# Technical note on coal, oil and gas demand destruction [internal use only]

**This note sets out the oil and gas demand destruction (asset stranding) methodology used in the low carbon portfolio tool.**

**This note is structured as follows:**

* Section 1.1.1 sets out the motivation for the energy demand destruction approach
* Section 1.1.2 details the methodology used in the demand destruction model
* Section 1.1.3 maps out the steps used in the model

### Abstract

**Fossil fuel demand destruction (asset stranding) is an important channel in the modelling of climate policy impacts.** Climate policy will **indirectly** affect the profits of producers of fossil fuel resources, whose **consumption** is associated with high levels of CO2 emissions:

* Carbon pricing policies **directly** impact the profits of companies manufacturing goods, for which **production****is CO2 intensive**, for instance, power generation, cement or steel-making;
* Climate policy **indirectly** affects the profits of producers of high-carbon content goods, for which **consumption** **is CO2 intensive**, through lower demand, for instance, coal, oil, and gas companies;
* These indirect effects require the use of alternative modelling approaches, as production-based CO2 emissions are a poor proxy for climate impacts on these companies.

### Modelling methodology

**The tool values the impacts of fossil demand destruction using changes in market prices, and company supply curves for coal, oil, and natural gas.** Market price changes are determined based on aggregate quantities of fossil fuels under each climate policy scenario, and a ‘merit order style’ supply curve for coal, oil, and natural gas. The intersection of the new market price, and energy company supply curves then reveals how many barrels each company produces, and how large the profit impact is. This approach is shown in Figure 1.

1. While oil industry supply determines the market price, each company’s supply curve determines its quantity contraction, and loss of profit



Note: An extreme case would be a very cheap oil producer (for instance, Saudi Arabia or Iran), for which the RHS supply curve would be low and flat

Source: <https://vivideconomics.sharepoint.com/:p:/s/projects/171211HSB/EXfp0kqSt_pCiOgeIbXexRABO70jDYH5-Tyvstmx-cLJiA?e=0nZL2x>

**Aggregate fossil fuel quantities are determined by energy system modelling of climate policy scenarios.** Each 2DS climate policy scenario is associated with an emissions cap required to keep atmospheric CO2 levels sufficiently low for 2 degrees of global warming. The combustion of fossil fuels in power generation, industry, transport, and buildings is the largest source of CO2 emissions, so any 2DS scenario will involve a restriction on the use of coal, oil and gas. The system model optimises the quantity of each fuel, depending on the value derived from its combustion, the fuel’s value in CO2 emissions abatement, and its substitutability as a feedstock and fuel source.

**Market price changes are found based on the aggregate fossil fuel quantities, and the industry supply curve for each fuel.** The new industry price is then overlaid against each energy company’s supply curve, with the intersection yielding the firm’s production quantity. Under this approach, each energy company is a price taker in global markets for coal, oil and natural gas.

**This analysis is repeated for coal, oil, and natural gas, for each model year (2017-2040), and for each company in the MSCI World index identified as active in fossil fuel exploration and production.**

**Analysis shows that the majority of energy industry profit losses can be attributed to falling margins rather than stranded assets.** While energy companies lose out on all the profits from fossil fuel resources which are no longer extracted (stranded assets), these are the most expensive (least profitable) extractable assets in their portfolios. The fall in production from to in Figure 2 represents stranded oil assets, that is, oil which is currently viable, but is no longer profitable to extract under a 2DS climate policy scenario. By comparison, the fall in oil price affects the profitability of every barrel which is still profitable under the 2DS scenario oil price, . This ‘margin squeeze’ is responsible for the vast majority of profit losses in the energy industry. The loss of profit on stranded units (quantity impact) and ‘inframarginal’ units (margin impact) is shown in Figure 2.

1. Margin squeeze is the main cause of energy industry profit losses under 2DS policy scenarios



Note: N/A

Source: <https://vivideconomics.sharepoint.com/:p:/s/projects/171211HSB/EXfp0kqSt_pCiOgeIbXexRABO70jDYH5-Tyvstmx-cLJiA?e=0nZL2x>

**The aggregate effect of fossil fuel demand destruction on a company’s valuation is found in net present value (NPV) terms.** The NPV of oil profits under business-as-usual, and 2DS scenarios is then found, with the difference in profits yielding the stranding impact for each company. The use of NPV profits, captures the higher value placed on near-term profits, than on profits in the longer-term; a discount rate of 7.75% is assumed for this purpose. This is salient as investors may be rational in investing in an energy company with a high risk of demand destruction, if those risks are sufficiently far in the future.

**This ‘merit order’ based approach to fossil fuel demand destruction produces considerable company-level heterogeneity in profit impacts:**

* companies with expensive assets, such as shale oil or oil sands producers, are high up on the merit order and produce very little oil under 2DS, experiencing considerable asset stranding, and large margin impacts on any oil still produced;
* state-owned producers with cheap assets, may experience very little asset stranding, and more modest margin impacts;
* producers with short-lived assets benefit from the upward trajectory of assumed climate policy pathways – in the early years of climate policy action, carbon pricing is low, so demand destruction impacts are modest;
* companies with assets that enter production late in the modelling period suffer due to high carbon prices, and large demand destruction impacts.

### Modelling steps

1. Within each scenario, the Imperial TIMES global energy system models produce forecasts of global oil, gas and coal demand by year; this is the quantity forecast
2. Using Wood Mackenzie company-level oil, gas and coal supply curves we then:
   1. Produce global oil, gas and coal supply curves, for each year
   2. The intersection between these curves and the quantity forecast from (1) yields the global oil, gas and coal prices, for each scenario, for each year
   3. The intersection between price and each company’s oil, gas and coal supply curve gives production for each company, for each scenario, for each year
3. Compute NPV profit for oil, gas and coal, for each scenario, for each energy company
4. The ratio of NPV profit for each scenario to NPV profit under business as usual, gives the % profit loss due to asset stranding for each oil and gas company
   1. This can be decomposed into quantity and margin impacts; that is, losses on inframarginal units which are no longer produced, and losses on units which are still produced, but less profitable due to demand contraction