supported by the US National Science Foundation. R.F.N., S.J.D. and F.C.M. were funded by the US National Science Foundation (INFEWS grant EAR 1639318). R.F.N. received supplementary support from the Ridge to Reef NSF Research Traineeship, award no. DGE-1735040 and the University of California’s Office of the President.

Author contributions

R.F.N., S.J.D. and F.C.M. designed the study. C.S. contributed to the data collection and analysis, while L.L. assisted in processing the data. R.F.N. led the analysis in close consultation with S.J.D. and F.C.M. R.F.N. wrote the paper with input and revisions from all co-authors.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1038/s41893-025-01707-5>.

Correspondence and requests for materials should be addressed to Robert Fofrich Navarro.

Peer review information *Nature Sustainability* thanks Chris Greig, David Rode and the other, anonymous, reviewer(s) for their contribution to the peer review of this work.

Reprints and permissions information is available at www.nature.com/reprints.

Publisher’s note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

© The Author(s) 2025

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

- | n/a | Confirmed |
|-------------------------------------|--|
| <input type="checkbox"/> | <input checked="" type="checkbox"/> The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> The statistical test(s) used AND whether they are one- or two-sided <i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> A description of all covariates tested |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals) |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted <i>Give P values as exact values whenever suitable.</i> |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated |

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection

Data analysis https://doi.org/10.5281/zenodo.14861495 (ref.65)."/>

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

The data used for this study are publicly available. Unit-level power plant data, power plant emission factors, and heat rates can be found on the Global Energy Monitor website (<https://globalenergymonitor.org>). While carbon prices can be downloaded from the Shared Socioeconomic Pathways database (<https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=about>). Power plant generating costs were obtained from the IPCC AR5 report (<https://www.ipcc.ch/site/>

Research involving human participants, their data, or biological material

Policy information about studies with [human participants or human data](#). See also policy information about [sex, gender \(identity/presentation\), and sexual orientation](#) and [race, ethnicity and racism](#).

| | |
|--|--|
| Reporting on sex and gender | N/A - This study does not include human participants |
| Reporting on race, ethnicity, or other socially relevant groupings | N/A |
| Population characteristics | N/A |
| Recruitment | N/A |
| Ethics oversight | N/A |

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

Life sciences Behavioural & social sciences Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

| | |
|--------------------------|---|
| Study description | In our study, we employ a quantitative approach to analyze the economic impacts on power generating assets under various climate mitigation scenarios, identifying companies and government entities with the highest financial risk due to continued operations of fossil-fired power plants. We use data from multiple public databases to quantify the additional costs imposed on these power generators under different future carbon pricing scenarios. This analysis characterizes potential lost profits as stranded assets and aggregates these losses at both company and country levels. Our research used published methods to model power plant operational costs, electricity generation capabilities, and operational lifetimes while also identifying the corporate ownership of each plant. We account for variations in regional, fuel-type, and unit-level operational conditions and costs. |
| Research sample | This study consists of data collected on 16,438 fossil-fired power plants that are either operational or under construction globally. We were able to identify the corporate owners of around 98% of these power plants, providing a comprehensive analysis of the financial risks to the power sector under stringent climate policies. The data used in this study includes unit-level attributes such as nameplate capacity, operational status, fuel type, year the power plant became operational (or year construction is expected to be completed), and ownership. |
| Sampling strategy | We aimed to provide the most comprehensive analysis possible of fossil-fired power plants stranding under a more ambitious climate policy. Therefore, we aimed to include as much data as was available for each power-generating asset. Exclusions were limited to power plants for which complete data on ownership was not available, as our analysis centered on highlighting the risks to individual companies which own fossil-fired power generating assets. |
| Data collection | The data used in this study was sourced from publicly accessible databases. Unit-specific power plant data, including operational conditions, were obtained from the Global Energy Monitor. Future climate mitigation scenarios and associated carbon pricing were sourced from IIASA's Shared Socioeconomic Pathways database, while generating cost data was derived from the IPCC's AR5 report. The Global Energy Monitor team, which includes one of our coauthors, collected power plant data from a combination of public and private sources, including national databases, energy reports, and industry publications. More details on their data collection methods can be found on their website: https://globalenergymonitor.org/projects/global-coal-plant-tracker/methodology/ . |
| Timing and spatial scale | The data utilized in this study reflects the status of global power plants up to late 2024, the time of the study's completion. It encompasses global coverage, with economic assessments performed at the unit level to capture the diverse operational costs across different regions and nations. |
| Data exclusions | In this analysis, exclusions were only applied to power plants for which ownership details was not listed by the global energy monitor or for power plants that were either retired or in the planning stages but not actively under construction. We establish the ownership exclusion criterion to ensure that the stranded assets could be accurately attributed to identifiable corporate entities. The decision to not include power plants that weren't already operational or under construction stemmed from the rationale that these power-generating assets could still easily be canceled and therefore wouldn't reflect the stranded assets that companies are currently exposed to. |

| | |
|-----------------------------------|---|
| Reproducibility | Our analysis was conducted using MATLAB and is based on custom code developed specifically for this study. The MATLAB script was executed multiple times, yielding identical results in each run. To ensure transparency and reproducibility, a copy of the code has been archived on GitHub allowing others to access, review, and validate our results. |
| Randomization | This study does not involve experimental groups or participants that require random allocation. Instead, we analyze a comprehensive dataset of power plants globally, incorporating all available unit-level data that included the necessary parameters rather than selecting a randomized subset. Our analysis aims to assign economic risk to individual companies, and therefore, randomization was not appropriate for our purposes. |
| Blinding | Given the nature of our study blinding was not conducted nor relevant for this type of analysis. |
| Did the study involve field work? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

| n/a | Involvement in the study |
|-------------------------------------|--|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Antibodies |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Eukaryotic cell lines |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Palaeontology and archaeology |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Animals and other organisms |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Clinical data |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Dual use research of concern |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Plants |

Methods

| n/a | Involvement in the study |
|-------------------------------------|---|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> ChIP-seq |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Flow cytometry |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> MRI-based neuroimaging |

Plants

| | |
|-----------------------|-----|
| Seed stocks | N/A |
| Novel plant genotypes | N/A |
| Authentication | N/A |