A First Estimation of Fossil-Fuel Stranded Assets in Venezuela Due to Climate Change Mitigation

BY SIMONETTA SPAVIERI

Introduction

Due to the increased interest of policy-makers in mitigating and adapting to Climate Change, the concept of the carbon budget has come about. The 2018 IPCC report suggests a remaining carbon budget for limiting warming to 1.5°C with a two-thirds chance of about 550 $GtCO_2$, and of about 750 $GtCO_2$ for an even chance. McGlade and Ekins (2015) report that fossil-fuel resources contain 11,000 $GtCO_2$, and according to their assessments one third of oil reserves, half of gas reserves and over four fifths of coal reserves must stay underground. The Carbon Tracker Initiative (Leaton et al., 2013) estimates that 60–80% of coal and oil and gas reserves of publicly listed companies would have to be abandoned. If the Paris agreement climate mitigation policies are put in place, or an energy transition follows, investors may be overestimating fossil fuels stocks value creating a 'carbon bubble' (Leaton, 2011; Leaton et al., 2017; Krause et al., 1989).

While this debate has mainly taken place in the world's financial hubs, over half of the world's least developed countries have plans to expand their fossil fuel production as a lever for their economic development (Bradle y et al., 2018). National Oil Companies control approximately 90% of the world's oil reserves and 75% of production (Tordo et al., 2011). Whilst most of these reserves can't be accessed without International Oil Companies technology and finance, this 'stranded nations' (Manley et al.,2017), have the largest proportion of assets exposed to stranding and the largest burden to avoid depleting the carbon budget (Heede and Oreskes, 2016).

Furthermore, many fossil-fuel rich states are characterized by lower long-term economic growth, high inequality, macroeconomic volatility and an uncompetitive manufacturing sector (Egert and Leonard, 2008). If fossil-rich countries governments decide to increase their production, anticipating their market is shrinking, they will be accelerating global warming, increasing their dependency and exposure and contributing to the sustained lower oil prices (van der Ploeg, 2016). However, they could decide to produce less, or not at all, proactively committing some assets to stranding. Ecuador attempted to strand a billion barrels of crude oil beneath the most diverse nature reserve on the planet. The Yasuni-ITT initiative asked the international community if they were willing to pay for stranding oil but failed. The proposal would have subverted the way oil is valued, from something that ought to be explored and extracted to something worth sequestering (Sovacool and Scarpaci, 2016).

To be able to find low-carbon development paths and leapfrog to a less carbon intense and diversified economy, the implications of stranded assets for developing countries needs to be further studied. Previous case-studies on stranded-assets include: South Africa (Leaton et al., 2012), Australia (Sussams et al., 2013), Brazil (Pimentel et al., 2013), Russia (Malova and van der Ploeg, 2017), China's Jilin province (Yuan et al., 2019). According to the Inter-American Development Bank (Caldecott et al., 2016) there is opportunity for pioneering work in this field in Latin America. This work is a first approximation to calculating stranded assets for Venezuela, the country with 18% of the world's oil reserves.

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Venezuela´s oil sector decline

Venezuela's oil is state-owned. The development of the resources is in the hands of the national oil company, Petróleos de Venezuela (PDVSA). In 1998 PDVSA produced around 3.4 mbpd (OPEC, 2018), but in the last 20 years the company has steadily lost autonomy and talent (Monaldi, 2015). Production has declined by 50% between January 2016 and January 2019, reaching 1.1 mbpd. Also, from 1999 PDVSA decided to invest in heavy crude through the development of the Orinoco Oil basin, making Venezuela's oil mix increasingly heavy, with a higher production breakeven cost. In 2017, Venezuela was the second global producer of heavy crude with 1.45 mbpd. Although oil was nationalized in the 70's, the policies have been pendular in terms of foreign participation in the oil sector. After 2007, a system of joint ventures was set in place where PDVSA has the majority ownership; foreign partners were sought particularly in the heavy oil which required more investment (Monaldi, 2015).

Venezuela's fossil-fuel assets at risk of stranding

Venezuela owns about 189,663 million USD in oil and gas related assets. The largest amount (33%) as property of oil wells and production facilities (Table 1).

In terms of reserves, the Orinoco Oil Belt has 1,457,912 million barrels of heavy crude with a 20% recovery rate. Venezuela is the country with the largest world reserves. However, excluding gas which is mainly produced as by-product to oil, 86% of the oil reserves are of extra heavy crude and only 4.2% of all reserves have been developed (Table 2).

Assets	Million USD
Total	189,663
Properties, plants and equipment's	127,564
Oil wells and production facilities	62,259
Refineries	23,513
Storage and transport facilities	11,090

Table 1. PDVSA financial assets in 2016
Source: PDVSA 2016 audited Financial Statement

	Condensates, light, medium and heavy crudes	Extra Heavy crude	Natural Gas	Total
Developed proven reserves	8,913	4,031	6,783	19,727
Undeveloped proven reserves	32,085	257,222	28,165	317,472
Total proven reserves	**40,998**	**261,253**	**34,948**	**337,199**

Table 2. Venezuela's oil and gas reserves by type (million barrels or million barrels of oil equivalent).
Source. PDVSA 2016 audited Financial Statement.

Venezuelan assets in a global Energy Carbon budget and transition scenarios

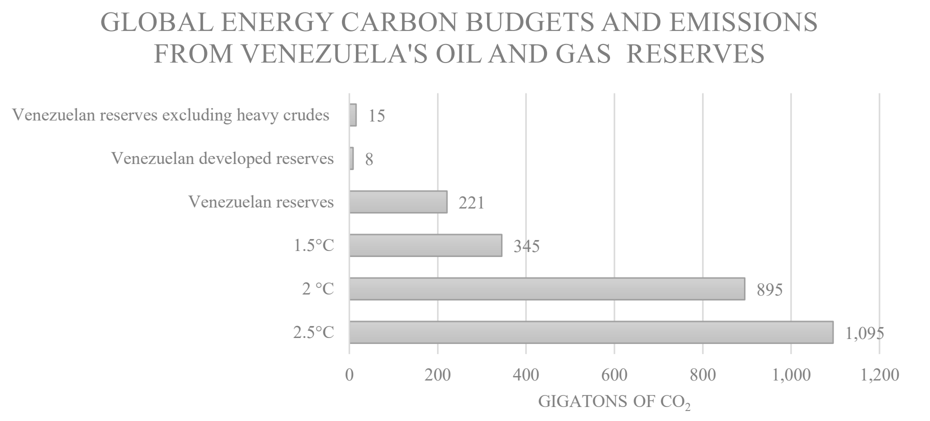
I chose to assess Venezuela's assets against a global carbon budget and energy transition scenarios.

Graph 1 shows global energy carbon budgets between 2019-2050 with a 50% probability of not exceeding the target temperature increase. I used the carbon budgets published by the Carbon Tracker Initiative (Leaton et al., 2013) and subtracted the emissions already committed (2013-2018) according to observations. The graph compares, the global energy carbon budgets with the emissions that would occur if Venezuela's reserves were burned. Emissions from Venezuela's total proven reserves would burn 64% of the 1.5 carbon budget and 24% of the 2 degrees. Whilst Venezuela's developed reserves, those that are already committed in ongoing projects represent 2.4% of the 1.5 carbon budget and 0.9% of the 2 degrees.

Table 3 shows my estimations of $GtCO_2$ for each type of Venezuela's reserves. I used Heede and Oreskes (2016) combustion emission factors 371 kg CO_2/bbl for the PDVSA crude typified as 'Condensates, light, medium and heavy crudes' and 53.4 kg CO_2/kcf for natural gas. For Venezuela's extra heavy oil reserves I used Gordon et al. (2015) global oil-climate index, which analyses thoroughly how different types of oil have different emission profiles. It evaluated Venezuela Hamaca Oil from the Orinoco basin as one of their initial 30 oil studied, and ranked it 4th in terms of overall emissions, producing 750 kgCO_2eq per barrel. The emission factor for extra heavy oil I have used is almost double the standard used by Heede and Oreskes (2016) who estimated PDVSA's remaining reserves emissions at 120 $GtCO_2$eq. My estimation is of 221 $GtCO_2$eq.

	Condensates, light, medium and heavy crudes	Extra Heavy crude	Natural Gas	Total
Developed reserves	3.3	3	2.1	8.4
Undeveloped reserves	11.9	192.9	8.7	213.5
Total proven reserves	15.2	195.3	10.82	221.32

Table 3. Venezuela's oil reserves in Gigatons of CO_2
Source. PDVSA 2016 audited Financial Statement and author's calculations.



Graph 1. Global Energy carbon budgets (2019-2050) in Gigatons of CO_2 with a 50% probability of not exceeding temperature increases of 1.5, 2 and 2.5 degrees Celsius, alongside emissions resulting from burning all Venezuelan reserves, the already developed reserves and reserves excluding Extra Heavy crudes. Source. Author's calculations based on CTI, IPCC, PDVSA.

My estimation places more burden in the emission factor of Extra Heavy and may be more similar in methodology to the McGlade and Etkins (2015) study. These authors estimated cumulative production of 3 billion barrels of Venezuelan extra-heavy oil and that 95% of the extra heavy reserves and 99% of the resources are unburnable, even with Carbon Capture and Storage deployed.

To also add a dimension of temporality and understand how much of Venezuelan oil might become stranded, I compared Venezuela's rate of production with global scenarios of energy transition. Under current levels of annual production, it would take Venezuela about 300 years to liquidate its reserves (Manley et al., 2017). Venezuela's market share between 2008-2014, was stable at around 7% of,OPEC production or 2.5% of World production. Considering that Venezuela recovers this market share and that in 2050 there will still be 50.59 mbpd of market for oil in IPCC scenarios for 1.5°C, my estimations are that Venezuela would be able to produce cumulatively by 2050 about 20,050 million barrels, which represents only 5.9% of the country's total reserves. Potentially, this would come from production of all currently developed reserves and only 7,000 million barrels of new undeveloped reserves, probably from the lighter crudes. This leaves untouched by 2050, 94.1% of the country's reserves.

Assessing potential stranding of PDVSA's refining capacity

With reduced global demand of crude oil, there will also be reduced demand for its products. Refineries margin of income could fall by over 50% by 2035 (Grant, 2017). Both national and international refineries owned by PDVSA have a life span of more than 60 years. Those in Venezuela are operating at below 30% capacity in 2017 and would require significant investments to regain full operativity. International refineries owned by PDVSA, particularly those in the U.S. help guarantee market for Venezuelan oil. With new regulations such as the reduced content of sulphur for marine shipping by 2020 (International Maritime Organization, 2019), Venezuelan extra heavy crude, typically high in sulphur may need further treatments in refineries, which may justify investments in foreign refineries. PDVSA refinery assets are worth 23,513 million USD in 2016. Given the nation's debt and the unpromising outlook of the refining industry it may be a good strategy to sell some refineries before they lose market value due to reduced energy demand.

Venezuela's breakeven production prices in stranded assets

Carbon Tracker Initiative's carbon supply cost curves report (Leaton, 2014) applied the carbon budget logic to the oil price and project breakeven cost. It estimated that a 360 $GtCO_2$ budget of cumulative emissions for oil, intersected with the supply cost curve at around the USD 60 breakeven price. The projects that fell in the 60-80 USD breakeven price were considered marginal barrels of oil, outside the carbon budget; projects with breakeven above 80 were clearly uneconomical. Under this procedure to evaluate oil projects, according to WoodMackenzie's breakeven estimates for ongoing Venezuelan oil projects four projects are above the 80 USD and the other three above 60 USD breakeven price, but only because of tax. Only Petroindependencia Heavy oil project has a pre-tax breakeven of 67 USD (Hernandez and Monaldi, 2016). This perspective of stranding CAPEX and projects by breakeven price, has practical limitations because the general global trend of reduction of production costs, due to technological improvement and regulation. PDVSA itself reports reducing costs of production between 2014 and 2016 by 57%. Venezuela Heavy Oil from Anzoategui ranked 11th in CTI 2014 study on CAPEX at risk of stranding with 20 bn USD exposed. This is most likely linked to new projects of extral upgraders which are unlikely to materialize. The current production and new lighter crude projects are viable under this tool for reviewing stranding. Futhermore, there is significant policy room to lower production costs by reducing taxes, as these represent 37.9% of the cost of producing a barrel (The Wall Street Journal, 2016).

Conclusions and policy recommendations

1. Venezuela may have become a failed state due to the natural resource curse and a stranded nation, with large amounts of wealth unworthy of extraction. My estimation is that 94.1% of reserves will not be used by 2050, when the world gets closer to carbon-neutrality.
2. Venezuela needs to reshape the national development discourse by:
   a. Prioritizing non-carbon intensive economic diversification, eliminating fossil-fuel subsidies, expanding electricity supply and a grid based on renewables and ensuring food security.
   b. Making the fossil fuel sector competitive, selling-out riskier assets such as old refineries, and quickly extracting initially to rapidly regain market-share but negotiating closely with OPEC and other producers to avoid rapacious depletion and sell-out scenarios, which leave Venezuela's heavier production out of the market (Mercure et al., 2018).
3. Future Venezuelans may ask how past generations of their citizens where able to deplete the income of PDVSA producing 1.1% of world's cumulative emissions, whilst not investing or creating any wealth and alternative pathways of development.

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