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Towards a Green Petro-State:

A Carbon Tax at the Wellhead in Guyana as a Measure to Reduce Pollution

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A Proposal for an

Upstream Carbon Tax 'at the Wellhead'

"Towards a Green Petro-State: A Carbon Tax at the Wellhead in Guyana as a Measure to Reduce Pollution"
by Thomas B. Singh and Tim Laing, UGGI Policy Brief, June 26, 2020.

0.433 metric tons of Carbon Dioxide per barrel of oil

THE 3 KEY PRINCIPLES

Global Climate

Wherever Combusted

Whenever Combusted

0.433 tons/bbl

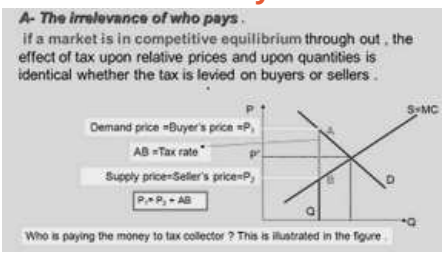
8B barrels of recoverable crude contain 3.5 $GtCO_2$-e.
Guyana's forests contain 12.6 $GtCO_2$-e.

Carbon Price

Tax on Consumption

Tax on Production

Same Economic Efficiency Effect



Nudge by Green Petro-State

Petroleum + Carbon

Upstream Tax on Carbon

Global CO_2 Emissions Reduced

No carbon tax => too much CO_2 released.
Upstream tax reduces CO_2 emissions AND raises $2.5B annually by 2025.

Consistent with Contract Terms, Paris Climate Agreement, Exxon itself ...

Tax on Carbon, not oil, income, property, transactions, petroleum activities.

Polluter Pay Principle applies as tax will be shared between producer and consumer.

No change in laws/regulations required. EPA has authority to levy upstream tax.

Cannot be easily challenged at the International Centre for the Settlement of Investment Disputes.

Towards a Green Petro-State:
A Carbon Tax at the Wellhead in Guyana as a Measure to Reduce Pollution

Submitted to the Guyana EPA

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1. Introduction

Taxing carbon dioxide emissions "at the wellhead" or upstream is based on two principles (Metcalf and Weisbach 2009)[1], one physical and one economic, both of which simplify and reduce the cost of using carbon taxes for the entire world, and make them particularly attractive. The physical principle is that a unit of fossil fuel will emit the *same* amount of carbon wherever and whenever it is burned. In the language of activity analysis, fossil fuels and emissions are respectively the input and output in fossil-fuel-based energy transformation activities, and there is a strict correspondence between input and output, such that carbon levies can be imposed on the input – the fossil fuel – rather than the output – the emission.

The economic principle that justifies the use of carbon taxes at the wellhead is known as the "irrelevance of who pays" a tax, and it says that the incidence of a tax (i.e. who 'really' pays the tax) is unrelated to the point of collection of the tax; and that this further implies that the effect of the tax on economic decisions will be the same, whoever happens to have the statutory obligation to remit the tax to the authorities. As such, an upstream carbon tax (at the wellhead, in Guyana) will achieve the same efficiency results as at tax imposed at (say) the pump in the United States, where advocacy for such a tax is growing especially because of the support it has, even from major oil companies. A carbon tax at the wellhead in Guyana would have the added and significant advantage of minimising the collection and monitoring costs and to ensure maximum coverage. There are also important equity benefits from this proposal, as it allows the revenues from such a tax, which has the same efficiency effects wherever it is collected, to accrue to Guyana, rather than downstream in consuming countries.

But a carbon tax at the wellhead in Guyana has special appeal because of Guyana's global leadership in promoting climate stabilisation, even while it was a country with a small carbon footprint that has historically been contributing significantly to the global effort to limit GHG emissions. Another basis for this for this carbon tax proposal is therefore the Paris Agreement on Climate Change (United Nations Framework Convention on Climate Change (UNFCCC) 2015) and the commitments that Guyana has made under this agreement; and the UN's Sustainable Development Goal (SDG) 13 (United Nations General

[1] Metcalf and Weisbach (2009, 24)

Assembly 2015). The former refers to the urgent need for a global response to climate change that is consistent with sustainable development and poverty eradication, while the latter makes "urgent action to combat climate change and its impacts" a goal of sustainable development.

Paris Agreement on Climate Change
Article 2

1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:
(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;
(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.
2. This Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.

(United Nations Framework Convention on Climate Change (UNFCCC) 2015)

While the importance of putting a price on carbon is now generally accepted, putting a price on the carbon associated with oil and gas production in Guyana must be put in a "local" context. Guyana has been in forefront of both the early Reducing Emissions from Deforestation and Forest Degradation (REDD) initiative and particularly the evolved REDD+ framework, the latter recognising the large amounts of carbon dioxide sequestered in standing trees. Estimates of the CO_2 stock in Guyana's forests differ as noted in Cedergren (2009), but Alder and van Kuijk (2009) puts it at 12.676 $GtCO_2$-e, greater than the annual emissions from all of China.

REDD+ and other schemes for the payment for environmental services (PES) are not without problems however (Karsenty, Vogel and Castell 2014) and at any rate Guyana has, precisely because of these problems, only received transfers amounting to some US$190 million[2] of the only contribution that has been so far made to its Guyana REDD+ Investment Fund (GRIF) (World Bank 2018).

Meanwhile, a crude estimate of the CO_2 in the recoverable petroleum resources so far discovered by ExxonMobil is about 3.5B metric tons, *guaranteeing* a flow reduction in sequestered carbon emissions directly attributable to Guyana whenever a barrel of oil is not produced. With the oil discovery, Guyana now faces a particular paradox, i.e., that is it both sequestering and adding to global carbon emissions.

The proposed carbon tax at the wellhead in Guyana will operate to reconcile this paradox, and it would serve as the basis for making Guyana a "Green Petro-State." While there are non-economic approaches

[2]In 2009 the Government of Guyana and the Kingdom of Norway signed a MoU for the latter to pay Guyana US$250M over a five-year period for its efforts and good performance in limiting greenhouse gas emissions from deforestation and forest degradation (Government of the Cooperative Republic of Guyana and the Government of the Kingdom of Norway 2009). The MoU has been extended beyond 2015, and in December 2019 the last tranche of approximately US$45M was transferred to the GRIF, for release to Guyana after the March 2020 elections. So far, US$190M has been released to Guyana for a variety of projects (Stabroek News 2019).

such as standards, regulation and technology that also constitute "climate action," economic instruments[3] - carbon taxes and cap-and-trade –operate by putting a price on emissions, either by explicitly specifying a price for CO_2 (as in the case of carbon taxes) or specifying the amount of CO_2 that will be allowed (as in the case of cap-and-trade systems) and allowing the price to be discovered by market participants themselves. Economic instruments are especially attractive because putting a price on CO_2 will cause firms to internalise the cost of the emissions from their otherwise beneficial activities.

The exact amount by which carbon emissions will decrease on account of a carbon tax will depend on a number of elasticities, but the value of the emissions reduction will amount to about US$2.4 billion annually when production capacity is ramped up to 750,000 barrels per day (bbd) and a very conservative CO_2 tax of US$20/t$CO_2$ is assumed. While these revenues can be used for anything, this "anything" could clearly include investment in renewable energy, for example. We do not attempt to discuss the important matter of using the revenues that will be raised from a carbon tax at the wellhead, but will do so in a separate University of Guyana GREEN Institute (UGGI) report.

Of the two economic instruments however, carbon taxes are preferred for a number of reasons, and has increasing support from a variety of agencies and individuals. We first (in Section 2) give a simplified theoretical argument for a carbon tax *at the wellhead in Guyana* largely because the discussion of carbon taxes has been confined to carbon taxes on the end-products that are made using fossil fuels. In Section 3, the technical and political feasibility of the proposed wellhead carbon tax is discussed, and mention is made of the distributional implications of revenues accruing to Guyana instead of elsewhere. It is noted however that a separate discussion will be required for addressing the use of any revenues raised from the proposed tax. Section 4 gives an indication of the support for carbon taxes, noting that even ExxonMobil has publicly stated its support for this approach to achieving the Paris Climate Agreement objectives. Section 5 points to the limited success that Guyana has had in securing payments for the environmental services of its forests, principally because of the inherent problems associated with any attempt (even REDD+) to do so; but it also suggests that crude oil extraction is very different, and that it does offer a better logical and economic rationale for earning revenues from the proposed carbon tax. Section 6 simply gives an indication of the relationship between barrels of oil and CO2 emissions, and motivates the discussion in Section 7 of the potential revenues that could be raised from a carbon tax at the wellhead.

A key issue that will have to be addressed is, of course, whether the Production Sharing Agreement signed with ExxonMobil would allow the levying of a carbon tax. Section 8 presents a prima facie case for this, noting that the proposed tax is one on carbon, not on crude oil itself. It is a tax on the "externality" and not on the good, crude oil. The point is also made that the proposed tax can be assessed without the need for new legislation or even new regulations. Section 9 concludes, noting among other things that the proposed tax has the effect of an informal and automatic depletion policy in that it deters production when prices are low, but makes it more attractive when prices are high.

[3] The UNFCCC (2014) makes a distinction between market and non-market approaches to mitigating CO_2 emissions, depending on whether the approach involves "tradable units." A carbon tax is, in this taxonomy, rendered a non-market instrument even though it is clearly an economic one.

2. A Carbon Tax (at the Wellhead) in Guyana: Theory and Mechanics

Fossil fuel production anywhere will ultimately lead, upon consumption of refined petroleum products anywhere, to (very specific) increases in carbon emissions that will impose a negative externality[4] on the whole world, not just Guyana. In other words, fossil fuels are associated with a negative global externality that arises from the carbon emissions that will be released into the atmosphere when those fossil fuels are consumed as petroleum and other products. The pure theory behind the carbon tax at the wellhead, or an upstream carbon tax, refers to why a carbon tax will work to solve the problem of the externality associated with fossil fuels, and why the tax might be levied at the wellhead in Guyana, on producers such as ExxonMobil, instead of on the consumer at the petrol pumps (including the petrol pumps in the developed countries that use Guyana's oil to refine and sell locally, in their jurisdictions).

The mechanics refer principally to the political difficulties that make it difficult for developed countries to impose a carbon tax and the fact that the carbon tax at the wellhead in Guyana will be collected nationally, in Guyana and will therefore be both easier, more equitable and more efficient (in the sense of the (Coase 1960) view of the reciprocal nature of externalities), while still solving the fundamental externality problem.

More detail on the theory behind the upstream carbon tax are provided in the appendix, however essentially a carbon tax is a Pigouvian tax levied at the rate of the social cost of carbon to *internalise* the negative *externality*. A key feature of such a tax is the irrelevance of who pays the tax. This means, from an efficiency perspective, it makes no difference as to whether the tax is levied on the producers of products that produce carbon, such as oil, or the consumers of that oil.

3. The Upstream Carbon Tax: Technical and Political Feasibility, and "Climate Justice"

As noted above, the diagram and the discussions about a carbon tax that gets people to internalise the SCC could be levied either on producers or consumers. A closer look at the discussion would however reveal that it didn't consider the implications of producers and consumers being from different countries. This section address this issue, noting first of all the implications of the global nature of the externality, and chemistry of fossil fuels that makes it technically possible for a carbon tax to work at any point in the value chain, and the behavioural arguments and political appeal, equity principles, and administrative efficiencies of the proposal rests. This section also notes another design feature of the proposed upstream tax, namely the potential for tax credits for upstream activities located in Guyana that reduce emissions from fossil fuels extracted here.

First, because of the global nature of the externality, it doesn't matter where the consumers are relative to the producers – the consumption anywhere in the world of fossil fuels, produced anywhere in the world, will be associated with carbon emissions that do increase the concentration of greenhouse gases (GHG) in the atmosphere. This externality will impose increasing costs on all countries and their

[4] A negative externality like pollution is a spill-over effect from one market onto third parties, without the participants in the former (market) taking into account the costs imposed on the third parties affected by those spill-overs.

inhabitants, to the extent that this increasing GHG concentration increases global warming and climate instability. By this very token, the benefits of any reduction of GHG concentration levels, regardless of where it occurs, will yield to benefits for the entire world.

Recognising this, many countries already have carbon taxes with variety of design features (World Bank and Ecofys 2018). Even more to the point however, is that many countries have considered levying carbon taxes *upstream*. In the issue of a carbon tax at the wellhead in Guyana, this is equivalent to taxing the producer in Guyana, instead of the consumer in another part of the world, given the "irrelevance of who pays the tax," discussed above. The other point that is often made (Carbon Tax Center n.d.) is that the carbon dioxide emissions released from the combustion of fossil fuels are strictly proportional to the carbon content of the fuels. This implies that any upstream regulation that reduces emissions will also reduce emissions in exactly the same way as it would if the regulation were imposed downstream instead. In the case of a carbon tax at the wellhead in Guyana, the transmission mechanism that ensures a reduction in emissions is that the higher upstream costs will be passed on the downstream user as an inward shift in the supply curve, thereby ensuring that the incidence of the tax will be exactly it would had the tax been levied downstream, even in a different country.

While there have been various opinions expressed about consumer preferences towards downstream versus upstream taxes, few studies have been undertaken, though it has been noted (Matthews 2010) that the psychological framing is important to the acceptability of alternative proposals to consumers. Evidence however shows that upstream emissions taxes tend to be unacceptable to consumers in countries such as France, where recent attempts to increase the carbon tax led to major public protests. In an important empirical study, which acknowledged that other 'anecdotal' studies of the likely psychological effects of taxes imply that "If consumers do hold others responsible for carbon emissions, they may be more likely to support more "upstream" carbon regulations, as these are perceived to hold the responsible parties accountable for their actions (p. 2)," (Hardisty, et al. 2019) find that in fact downstream carbon pricing to predict consumer preferences and therefore to be more acceptable to consumers than upstream carbon pricing. This seems to make intuitive sense as well.

An important design element of the proposal for a carbon tax at the wellhead in Guyana is that the *proceeds of such a tax would be retained nationally, by Guyana*. One of the significant concerns about the political economy of climate mitigation measures is the so-called climate justice argument that more developed countries had in the past contributed more GHG emissions in the process of growth and development, but that developing countries that are now attempting to "catch up" are being asked to bear the brunt of carbon mitigation efforts. This concerns surfaces in the practicalities of implementing some of the Paris Climate Agreement measures that address this concern. But the design feature that allows Guyana to retain the proceeds of a carbon tax at the wellhead has no such equity concerns, and indeed is clearly more equitable from a climate justice perspective than an upstream carbon tax, the proceeds of which would also be distributed nationally, but in developed countries.

Finally, there are various design features that could be leveraged to even increase value added activities in Guyana. A particularly appealing option is to offer carbon tax credits to oil companies for each ton of carbon captured in the refinery process (van Straelen, et al. 2009). This will have the two fold effect of first increasing employment and value added in the economy, and it will also allow Guyana to earn revenues from the part of the downstream process that yields a much higher rate of return than does the upstream activities currently being undertaken by ExxonMobil, and envisaged by other companies.

4. Support for Carbon Taxes in General and by ExxonMobil in Particular

The prevalence of carbon pricing has grown exponentially over the last two decades since the nascent processes embodied in the Kyoto Protocol and institutionalised in mechanisms such as the EU's Emissions Trading System (EU ETS). Currently there are 61 carbon pricing initiatives across the world that are implemented or scheduled for implementation, covering nearly a quarter of global emissions.[5] Of these mechanisms 30 are carbon taxes. However even perhaps the most extensive carbon taxation system, in Norway doesn't fully tax emissions upstream. In their system direct emissions from the petroleum and gas extraction sector face particular high rates of taxation – around US$50 per ton of CO2- in addition to meet their commitments under the EU ETS. Like many other countries indirect emissions are implicitly captured in a fuel excise duty – charged to consumers when they purchase the refined products.[6] Guyana can therefore be a leader in addressing climate change mitigation and climate justice with an upstream carbon tax.

Many oil companies have now signalled their support for carbon taxes as the most effective way to address climate change and meet the ambitions of the Paris Agreement. Of particular importance is ***that ExxonMobil itself supports the carbon tax***,[7] noting that:

"ExxonMobil is proud to be among the Founding Members of the Climate Leadership Council. We join other leading companies such as General Motors, PepsiCo, BP, and Johnson & Johnson, not to mention key individuals such as Michael Bloomberg, Lawrence Summers, Steven Hawking, Steven Chu, Marty Feldstein, Greg Mankiw, Vinod Khosla, and Rob Walton. Two prominent environmental organizations – The Nature Conservancy and Conservation International – are on board as well."[8]

It should be noted that there are in fact two major carbon tax plans in the US: The Baker-Shultz Climate Leadership Council proposal that is supported by ExxonMobil, and the Energy Innovation and Carbon Dividend Act. The Climate Leadership Council proposal envisages that the revenue raised by the carbon tax will be redistributed to consumers so that the tax will be revenue neutral, but there is nothing that would prevent Guyana from using carbon tax revenues to finance things like renewable energy investments, for example.

5. Petroleum Production under REDD+

REDD+ is supposed to incentivise the climate change mitigation services of forests by attracting revenues for activities that reduce emissions from deforestation and forest degradation, and avoid those activities that would reduce the carbon stocks that are embodied in standing forests. It would do so by compensating for the opportunity costs of forest conservation when there are real financial benefits to forest conversion to other uses. As a scheme, REDD+ however has significant efficiency as well as strategic

[5] https://carbonpricingdashboard.worldbank.org/

[6] https://energifaktanorge.no/en/et-baerekraftig-og-sikkert-energisystem/avgifter-og-kvoteplikt/

[7] Note however that the Internal Carbon Pricing by oil majors such as ExxonMobil is a classic example of a carbon price that is used to evaluate the economics of projects and particularly capital investments, as against being used to gauge the impact of those projects and investments on third parties (ExxonMobil 2016).

[8] https://energyfactor.exxonmobil.com/perspectives/broad-carbon-tax-coalition/

problems for Guyana (and other High Forest Cover Low Deforestation (HFLD) countries). Together, these problems have significantly limited the flow of REDD+ revenues to Guyana.

As pointed out in Karsenty et al (2014), the REDD+ scheme was expected to operate within the same framework that was developed for the Kyoto Protocol's Clean Development Mechanism (CDM): carbon credits will only be earned for those activities that permanently reduce emissions, minimise the risk of leakage or arbitrage that leads to emissions increases elsewhere, and importantly, involve "additionality," or measured and verified *reductions* in emissions relative to some baseline or reference level. The last of these principles clearly precludes a country like Guyana from earning credits for the stock of carbon sequestered in its forests. Naturally, any scheme that seeks to incentivise the services of forests in the quest for climate change mitigation would, from an efficiency perspective, be upended by payments that are not based on the principle of additionality, as incentive schemes work best when they reward deliberate actions (e.g., greater effort, better designed policies, etc.) that cause and lead to enhanced outcomes. This implies that REDD+ countries must only be rewarded for *increases* in the absorption, or "avoided" emissions, of CO_2. To do otherwise is to change the intention of REDD+ into a mechanism to secure climate justice and equity, with an argument that HFLD countries would have putatively foregone forest conversion while industrialised countries didn't. Karsenty et al (2014) point out however that this is a spurious argument if many of the drivers of deforestation (high populations, significant investment opportunities that threaten forests, etc.) are absent, as is the case in Guyana.

But if these challenges are enough to compromise the success of REDD+, then the strategic difficulties would certainly cause REDD+ to fail in Guyana.[9] In contrast, even with the existing contract with investors in its emerging oil sector, Guyana will be able to earn significant revenue flows from its petroleum resources. The deep paradox of a country that has constructed most of its recent policies on low carbon growth and a green economy, with extensive rainforests and a rich biodiversity, now becoming a fossil fuel producer, is one that must be addressed, especially in the face of limited REDD+ funding.

The proposed carbon tax will do just this. It will do so most obviously by raising the financing that is required for Guyana to make its contribution to climate stabilisation by meeting its obligations under the Paris Agreement.

Guyana's Nationally Determined Contributions (NDCs) under the Paris agreement include both conditional and unconditional commitments in the energy sector, which is easily one that urgently needs investment. Unconditional contributions can be undertaken by a government without foreign financial assistance, while conditional ones will require it. A consideration of Guyana's NDCs in the energy sector makes it clear that the country might be unable now to even meets its unconditional obligations, much less the conditional ones. The energy related NDCs is presented below:

[9] Singh (2009).

Guyana's Energy NDCs[10]
Unconditional Contributions to be Achieved Independently
Develop a mix of wind, solar, biomass and hydropower to supply both the demand of the national grid and the energy requirements for towns and villages in Guyana's hinterland in support of the rapid expansion of a renewable energy supply.
Construct and/or promote the construction of small hydro systems at suitable locations such as Moco Moco, Kato and Tumatumari.
Power all of the six newly established townships, starting with Bartica, using renewable energy sources.
Encourage independent power producers and suppliers to construct energy farms and sell energy to the national grid. Preliminary approvals given for a 26MW wind farm.
Work closely with farmers in agricultural areas to encourage the use of bio-digesters to reduce waste, produce biogas and provide affordable, healthy and efficient cooking means at the household level.
Remove import duty and tax barriers for the importation of renewable energy equipment, compact fluorescent lamps and LED lamps to incentivize and motivate energy efficient behavior.
Conduct energy audits and replace inefficient lighting at public, residential and commercial buildings to reduce energy consumption.
Using public education and awareness programmes, provide consumers with information and tools to reduce energy consumption and expenditure.
Implement other policies (building codes and net-metering of residential renewable power) to encourage energy efficiency and the use of renewable energy.
Conditional Contributions to be Achieve with External Assistance
Eliminate the near complete dependence on fossil fuels by developing a 100% renewable power (wind, solar, hydropower) supply by 2025.
Assess the potential of the renewable power sources to determine the most cost effective and efficient means of developing this potential.

It should be obvious that the carbon tax at the wellhead will yield precisely the revenues that could be used in a targeted way to achieve these NDCs.

6. Amount of Carbon Dioxide Sequestered in a Barrel of Oil

Any upstream carbon tax levied will be on, not the quantity of physical product extracted, but the carbon embodied in that physical product. Without detailed information on the exact carbon content of the oil being extracted in Guyana the following is an example of the various calculations of the amount of carbon dioxide (CO_2)[11] "sequestered" in a barrel of oil:

1. The US EPA's *GHG Equivalencies Calculator*

Heat content X the carbon coefficient X the fraction oxidized X the ratio of the molecular weight of carbon dioxide to that of carbon (44/12). The average heat content of crude oil is 5.80 mmbtu per barrel (EPA 2017). The average carbon coefficient of crude oil is 20.31 kg carbon per mmbtu (EPA 2017). The fraction oxidized is 100 percent (IPCC 2006). This leads to the following calculation:

[10] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Guyana%20First/Guyana%27s%20revised%20NDC%20-%20Final.pdf

[11] In other words, reserves contain potential emissions of carbon dioxide that will not be released into the atmosphere unless oil is produced. There will also be methane (CH_4). Both CO_2 and CH_4 are greenhouse gases (GHG).

- 5.80 mmbtu/barrel × 20.31 kg C/mmbtu × 44 kg CO_2/12 kg C × 1 metric ton/1,000 kg = **0.43 metric tons CO_2/barrel**.

2. *Pyrolysium*:
Mineral oil has a density of around 0.8 g/cm3, "good" crude oil of around 0.8 – 0,83 g/cm^3 and "heavy" crude oil is above 0,92 g/cm^3. Crude oil consists (by weight) of 83% to 87% carbon.

One barrel is about 159 liters. Assuming a density of 0,85g/cm^3 for our oil we would end up with 135 kg of oil, which contains on the higher end (87% carbon) 118 kg of carbon.

For the carbon dioxide:
Carbon Standard atomic weight: 12.0107(+/- 0.00008) g·mol^{-1}
Oxygen Standard atomic weight: 15.9994(+/- 0.00003) g·$mol^{-1}$are per
Lets say: Carbon = 12 and 2 x Oxygen = 2 x 16 = 32 => Total: 44
(12/44 = 27.27% of Carbon in CO_2)

- 100/27,27 = 3,67 X 118 kg = **432.71 kg CO_2 or 0.433 metric tons CO_2 per barrel of oil.**

7. Carbon Price Ranges and Revenues from an Upstream Carbon Tax

In this proposal, a specific rate for a carbon tax at the wellhead is not being suggested as the main thrust is to advance the view that the base of taxation can be oil produced (and gas flared) by oil companies. Even so, it is useful to note that the range of price levels "consistent with achieving the temperature goal of the Paris Agreement" is US$40–80/tCO2e in 2020 (World Bank, Ecofys and Vivid Economics 2017, p. 11). In the introduction to this document, a rate of US$20/tCO2e was used, and below, scenarios with US$5/tCO2e and US$40/tCO2e are used – all for illustrative purposes.

Two dimensions of the crude production must be considered when designing an upstream carbon tax, as both are responsible for increased global carbon dioxide emissions. The first is to levy the tax on just the direct emissions from the operations of ExxonMobil (and later, other oil companies) in Guyana, with the main (but not the only) issue being the flaring of natural gas at the point of extraction. The second would be levying also on the indirect emissions associated with using the crude oil that is being extracted.

Estimated revenue from the first dimension would be much smaller than the second, but would still offer an important revenue stream for the country, and create a powerful incentive to improve environmental management by Exxon and other future oil producers in the country.

To estimate the scale of this revenue a number of assumptions were made:

- Scale of flaring of natural gas was assumed to be 15 million cubic feet per day.

- Emissions from the flaring of natural gas were computed as per the methodology outlined in Gervert (2007).

- Two levels of tax were assumed:

    - US$5 per ton of CO2 emitted. The same carbon price that was included in the Norway REDD+ agreement, and lower than many estimates of the social cost of carbon, and the current price in the European Union's Emissions Trading System (EU-ETS) (which is approximately €15 per ton of CO2).
    - US$40 per ton of CO2 emitted. A similar figure that has been reported as BP's internal carbon price.[12]

Revenue from this source is estimated at approximately US$425,000 per annum under the low tax level scenario – but would be larger if flaring of gas has been underestimated or grows with future expansion of oil production. Under the higher tax rate revenue rises to US$3.4 million per annum.

To estimate the scale of revenue from levying a tax on the indirect emissions the following assumptions were made:

- CO2 emissions per barrel is 0.43 tons of CO2 (See Section 6, above).
- Carbon tax per barrel is levied at US$5 per ton of CO2 – with the same caveats as discussed above, with a second scenario for a tax rates at US$40 per ton of CO2.
- Production per day is initially estimated at 220,000 barrels per day, rising to 750,000 barrels per day by 2025.
- All production is levied with the same carbon tax.

These assumptions give an estimated tax revenue of approximately US$173 million per annum presently, rising to over US$588 million per annum by 2025 in the low tax level scenario; and US$1.4 billion per annum rising to US$4.7 billion per annum by 2025.

It should be noted that some of this tax revenue would accrue from the government itself from its share of profit oil. It would be equally important to levy the tax on this oil as it would be to levy the tax on all other oil, to ensure consistency and credibility that the tax is indeed an environmental measure.

A further amendment could be made to ensure that there is no double carbon taxation. Should it be possible to prove that a certain portion of oil was being sold in a jurisdiction where it would face a subsequent carbon price, such as for example, oil being sold to a company covered by the EU-ETS, then the seller could be exempt from the carbon tax levied in Guyana. It is likely that such double taxation would be extremely rare given the current lack of carbon taxes on transportation and other key users of oil across the world.

[12] https://www.climatechangenews.com/2013/12/06/exxon-shell-and-bp-operating-internal-carbon-prices/

8. The Production Sharing Agreement (PSA) between Guyana and ExxonMobil

The Production Sharing Agreement between Guyana and ExxonMobil has a number of provisions that would seem to make it difficult, if not impossible to levy the proposed carbon tax at the wellhead in Guyana. Each of these will be addressed, and it will be shown that the potential legal objections to the introduction of such a tax are not as clear cut as might appear.

1. Article 15 of the Petroleum Agreement (2016) addresses Taxation and Royal. Section 15.1 specifies that "no tax, value-added tax, excise tax, duty, fee, charge or other impost shall be levied at the date hereof or from time to time thereafter on the Contractor or Affiliated Companies in respect of income derived from Petroleum Operations or in respect of any property held, transactions undertaken or activities performed for any purpose authorised or contemplated [other than what is explicitly stated in the Agreement]".

The point to note here is that the proposed carbon tax will not tax income, nor does it apply to property held, transactions undertaken or activities performed for any purpose authorised or contemplated under the PSA. It is a tax on the carbon in the fuel that is extracted, which carbon will become carbon dioxide (emissions) when combustion takes place.

2. Article 32.1 of the PSA discusses what will happen if there is a change in laws in Guyana, an amendment of those laws, or an enactment of new laws … that "have a materially adverse effect on the economic benefits, including those resulting from the fiscal regime provided by this Agreement, accruing to the Contractor, the Government shall promptly take any and all affirmative actions to restore the lost or impaired benefits to the Contractor, so that the Contractor receives the same economic benefit under the Agreement that it would have received prior to the change in law, or its application or implementation."

The Section 4 (4) (a) Environmental Protection Act 1996 specifies that the Environmental Protection Agency "shall make use of current principles of environmental management, namely:

> … the "polluter pays" principle: the polluter should bear the cost of measures to reduce pollution decided upon by public authorities, to ensure that the environment is in an acceptable state, and should compensate citizens for the harm they suffer from pollution …"

As such, the carbon tax that is being proposed can be achieved by a decision by the EPA (the relevant public authority) using the stated "polluter pay" principle of environmental management. In other words, *the proposed measure can be introduced without the need for any change in laws or regulations, either by amendment of existing ones or the introduction and promulgation of new ones*.

3. Article 26 of the PSA discusses the process that will be followed if there is any dispute, as might be expected if a carbon tax such as the one proposed is levied on ExxonMobil. It makes particular reference to the role that will be played by the International Centre for the Settlement of Investment Disputes (ICSID).

The Carbon Tax will only be considered as a matter for arbitration by the ICSID if the tax is confiscatory or impairs the investment; otherwise the domestic legal framework will apply.[13] But apart from that, the ICSID will find it difficult to make decisions that are inconsistent with any international agreements such as the Paris Climate Agreement. Thus, while the Agreement doesn't specifically allow the carbon tax, it doesn't preclude it.[14]

Moreover, at a December 7, 2016, ICSID organized a session on enforcing environmental obligations all of the panellists recognised that that "the framework of international arbitration already [being] firmly established, ICSID and other international institutions could prove to be useful venues for the enforcement of environmental obligations."[15]

Finally, Tienhaara (2018) notes about the use of investor-state dispute settlement (ISDS) that "At present, there are no known cases where an investor has taken the step of formally launching ISDS over the introduction of a carbon tax, emissions trading scheme or renewable energy incentive scheme." What has been taken to the ISDS however are measures such as bans on particular processes and quantitative restrictions that seek to limit carbon emissions.

9. Conclusion

In the foregoing, a case has been made for assessing a carbon tax at the wellhead on oil companies engaged in extracting crude oil. The argument was based on the "Pigouvian" nature of the proposed tax that renders it a market instrument to achieve the objectives of the Paris Agreement on Climate Change. What might very well happen, if EPA were to consider this proposal, is that a significant nudge would be provided to the emerging view, shared even by oil companies, that carbon pricing is crucial to the global effort to stabilize the climate.

The other point that was made is that even under the existing Production Sharing Agreement, there is room for the levying of this proposed carbon tax. Lawyers will have to advise on the particular language that must be used, but there is a strong prima facie case that the (even) stability clause in the PSA, along with the Guyana EPA Act, together provide the legal space for further work to be done by legal experts.

What ought to be clear however, is that the various elements of the proposal will have to be worked out more carefully to actually design a carbon tax. Among the issues raised were the tax rate, inclusion of flaring emissions in the base, and double taxation. What was not discussed was the trajectory of tax rates, the need to avoid discrimination where this matters, and proposals for spending any revenues raised. The latter will anyway have to be addressed separately and independently.

Finally, and importantly, though Guyana has never had something like a depletion policy even though it depends heavily on the extraction of exhaustible natural resources as an economy and as a society that must provide for the sustainable livelihoods of its citizens, the proposed carbon tax at the wellhead can be something of an informal depletion policy. Because the rate will be expressed as the social cost of carbon as against being indexed to the price of oil, it will discourage the extraction of its finite oil resources when oil prices are low, and encourage them when oil prices (are expected to) rise. This will allow Guyana

[13] https://www.italaw.com/documents/Enron-Jurisdiction.pdf.
[14] https://www.c2es.org/document/whats-ahead-for-carbon-markets-after-cop-21/
[15] https://icsid.worldbank.org/en/Pages/resources/ICSID%20NewsLetter/January%2017/Enforcing-Environmental-Obligations.aspx

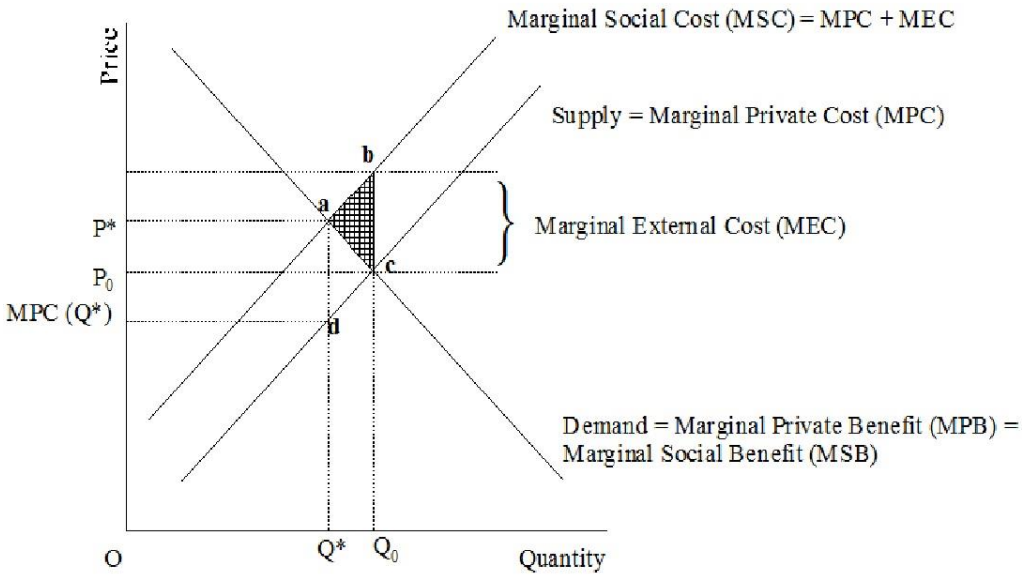
to have an informal policy that enables it to have a "more optimal" extraction path for its newfound oil reserves.

10. Appendix: Theory behind an upstream carbon tax

The pure theory behind the carbon tax at the wellhead, or an upstream carbon tax, refers to why a carbon tax will work to solve the problem of the externality associated with fossil fuels, and why the tax might be levied at the wellhead, on the producer, instead of on the consumer at the petrol pumps (including the petrol pumps in the developed countries that use Guyana's oil to refine and sell locally, in their jurisdictions). The mechanics refer principally to the political difficulties that make it difficult for developed countries to impose a carbon tax and the fact that the carbon tax at the wellhead in Guyana will be collected nationally, in Guyana and will therefore be both easier, more equitable and more efficient (in the sense of Ronald Coase's view of the reciprocal nature of externalities), while still solving the fundamental externality problem.

First, the pure theory of the carbon tax is as a so-called Pigouvian tax that will solve a problem known as a negative externality, which is a spill-over effect from one market onto third parties, without the former market taking into account the costs imposed on third parties by those spill-over effects. Fossil fuel production anywhere will ultimately lead, upon consumption of refined petroleum products anywhere, to (very specific) increases in carbon emissions that will impose a negative externality on the whole world, not just Guyana. In other words, fossil fuels are associated with a negative global externality that arises from the carbon emissions that will be released into the atmosphere when those fossil fuels are consumed as petroleum and other products. The theory applies whether the externality is global or local however. In the rest of the discussion it is assumed that the negative externality is constant, i.e., that each barrel of oil is associated with a given quantity of carbon emissions. (In Section 6, this was shown to be 0.43 metric tons of CO_2 per barrel).

Though externalities occur outside markets, it is usual to depict them in the demand and supply framework, as in the diagram below, as a "shift" in one or the other, or both, curves. Externalities can be represented by 'virtual' demand and supply curves that are distinct from the demand and supply curves of the private transactors in any one market. A negative production externality is illustrated in the diagram below as inward shift in the supply or Marginal Private Cost (MPC) curve:



The negative externality renders Marginal Social Costs (MSC) greater than the Marginal Private Costs (MPC) by the (constant) Marginal External Cost (MEC), which in the case of fossil fuels, is the value of the negative externality described above. The profit maximising producer (say, ExxonMobil) is only conscious of the marginal private costs, so that the supply curve is the MPC curve. Had all costs been considered by the producer, the supply curve would have actually coincided with the Marginal Social Cost curve.

The "Pareto Optimum" or the proper economic optimum secured by a perfect market system without externalities actually has the property that Marginal Social Benefits equal Marginal Social Costs at the equilibrium in each market. This is consistent with private utility and profit maximising behaviour because social benefits and costs are coincident with private benefits and costs and is the ideal case of a one-to-one correspondence between private and social net benefits. The problem posed by externalities is precisely that this correspondence breaks down on account of the externality.

In the above diagram the quantity of fossil fuels produced is on the *x*-axis and is labelled ***Q***, while the price of oil ***P*** is on the *y*-axis. The net loss to society – and the world - of producing at the privately rational, profit maximising, equilibrium (***Q₀***, ***P₀***) is given by the area **abc**. To see this, consider the case of reducing output and sales to the socially optimal level ***Q**** instead. By reducing output to ***Q****, total social costs fall by ***Q****ab***Q₀***, the area under the "true" supply curve in the output range ***Q******Q₀***. The reduction in output also leads to fall in total social benefits, by the amount ***Q****ac***Q₀***, the area under the demand curve in the given output range ***Q******Q₀***. Clearly, the fall in total social costs is greater than the fall in total social benefits by the amount **abc**. In other words, society will gain **abc** by reducing output from ***Q₀*** to ***Q****, or alternatively, society loses **abc** when say ExxonMobil puts ***Q₀*** instead of ***Q**** on the market.

The Carbon Tax as a Pigouvian Tax: Economic Efficiency

One of the standard solutions to this problem of externalities is for the government to impose a tax exactly equal to the external cost imposed on third parties, and to impose that tax on the producer/supplier or on the consumer of the good that is responsible for the externality. This is known as the Pigouvian solution to the problem of externalities, and the tax that is set exactly equal to the MEC is known as a Pigouvian Tax (Baumol 1972). Such a Pigouvian tax has the effect of shifting the supply curve up by exactly the

amount of the tax. Remarkably then, with a Pigouvian tax, producers are made to operate on the Marginal Social Cost curve, and their own privately rational, profit maximising, choice would be to produce ***Q****, the socially optimal amount! The tax raises the cost of production so that it is now rational to produce the socially optimal output level. **The proposed Carbon Tax is precisely such a Pigouvian tax, as it will be set equal to the marginal external cost – or as it's called in the recent literature, the Social Cost of Carbon (SCC) - of each additional ton of CO_2-e**.

For emphasis, note that the proposed carbon tax is a tax on carbon, and not on fossil fuels itself. It is a tax that is intended to get buyers and sellers in the fossil fuels market to internalise the costs they are imposing on the world when carbon emissions are released in the atmosphere on account of their production and consumption activities.

An important question has to do with the so-called incidence of the tax, or who really bears the burden of the tax. The first point to note is that the legal incidence of a tax and the economic incidence are not the same; i.e., the person who has the legal responsibility for remitting or paying a tax is not necessarily the person who bears the entire burden of the tax.

As noted above, without the carbon tax, the privately rational, profit maximising price is the one indicated as P_0 on the *y*-axis; and the quantity traded (bought and sold) would be Q_0 on the *x*-axis. The key take away here is that both the consumer pays P_0 for each unit of the product, and the supplier receives the same P_0 as payment. When it is levied on the producer who is operating on the MPC (supply) curve, the proposed carbon tax will have the effect of shifting the supply curve back upwards onto the MSC (supply) curve. The vertical distance between these two lines, measured in monetary units of course, is (**a**-**d**), which is also equal to the MEC and the proposed carbon tax. Quantity traded now falls to ***Q****. The total tax revenue paid will be ($\mathbf{Q_0} - \mathbf{Q_1}$)(**a**-**d**). ***P**** is the price paid by buyers, and it is (**a**-**d**) more than MPC(**Q***), the price the sellers receive. Whereas the market price was a unitary one, the tax has driven a wedge between the price paid by the buyer and the price received by the seller.

What is more, the diagram makes it clear that the seller does not usually pay all the tax; i.e., that the seller does not usually bear the entire burden of the tax (**a**-**d**), even though the seller/producer has the legal responsibility for collecting the tax. In what sense does the consumer bear part of the burden of the tax? It is clear that because of the tax, buyers now have to pay a higher price than P_0, and in response to this higher price *quantity demanded falls*, from Q_0 to ***Q****. To the extent that consumers are driven to consume less than the preferred amount, the tax is imposing a burden on them.

The Irrelevance of Who Pays the Tax

Note that in the case of the proposed carbon tax, the consumers of Guyana's fossil fuels are not the domestic residents of the country Guyana. But for the moment, consider what would have happened instead, if the carbon that that is being proposed had been levied on the consumers. Graphically, the demand curve would have shifted downwards along the MPC curve, passing through the point **d**. *All* of the effects noted above – the incidence of the tax, the reduction in quantity traded, the government revenue, the gain to society from the tax and its effects, would be exactly the same. In other words, the carbon charge could be levied on either the consumer in say the United States or the crude oil producer Guyana, without any prejudice to its efficiency and equity consequences.

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