Unburnable fossil fuels in a 2 °C world

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Highlights

- Remaining within a 2 °C limit requires that the majority of existing fossil fuels reserves stay in the ground.
- A recent study suggests that 80% of current coal reserves, half of gas reserves, and a third of oil reserves globally should be classified as 'unburnable'.
- It can thus be argued that Member States' policies oriented towards the maximisation of domestic resource extraction are incompatible with an economically-optimal scenario to remain within the 2°C limit.
- The issue of unburnable fossil fuels could have implications for investors in fossil fuels, with possible future liabilities set against carbon-intensive assets.

What are 'unburnable fossil fuels'?

Recent climate studies[1] have demonstrated that average global temperature rises expected in the future are closely related to the cumulative emissions of greenhouse gases that are emitted over a given timeframe. Coupled with the political commitment to keep global warming below 2 °C (out to 2100),[2] this has provided the concept of a remaining global 'carbon budget' associated with avoiding dangerous climate change.

While the precise range of carbon budgets associated with the 2 °C threshold vary, the Intergovernmental Panel on Climate Change (IPCC)[3] recently suggested that the carbon budget between 2011 and 2050 that gives a better-than-evens chance of avoiding a 2 °C temperature rise, is around 870 – 1,240 billion tonnes (Gt) CO_2.

It has subsequently been noted that the CO_2 emissions that would result from the unabated combustion of current estimates of fossil fuels reserves are more than three times this estimated carbon budget (Figure 1).[4] To have a reasonable chance of staying below the 2 °C threshold, the majority of existing fossil fuels reserves must therefore not be produced – these reserve volumes have been termed 'unburnable fossil fuels'.

There are a wide range of definitions used to report the availability of fossil fuels and in particular the precise meaning of the terms reserves and resources can vary substantially. 'Reserves' are generally volumes of oil, gas or coal that are recoverable under current economic conditions and have a specific probability of being produced; 'resources' encompass a much broader estimate that includes volumes that are considered recoverable over all time with both current and future technology, irrespective of current economic conditions.

In 2012 global CO_2 emissions from fuel combustion were 32 $GtCO_2$, with coal

[1] Meinshausen, M. et al. Greenhouse gas emission targets for limiting global warming to 2 °C. Nature 458, 1158–1162 (2009).
[2] United Nations Framework Convention on Climate Change (UNFCC). Report of the Conference of the Parties on its Fifteenth Session Part Two
[3] Clarke, L. et al. in Climate Change 2014: Mitigation of Climate Change (Edenhofer, O. et al.) Ch. 6
[4] Raupach, M. R. et al. Sharing a quota on cumulative carbon emissions. Nature Clim. Chang. 4, 873–879 (2014).

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accounting for 44%, oil 36%, and gas 20%.[5] Emissions have risen by over 50% since 1990 largely driven by increases in non-Annex I countries and they are anticipated to continue to grow in the future in the absence of strong and firm mitigation commitments.

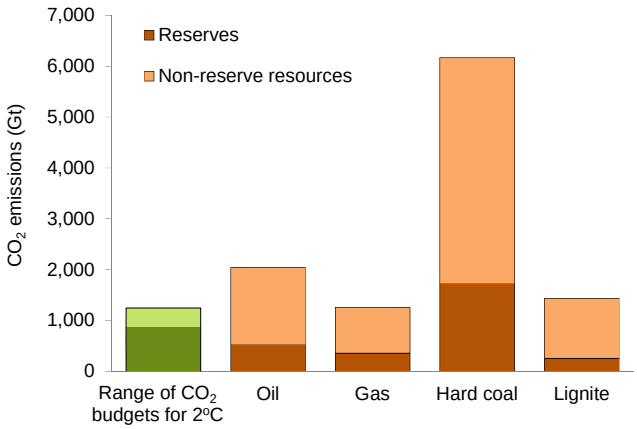

Figure 1: Aggregate CO_2 emissions from unburnable resources.

Unburnable fossil fuel reserves

A recent paper published in Nature[6] provided the first geographic distribution of the oil, gas and coal reserves that should stay in the ground (or be classified as 'unburnable') under an economically-optimal scenario in which there is a global effort to mitigate GHG emissions and thus have a 60% chance of staying below the 2 ºC threshold (Table 1).[7]

The headline figures from the study were that over 80% of current coal reserves, half of gas reserves, and a third of oil reserves globally should be classified as unburnable. However, the reserves identified as unburnable are not spread evenly around world. For example, the overwhelming majority of the very large coal reserves in China, Russia and the United States should remain unused, along with over 260 thousand million barrels of oil reserves in the Middle East (a volume equivalent to all of the oil reserves currently held by Saudi Arabia). The Middle East should also leave over 60% of its gas reserves in the ground.

It was also found that because of its expense, its relatively late date of introduction (2025), and the assumed maximum rate at which it can be built, carbon capture and storage (CCS) has a relatively modest effect on the overall levels of fossil fuel that can be produced before 2050.

	Oil		Gas		Coal	
	Gb	%	Tcm	%	Gt	%
Africa	23	21%	4.4	33%	28	85%
Canada	39	74%	0.3	24%	5.0	75%
China & India	9	25%	2.9	63%	180	66%
CSA	58	39%	4.8	53%	8	51%
Europe	5.0	20%	0.6	11%	65	78%
FSU	27	18%	31	50%	203	94%
MEA	263	38%	46	61%	3.4	99%
OECD Pacific	2.1	37%	2.2	56%	83	93%
ODA	2.0	9%	2.2	24%	10	34%
USA	2.8	6%	0.3	4%	235	92%
Global	431	33%	95	49%	819	82%

Table 1: Distribution of reserves unburnable before 2050 under a 2 ºC scenario with CCS[8]

Implications for Member States

With less than 20% existing oil and gas reserves in Europe unburnable in this scenario, overwhelmingly concentrated in the North Sea, the potential direct impact of stringent carbon constraints on Member

[5] IEA Statistics: CO_2 emissions from fuel combustion, 2014
[6] McGlade, C. and Ekins, P. The geographical distribution of fossil fuels unused when limiting global warming to 2 ºC Nature 517, 187–190, 2015
[7] This issue was also discussed in Meinshausen, M. et al. (2009).

[8] Some unconventional oil and gas reserves are included in relevant regions e.g. 48 billion Gb oil sands in Canada. Gb, billions of barrels; Tcm, trillions of cubic metres; Gt, billions of tonnes; FSU, the Former Soviet Union countries; CSA, Central and South America; MEA, Middle East; ODA, Other developing Asian countries; OECD, the Organisation for Economic Co-operation and Development; USA, United States of America.

States' oil and gas reserves could be viewed as somewhat limited.

However, the results still raise questions around how Member States reconcile their commitments to the 2°C goal with their seeking to produce all indigenous fossil fuel reserves (e.g. in the UK[9]). The use of fiscal incentives to boost extraction or carry out research into fossil fuel extraction will also likely be increasingly questioned in a carbon constrained world.

In addition, many Member States are actively considering the development of their potential shale gas resources[10]: Poland views shale gas as a strategic asset due to its current high gas import reliance, while the UK, despite recently introducing restrictions on where drilling for shale gas can take place, is continuing to permit exploration over large areas of the country. While shale gas exploration is in its infancy, and the resource potential and regulatory positions of countries are still being reviewed and developed, it can be anticipated that countries will be asked to establish how the development of new shale gas resources fits within their decarbonisation obligations. The above paper also indicated that the development of the potential oil and gas resources in the Arctic was inconsistent with efforts to limit climate change, which will impact those countries and multinationals with stakes in the Arctic region.

Table 1 shows that nearly 80% or 65 Gt coal reserves in Europe should be classified as unburnable before 2050 in order to stay within the 2 °C global temperature increase. This is because the use of coal diminishes rapidly and significantly. This will affect those EU Member States with both large current coal production (e.g. Germany: 196 Mt in 2012) and large consumption (e.g. Poland: 56% of total primary energy consumption in 2012).[11] In 2012, coal was particularly prevalent in the electricity sector in a number of Member States including: Poland (83% of total generation), Greece (51%), the Czech Republic (51%), Bulgaria (48%) and Germany (44%). If the world is to stay below the 2 °C limit, the use of unabated coal in power generation should decline swiftly and be replaced by lower carbon sources. It is therefore questionable how the continued use of coal without CCS, and more generally the opening of new coal production facilities in the absence of large-scale CCS demonstration, can fit with the EU's agreed aims of almost full decarbonisation of the power sector by 2050.

Finally, if Member States seek to burn their fossil fuel reserves beyond the limits shown in the economically-optimal scenario or develop new resources, they put the 2°C objective at risk. Logically, other regions would need to produce less reserves than what their own limits suggest, for the world to stay within the global carbon budget. If such adjustments are made, the regions concerned could ask for a financial compensation, arguing that the deviation from the economically-optimal scenario created an additional shortfall of revenues for them. While compensation mechanisms have been debated for long in the climate negotiations, the optimal distribution put forward by this recent study could form a more concrete basis for the discussion.

Implications for European energy industries & financial markets

Building on the above concept, some researchers have highlighted that the reserves

[9] UK Department of Energy and Climate Change (DECC), Government Response to Sir Ian Wood's UKCS: Maximising Economic Recovery Review

[10] Many aspects of the potential for shale gas have been described in a previous INSIGHT_E paper, *HET3 Shale gas prospects for Europe*.

[11] EURACOAL:http://www.euracoal.be/pages/medien.php?idpage=1518

of publicly listed fossil fuel companies may become stranded assets.[12] Should these companies be allocated a share of the remaining carbon budget to 2050 based on the percentage of total proved fossil fuel reserves that they own today (25%), it can be argued that a large portion of their reserves will not provide positive cash flows.

Because the share prices of fossil fuel companies are partly based on their reserves, one risk could be that these companies are currently overvalued by investors. However, the estimated exposure to firms holding fossil fuel reserves and to commodities is around 5% of total assets for EU pension funds, 4% for EU insurance companies and 1.4% for EU banks[13]. Therefore, while any potential 'carbon bubble' may create losses, this is unlikely to be to the point of threatening the stability of the EU financial system.

Furthermore, the conclusion that *any* reserves are at risk has been challenged. Some companies[14] contend that at the current rate of production, their proved reserves will be entirely produced before climate policy has an impact on fossil fuel demand (e.g. Royal Dutch Shell indicate that their current proved reserves will be fully produced in 11.5 years and similarly 16 years for ExxonMobil). It has also been argued that climate policies are most likely to be implemented gradually, leaving financial institutions and companies sufficient time to adjust their capital allocations instead of facing sudden losses[15].

Nevertheless, beyond the valuation of current reserves, the productivity of the capital invested to develop new resources (estimated at $674bn/yr[16]) is also questioned as it increases the potential for future stranding over the longer term. Such expenditure means that fossil fuel companies may be viewed as increasingly risky for investors in terms of the delivery of long-term returns.

Although the extent to which carbon risks will materialise is hotly debated, mitigation strategies are emerging as a key trend for investors[17]. One area of work relates to information disclosure. For investors to better measure their exposure, companies should be required to report on the carbon stocks embedded in their reserves and resource base and provide stress-testing for their business model will continue or flourish in carbon-constrained world. [18]

There is an increasing divestment movement focusing on fossil fuel companies and the need to reduce financial risks is strengthened by the ethical argument that companies contributing to climate change should not be funded[19]. Others consider that investors should have a constructive engagement with the fossil fuel companies[20], as a way to incentivise them to factor carbon risk into their decision-making (e.g. using theoretical CO_2 prices), to curb investments in the highest-cost and most carbon intensive projects, and also to reduce their operational emissions (with investments in CCS technologies for instance).

For further reading or information, please visit www.insightenergy.org

[12] See in particular: Carbon Tracker and the Grantham Research Institute, LES, Unburnable carbon 2013: Wasted capital and stranded assets, 2013
[13] Green European Foundation, The price of doing too little, too late, 2014
[14] Shell, Letter to shareholders, 21 May 2014 / Exxonmobil, Report: Energy and Carbon – Managing the risks, 2014
[15] CIEP, Transition, what transition?, 2014
[16] idem 3 (CAPEX spent by the first 200 listed fossil fuel companies from August 2012 to August 2013)
[17] MSCI, 2015 ESG Trends to Watch, 2015
[18] See for instance: Kepler Chevreux, Stranded assets, fossilized revenues, 2014
[19] See for instance: the Fossil Free campaign, http://gofossilfree.org/the-great-deflation/
[20] See for instance: Institutional Investors group on Climate Change, Investor Expectation: Oil and Gas Company Strategy, 2014