Stranded carbon assets: The (hidden) risk of fossil fuels[1]

How to assess cost and benefits of investing and divesting in carbon intensive sector

HIGHLIGHTS

- *COP21 final agreement has set an ambitus target: containing temperature increase below 2° Celsius.*
- *To achieve that, there is a limited amount of CO2 – between 870 and 1,100 Gt – that can be emitted in the next 35 years.*
- *Current fossil fuel reserves largely exceed this carbon budget.*
- *Recent estimates indicate that if we want to meet the COP21 target, at least 60% of proven fossil fuel reserves have to stay underground.*
- *Moreover, unneeded investment in the fossil fuel industry could amount up to 1.8 trillion, entailing a considerable risk of a "carbon bubble".*

POLICY AND STRATEGIC IMPLICATIONS

- *Governments have to decide when and how to implement fossil fuel phase-out policies: early implementation would bring about sudden collapse in asset values while not guiding towards an energy transition; late implementations would result in unnecessary profits to fossil fuel assets .*
- *Energy companies should anticipate the possibility of Influential investors to engage as active participants in driving fossil fuels out of markets.*
- *Risk-averse investors such as pension funds will adjust their portfolios to reduce exposure.*
- *Fossil fuel companies can either focus on short-term cash flow strategies or engage in the energy transition by using the revenues from fossil fuels for investments in new and renewable technologies.*
- *Power companies need to carefully plan any investment decision in traditional thermal plants, as the useful life is likely to be shorter.*
- *The regional distribution of stranded assets is uneven: Canada and Australia are likely to face the worst consequences of future divestments.*

[1] This policy brief has been prepared by Federico Pontoni, within the Value Added in Motion (VAM) project, funded by the Enel Foundation

Introduction

Defining carbon budget and stranded assets

The COP21 final agreement has set a very ambitious goal: to contain the increase in global temperatures below 2° Celsius. This ambitious goal has yet to be translated into specific and easily quantifiable targets, but, given that climate change is caused by GHG emissions, it is possible to claim that not only this is the first time that all Countries agree to cap global emissions, but they have also set an indirect global target on future emissions. In fact, taking into account the stock of CO2 and other GHG already in the atmosphere, it is possible to determine the overall quantities of GHG that we can emit before we reach that cap. Of course, emissions depend on the quantity of fossil fuels that we burn for our energy needs: this implies that the World has indirectly agreed on a cap on fossil fuel use.

This endangers the profitability and economic viability not just of future fossil fuel investments but, possibly, of assets which already are in production. This phenomenon might generate different responses according to the varied visions, attitude and strategies that all relevant stakeholders have on the matter.

Back in 2011, Carbon Tracker Initiative (CTI)[2] carried out a first comprehensive assessment of this complex issue: they introduced the concept of carbon budget and stranded assets, when the Paris agreement was far from being signed. Carbon budget refers to the fixed overall quantity of CO2 that can be emitted before we reach the cap.

In general, stranded assets refer to assets that suffer from unanticipated or premature write-offs, downward revaluations or are converted to liabilities. Within this context, CTI specifically calls stranded assets both those proven and listed fossil fuel reserves that cannot be exploited due to the carbon budget and all the financial instruments (from shares to derivatives) related to companies that own or operate those fossil fuel reserves and fields.

Introducing the "carbon bubble"

In 2011, CTI claimed that only one-fifth of the proven fossil fuel reserves owned by public and private companies could be burnt, if the World wanted to meet the 2° Celsius target. This entails that there is a significant amount of reserves that are economically stranded, that is, they cannot be profitably used. CTI claimed that such a risk should be priced by financial markets and should be taken into account by global investors; otherwise, we face the risk of a "carbon bubble", that is the risk of holding too many stranded assets which will sooner or later depress global markets.

Mounting attention

Since 2011, the concept has gained worldwide attention and many new attempts of estimating both the overall budget, as well as the amount of fossil fuel that must stay underground have been made. In 2015, Mark Carney, governor of the Bank of England, claimed "carbon stranded asset" to be a major concern for financial markets.

The stranded asset debate could pave the way to a divestment campaign aiming at forcing the hand of the fossil fuel companies and pressure government—e.g. via a carbon tax — to leave the fossil fuels (oil, gas, coal) in the ground.

In particular, those who support divestment campaigns would like to push fossil fuel companies to undergo a transformative change that can cause a drastic reduction in carbon emissions—e.g. by switching to less carbon-intensive forms of energy supply.

[2] CTI, (2011), Unburnable Carbon—Are the World's Financial Markets Carrying a Carbon Bubble? , London.

To understand the debate and what all is about, this policy brief will first discuss and assess the magnitude of the assets that face the risk of becoming stranded as the energy transition accelerates; then it will present and briefly talk over the influencing factors and the possible strategies for different stakeholders.

What is at stake?

Quantifying the carbon budget

According to the most recent IPCC estimates[3] based on different probabilities of meeting the 2°C target, the global carbon budget for 2011 -2050, varies from 870 Gt of CO2 to 1,200 Gt of CO2.

Other studies[4] show different and more alarming figures, particularly because they claim that a part of the budget has already been spent. Moreover, these studies claim that the World has to work hard to increase the probability of meeting the 2°C target and, therefore, the overall emissions have to be lower.

In the end, 1,200 Gt CO2 can be considered as the upper bound of the carbon budget that the World can spend by 2050.

Therefore, if one takes into account the remaining fossil fuel reserves and resources[5], then it is possible to determine how many of them must stay unburnt, if the World is to reach the temperature increase target. The data discussed below are taken from McGlade and Ekins, 2015 and the extended database from TIAM - UCL[6].

Best estimates on reserves indicate that, at present, there are: 1,294 billion barrels of oil, 192 trillion cubic metres of gas, 728 Gt of hard coal, and 276 Gt of lignite. These reserves would result in 2,900 Gt of CO2 if combusted unabated.

If we enlarge the picture to resources, than the best estimates indicate that there are: 2,655 billion barrels of oil, 300 trillion cubic metres of gas, 2,565 Gt of hard coal, and 1,520 Gt of lignite. The sum of reserves and resources would result in 11,000 Gt of CO2 if combusted unabated.

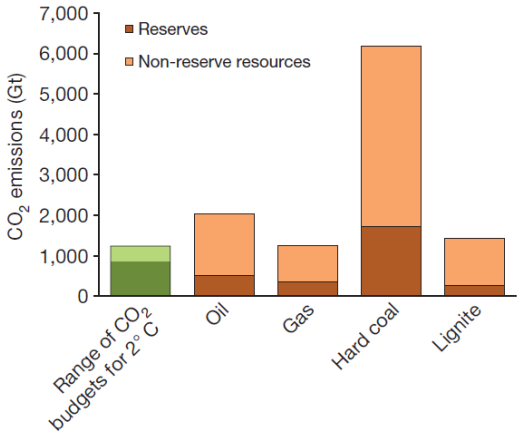

Figure 1: Implied CO2 content of all reserves and resources

Figure 1 compares the above carbon budget with the CO2 emissions that would result from the combustion of reserves and resources. As it is immediate to see, with just the combustion emissions of the remaining reserves alone, the disparity between what can be theoretically burnt and the most generous carbon budget is therefore stark.

[3] United Nations Framework Convention on Climate Change (UNFCC). Report of the Conference of the Parties on its Fifteenth Session, held in Copenhagen from 7 to 19 December 2009. Part Two: Action taken by the Conference of the Parties at its Fifteenth Session. United Nations Climate Change Conf. Report 43

[4] See, for instance. Raupach, M. R. et al., (2014), Sharing a quota on cumulative carbon emissions. Nature Climate Change. 4, 873–879.

[5] In this work 'resources' are taken to be the remaining ultimately recoverable resources (RURR)—the quantity of oil, gas or coal remaining that is recoverable over all time with both current and future technology, irrespective of current economic conditions. 'Reserves' are a subset of resources that are defined to be recoverable under current economic conditions and have a specific probability of being produced.

[6] https://www.ucl.ac.uk/energy-models/models/tiam-ucl

Therefore, almost 62% of proven reserves has to stay unburnt; moreover, not a single drop of all the resources the World has can be extracted.

Back in 2012, CTI estimated the fossil fuel reserves held just by the top 100 listed coal companies and the top 100 listed oil and gas companies in all stock exchanges, and they found out that these reserves represent potential emissions of 745 Gt of CO2, close to the tighter budget estimated by the IPCC.

Adding the proven reserves of other Companies and, in particular, those of big National Oil Companies (such as Saudi Aramco or Iranian National Oil Company) implies that listed companies might be overvalued due to assets that cannot be profitably sold. In fact, contrary to other sectors, Analysis by McKinsey and the Carbon Trust[7] demonstrates that greater than 50% of the value of an oil and gas company resides in the value of cash flows that will be generated in the long run (that is after ten years). This entails that the value of oil and gas companies heavily relies on what reserves that are owned and not yet exploited will generate.

Quantity of fossil fuels that have to stay in the ground

Knowing that there is the possibility that almost 60% of the proven reserves will go unburnt does not add much to policymakers and investors.

In order to shape policies and investment decisions, there is the need to estimate those reserves and those fuels that are more likely to stay underground.

As stated in the VAM background paper, the geography of energy abundance and scarcity is a key tool for understanding the macroeconomic performance of different regions of the World. This is even more important when assessing where "the stranded asset curse" will hit harder.

Moreover, economic analyses should provide policymakers estimates of different energy transition strategies, as well as possible redistributive effects. As we will discuss further below, the timing and the stringency of transition policies is crucial for attaining the objective of a low carbon and affordable energy sector.

This forecast analysis is complex and requires hypotheses on production and transportation costs, on the foreseeable evolution of CO2 and fossil fuel prices as well as the projected demand.

The abovementioned study by McGlade and Ekins (2015) has carried out this type of analysis.

Their forecasts are based on the TIAM – UCL model, which determines the economically optimal solution for supplying regional fossil fuel demands, using as inputs production costs, transportation costs and CO2 content.

In terms of unburnt reserves, McGlade and Ekins estimate that without any form of carbon capture and storage (CCS), almost 35% of oil will remain below the surface, as well as 52% of natural gas and 88% of coal. With CCS, percentages change slightly, as it is foreseen that CCS will remain a very costly option. Anyway, in the CCS scenario 33% of oil reserves will go unburnt, as well as 52% of gas reserves and 82% of coal reserves.

Geographical distribution

Oil

As for oil, the geographical distribution of unburnt reserves is strikingly unbalanced and it depends mainly on extraction costs. The Country with the highest level of unburnt reserves is Canada: 75% of its natural bitumen

[7] Carbon Trust, (2008), Climate change – a business revolution? How tackling climate change could create or destroy company value, London.

will stay underground. High costs of production and transportation are the main reason for this result.

The Middle East, although using over 60% of its oil reserves, carries over half of the unburnable oil globally, leaving over 260 billion of barrels in the ground.

Finally, the United States has the lowest level of unburnt reserves and this is explained by the proximity of supply and demand centres that reduces the overall supply cost, which the model estimates to be the lowest.

Gas

As for gas, the Middle East also holds half of the unburnable global gas reserves, with Former Soviet Union countries accounting for another third, meaning that they can use only half their current reserves. North America, instead, will exploit more than three quarters of its reserves.

Coal

As already anticipated, coal reserves are by far the least-used fossil fuel: contrary to the other two, the geographical distribution is much more even. The United States and the Former Soviet Union countries each use less than 10% of their current reserves, meaning that they should leave over 200 billion tonnes (Gt) coal (both hard and lignite) reserves unburnt.

The table below summarizes the percentages of unburnable fossil fuels.

Table 1: Regional distribution of reserves unburnable before 2050 for the 2° C scenario without CCS

Country/Region	**Oil**	**Gas**	**Coal**
Africa	26%	34%	90%
Canada	75%	24%	82%
China and India	25%	53%	77%
Russia and Former Soviet Union	19%	59%	97%
Central and South America	42%	56%	73%
Europe	21%	6%	89%
Middle East	38%	61%	99%
OECD Pacific	46%	51%	95%
Other Developing Asian Countries	12%	22%	60%
USA	9%	6%	95%
Global	35%	52%	88%

These forecasts have important indications: some regions will face higher risks than others will; investors and policymakers have to start worrying about the financial consequences.

Financial aspects

Exploration and production

Unused reserves means that some planned investments will never take place and that some existing assets will not generate any profit. To this respect, CTI has recently calculated the unneeded investments, quantifying not just the risk of current production fields, but also that of scheduled investments[8].

From their results, the coal industry is facing the most credible and immediate threat. CTI has estimated that there are almost 220 billion USD of planned and existing investments in the sector that are not needed. In particular, their estimates indicate that almost 47 billion USD of existing and operating assets (of which 60% in China), will not be able to produce any cash flow to shareholders.

As for oil, CTI estimates that almost 1,200 billion USD of planned investments are actually not needed. Finally, almost 460 billion USD are investments that should not take place in the natural gas sector.

Overall, unneeded investment risk to sum up to almost 1.8 trillion dollars, of which 67% are concentrated in the oil sector.

[8] CTI, (2015), The $2 trillion stranded assets danger zone: How fossil fuel firms risk destroying investor returns, London.

In terms of geographical location, unneeded oil and gas investments should put Canadian and Australian companies and subsidiaries under investors' scrutiny, as a consistent amount of short-term investments should take place in these countries.

Below, we report CTI's list of the first ten most exposed companies. The table below shows that State-owned companies and listed public companies alike face huge risks in incurring in unneeded investments.

The presence of Pemex and Petronas among the first ten companies also shows that offshore production is likely to suffer more should carbon budget become a stringent policy.

Table 2: Ranking of companies by unneeded CAPEX

Rank	**Company**	**Unneeded investment (billion USD)**
1	Pemex	77
2	Shell	76.9
3	ExxonMobil	72.9
4	Rosneft	53.3
5	BP	45.5
6	Chevron	44.8
7	Iran Oil Company	44.2
8	PetroChina	42.8
9	Gazprom	38.8
10	Petronas	38.3

Electricity generation

A recent paper by Pfeiffer *et al.* (2016) has carried out a specific analysis for the global power sector, showing that after 2017, all new CO2 emitting power plants will be unneeded, unless other electricity infrastructure is retired early or retrofitted with CCS.

In particular, their study shows that the existing global power fleet, if allowed to produce until the end of its useful lifetime, has already enough capacity to produce more than its expected share of the overall carbon budget.

Morevoer, If all other emitting sectors, such as transportation and industrial production, continue to develop at business-as-usual, even immediate and complete decarbonisation of the global electricity sector would be insufficient to constrain temperature increases to 2°C .

Influencing factors

Policy and regulation

The likelihood of companies and investors to remain stuck with stranded assets ultimately depends on whether policies will really enforce Paris and future global climate agreement.

Hence, companies and investors need clear and long-term policy signals in order to adjust their investment and production strategies in due time.

At the same time, financial regulators should start monitoring and reporting the exposure of listed companies, by requiring those companies to disclose information on fossil fuel reserves and potential CO2 emissions. Moreover, they should aggregate and publish the levels of reserves and emissions using appropriate accounting guidelines, so that investors can verify the overall exposure of the stock exchange to the risk of carbon bubbles.

For instance, CTI reports that the CO2 potential of the London Stock Exchange is equal to almost 20% of the overall carbon budget.

Technology

As discussed before, technology becomes a positive or negative game changer. Should CCS become an efficient and viable solution, fossil fuel use and carbon emissions could in principle decouple. On the other hand,

advanced RES technologies and new electricity storage solutions could accelerate the end of fossil fuels.

Social momentum

World population is becoming more aware of the risks and costs related to climate change. Therefore, the use of fossil fuels might be hindered by changes of people's attitudes. For instance, a recent study has shown that Universities endowments as well as other funds are beginning to slowly divest from carbon assets, in response to the increasing pressure of their stakeholders.

The study also considers the possibility that changes in energy consumption patterns and the demand for more environmentally friendly policies might drive and foster strong fossil fuel divestment campaigns

Implications

The stranded asset debate is emerging because of the long-term nature of energy assets, particularly in the fossil fuel sector. In this past decade we have rapidly moved away from the idea of peak-oil, i.e. the risk of running out of fossil fuel, to the concept of unburnable oil.

This transition poses several threats and opportunities to different stakeholders. First, at a global level the transition should not bring about a burst: there is the need to avoid a collapse in the value of fossil fuel assets.

Stakeholders have to work together to reconsider the amount of the investment really needed and to free financial resources for other purposes.

At the same time, there is the need to avoid panic overselling of fossil fuels due to unrealistic fears of being stuck with worthless assets.

An even worse situation would be a false transition, i.e. a necessary comeback of fossil fuel after initial divestments. This would not just entail an unfair under valuation of fossil fuel assets, but it would then shrink the possibility of reaching the temperature target due to the lack of time and resources.

Governments

In this complex scenario, Governments have to decide when and how hard to push on regulation and legislation. Of course, only coordinated global actions can be effective and the Cop21 spirit has to be kept and nursed.

Investors

Influential investors can engage both in favour of fossil fuel or, more probably, as active participants of the divestment campaign.

Risk-averse investors with long-term strategies might be willing to adjust their portfolio in order to reduce exposure risks.

Fossil fuel companies

Finally, fossil fuel companies will face the dilemma on whether to focus on short-term cash flow strategies, with no investments and high dividend yields or, instead, to engage in the energy transition by using the revenues from fossil fuels for investments in new and renewable technologies.

Power companies

Any new addition of traditional thermal capacity faces the risk of a reduced amortization period. Moreover, if emission limits are to increase, by 2020 power generators should only install 100% zero carbon power plants.

Moreover, coal-fired power plants will be under increased stress to a lack of supply, as coal miners might go bankrupt, once hit by divestment campaigns.

Either power companies can invest to retrofit their fossil fuel assets with CCS technologies or they will have to be ready to manage a

significant dismissal of unusable assets, while replacing their generating capacity with emission-free technologies.

Further readings

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