CAN TECHNOLOGIES MITIGATE THE RISK OF FOSSIL FUEL ASSETS BEING STRANDED IN THE POWER SECTOR?

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Overview

The future emissions from the generation capacity of existing and currently planned power plants go beyond the limits of a 2°C carbon budget(Davis and Socolow, 2014; Pfeiffer *et al.*, 2016; Tong *et al.*, 2019). Some of these assets will have to be stranded unless carbon is sequestrated with carbon capture and storage (CCS) or the carbon budget is expanded by the large-scale deployment of negative emissions technologies (NETs, e.g. bioenergy). But to which degree could CCS and NETs reduce the risk of fossil fuel assets being stranded? Energy demand technologies (e.g. improved energy effeiciency) and alternative energy supply technologies like nuclear and renewable energy could reduce the amount of energy supply required from fossil fuel power plants. Will these technologies aggravate the risk of fossil fuel assets being stranded in the power sector?

To the best of our knowledge, no previous study has investigated the impact of technologies on the amount of assets stranding. Previous literatures confirmed that substantial assets are potentially to be stranded (Davis and Socolow, 2014; Pfeiffer *et al.*, 2016, 2018), however, the amount of stranded assets is rarely made explicit and the impact on assets stranding remain unclear.

Understanding the impact of technologies on asset stranding is important for investors in the energy sector: are decisions to invest in new long-lived fossil fuel plants potentially profit maximizing if climate policy constraints are in place? The question is also very relevant to policy-makers. Existing infrastructure already increases the difficulties of achieving a climate policy consistent with the Paris goals(Johnson et al., 2015) and weak near-term energy policies that allow the building of even more polluting fossil fuel capital stock will make it even harder for climate policies to succeed in the future (Rozenberg et al., 2017).

In this paper, we evaluate whether power-sector asset stranding is sensitive to the availability of different technologies, including carbon capture and storage, NETs, energy intensity, nuclear energy, and renewable energy. Our contributions are two-fold. We are the first to study the impact of technology pathways on assets stranding. This provides important implications for investors in making investment decisions and policy makers in deiciding the choice of future environmental, climate and energy policies. We are also the first to quantify the explicit amount of assets stranding in power sector (measured in MWh). We extends from the previous literature analysing assets stranding in the power sector and further developed the method to make the amount of assets stranding explicit.

Methods

We undertake this study in two steps. Firstly, we estimate the amount of asset stranding from 2021 to 2100 by comparing the available capacity of existing assets to the electricity generation in the Integrated Assessment Model (IAM) scenarios. We define assets stranding as the electricity that should be generated from current existing capacity (including operating, planned and under construction) following historical utilization rate, while not generated because of climate policy constraints to match the electricity generation assumed in IAMs scenarios. Our rich and unique set of global power plant level dataset manually compiled from CoalSwarm, World Electric Power Plants and other asset-level databases allow us to evaluate the total amount of electricity that existing assets will be able to provide over the course of their lifetime. We compare the amount with IAM scenario data collected from AMPERE, IPCC AR5 and EMF27 databases.

Secondly, we evaluate the impact of a particular technology by comparing the amount of assets stranding between matched scenario pairs. Matched pairs refer to scenarios using the same Integrated Assessment model, modelling the same policy target, covering the same geographical region, and having only one technology setting different. The advantage of this method is that it allows us to compute the impact of technology on assets stranding across different IAMs to provide more robust estimates and a clearer representation of uncertainties. We could ease out the concern that results from IAMs models constructed on different structures and assumptions are usually not directly comparable(Kriegler et al., 2015).

Results

We find fossil fuel assets are at huge risk of being stranded in climate scenarios. In more stringent climate scenarios (450ppm), the estimated amount of global electricity generation being stranded from 2021 till 2100 amounts to 270 PWh, which equals to about 10 years of global electricity generation at 2018 level. Coal assets are at most risk compared to gas and oil assets. Asia is the region that holds most fossil fuel assets stranding, most of which stem from coal-fired power plants.

CCS and NETs technologies could significantly reduce the amount of assets stranding. In more stringent scenarios (450ppm), CCS and bioenergy could reduce the global assets stranding by 50% and 25% respectively. Coal assets would strongly benefit from CCS and NETs with lower stranding, while gas-fired power plants do not have such benefits. Although demonstrating large impact in percentage, considering the total amount of assets stranding is huge, the effect of CCS and NETs in mitigating the stranding risk remain limited.

Increased energy efficiency (demand side technology) does not have significant impact on the amount of assets stranding. On the supply side, both nuclear and wind and solar energy would slightly increase the amount of fossil fuel assets stranding. This can be explained that when alternative energy supply is enabled, more energy would be supplied through these alternatives and thus less energy supply would be needed from fossil fuel power plants, causing more assets to be stranded. But the impact is very limited as the difference in the amount of stranding is smaller than one year of regional electricity generation in most cases.

Conclusions

In this paper, we find that fossil fuel assets in power-sector are at huge risk of being stranded, even allowing for the development of diverse technologies. Our results provide little comfort for investors in long-lived fossil-intensive assets, especially coal. Even in optimistic scenarios in which CCS and NETs exist and are scaled up, the amount of assets at risk of stranding is still huge. However, as NETs could extend the carbon budeget and CCS could capture the carbon emitted from power plants, these solutions will still be needed to offset the dangerous levels of emissions expected from existing fossil fuel power plants. We also find that deployment of demand and supply side technologies will not largely increase the amount of assets stranding.

References

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