Carbon Taxation Mechanism

1. Introduction

This paper was inspired by result of an update to the Silva Elm About webpage tracking the background leading to the Silva Elm name and subsequent history of developments culminating in the design of the Sense Editor. The Sense Editor was a spin-off development of a preceding Environmental Reporting software package with design based on the UK's DEFRA Environmental Reporting - Guidelines for Company Reporting on Greenhouse Gas Emissions.[1]

Despite the passage of at least 15 years since the Silva Elm development, UK regulatory accounting requirements remain restricted to quoted companies and enterprises with over 500 employees. The requirements remain wholly inadequate with direct and (indirect) energy related emissions reported only: outsourced emissions accounting is excluded. As a result, enterprises may grandly announce progress in emissions reduction while outsourcing emissions responsibility to upstream and downstream supply chain providers. The outsourcing of manufacturing to Asia, notably China, is an obvious example and to an extent allowed the UK to claim significant reductions in global emissions since 2010.

With the UK a signatory to both the Kyoto and subsequent Paris climate change Protocols, it becomes apparent throughout this study that the failure to reign in greenhouse gas emissions is systemic by not only inadequately tackling the issue of emissions outsourcing, but also by

- not providing a framework to establish realistic carbon pricing at a truly international level
- allowing the use of underpriced carbon offsets
- recommending the use of an inappropriately long (100 year) climate metric time horizon for the measurement of both emissions and emission reductions
- not ensuring adequate climate financing.

This paper examines each aspect of the perceived deficiencies of the Paris Climate Change Agreement and attempts to counter these within the context of a proposed global Carbon Taxation Mechanism comprising a Carbon Added Tax, Carbon Relief Vouchers as a taxation cushion and Carbon Additionality Schemes to generate Carbon Additionality Certificates within a framework of unified carbon pricing and taxation.

2. Climate Change and Outsourcing

There are two, diametric opposite, outsourcing issues that must be understood in order to plan a pathway towards effective climate change mitigation:

- Outsourced GHG Emissions measured in tonnes of CO2-eq.
- Outsourced Emission Reductions comprising:
    - Carbon Offsets in measures of tonnes CO2-eq
    - Renewable Energy Certificates (RECs) in measures of Megawatt-Hours (MWH) of electricity.

Outsourced emissions relate to those GHG emissions generated outside the sphere of influence and quantifiable measurement of the service or product buyer. To the end consumer, all GHG emissions aside of direct burn (fossil fuel) emissions such as for transport are outsourced.

In contrast, Outsourced Emissions Reductions have historically been purchasable as Carbon Offsets within

the UN's Clean Development Mechanism (CDM). A further offset market has developed separately of the CDM to sell Renewable Energy Certificates (RECs) or regional equivalents enabling electricity grid utilities to market at least a proportion of their supply as being renewable.

Unfortunately, both energy and energy offset markets lack agreed global mechanisms to:

- determine effective carbon taxation levels for Primary (fossil fuel) energy providers and consumers.
- determine an effective pricing structure for Carbon Offsets.
- determine an effective mechanism for regulating how Secondary Energy (Electricity) Generation Utilities report and sell that part of their supply that is from Renewable Energy Sources.
- Rationalise taxation and pricing between CO2-eq emissions, CO2-eq offsetting schemes and Megawatt-hours of electricity.

As a consequence, large disparities in pricing both nationally and internationally has both frustrated a consistent market led approach towards reducing greenhouse gas emissions and allowed, by lack of regulation and monitoring, a considerable level of corporate greenwashing by result of underpriced offseting schemes.

In summary by paraphrasing George Orwell from Animal Farm:

All tonnes of CO2 are equal but some tonnes are more equal than others!

2.1. Outsourced Emissions

The UK's DEFRA Environment Reporting Guidelines provide an incomplete picture of an organisations greenhouse gas emissions due to the lack of a rigid framework for outsourced emission accounting. Simply put, the emissions impact of any product (including fuel) or service purchased does not have a quantifiable reportable figure that may be used by the consuming organisation whether large or small or even individual person. As an example, a litre of gasoline may be directly equated to its CO2 emissions equivalent taken in isolation whereas the true emissions will be significantly higher when all aspects of transport and processing / refinement have been taken into account. This difference cannot be magically drawn from the monetary cost.

While environmental costs remain externalised from monetary cost, then regional based Carbon Taxation and schemes such as Emissions Trading (ETS) and Carbon Offsetting can only fail to reduce overall greenhouse gas emissions - it is no surprise that the carbon dioxide concentration in the environment has surpassed the limit agreed by many of the world's leading scientists in the "Declaration on Climate Change" (Climate Crisis issue of the Ecologist Apr/May 1999).

Outsourced emissions is a truly global issue and it is difficult to comprehend how carbon taxation and emissions trading schemes could possibly halt the climb in atmospheric GHGs when they are applied in a patchwork of uncoordinated country or bloc arrangements. Indeed, the application of Carbon Taxes to reduce emissions has been found to be "underwhelming" due to the political difficulties in applying sufficient charges to reflect the true cost. In 2019 the World Bank reported that 57 carbon pricing initiatives only covered 20% of global GHG emissions and then at a pricing level generally too low. Thirty years from the first IPCC report on greenhouse emissions, China is finally starting its own national Emissions Trading Scheme in 2020 while it continues to build more coal fired power stations.

It is clear that a globally agreed framework is needed by which greenhouse gas emission valuations may be

attributed to product/food manufacture anywhere on the planet.

One tonne of CO2-eq released into the atmosphere in China has the same environmental cost as that amount released in the United Kingdom

Yet the monetary costs of product manufacture in China may be significantly lower than in the western hemisphere.

2.1.1. Carbon Offsets

Carbon offsetting has historically been the method by which polluting organisations and individuals may compensate their GHG emissions by buying Certified Emissions Reductions (CERs) / Carbon Credits from a reduction scheme in a Less Developed Country (LDC) as part of the CDM.

In general, there were two types of carbon offset:

1. Compliance Market offsets purchased by organisations, typically large energy intensive industries, that have mandatory GHG emissions limits imposed by Emissions Trading (Cap and Trade) schemes.

2. Voluntary Market offsets purchased by organisations that have no compliance target and individuals.

Carbon Offsetting schemes have been beset with a historical lack of regulation and misused with Carbon Credits treated as a Get out-of-Jail-Free option being often cheaper to buy and continue polluting rather than investing in more energy efficient and / or renewable energy alternatives. A brief project review of the UN's Carbon Offset Platform reveals Carbon Prices varying between less than $1 up to $15 per tonne whereas the EU Carbon Market price was in the order of 26 euros.

It is noteable how limited in scope the CDM initiative has been with only 1.9 billion CERs issued by 2019 roughly compensating aviation emissions in 2019 comprising direct fuel burn 0.9 billion tonnes CO2 and another similar amount resulting from the Radiative Forcing Effect. In context, aviation contributed only 2% of total energy industry GHG emissions in 2019.

Having largely failed to significantly provide additional emission reductions, carbon offset purchases have succeeded in allowing organisations such as airlines to greenwash their profile.

Carbon Offset Projects also have very different mitigation timescales ranging from short term realisation (provision of wood burning stoves) to long term (reforestation / afforestation) or even never, the latter being projects based on deforestation avoidance or new wind farms developments to offset potential emission increases due to population growth. The failure is such that the EU has decided not to allow the use of Carbon Offsets to meet climate goals beyond 2021.

However, Carbon Offsetting will persist globally as a mechanism with many enterprises including airlines rushing to declare their goal to become carbon neutral by 2050 if not by 2030. It is difficult to envisage that without sufficient governance imposed at a world-wide level, carbon offsetting will succeed any more than the fragmented approach adopted for Emissions Trading (Cap and Trade) Schemes.

Article 6 of the 2015 Paris Agreement outlined the replacment of CDM with a Sustainable Develeopment Mechanism (SDM) to improve and widen the scope and effectiness of achieving realisable GHG emissions reductions. In short, SDM schemes will apply to all countries rather than projects in less developed (Annex 1) countries and achieve real GHG emission reductions rather simply trade an emission from a developed country for a saving in an LDC. However, the rules for Article 6 have still not been agreed by the end of 2019 .

Carbon Offsets should not be considered the same as ETS (Cap and Trade) emissions permissions with the

former priced according to a sustainable development projects worth and latter priced via emissions market trading. Indeed, despite the EU discrediting the use of Carbon Offsets beyond 2021, it still endorses the UN's Carbon Offseting and Reduction Scheme for International Aviation (CORSIA) recommendations. Furthermore, as result of the collapse in air travel due to the Covid-19 pandemic, implementation of CORSIA is now delayed until 2023.

2.1.2. Renewable Energy Certificates

Electricity is a Secondary Energy. According to the World Nuclear Association 2017 figures, 64.5%[4] is generated by burning fossil fuels with the remainder a mix of nuclear, biomass and renewables such as hydroelectric, wind and solar. Supply is primarily via a complex distribution (grid) network which may be regional, national or trans-national.

Electricity consumers supplied by the grid have no control over the generation mix of electricity so cannot justifiably claim their supply as 100% renewable. To overcome this barrier, a market, quite separate from the Carbon Offset market, has developed whereby electricity consumers may buy RECs[5]or regional/national equivalents that certify their energy is from a renewable energy provider. Through this market, many large corporations around the planet have adopted the strategy of purchasing RECs in order to declare their committment and contribution towards tackling climate change.

An important distinction must be drawn between certified electricity generated from renewable energy schemes that verifiably reduce GHG emissions by displacement of polluting generation and those commonly regarded as avoidance schemes to satisfy rising energy demand. Without the capability of attributing electricity generation to a one-to-one reduction in emissions, renewable energy certificates have no accountable emissions reduction attribution and are, what they claim on the green marketing tin, simply electricity generated from renewable sources.

A further complication regards the accounting of up-front GHG emissions incurred during a schemes construction. Irrespective of energy scheme, in the absence of effective and verifiable pairing to carbon offsets, renewable energy certificates may be attributed varying shades of grey-green marking a clear distinction between truly carbon neutral green energy and renewable energy.

In common with Carbon Offsets, there is no standard price for RECs - within the US in 2014, an (unbundled) REC could be bought for as low as $1[7] with inevitable claims of greenwash. In the UK, supply utilities are alleged to be using a REC equivalent (REGO) trading loophole to unjustifiably claim 100% renewable electricity.

Furthermore, RECs and Carbon Offsets are very different. RECs are measured in blocks of 1 MegaWatt-hour (MWh) of renewable sourced electricty - there is simply no direct relationship between the GHG emissions measure of 1 tonne CO2-eq and 1MWh of electricity unless generation is genuinely paired against GHG reductions rather than avoidance. Under the EU-ETS, RECs were not eligible as emissions reductions (Sorrel 2003).

To resolve the disparity between the Carbon Offsets and RECs, renewable energy projects and associated initiatives such as RE100 and EV100 encouraged by the COP26 President, Alok Sharma, must be capable of assessment as Climate Mitigation (Carbon Offset) Projects for meaningful inclusion as Nationally Determined Contributions (NDCs). For this to happen, it is imperative that Renewable Energy Certificates Deliver Real World Benefits.

Aside of the underlying complexities of NDC accounting, great vigilence is needed to avoid double counting by distinguishing between verifiably additive[16] Renewable Energy projects or simply new to satify increasing energy demand.

3. Global Carbon Taxation Scheme

To date, 2021, the reality is that the Clean Development Mechanism(CDM) coupled with uncoordinated carbon pricing initiatives and schemes, such as ETS (Cap and Trade), have failed to reign in the increasing levels of atmospheric greenhouse gases driving climate change. There is no guarantee that the Paris Agreement (PA) with Nationally Determined Contributions (NDCs) being at its heart alongside the Sustainable Development Mechanism(SDM) replacment of CDM will be any more successful without overcoming the main weaknesses comprising:

- the voluntary nature of NDCs in reducing GHG emissions (PA Article 6).
- a part legally binding and voluntary Financial Mechanism that is unrelated to progress in achieving climate change mitigation.(PA Article 9).

It is evident that the Paris Agreement requires re-inforcement beyond its current mix of compromises of legally binding and voluntary obligations to incentivise and link both the reduction of GHG emissions and provision of climate financing as a deterministic (feedback loop) mechanism. Adopting a holistic approach, a "One World" Carbon Added Tax with revenues raised re-invested into climate financing for , inter-alia, sustainability projects, assisting as a minimum the less developed countries (LDCs) to meet their NDC targets, would meet this criteria.

The idea of a Carbon Added Tax (CAT) was floated over ten years ago and, to some at that time, regarded too difficult to implement and of little value. However, placed into context of a no-border global carbon taxation scheme, it may be argued that CAT in conjunction with product and service GHG Valuations should become the new heart of global GHG Emissions control rather than Nationally Determined Contributions.

Carbon Added Tax cannot be considered in isolation of its consequent effects of plunging many into further levels of deprivation without some form of cushioning mechanism applied in a non-discriminatory manner. The mechanism would need to encompass all peoples of the world including those that live within subsistance economies by providing realisable (redeemable) benefits rather than simply (aid) relief up to a annually reviewed (CAT) threshold expressed in tonnes of GHG. It is envisaged that Carbon Tax Relief Vouchers (CRVs) distributed in some form, physical or electronic, to the adult, 15 and over, world population would satisfy this requirement. This funding would also need to be sourced from CAT revenue.

3.1. Greenhouse Gas Emissions Value

Fundamental to Carbon Added Taxation, all products and services would need to be attributed a "GHG Emissions (Carbon Footprint) Value" much as foods have ingredients labelling in the EU to reflect the overall GHG Emissions loading on the environment:

- Products comprising many component parts would need to have a consolidated value.
- Foods would not be exempt either as, for example, intensive farming methods typically have a profound environmental (GHG) loading.
- Foods and products resulting from land-use change (eg deforestation) typically cause a net and ongoing carbon sink deficit that would require inclusion in GHG Emissions accounting.
    - The World Resources Institute cites the IPCC's Special Report on Climate Change and Land statistic that "About 23% of global human-caused greenhouse gas emissions come from agriculture, forestry and other land uses".
- Hydrocarbon fuels derived from agriculture as renewable biofuels would be attributed GHG

Emissions Values comprising two components derived from potential burn emissions and upstream emissions:

- When upstream emissions are taken into account, Emissions Analytics suggest biofuels offer little advantage in reducing transportation emissions and this appears without taking into consideration Land-Use Change.

- The GHG Emissions value for hydrocarbon (fossil based) fuels such as natural gas, coal and petrol would comprise two parts derived from their potential burn emissions and upstream emissions.
  - According to the World Resources Institute, upstream emissions account for between 5 - 37% of fossil fuels' overall emissions.

- Hydrocarbons being used as feedstock for the petro-chemical industry to produce, inter-alia, plastics, and lubricants would have a GHG Emissions valuation excluding that otherwise attributable to direct burn.

- Renewable energy and energy storage systems (ESS) would necessarily include life cycle assessed GHG Valuations. In the wider context of renewable energy projects, GHG valuations may be used as input data towards estimating the Carbon Payback timeframe as part of a Marginal Abatement Cost Curve (MACC) analysis.
  - Carbon Payback for renewable electricity generation and supply would be dependent on many factors including consideration of:
    - nature of connected electricity (grid) supply network.
    - curtailment when input has to be scaled down by result of base generation inflexibity.
    - curtailment when the input has to scaled down by result of transmission inadequacies in the grid distribution infrastructure.
    - existing capacity and future plans for increasing the capacity of backup Energy Storage Systems to overcome:
      - ✓ the need for traditional and inflexible (fossil fuel and nuclear (fission) based) generation.
      - ✓ the "wrecking" impact on power markets by fluctuating availability from renewable (wind turbine and Solar PV) sources.
    - government support policies and/or subsidised power generation that may skew monetary considerations in favour of traditional, less flexible fossil fuel based generation.
  - Carbon Payback for other types of renewable heat generation and heat storage energy systems.
    - Locally produced domestic thermosyphon Solar Water Heating (SWH) installations have been common in the Mediterranean region since the 1970's with Cyprus the world leader in terms of per capita SWH capacity in 2012.
  - Carbon Payback for (electricity regeneration) Energy Storage Systems will vary according to type of storage system whether, as examples, pumped hydro or battery based.

- Energy storage technologies, including conventional batteries and cryogenic, are typically characterised by an "all-in" Levelised Cost of Storage (LCOS) metric[17] used for straightforward economic comparison[18]. The metric, however useful, cannot be used to assist with identifying cost effective abatement actions.

- Carbon Payback for hydro-electric schemes would necessarily take into account not only the short term costs associated with infrastructure development but also long term effects of land-use change which in some cases might substantially reduce or eliminate project justification.

3.1.1. Climate Metric and Time Horizon

The assignment of GHG Emissions (Carbon Footprint) values to products and services depends critically on both the climate metric chosen and time horizon. Essentially, the climate metric refers to the methodolgy used to assign climate forcing effects over a specific (time horizon) period to greenhouse gases. Global Warming Potential (GWP) and Global Temperature Change Potential (GTP) are the predominent climate metrics. With Carbon Dioxide (CO2) used as a measurement reference with an impact valuation of 1 throughout, the relative impact of other polluting gases such as methane may be estimated. Although the measures are associated with considerable uncertainty, the selection of different time horizons result in wide variations such as, for example, methane has GWP valuations of roughly 28 and 84 for 100 year and 20 year time horizons respectively. For comparison, equivalent GTP valuations are 67 and 4.3.

The GWP 100 year time horizon metric has been widely adopted for GHG reporting and submission of National Greenhouse Gas Inventories but not without increasing concern as the effect of methane emissions become implicitely under-rated compared to the 20 year time horizon. With carbon dioxide and methane comprising 76% and 16% of global GHG emissions respectively then methane emissions outweigh, in climate impact terms, the effects of CO2 emissions by a factor of over 5 using the 100 year GWP time horizon and over 15 using the 20 year figure. Even worse, the rate of increase of atmospheric methane has historically, and continues, to outpace that of carbon dioxide: since pre-industrial times, methane levels have increased by a factor of 2.5 while the comparable figure for carbon dioxide is 1.5. Further compounding the issue is that methane has a much shorter atmospheric lifetime of 12 years compared to the commonly accepted 100 years for carbon dioxide.

The question may be justifiably raised as to what effect has the common adoption of a 100 year time horizon skewed climate change policy, not least the Kyoto and more recently the Paris Agreement while compromising the scientific consistency of meeting the temperature goals? Has it justified a bridging solution rush to switch electricity power generation from coal to natural gas (natural gas being primarily methane) while potentially, if not verifiably actually, moving the problem to the more difficult quantisation of fugative, upstream, methane emissions with possibly little or no overall benefit?

By nature of application, the time-horizon for a carbon added tax would be implicitlty 1 year simply on the basis that reporting would be periodic, typically on a 3 month basis, with the prevailing rate reviewed annually. With emissions effectively monitored, via CAT returns, in a time-scale approaching real-time, the use of GHG valuations based on a 100 year climate metric would be equivalent to inserting a huge time delay into a taxation system designed to respond in a timely manner to influence GHG emissions reduction. Such considerations would suggest adoption of 1 year time horizon but would most probably result in undesirable CAT rate instability rendering projections for medium term financial investments into renewable energy projects, energy storage schemes and sequestration (carbon offset) incentives difficult. The choice of a 20 year time horizon climate metric for product and service GHG valuation would be a pragmatic compromise and be consistent with the Paris Agreement timescale while addressing the

scientific inconsistency, namely undervaluation, of methane and other climate damaging pollutants.

3.1.2. Tackling GHG Emissions Valuation Uncertainty

GHG Emissions Valuations would undoubtedly be subject to differing levels of uncertainty. Simplistically, it would be expected that the emissions resulting directly from hydrocarbon fuel burn be far more accurately assessed than the emissions resulting from the production of food and forestry products. Similarly, fugitive (accidental) emissions resulting from oil and gas industry operations are far more difficult to quantify to a significant level of certainty than direct fuel burn emissions.

IPCC guidelines state that a 95% confidence interval is typically used for national greenhouse gas inventories - in other words, actual emissions would have a 95% probability of falling within a range bounded by the 97.5th and 2.5th percentiles of a probability distribution curve based on, as example, repeated measurements. However, a 95% confidence interval (or any confidence interval for that matter) does not determine the actual uncertainty expressed as a percentage variance about the estimated (mean) emission. As two widely differing examples applied at product level rather than national inventory, a 95% confidence interval for fuel burn emissions might be determined by direct scientific measurement to within a +/-2% uncertainty whereas emissions for a wetland area might be empirically derived yielding a -40% /+200% uncertainty.

It is clear that each stage of GHG (Emissions) valuation for any product and service for the purposes of CAT should be based on an international standard such as ISO 14067. Furthermore, if the heavily criticised carbon offsets issued according to GHG Program verification have future relevence within a global carbon taxation scheme, then such offsets would require the same standardisation of GHG (Reduction) valuation.

GHG valuation, whether emissions related to products and services or reductions from mitigation projects would be assessed according to the concept of good practice outlined within the IPCC National Greenhouse Gas Inventories guidelines. Although the IPCC methodological tiering of assessment may be generalised into expected levels of uncertainty with tier 1 the most uncertain and tier 3 the least, a well defined approach regarding the utilisation of uncertainty is necessary for a carbon taxation scheme.

Uncertainty based emission reduction corrections (discounting) are already employed by GHG Programs but with little conformity and generally applied at very conservative levels. Furthermore, straightforward adoption of a discounting scheme similar to that proposed within CDM guidance would be inappropriate in context of a Carbon Taxation Scheme that would necessarily be required to address both emission and reduction valuation uncertainty. An additional challenge would be to avoid valuation leakage whereby carbon offset reductions are overstated and product and service emissions are understated. It is for these reasons that beyond certain levels of uncertainty, the use of 97.5th and 2.5th percentiles be used in preference to factor-based discounting as detailed in the Table 1.

Table 1: Uncertainty Based GHG Valuation Scheme

Uncertainty	Valuation	Comment
<=±10%	Use mean value	Symmetric uncertainty up to 5% asymetric uncertainty
>±10%	Use 97.5th percentile for emission Use 2.5th percentile for reduction	Any symmetric uncertainty above ±10% irrespective of asymmetry

>5%	Use 97.5th percentile for emission Use 2.5th percentile for reduction	Any asymmetic uncertainty above 5%

Aside of incentivising the need for the progressive reduction in the causes of uncertainty, higher levels of carbon pricing are further justifiable in order to finance the additional costs of valuation validation and verification of all carbon offset (CDM/SDM) projects including those that would previously have been accredited an assumed uncertainty based on assessment methodology.

3.2. Carbon Added Tax (CAT)

The GHG Emissions Value would be monetised as a "Carbon Added Tax (CAT)" much as "VAT" (Value Added Tax) is charged in many countries but, in contrast with VAT, applied globally and at a standard (but flexible, learning by doing) rate expressed in US dollars per tonne of Greenhouse Gas emissions.

The administrative burdon, at least in the initial stages of implementation, would no doubt be high. Allocation of GHG Emissions values to products and services would necessarily fall on the supplier, not on the state, albeit an overseeing body for audit and certification would be needed possibly similar to the global Fairtrade certifier FLOCERT. Without such certification, products would be subject to an "Emergency or Worst Case" Emissions Value that would put the supplier at a market disadvantage. Industries that have used Emissions Trading (or otherwise known as Cap and Trade) Schemes to continue polluting, often in already over-polluted locales, will similarly find themselves at a market disadvantage.

Once products and services are allocated GHG Emissions Values, even store Electronic Point of Sales systems may be straightforwardly modified to provide a monetised CAT balance itemising both product CAT and a store wide (services) value.

The environmental cost of GHG Emissions is difficult to quantify and even more difficult to estimate a carbon pricing that will encourage the urgently needed acceleration in GHG emission reduction to limit global warming to the Paris Agreement 2 degrees celcius peak above pre-industrial levels:

- The OECD has reported that carbon prices for most countries are not high enough to meet climate targets being significantly lower than the EUR 30 per tonne CO2 benchmark.
- The IMF have modelled a carbon price per ton of $75 and while being significantly above EUR 30, it is questionable that this is still a realistic valuation.
- The IPCC suggestis much higher carbon prices may be needed to drastically cut emissions.

For the purposes of demonstrating the financial impact of CAT in various scenarios within this document, the USD75 carbon pricing has been adopted.

3.2.1. Carbon Added Tax Relief Threshold

With similarity to VAT, CAT would be paid by the product / service buyer. However, to overcome inequity between developing and richer nations, or indeed between ethnic or socialogical groupings irrespective of nationhood, the application of CAT would be subject to a per capita relief threshold.

It is evident that the CAT Threshold would need to be annually adjusted to reflect progress in achieving the substantial GHG emissions reductions pledged at the COP21 Paris meeting in 2015. However, such is the voluntary nature of these non-binding Nationally Determined Contribution (NDC) pledges and the absence of a globally agreed reduction target, it is appropriate to adopt the EU approach of achieving at least a 40% (domestic) emissions reduction by 2030 compared to 1990 levels but applying this at a truly global level to

overcome the problem of outsourced emissions accounting discussed earlier. This approach parallels the 26 November 2019 UNEP warning that global emissions must be cut by 7.6% every year for the next decade to meet the longer term 1.5 degree C Paris Agreement target. This amounts to a year on year 2.2 billion tonnes reduction from the current 36 billion tonnes of Energy Sector emissions to 13.4 billion tonnes by 2030 without taking into consideration less quantifiable emissions from other sources namely land use, land use change and forestry.

3.2.2. Carbon (Added Tax) Relief Vouchers

It would be unjust to impose the additional burden of a Carbon Added Tax on the worlds population without providing some form of lower income group relief. Such protection might be in the form of Carbon Tax Relief Vouchers (CRVs) that would be assigned either electonically or in material form to the adult population.

The implementation of CAT in conjunction with CRVs would be significantly more encompassing than existing ETS and Carbon Tax schemes and provide an alternative to, or otherwise strengthen, the new carbon market concepts declared in Article 6 of the Paris Agreement for which agreement between countries continues to fail. Rather than relying on bilateral and voluntary NDC agreements and cooperation between countries as frameworked in Article 6, CAT with CRVs offers an incentivised model for carbon accounting, carbon taxation and significant ratcheting up of the Paris Agreement Financial Mechanism for climate financing.

With CAT nominally expressed as a rate in US dollars per tonne GHG Emissions, it is pertinent to base the issue of CRVs on a per capita tonnes of GHG Emissions Threshold. The simplest approach would be to assign this threshold as a simple (6 tonne) per capita average of global energy sector (36 billion tonnes) GHG emissions for an adult (6 billion) world population. However, such a simplistic averaging approach might mask extreme inequities between lower income groups particularly within the Least Developed Countries (LDCs) and those in the industrialised nations.

However the threshold is derived, the major objective would be to maximise world population inclusitivity into the task of tackling climate change.

For this reason, and in contrast to straightforward income tax relief, CRV monetization (nominally tonnes to US dollars at the CAT rate) would not only provide relief up to the CAT threshold but for many would leave surplus funds. A key strategy would be to incentivise CRV utilisation beyond nominal valuation and basic CAT relief towards the adoption of cleaner, more efficient energy use and wider sustainable developments whether organised at local community or wider levels of society.

The concept would especially benefit developing countries enabling resources to be directed into projects designed inta-alia to improve health, housing, schooling, water supply and eco-friendly developments such as provision of low cost domestic solar water heating, conservation, eco-tourism, sustainable farming and afforestation / re-forestation. Ideally, such projects should develop from bottom-up local needs and with sufficient governance be encouraged to evolve into Carbon Offset schemes. It is considered AID agencies be able to provide a vital role in overseeing but not dictating the direction of these developments.

The World Bank per capita figures for GHG emissions in 2014 show 0.5 tonnes in Ghana whereas for Australia, China and the US it was 15.4, 7.5 and 16.5 respectively masking gross inequities of disadvantaged groupings within individual states. In the context of CAT, a more useful approach would be to use a per adult figure for GHG emissions. Using Ghana as example, with 36.5% of its 32 million population below the age of 15 in 2020, the per adult figure for emissions becomes approximately 2 tonnes leaving 4 of the proposed 6 tonne CRV threshold surplus. A two adult household would have USD 600 for focussed expenditure on, as example, a locally made thermo-syphon Solar Water Heating system. In Cyprus, locally

made system installations might cost as low as 550 euros.

4. Beyond the Energy Sector: LULUCF and Blue Carbon

Having focussed on the largely quantifiable Energy Sector GHG Emissions of 36 billion tonnes in 2019, total anthropogenic GHG emissions were estimated at 56 billion tonnes. Approximately 23% of this total (13 billion tonnes) is attributed to emissions from farming, forestry and other land use.

A significant quantity of methane (CH4) emissions result from ruminent livestock such as cattle. Methane has a particularly damaging climate change influence with 1 tonne being equivalent to 28 tonnes of CO2 based on the GWP100 year time horizon. Other greenhouse gases include Nitrous Dioxide (NO2) resulting from intensive application of artificial fertilisers.

Whereas the GHG Emissions value (Carbon Footprint) of non-food products would primarily reflect fossil fuel based (direct and indirect / fugative) emissions, applying a value to food products would need to account for, as examples, land-use change and emissions from lifestock. The Visual Capitalist provides a revealing chart detailing the Carbon Footprint of the Food Supply Chain of a wide variety of foods - in particular, the GHG emissions relating to land-use change and methane emissions for producing 1 kilogram of beef are approximately 16.5kg and 39kg respectively with a total supply chain emission of 60 kg amounting to $4.5 CAT at (presumed rate) $75/tonne (See Note*). As comparison and on average, a newly (2019) registered passenger vehicle in the EU would have to travel 490 km for this same emission. The Carbon Footprint chart figures are derived as averages from many commercial farms across many countries so it may be reasonably expected that there will be a wide spread of emission valuations: indeed, as example, 25% of beef producers cause 61% of land use emissions.

*It is assumed that the GHG emissions contributing to the Visual Capatalist food supply chain are based on the 100 year GWP time horizon. If this is correct, then the methane emissions based on a (GWP) 20 year time horizon would be increased by a factor of 3 raising the overall supply chain emissions to 138kg and CAT to over $10 for 1kg of beef.

Countries party to the UN's Climate Change Convention are required to submit national greenhouse gas inventories that include both (carbon sink) removals and source emissions from, not least, the burning of fossil fuels and that resulting from land use, land use change and forestry (LULUCF). Guidance for LULUCF inventory estimation is provided within the IPCC's Good Practice Guidance for Land Use, Land-Use Change and Forestry.

To apportion GHG emission valuations to land derived products, whether food or forestry, it is implicit that such lands have a reference emissions database extrapolated back to a time of natural undisturbed ecosystem. Such baseline allocations would also enhance the opportunities for land use and forestry to be quantified and included as part of Nationally Determined (climate mitigation) Contributions (NDC's) in the context of the Paris Agreement.

The reference emissions database would facilitate GHG emissions valuation to products associated to loss of biodiversity resulting from mono-culture (eg biofuel) crops and forestry as well as land degradation resulting from mining for, inter alia, raw materials for cement, gemstones and rare earths.

IPCC guidance for the inclusion of wetlands into national greenhouse gas inventories is also provided but estimation of methane sinks and emissions have possibly been seriously underestimated using a 100 year time-horizon assessment for regions such as impounded wetlands suffering reduced salinity resulting from, possibly historic, drainage, dikes and tide gates. The use of a 20 year time horizon would potentially incentivise Blue Carbon climate change intervention with possibly more immediate realisation than land based (afforestation, reforestation) initiatives.

It is inevitable that climate mitigation initiatives, such as a global tax regime in the form of CAT, applied to food and forestry products would affect economies and conflict with the imperitives of feeding the world's growing population particularly within the less developed countries. As a counterbalance, the proposed CAT threshold relief implemented as a Carbon Tax Relief Voucher (CRV) distribution would cushion the most vunerable from increased commodity costs.

5. Carbon Added Tax Implementation

In very broad terms:

1. Carbon Taxation in the form of Carbon Added Tax (CAT) would be charged at an annually reviewed rate based on progress towards achieving GHG Emissions reduction goals and expressed as US Dollars per tonne of CO2-eq emissions.

2. GHG valuation, for both emissions and reductions, would be based on a balance between IPCC National Inventory Guideline methodologies and ISO 14067 but

    1. based on a 20 year (GWP) time horizon rather than 100 year to reflect the greater forcing effects of other climate damaging gases such as methane.

    2. and subject to final adjustment according to the Uncertainty Based GHG Valuation Scheme designed to limit valuation leakage.

3. CAT would be additive at each stage of a supply chain according to GHG valuation with the final product or service consumer paying the accumulated tax at the prevailing CAT monetary conversion rate.

4. Organisations that supply end-use fuels directly to the domestic market would charge further carbon tax based on predicted GHG emissions from combustion and be regarded, for the purposes of differentiation from CAT when specifically needed, a CarbonCombustionTax(CCT). Otherwise CCT would be indistinct from CAT and charged at the same CAT rate.

5. The use of carbon offsets (issued as Carbon Additionality Certificates) to reduce CAT would be permitted up to a limit of achieving emissions neutrality defined by balancing CAT input to output in terms of tonnes CO2-eq equivalence within an organisation.

6. All human activities that cause an increase in the atmospheric greenhouse gases would be subject to CAT based on product and service supply chain GHG Emissions (Carbon Footprint) resulting from:

    1. Primary (Fossil Fuel based) Energy Production and Supply.

    2. Secondary (Electrical) Energy Consumption.

    3. Land Use, Land Use Change and Forestry.

    4. Radiative Forcing.

7. Primary (Fossil Fuel based) Energy Producers and Suppliers would charge Carbon Added Tax (CAT) according to:

    1. upstream emissions resulting from, as examples, extraction, transport of unrefined product by a third-party.

    2. the producer's internal supply chain emissions irrespective of national / regional boundary including, as examples, extraction, transport of unrefined product and refinement /

processing to an end-use fuel.

3. end-use burn emissions established against internationally recognised figures, measured in tonnes CO2-eq, per quantity of primary fuel by weight or volume as appropriate.

8. Secondary Energy Producers that generate all or some proportion of their electricity from fossil fuels would pass on CAT to the consumer in a manner that best suits their business model by:

1. dynamic CAT levy to reflect the electricity generation mix that includes input supplies from renewable sources such as solar PV, wind and energy storage systems.

2. fixed CAT levy based on an averaged fuel mix scenario that excludes input supplies from renewable sources and energy storage systems.

3. The CAT levy applied would be based on the CO2-eq emissions factor applicable to the residual grid mix following supply exemptions and exclusions according to business model and applied at the reporting period specific CAT rate.

4. The CAT levy applied by a renewable energy supplier would be required to be consistent with its employment of market based tracking mechanisms such as the EU's Guarantee of Origin (GO) Certification.

    1. The use of contractual instruments to prove consumption of renewable energy would be considered entirely consistent with carbon accounting such that, as example renewable electricity the applied CAT levy would be dependent on the Carbon Payback Scheme employed.

5. For the purposes of clarity, electricity supplied to a grid from energy storage systems would be considered under the same terms as renewable energy. Although consideration of each energy storage scheme would require assessment, the underlying basis would be that irrespective of the originating source of the stored electricity, the GHG emissions balance between original generation and final consumption would only be reflected in an effective emissions factor rise depending on storage / regeneration efficiency.

9. Land Use Change inevitably changes the Carbon Sink potential from its natural terrestial ecosystem state. Such changes may be a result of altered Land Management Pactices ranging, but not limited to, logging, deforestation, afforestation and reforestation.

1. Despite the difficulty of calculating the changes in sequestration resulting from land use change, it is vital that carbon accounting models and databases are internationally applied so that products and services resulting from land use change may be allocated a CAT levy. The groundwork for at least tropical timber products has been outlined by The Sustainable Trade Initiative.

    1. In circumstances where altered land managment methods has degraded the Carbon Sink potential from its natural ecosystem, then CAT would be proportionately charged on products and / or services resulting from that land use change. Such changes may involve logging in previously unharvested forest and forest clearance for radically changed land use.

    2. In circumstances where altered Land Management methods increase carbon dioxide removal and sequestration with verifiable additionality, then the increase in Carbon Sink over the natural ecosystem would be tradable as certified carbon offsets measured in tonnes of CO2-eq and costed at the current CAT levy. As example, this

might be the result of afforestation.

10. Radiative Forcing refers to an imbalance between incoming solar radiation and outgoing infra-red radiation from the Earth's atmosphere. Although there are many natural sources contributing to radiative forcing and consequent change in level of atmospheric carbon dioxide, in this context, radiative forcing applies to anthropenic sources such as that caused by the emissions from high altitude flying of jet aircraft. Although difficult to quantify, CAT would be charged at an agreed conversion factor related to the primary GHG emission.

5.1. Carbon Pricing: Carbon Added Tax

The failure of the Kyoto Clean Development Mechanism(CDM) to reduce GHG emissions dictates the need for a more effective approach to carbon pricing. In this context, it may be argued that the Paris Agreement has offered nothing other than allowing both the continuance of disparate financial systems to establish carbon pricing within the reality vacuum of cap and trade market trading and less than transparent national carbon /excise taxation policies.

To achieve year-on-year GHG emissions reductions, carbon pricing, in the form of Carbon Added Tax (CAT), would become the main controlling influence within, what may be regarded in engineering terms, a deterministic (feedback loop) mechanism based on a combination of real-world factors controlling its periodically (annually) reviewed rate directly linking a monetary valuation to 1 tonne CO2-eq emissions.

Such a feedback mechanism would implicity redress complicating factors such as elasticity between CRV inspired expenditure and energy use / emissions - that is, tackling energy proverty by CRVs for the world's most disadvantaged would inevitably cause increased energy use, the challenge being that the increased energy generation be less polluting , renewable and resulting in a net reduction in emissions.

The CAT rate would to a greater or lessor extent reflect progress towards achieving a net reduction of emissions with factors comprising:

- Marginal Abatement Cost (MAC): The cost of reducing emissions by 1 tonne CO2-eq.
- Emissions Gap: A cost curve reflecting progress in reducing emissions to a designated goal.
- Co-Benefits: Funding to support, inter alia, Sustainable Developments.
- CO2-eq Concentration: A factor related to both the absolute level of atmospheric greenhouse gases but also the rate of change against the target level of limiting the long term global temperature rise to 1.5 degrees C above the pre-industrial temperature level.

The MAC is the cost of reducing emissions by 1 tonne CO2-eq and expected to rise over time as the cheapest abatement options are used up. The MAC would necessarily require to be determined at a global level rather than national, sub-national or regional.

The Emissions Gap cost curve would necessarily reflect an increase from a base CAT rate determined, at least in part, from the marginal abatement cost if achieved reductions are less than the designated annual, UNEP 7.6% reduction, goal. The curve should increase the CAT at an aggressive rate should the Emissions Gap widen and take into account uncertainty in the accuracy of measurement of global emissions.

The CAT rate would also include sufficient overhead to support Sustainable Development Goal (SDG)funding.

The annual rate of change of atmospheric CO2-eq concentration undoubtedy provides the most important indicator towards achieving successful climate mitigation. Since the beginnings of the industrial revolution,

carbon dioxide (CO2) levels have increased from less than 280 parts per million (ppm) to over 400ppm in 2019 and still shows a progressively increasing rate of change on an annually increasing concentration. Atmospheric methane (CH4) has increased at an even faster rate. With considerable uncertainties surrounding accurate carbon accounting for land use, land use change and forestry, the annually reviewed CAT levy would be factored against both the absolute amount of atmospheric GHG concentration but also the rate of change of this concentration.

5.2. Carbon Added Tax Revenue and Returns

In contrast to excise tax whereby discriminatory percentage rates, exemptions, relief and allowances typically apply according to the tax payer whether individual or organisation, no such discrimination would apply to CAT.

Unlike VAT whereby enterprises are typically required to register if taxable turnover is above a certain threshold, no such level would exist for CAT - all enterprises including publically financed institutions would be required to register and provide periodic returns in a manner similar to VAT.

CAT registration would be country specific according to the country's status within the Paris Agreement

Any CAT registered enterprise would be entitled to establish a Carbon Additionality Scheme (CAS) with the intention of generating Carbon Additionality Certificates (CACs) to reduce CAT liability and / or gain income by sale via a Global Carbon Additionality market.

Individuals and collectives would also have the option to voluntarily register for CAT to establish a privately financed CAS to benefit from CAC income as a non-trading venture.

To clarify, the application of carbon added tax and income gained from Carbon Additionality Schemes would be entirely independent of a states established tax revenue system.

With CAT applied to goods and services according to their supply chain GHG Emissions valuation expressed in tonnes CO2-eq, CAT relief by CAC purchase from a global CAC market would be restricted to a specific group of industries and organisations and limited to those emissions resulting from their internal value chain activities.

Importantly, CAT returns would include CAC utilisation and facilitate, amongst other information, detailed sector and regional statistics by recording both inputs and outputs as tonnes CO2-eq emissions:

- CAT returns would separately quantify entries as revenue expenditure according to emissions Scope as defined within the CDP Technical Note Accounting for Scope 2 Emissions[22]:
  - direct, internal organisation (Scope1) emissions.
  - indirect (Scope 2) emissions resulting from energy purchase such as electricity.
  - indirect (Scope 3 upstream) emissions.
  - indirect (Scope 3 downstream) emissions resulting from (assumed) fuel combustion by end of supply chain (non CAT registered) consumer.
- Apart from input and output entries, CAT returns would also record CAC utilisation to adjust overall net CAT liability or gain a CAT rebate.
- CAT returns would separately detail CAT inputs arising from capital expenditure as deferred output CAT to be explicitely amortised into product and service pricing.

- Deferred CAT would be required to be explicitely amortised into product and service charges determined by the supplying organisation according to tonne CO2-eq equivalence rather than input CAT rate.
- Deferred CAT would be applied at the prevailing tonne CO2-eq rate with any difference to the original CAT input rate resulting in either a balance repayment or charge.
- Although applicable to capital investment in general, deferred CAT would have specific relevance to Carbon Additionality Schemes with the option to offset up to a level of equalisation in the tonne CO2-eq measure by CAC purchase to achieve 100% renewable status.

- CAC utilisation would differentiate between those generated by a registered enterprise's CAS and those purchased from the global CAC market.
- For registered enterprises that have invested into a CAS, CAT returns would provide further details of CAC utilisation differentiating allocation towards initial CAS investment repayment and those allocated to and sold on the global CAC market.
- CAT returns would differentiate between schemes that specifically provide direct carbon additionality through one-to-one tonnes CO2-eq reductions and those that, in the first instance, provide indirect carbon additionality through electricity generation in 1 MegaWatt Hour (MWh) measures via renewable energy and energy storage systems displacing emissions. In the latter case, electricity generation via carbon additionality schemes would be subject to special considerations regarding CAC reward leading to scheme maturity.
- CAT returns would be publically available allowing independent organisations to monitor and verify an enterprise's climate impact.
- A CAC global market purchase limit of +10% emissions equivalent overcompensation would be an allowable return declaration. The 10% measure would be based on the organisation's internally generated GHG emissions declared within the return.
- Any CAC overcompensation excess in measures of tonnes CO2-eq up to the 10% limit would be allowed to be brought forward as rollover into the succeeding CAT return.
- The return would detail any excess beyond the 10% rollover allowance required for surrender to the global CAC market with remuneration at the original CAC purchase price.
- CAT returns from enterprises and institutions that offset their emissions by renewable electricity feed-in will be expected to balance the difference between input and output by CAC (carbon additionality certification) from the energy recipient declaring both electricity supplied in terms of MegaWatt hours (MWh) and emissions reduction in tonnes CO2-eq.
- CAT returns that show a certified net additionality measured in tonnes CO2-eq in reducing emissions would be paid by the revenue at the applicable CAT rate.

5.2.1. Carbon Additionality Schemes

Although the term CarbonAdditionality is subject to much debate over precise meaning, for the purposes of this document it refers to the quantified net reduction of GHG emissions caused by the Pairing of specific anthropological biosphere disturbance or activity with Mitigating Measures within a Valuation System that truly reflects the impact and timescales of the various climate damaging gases:

- Pairing is considered a key element towards the achievment of quantified net reductions.
- Mitigating Measures include the use of (as examples) market based renewable energy tracking mechanisms as well LULUCF initiatives
- Valuation System refers to the underlying requirement that GHG measurement and / or estimation uncertainty is tackled by appropriate choice of a climate metric and time horizon to reduce leakage (disparity) between emissions and reductions.

Carbon Additionality Schemes would be voluntarily established by any CAT registered enterprise, trading or otherwise including individuals, cooperatives, collectives, public and government institutions as privately financed ventures to quantifiably reduce GHG emissions. Such schemes would involve, inter alia, renewable energy and energy storage projects including those providing electricity grid feed-in, afforestation and reforestation.

Carbon Additionality Schemes would be required to undergo similar strict vetting and approval methodologies as Clean Development Mechanism (CDM) projects and would be expected to reject projects, as examples, involving reforestion of areas deforested for the purposes of reforestation, avoided deforestation and renewable energy projects that simply satisfy rising energy demand rather than displacing existing quantifiable GHG emissions.

In common with CDM projects, carbon additionality schemes demonstrating additionality as a small-scale project activity would typically apply to those initiated by CAT registered concerns such as individuals, collectives and cooperatives. Although privately financed, projects intended as small scale and located in developing and least developed countries would be allocated special assistance status to allow external scheme assessment funding leading to an additionality rating not exceeding 60 kilo-tonnes CO2-eq per year.

CA schemes would be rewarded Carbon Additionality Certificates (CACs) measured in tonnes CO2-eq for the purpose of offsetting CAT liability and/or gaining a net income within limitations. As marginal abatement costs would be expected to progressively increase, early investment into Carbon Additionality Schemes would provide a level of future proofing against inevitable rises in the CAT rate.

It would be hugely vital that renewable energy and energy storage developments of capacity greater than 15MW qualify for Carbon Additionality Certificate reward in contrast to the limit imposed on CDM renewable energy projects. Historically, these medium and larger scale developments have been typically dependent on winning a renewables auction that in some cases apply a mixed (compound) bidding criteria aimed at achieving wider socio-economic-environmental objectives beyond the cheapest energy price. The application of mixed bidding criteria would be a pre-requisite for an energy project's consideration as a CAS.

Registered enterprises would have the option to decide on prioritisation regarding utilisation of Carbon Additionality Certificates. Schemes in less developed countries run by co-operatives may put proportionately higher priority on gaining wider social benefits rather than recouping initial investment costs particularly if the scheme's finance was in some part the result of CRV utilisation. In contrast, registered enterprises wishing to declare emissions neutrality (net zero emissions) would prioritise additionality certificate utilisation towards reducing their CAT liability to zero.

Carbon Additionality Certificates would be rewarded ex-post assessed according to Uncertainty Based Valuation.

In contrast to the UN's Carbon Offset Platform, no restriction would be imposed on the geographic location of CA schemes. For example, a registered enterprise in one country would be allowed to establish a CA scheme in another providing both countries are signatories to a proposed Carbon Taxation Mechanism

(CTM). Additionality certificates would be valued at the prevailing CAT rate in contrast to the variably priced Certified Emission Reductions (CERs) of the CDM and other openly marketed carbon offsets. Importantly, the CAS would require a globally accessible platform similar to the UN's Carbon Offset Platform but extended to provide the ability of CAT registered enterprises to manage utilisation of their uniquely identified additionality certificates within certain limitations outlined below.

Again, and in contrast to the UN's Carbon Offset Platform, CACs available for purchase within the global marketplace would not identify the generating CAS or its associated CAT registered enterprise. However, the platform would have the ability to search details of registered enterprise funded Carbon Additionality Schemes as part of publically available CAT returns.

Similar to the CDM's registry process of CER cancellation, CACs would be cancelled once utilised towards CAT rate reduction to avoid double counting.

5.2.1.1. CAC Purchase and Surrender

Carbon Additionality Certificate purchase and surrender would be subject to a number of rules for the purpose of CAT accountability. Specifically, CAC purchase would be subject to restrictions according to Emissions Scope.

A closed group of institutional and commercial activities would have the option to offset CAT liability resulting from their internal value chain operations by CAC purchase - that is, those emissions resulting typically from direct (Scope 1) fossil fuel combustion.

Carbon Additionality Schemes would have the option to offset deferred CAT output charges resulting from development investment by CAC purchase being explicitely relevant to renewable energy schemes wishing to gain 100% carbonpayback.

Any organisation would have the option to offset CAT liability arising from their (Scope 2) energy usage by CAC purchase.

CACs would not be used to offset imported (Scope 3) emissions resulting from product and service purchase.

In effect, a purchase of a CAC would be the one-to-one transfer of 1 tonne CO2-eq emissions reduction by an accredited scheme to 1 tonne CO2-eq emissions generated by the purchasing, CAT registered, organisation.

The surrender price of CACs to the global market would be at its most previous purchase prices rather than the prevailing CAT rate to prevent buy-sell speculation.

The purchase price of CACs would be at the prevailing CAT rate with prioritisation based on a first in- first out surrender date basis.

No resale or transfer of purchased CACs would be allowed between separately CAT registered enterprises.

The closed group with the option to purchase CACs would be restricted to those providing public facing services such as passenger rather than materials transportation and end of supply chain institutions without directly chargeable end users. Examples of former include road, rail and air passenger transport, private hospitals, financial service institutions including banks, the hospitality industry, hotels, tour operators with the latter including state financed institutions such as schools, museums, hospitals and government offices. The mandatory requirement would be that CAT liability reduction by CAC purchase should not skew downstream carbon (GHG emissions) accounting of inorganic and organic products.

The interplay of considerations between simply paying CAT, the purchase of Carbon Additionality Certificates to offset CAT liability or direct investment into a Carbon Additionality Scheme would be a financial judgement that best matches the circumstances of the organisation and its aspirations regarding public perception of carbon footprint reduction and wider contribution to the meeting of Sustainable Development Goals (SDGs) outlined in the Paris Agreement.

Carbon footprint reduction would be best served by the use of CAC's whether by direct purchase or indirect input from investment into a CAS rather than straightforward CAT payment. Although CAT and CAC valuation would be nominally interchangeable both in monetary and tonnes CO2-eq terms, CACs would provide a tangible emissions reduction in contrast to CAT payment which would be directed to the less quantifiable SDG benefits of Carbon Relief Voucher (CRV) financing.

Beyond carbon offsetting, a financial benefit in CACs would be their (overcompensation) purchase as a financial hedge against a rising CAT rate. Simply put, in order for an organisation to achieve emissions neutrality, it would need to balance CAC purchase against CAT within any accounting period. However, uncertainties in the exact levels of internal organisation emissions within an accounting period would mandate the organisation to over-purchase CACs with an allowable excess (10% limit) rollover to the next accounting period.

The surrender to the global certification marketplace of any CAC excess beyond the 10% rollover allowance would be required. CAC remuneration to the surrending organisation would be its original purchase price once that CAC had been resold with any difference between resale and original pricing being directed towards global marketplace running costs.

5.2.1.2. Income Generation from Carbon Additionality

Any CAT registered enterprise would have the option to invest into a CAS in order to generate income from CACs via allocation to the global marketplace. CAC reward would be dependent on the nature of the CAS which in turn would dictate the ultimate lifetime of the scheme.

Schemes based on LULUCF would be expected to have relatively long term lifetimes, both on initial realisation of CAC reward and subsequent medium/long term maturity where additionality becomes statistically unverifiable. Income beyond that servicing CAS operating expenses would be allocated towards achieving wider sustainable development goals in the local region of the CAS having particular relevence to developing and least developed countries such as those in Sub-Saharan Africa.

In contrast, renewable energy and energy storage projects focussed on the displacement of polluting electricity grid generation capacity, CAC reward would be limited to the CAS achieving financial maturity. In circumstances where initial investment costs were wholly or part funded by CRVs such as for CAT registered individuals and collectives, CRVs would be regarded as part of the initial investment costed at their issued CAT rate valuation.

5.2.1.2.1. Carbon Additionality Certification for Energy Supply to Grid Systems

Historically, to qualify as a CDM renewable electricity project , capacity would be no greater than 15MW and be required to demonstrate additionality for small scale projects or even micro scale projects. However, in the context of carbon additionality schemes, no such limit would be imposed enabling inclusion of medium and large scale energy projects - Table 5.1 of the Policy Risk in Renewable Energy Investments study[23] provides a useful overview of project scaling versus the wider features including finance, insurance and guarantees.

To qualify for carbon additionality certification, new projects would be required to verifiably reduce existing

GHG emissions rather than simply meeting rising energy demand. In the context of electricity grid networks, feed-in must verifiably reduce the GHG emissions from established plant that would otherwise generate all or some proportion of their electricity from fossil fuels. Renewable Energy Certificates (RECs) and regional equivalents such as the United Kingdom's Renewables Obligation Certificate (ROC) and EU's (UK's Renewable Energy) Guarantee of Origin (GO/REGO) Certificate do not meet this Additionality Criteria.

There are a number of complicating issues regarding both qualification and validated measurement of electricity feed-in to be rated as additional. Additionality cannot be measured without the establishment of an emissions baseline and highlights the fundamental difference to how RECs, representing MegaWatt hours of generated electicity, are issued. Another fundamental difference would be the need to differentiate electricity supplies between that regarded as additional and that what is not. The underlying implication is that energy supply projects at some point require to become integrated into the established generating infrastructure losing their status as additional.

The loss of additionality status must be regarded in the wider context of incentivising permanence of emissions reductions and further disadvantage the building of new polluting generating capacity and /or the reconnection of otherwise decommissioned/removed polluting plant. It becomes apparent that the emissions baseline would require to be progressively reduced to advance these aims. It is clear that the definition of trigger points determining loss of additionalty status of energy supply projects and the rate of emission baseline reduction be closely linked to a state's Nationally Declared Contribution (NDC).

At its simplest, the loss of additionality status of an energy supply project would need to be reflected in the permanent decommisioning of GHG emitting power generation. Energy supply projects would necessarily require to be assigned additionality within a supply contract with the electricity grid utility. In turn, the utility would also be required to contractually commit to the permanent removal / decomissioning of GHG emitting electrical power plant equal to the contracted electrical energy supply - critically, this paired power plant would need to contractually chosen as the most polluting in terms of emissions per unit of electricity generated, that is the highest emissions factor rather than based on cost per unit of electricity generated. Furthermore, while the energy supplier has additionality status, it would be rewarded Carbon Additionality Certificates rather than RECs.

As grid systems incorporate proportionately more variable, photo-voltaic and wind power, renewable generation capacity, curtailment, such as the switching off of surplus renewable energy supply, becomes more frequent to maintain stability of grid systems historically based on less flexible GHG emitting and / or nuclear generating capacity. As a general guideline, when the variable renewable generating capacity of a grid system exceeds 50%, then curtailment events would be expected to increase without counterbalancing by energy storage systems whether pumped hydro storage, compressed air or large scale battery. The relatively higher cost of storage systems in comparison to renewable generation dictates higher investment levels that would potentially retard adoption and slowing closure of remaining GHG emitting plant as well as nuclear. [The issues regarding the "extremely long term safe" storage of nuclear waste and causes underlying the Three Mile Island, Chernobyl and Fukishima major incidents only highlight the inherent dangers and long term consequences of any reliance on fission technology. Economically, it may be argued that investment into energy storage systems would be a safer and more sustainable alternative to nuclear.]

In order to incentivise the building of energy storage capacity, energy storage schemes would be considered in the context of additionality particularly when integrated as combined renewable energy / storage projects. Critically, these projects, would benefit from a predictable cash flow as part of the carbon additionality scheme and at the established CAT rate up to the point of loss of additionality status. In other aspects, where the economic viabilty of new supply project developments is determined by the bidding process of energy auction, feed-in tariffs would necessarily be required to be established for longer term

economic viability without income flow from CACs.

It is clear that a revised form of energy auction would be required to ensure carbon additionality schemes bid within a level playing field. Implicitely, carbon additionality auctions would automatically exclude energy projects not bidding as accredited carbon additionality schemes. In addition, as part of the mixed (compound) bidding criteria, energy projects would be required to include the full costs of grid connection. The auction bidding criteria would also be required to stipulate the required type of energy supply, whether variable or stable: in the latter case, energy storage schemes become an implicit requirement for round-the-clock uninterrupted supply whereas for the former, bidding would only be accepted from renewable energy projects.

The expected downside of energy projects accredited as carbon additionality schemes would be a higher per unit energy cost in comparison to projects bidding within "classical"minimum price auctions. However, as counterbalance, the upside challenge of carbon additionality auctions would be:

- to incentivise investment into carbon additionality energy schemes.
- to increase certainty in viability of the winning energy scheme.
- to attract more energy projects to bid.
- to encourage smaller scale projects to bid.
- to accelerate the decomissioning of GHG emitting electricity generation capacity.
- to specify the terms of loss of CAS additionality criteria for the winning bid and how that would be contractually linked to both the decomissioning of GHG emitting generation capacity and accelerated investment payback.

5.2.1.2.1.1. Financial Maturity for CAS Energy Schemes

The criteria determining loss of CAS additionality status - CAS Financial Maturity - would, in general, be common to all electricity grid supply developments irrespective of capacity size and factors determining financing whether by result of auction or otherwise. At the heart of the criteria would be an emissions baseline facilitating the tracking of GHG emissions reductions and determining the point of scheme maturity. Maturity would be based on a schemes reward of Carbon Additionality Certificates reaching a defined limit of capital expenditure payback. Beyond maturity, the terms of operation of the energy supply project would continue under contractual agreements with the energy purchaser, in most cases the grid utility, typical to those negotiated for renewable energy projects without additionality.

As specific clarification, additionality would be supplementary to typical energy supply agreements with CAC reward quite distinct and independent from the main contract involving no monetary exchange between purchaser and supplier but with commitment by the purchaser to decommission equivalent GHG emitting plant at a schemes maturity. In most cases, it would be expected that the contractual terms of this decomissioning be underwritten by the state (party to the Paris Agreement) and be commensurate with its Nationally Declared Contribution (NDC) towards reducing emissions. At most, any overlap between a typical energy supply contract and one for a scheme including addionality criteria would specify the reward of CACs to the exclusion of RECs (or similar) up the point of scheme maturity.

Above and beyond the recognised risks associated to renewable energy supply schemes particularly, but not exclusively, in developing countries, the most significant risk to a CAS accredited energy producer would be a failure of CAC reward by the energy purchaser resulting from increases in energy demand outstripping the CAS energy supply. Aside of guarantee and insurance protection to cover these circumstances, the

most immediate interim fallback would be the issue of RECs to maintain a level of certificate based income. Prior to the issue of requests for tender, it would be incumbent on the energy purchaser to ensure that predicted energy demand balances energy generation capacity without compromising the intended emission reductions resulting from carbon additionality schemes.

In principle, the trigger for achieving Financial Maturity would be when an energy scheme has been rewarded CACs to achieve:

- monetary payback equalling its estimated development investment excluding CAT. The estimation would itemise costs into major categories such as infrastructure construction, labour, insurance, legal fees and exchange rate fluctuation provisions to the point of CAS generation going live.
- CarbonPayback relating to CAT arising from the development investment by CAC purchase would be permissable for an energy scheme to gain 100% renewable energy status.

Although requiring an unusual degree of transparency by bidding enterprises, investment costs would be assessed in confidence by an independent CTM approved adjudicator to filter unrealistic (over) estimation. The adjudicator would only reveal the CAC reward quota to the energy purchaser once contracts have been signed so as not to influence the choice of winning supplier.

Monetary payback would explicitely exclude remuneration of carbon added tax (CAT) resulting from construction, land (LULUCF) disturbance, etc, as well as upstream emissions resulting from, inter alia, infrastucture (eg PV, wind turbine) manufacture, concrete manufacture, transportation and rare earth mining. Indeed, a totalised CAT figure generated at the point of a CAS scheme achieving full capacity generation would provide a definitive indication of the scale of carbon payback and from this an estimated payback timescale.

A disadvantage of CAC reward would be the timescale delay in an energy project achieving carbon payback as being the point where reduced emissions (through additionality) have balanced the initial investment costs in emissions as measured by CAT totalisation. The advantage of CAC reward excluding CAT costs would be the incentivisation to intensify focus on the negative environmental costs of an energy project in terms of GHG emissions.

Carbon Payback is not equivalent to carbon neutrality. If any energy scheme whether accredited additionality or not has caused GHG emissions during its development, then it could not be considered as being carbon neutral irrespective of the amount of renewable energy subsequently generated over its lifetime. The exception would be if its emissions were paired to an intended equivalent, measurable and long term withdrawal in atmospheric greenhouse gases leading to emissions neutrality (eventually) - such is the importance of allying atmospheric greenhouse gas removals to LULUCF projects however high the challenge.

5.2.1.2.1.1.1. Emissions Baseline and CAC Reward

The reward of CACs to qualifying energy suppliers would be based on additionality taking the definition as being the measure of emissions reduction below an emissions baseline. The general principle would be that aside of interruption from any supplier by causes within its operation, CAC distribution would be applied in a fair and equitable manner. Situations where renewable supplies are reduced or stopped (curtailed) by the energy purchaser due to circumstances such as energy oversupply or lack of grid flexibility would not be factors influencing CAC distribution. Importantly, free rider and outsider effects due to curtailment and resulting in inequitable CAC reward should be avoided.

The establishment of an emissions baseline derived from the aggregrate of generating capacity within an entire electricity grid would only be practical for relatively uncomplicated, self contained (regional), grid

networks. For a complicated grid network comprising many types of generating plant, the derivation of an emissions baseline would be impractical particularly for those which have trans-national interconnections. For this reason, supplier - purchaser contracts would be required to pair CASs to a specific fossil fuel based generation plant. As priority, where practical, the paired fossil fuel based generation would be associated to that plant with the highest emissions factor to achieve not only the fastest reduction rate in emissions but also maximise speed of CAS Financial Maturity.

For a supply contract to be realistic in its objectives of achieving additionality, the emissions baseline would be based on a statistical expectation of emissions over a year period taking into account longer term fluctuations of energy demand resulting from temporary changes in ,inter alia, economic activity and weather. Rather than using a consumption-based grid average emissions factor, termed by the EU as a residual mix and reliant on complicated (GO) certification tracking, a "bottom-up" measurement approach would be based on internal (Scope 1) GHG emissions (CAT) accounting enabling the calculation of emissions factors relating directly to both the fuel used and operating conditions of the grid connected plant.

CAC reward would be based on the plant specific emissions factor used to translate MWh blocks of CAS electricty supply to GHG (tonnes CO2-eq) emissions reduced by verifiable generation plant capacity change or actual closure of the paired GHG emitting plant. Indeed, the energy purchaser would require to be legally bound, and subject to penalties, by contract to direct output reduction to the paired plant once the CAS generation is opened to a threshold capacity sufficient to allow reduction or closure of the paired plant. CAC reward would be based on the grid's emissions factor for an intermediate contractually phased commissioning period when the energy scheme's generation falls below the threshold capacity.

5.2.1.3. Balancing Supply and Demand for CACs

Carbon Additionality Certificate pricing would be locked to the prevailing Carbon Added Tax rate in order to provide a firm financial basis for CAS investment and payback. Accordingly, conventional supply - demand pricing would not apply avoiding undervaluation such has occurred historically for both Emissions Trading Cap and Trade carbon credits and voluntary market carbon offsets. Indeed, at the highest macro-economic level, it may be justly argued that carbon pricing should not be left to supply - demand forces as ultimately there is only one planet. Carbon Added Tax with periodically updated rate valuation based on a number of influencing factors would provide an alternative pricing framework to stimulate investment into advancing energy storage technologies and direct action into sequestration (LULUCF) and Blue Carbon projects.

The tradeoff of having a fixed carbon pricing mechanism would be that CAC availability on the open market would rarely balance between supply and demand. However, provisions within the CAS and its CAC supply, surrender, purchase and cancellation should eleviate major disparities to reduce financial risk exposure to participating organisations. The largest risk would be a fall in CAT rate so the overarching challenge would be to model a stable relationship between the various controlling factors governing the annually reviewed CAT rate to achieve a steadily increasing valuation. Such a premise is based on the expectation that the MAC-MarginalAbatementCost - will progressivley increase and that, in the medium term at least, atmospheric concentrations of greenhouse gases will continue rising.

Indeed, undersupply of CACs would denote an overall desire by the closed group of organisations allowed to purchase CACs to reduce their net emissions. Rather than reliance on uncertain CAC supply, organisations would have the option to directly invest into carbon additionality schemes to provide a medium term framework of CAC supply certainty and provide a financial hedge against an increasing CAT rate. Such investment should be encouraged with those CACs available via the global market used to bridge CAS shortfall.

With CAC undersupply indirectly encouraging CAS investment, CAC oversupply would potentially benefit funding to support small-scale carbon additionality schemes in developing and least developed countries arising from the difference between surrender and purchase prices of CAC holdings spanning a CAT rate increase. Notwithstanding any CAC oversupply, uninterupted funding support for small-scale carbon additionality schemes would be expected to be underwritten as part of a revised pledge by developed nations to mobilise at least $100 billion climate finance per year.

5.2.2. Climate Impact Factor: Transcending Carbon Confusion

It would be appropriate to introduce a formalising measure to facilitate and overcome misunderstandings surrounding commonly used terms such as carbon neutral, carbon zero, carbon negative, carbon positive and net-zero. Indeed, the terms carbon negative and carbon positive are widely used interchangeably by global corporations describing their goal to reverse their carbon footprint as a marketing strategy. The new measure would need to provide quantification similar to emission factors but with extention to include atmospheric GHG reductions resulting from carbon capture initiatives within an all-embracing positive-negative GHG weighting by activity spread.

A Climate Impact Factor would transcend the difficulties and implicit connotations of carbon centric terminology. It would provide definitive meanings to climate positive, climate neutral and climate negative activities on the accumulation or reduction of atmospheric greenhouse (CO2-eq) gases. In regard to Carbon Added Tax and Carbon Additionality Certificate reward, the ability to derive the Climate Impact Factor from a CAT return as an indication of an organisation's climate impact would be a bonus particularly in the context of Carbon Payback.

5.2.2.1. Carbon Payback and Emission Factors

CarbonPayback may be defined as the timescale of a GHG emissions debt accrued during any climate mitigation development becoming matched by subsequent avoided emissions. Avoided emissions may refer to actual emission reductions or estimated emissions that might have occurred should a climate mitigation development not have existed.

For renewable electricity developments explicitely paired to reductions in GHG emitting plant via grid connected carbon additionality schemes, avoided emissions would have an emissions baseline enabling MegaWatt hours (MWh) of electricity generation to be quantified into tonnes CO2-eq reduced allowing the carbon payback timescale to be calculated with a reasonable level of accuracy.

For renewable electricity developments not explicitely paired to GHG emitting plant, the calculation of avoided emissions would be significantly more challenging. Depending on the methodologies employed, how conservative the approach regarding establishing a baseline scenario, statistical accuracy of available data, scheme viability would be highly sensitive to the emissions factor used to estimate the carbon payback timescale.

It would be vital that emissions resulting from, inter alia, land disturbance, concrete manufacture and purchase of products and services resulting from a project development be included into the GHG emissions debt with CAT passed to the end consumer rather than disguised within main energy supply tariffs.

5.2.2.2. Climate Impact Factor Explained

The impact of CAT on the financial viability of renewable energy schemes and climate mitigation developments in general would be expected to disadvantage those schemes with the longest carbon payback timescale and preclude those with a timescale stretching beyond the schemes (contracted) project

lifetime. Simplistically, an energy project's "renewability (percentage) rating" may be calculated as:

((project lifetime - carbon payback timescale)/project lifetime) x 100.

However, the efficacy of a "renewability rating" based on the carbon payback timescale would be undermined by the use of estimated emission factors based on, as example, residual mix grid generation. A grid system largely dominated by GHG emitting plant would be expected to have a much higher emission factor compared to one with a large percentage mix of renewably generated electricity. For two otherwise identical renewable energy schemes avoiding the same quantity of emissions, radically different carbon payback timescales and renewability rates would result.

To overcome disparity, an alternative level playing field approach would be to base renewability on an energy (electricity generation) project's emission factor (ef):

ef = (project carbon debt (tonnes-CO2eq)/ {project lifetime rated generation (MWh)).

Even so, a system based on renewability ratings alone appears too restrictive requiring a more generalised approach to formalise the level of impact on the climate by a broad spectrum of activities. Such a factor may be named the Climate Impact Factor (CIF) with dimensions specific to the activity and range from positive to negative valuations. For example, a carbon capture scheme that uses (100%) renewable electricity to capture carbon from the atmosphere would be expected, indeed required, to have a positive measure with dimensions stated in tonnes CO2-eq per MWh whereas for a reafforestation scheme the dimensions would typically be in tonnes CO2-eq/hectare/yr. For activities with established emission factors, the conversion to CIF would simply be a negation:

climate impact factor = -ef;

Table 2 summarises the generalised interpretation of climate impact factors:

Table 2: Carbon Impact Factors

Climate Impact Factor	Emission Factor (ef)	Climate Impact	Activity Impact
< 0	> 0	Climate Negative	Net increase of CO2-eq to atmosphere resulting from (e.g.) fossil fuel combustion
0	0	Climate Neutral	Net Zero CO2-eq contribution to atmosphere
> 0	n/a	Climate Positive	Net reduction of atmospheric CO2-eq by sequestration / Carbon Capture

The EU Convenant of Mayors document details emission factors for common fuel types and sources of renewable energy sources. For example, all renewable sources are credited with climate neutrality according to standard IPCC 2006 figures whereas lifecycle (LC) emissions factors translate to between -0.007 and -0.05 climate impact factor valuations. Unfortunately, the figures may be rather more favourable than they should be: the effects of land use change and resulting contribution from methane (CH4) and other pollutant gases to lifecycle based emission factors appear either or both entirely absent and / or underrated by the use of the 100 year (GWP) time horizon (Section 3 Emission Factors Guidebook "How to Develop a Sustainable Energy Action Plan (SEAP)")[24].

In similarity to the emission factor, the Climate Impact Factor would be activity based so direct comparison between factors of differing dimensions would be subjective rendering comparitive objectivity to activities with the same dimensions. In terms of business performance, CIF would be expressed as (CO2-eq / expenditure) extracted from the CAT return.

5.2.2.3. Derivation of Climate Impact Factor from Carbon Added Tax return

CAT returns would consolidate and differentiate CAT arising from revenue expenditure into (GHG Protocol defined) Scope 1, Scope 2, upstream (Scope 3) and downstream (Scope 3) GHG emissions within the limits defined by the CAT accounting procedure.

CAT returns would also include enumeratation of Carbon Additionality Certificate reward and/or offsetting utilisation against CAT as well as detailing deferred CAT arising from capital expenditure and its amortisation as Carbon Payback.

From the information provided within the periodic CAT return, clarity of an organisation's overall contribution to tackling climate change would be possible by calculation of its Climate Impact Factor (CIF) as:

(CAC Utilisation - Emissions Totalisation)/(Expenditure)

where

CAC Utilisation = Equivalence in tonnes CO2-eq of (CAC Reward + CAC Purchases)

Emissions Totalisation = CAT Equivalence in tonnes CO2-eq arising from (Revenue Expenditure) + (Amortised Carbon Debt Payback)

CAT arising from Revenue Expenditure = Scope 1 + Scope 2 + Scope 3 (Upstream) + Scope 3 (Downstream) carbon accounting

Expenditure = Revenue Expenditure + Amortised Capital Expenditure

As clarification:

- Energy provider utility bills would reflect carbon (debt) payback by CAT. The rate of payback would be left to the energy supplier's discretion in order to recover deferred output CAT.
- Renewable energy schemes wishing to gain income via market based tracking mechanisms such as the EU's Guarantee of Origin certification and justifiably claim 100% renewable supply labelling would have the option to offset its carbon debt by either Carbon Additionality Certificate purchase or by explicit pairing against a carbon additionality (sequestation/carbon capture) scheme to achieve a Climate Neutrality.

It would be important that CAT returns be publically available to provide a transparent report of an organisations emissions value chain. The Climate Impact Factor would usefully serve as an instrument allowing organisations to declare independently verifiable climate neutrality or better as climate positivity denoted by a CIF greater than 0.

5.2.2.4. Climate Impact Grading

The Climate Impact Factor would provide a measure of an organisation's climate impact, whether neutral, negative or positive and expressed in tonnes CO2-eq per currency unit of expenditure. Typically, the CIF may be expected to range between 1 and -1 with levels of precision difficult to comprehend in a meaningful comparative manner. To aid visualisation, it would be useful to calibrate the CIF into range based grades. Although not excluding other approaches, a system similar to that applied to grade appliance energy efficiencies might be adopted with adaption to refect both Carbon Capture- Sequestration and GHG Emissions by Climate Impact Factor as detailed in Table 3.

Table 3: Climate Impact Gradings by CIF Range

Climate Impact Grade	CIF Range (tonnes CO2-eq/Currency Unit)	Carbon Capture-Sequestration or Emissions (CO2-eq) by Currency Unit
A5	>1.000	>1 tonne capture/seq
A4	>0.100 & <= 1.000	>100 kg capture/seq
A3	>0.010 & <= 0.100	>10kg capture/seq
A2	>0.001 & <= 0.010	>1kg capture/seq
A1	> 0 & <= 0.001	<=1kg grams capture/seq
AA	0	Climate Neutral (No CAT)
A	0	Climate Neutral
B	>=-0.001 & < 0	<= 1kg emissions
C	>=-0.010 & <-0.001	>1kg emissions
D	>=-0.1000 & <-0.010	>10kg emissions
E	>=-1.000 & <-0.1000	>100kg emissions
F	<-1.000	> 1 tonne emissions

A distinction is made between two forms of Climate Neutrality attainment:

- Grade AA Climate Neutrality denotes any organisation that has zero CAT liability resulting from its value chain without the use of CAC offsetting.
- Grade A Climate Neutrality denotes any organisation that offsets its CAT to zero-liability within Carbon Additionality Certificate purchase limitations.

Beyond Climate Neutral, gradings are based on a scale factor of 10 ranging from 1 kilogram up to 1 tonne CO2-eq with alphanumeric A ratings indicating increasing levels of carbon capture/sequestration and B through to F representing increasing levels of GHG emissions.

Organisations achieving a Climate Positive alphanumeric A grading would be expected to gain income via Carbon Additionality Certificate reward resulting from a Carbon Additionality Scheme.

The grading structure is based on a notional Currency Unit to provide and illustrate a fixed benchmark

relationship to CO2-eq weightings. In a real-world scenario where the grading system would require relating to national currencies, each currency would require a Currency Unit exchange rate undoubtedly strongly linked to the US dollar as the World's Reserve Currency. Aside of Climate Neutral A/AA grades, marginal Climate Impact Grading slippage would follow currency exchange fluctuations with the most stable currencies affected least.

6. Carbon Taxation Mechanism: Climate Financing in Context of Carbon Added Tax and Carbon (Tax) Relief Vouchers

The financing of Sustainable Development Goal initiatives may be regarded as one of the core objectives of a Carbon Taxation Mechanism (CTM) built upon four primary interdependent components:

- The assignment of GHG Emissions valuations to products and services.
- A Carbon Added Tax (CAT) levy applied to products and services based on GHG Emissions valuations.
- A Carbon Combustion Tax (CCT) levy applied at the same rate as CAT for end use fuels.
- CAT revenue mobilisation into safety net distribution of Carbon (Tax) Relief Vouchers (CRVs).
- Carbon Additionality Schemes (CAS) to generate Carbon Additionality Certificates (CAC) for optional income generation and / or CAT liability reduction.

In circumstances where GHG Emissions Valuation cannot be readily applied to products and services, an emissions intensity measure would be permitted for a limited period of, by nation, CTM adaption. The measure, in terms of tonnes CO2-eq GHG emissions per USD of Gross (Global or Domestic) Production, would be calculated on GHG emissions resulting from all sources and levied at the current CAT rate. The domestic emissions intensity would apply to both domestic trade and export valuation with imports subject to an emissions intensity measure dependant on the signatory status of the bilateral trading partner. For a non-signatory trading partner, the greater of the global or domestic (trading partner) emissions intensity would be used, whereas a signatory partner's emissions intensity would be used by default.

Revenue raised by both emissions intensity monetary valuation and GHG emissions valuation would have identical status as CAT permitting parallel utilisation. Indeed, at the expense of applying a tax that would reflect little of the true GHG emissions cost of products and services, emissions intensity based taxation would undoubtedly be adminstratively less costly, simpler and faster to implement justifying its early adoption for CTM adaption. In the longer term, while GHG emissions valuation displaces emissions intensity based carbon taxation within and between CTM member states, international trading with non-member states would remain as an emissions intensity by value tariff.

A wide number of scenarios for the implementation of the CTM may be envisaged regarding the breadth and depth of replacement of existing mechanisms that currently determine the effective carbon rate (ECR) as determined by the OECD. Such scenarios extend between two extremes being the wholesale replacement of national (carbon) taxation strategies encompassing carbon and excise taxes as well as deprecation of Emissions Trading Schemes to the CTM being simply additive to existing carbon pricing mechanisms. The latter, additive, scenario is adopted here as it avoids the complication of redressing loss of existing national (carbon) taxation revenue flows that vary, as a GDP percentage, widely between countries.

The primary unit by which Carbon Added Tax (CAT), Carbon Combustion Tax (CCT), Carbon (Tax) Relief Vouchers (CRVs) and carbon offsets exchanged as Carbon Additionality Certificates (CACs) would be enumerated in the tonnes CO2-eq measure which may be regarded as the underlying Carbon Currency. Monetisation of CAT, CRVs and CACS would be according to a periodically reviewed tonne CO2-eq to US Dollars conversion rate. Such straightforward equity between CAT, CRV and CAC monetary valuation ignores obvious organisational and operational overheads. In order to maintain this equity, a proportion of uncommitted CAT revenue, that is, that amount not directly committed to CRV monetization, would need to be reserved to finance overheads including the establishment and running, but not limited to, of national CAT Revenue infrastructures.

The CTM:

- is proposed as an additive, if not alternative, global level playing field financing mechanism within a revised Paris Agreement to overcome the uncertainty in funding climate mitigation highlighted by the World Resources Institute 2018 publication Aligning Finance is the Forgotten Goal of the Paris Agreement.
- would provide explicit carbon pricing.
- would enable carbon pricing of the impact of land use, land-use change and foresty (LULUCF) beyond fossil fuels.
- would provide an explicit price for carbon offsets exchanged as Carbon Additionality Certificates.
- would have the advantage to transcend the omnipresent reluctance of governments to implement meaningful and consistent national carbon taxation policies that have been historically influenced by political / economic self interest and power group (e.g Big Oil) lobbying.
- has the potential for overcoming the complicating argument for developing countries wanting to maintain the exclusive obligation of developed countries to provide and to mobilize climate finance[26]. In practice, this financing would remain largely sourced from the developed countries but via CAT revenue collection rather than by the less than transparent Paris Agreement Article 9 obligations.
- has the potential to overcome the current underfunding of climate finances.
- has the potential of raising personal awareness of actions and choice directed at reducing CO2-eq emissions.
- has the potential to involve and empower the world's population in influencing choice and direction of local measures to tackle climate change.
- has the potential to redress historic inequality between, not only, developed countries and less developed countries but also different cultures and creeds within, inter alia, nations and regions.
- has the potential to encourage increased levels of, inter alia, sustainable development within developing countries.
- has the potential to reduce dependance of both developing and least developed countries on long-term international aid.
- has the potential to alleviate the serious problem of economic migration.
- has the potential to transcend political uncertainty by nature of changing national administration policies resulting in stop-go, if not forward gear, reverse gear climate change committment.
- has the potential to transcend the lack of transparency within tax systems regarding climate change policy implemented via carbon taxation.

It is clear that for the CTM to gain traction, widely based multilateral cooperation and agreement would be necessary. Indeed, the CTM and its application should not be regarded as constituting a means of applying arbitrary or unjustifiable discrimination between countries to avoid WTO/GATT legal complications regarding international trade. However, in the event of complication, the challenge to the WTO would be to negotiate rules specific to climate change rather than continuing its largely passive role.

6.1. CTM Engagement

Adopting the approach taken by the Paris Agreement, it is proposed that signatory parties (countries) would engage into the CTM within the following broad terms:

1. Signatory parties would declare their intended period of phased adaption to fully implement GHG emissions valuation based Carbon Added Tax (CAT) supplanting intermediate carbon taxation based on the party's emissions intensity.

2. A Climate Finance Authority would assist and support the application of carbon taxation, both domestically within Signatory Parties and to their international trade being dependent on the signatory status of the bilateral trading partners.

3. The value of Carbon Relief Vouchers (CRVs) would be fixed at the (annually reviewed) CAT rate as opposed to the variable price paid for Certified Emissions Reductions (CERs).

4. Carbon Additionality Certificates (CACs), measured in units of tonnes CO2-eq, would be priced linked to the CAT rate applicable at time of surrender or purchase as part of a Carbon Additionality Scheme(CAS) rather than being based on a marginalabatementcost alone.

    1. Renewable Energy Certificates (and similar) would have no representation in terms of additionality or equivalence in GHG emissions.

5. CACs would be optionally used to reduce CAT liablity resulting from an organisation's internal value chain.

6.1.1. Climate Finance Authority (CFA)

1. A Climate Finance Authority (CFA) possibly under the auspices of the UNFCCC would oversee coherance, coordination and optimized balancing of CTM revenue flow into CRV monetization and achieving wider climate mitigation goals.

2. Annex II Signatory Parties to finance adminstration of the CFA commensurate to their reported 2015 GHG Emissions.

3. The CFA would assist and support Signatory Parties to establish national infrastructures to meet their CTM obligations including:

    1. Support for CRV monetisation and distribution as priority ahead of CTM revenue collection.

    2. CTM revenue collection independent of conventional tax collection and be either in the form of GHG valuation based CAT, carbon taxation based on emissions intensity or a mix of both.

    3. Border entry CAT collection where there is none or little internal country supporting infrastructure.

4. Irrespective of CTM phased adaption, the CFA would prioritise early adoption of a Carbon CombustionTax (CCT) for fuels with well established end-use GHG emissions factors. CCT would be additive to carbon taxation applied by either the exporting party's emission factor or upstream CAT.

5. The CFA would assist and support Signatory Parties to apply carbon taxation and CTM revenue collection adaption options best suited to their situation regarding its domestic taxation and taxation applied to Import / Export trading partners:

    1. Imports into any signatory party from a non-signatory party would be charged as a border

import carbon tax levy based on monetary valuation using the greater of either the World's Emissions Intensity or the exporting state's emissions intensity.

2. Carbon taxation applied to a signatory party's domestic consumption in both goods and services excluding end-use fuels would default to the party's emissions intensity in the absence of explicit CAT based on GHG valuation.

3. Exports excluding end-use fuels from a signatory party irrespective of destination state would be charged at the exporting party's emissions intensity in the absence of explicit product or service CAT based on GHG valuation.

4. GHG generating fuels would be levied carbon taxation based on either specific GHG emissions (intensity) valuation or purchase cost factored by the World's Emissions Intensity as detailed in World Bank Data. {For clarity of purpose, CAT applied to end-use fuels is termed CarbonCombustionTax(CCT)):

    1. End-use fuels imported from a non-signatory party to a signatory party would not be subject to border carbon taxation to avoid double taxation on the provision that taxation be applied within its domestic downstream supply chain.

    2. End-use fuels exported to non-signatory parties would be subject to carbon taxation at the exporting signatory state's border in addition to upstream supply chain carbon taxation.

5. Signatory parties would be responsible for border revenue collection on exports to non-signatory parties.

6. Signatory parties would be responsible for domestic CTM revenue collection irrespective of being CAT based on product and service GHG valuation or a carbon tax based on the party's domestic emissions intensity.

7. Signatory parties would be required to adhere to the general principles regarding preferential trading to avoid unfair market competition:

    1. Signatory parties would be required to preferentially trade with other signatory parties except in circumstances where product and / or service supply is not possible.

    2. Signatory parties would be required to demonstrate an absence of preferential trading with any country, signatory or otherwise, as a means of gaining unfair benefit from the CTM.

    3. Signatory parties would be required to avoid practises of applying unfair prices on goods and / or services by nature of preferential trading with signatory and non-signatory parties alike.

6. The CFA would assist and support Signatory Parties in conjunction with NGO's where appropriate to best tailor CRV mobilisation to advance both its nationally and internationally declared objectives within the context of ground level circumstances and needs. Considerations would include but not limited to:

    1. CRV mobilisation within a signatory party would not be conditional on its level of CTM adaption other than its obligations towards carbon taxation revenue collection be satified.

    2. The reservation in trust of CRV funds where CRV mobilisation is prohibited by prevailing risk

conditions such as internal conflict or deficient regional governance.

3. The mobilization of funds previously reserved into trust towards the purchase of, or investment into, products or systems that, depending on local / regional circumstances, mitigate energy proverty as priority and provide longer term sustainable benefits.

4. The bulk purchase of energy saving equipment such as cookstoves and solar panels as part of tactical incentivization campaigns for CRV mobilisation.

5. Promotion of schemes to tackle energypoverty and its impact on domestic well-being, health services and education by the provision of renewably generated electricity.

6. The adoption of prioritisation strategies for Least Developed Countries in the first instance to counter negative carbon taxation balance during CTM Adaption.

7. Plus-Plus schemes to incentivize use of CRVs towards achieving measurable emissions reductions as Carbon Additionality Schemes.

7. As part of the CFA responsibilities, uncommitted revenue, that is, revenue remaining after CRV monetization and revenue raised via Emissions Intensity based carbon taxation, would be allocated towards a range of internationally agreed objectives involving transfer to:

1. the Green Climate Fund or similar to further finance both climate mitigation and sustainable developments within, as priority, the least developed countries (LDCs).

2. financially boost research and development into cheap renewable Energy Storage Systems (ESS) as alternatives to the building of additional fossil fuel and nuclear (fission) based generation capacity to overcome natural variations in electricity supply from solar (PV) and wind.

3. combat both impact and adapt to the effects of climate change estimated by the United Nations Environment Programme (UNEP) to be between 140-300 billion US dollars per year by 2030.

8. In circumstances where revenue raised from both CAT and Emissions Intensity based carbon taxation be insufficient to support meaningful CRV monetization, the CFA would utilise this as uncommitted revenue.

9. Signatory parties would have a legal first claim right to carbon taxation revenue collected within their borders irrespective of phased adaption for domestic CRV distribution up to the prevailing limit.

10. The CFA would provide up to 100% relief to internationally recognised LDCs and lower income Developing Countries for emissions intensity based carbon taxation on exports by directing re-investment into Sustainable Land Management (SLM) and other sustainable carbon offsetting developments for Carbon Additionality Scheme certification. The amount of relief would be scaled according to, but not exclusively, the per capita income circumstances of individual states.

11. No CRVs would be allocated for populations within non-signatory parties.

12. Signatory parties that fail to adhere to one or more of the principles of the agreement would after warning and sufficient time to rectify the failure would be struck off as a signatory.

6.2. Climate Financing in Monetary Figures

Before exploring how the application of CTM has the potential to transform the scale and economic

dynamics of climate financing, it is necessary to understand its purpose:

> Climate Finance is intended to support mitigation and adaption actions to address the negative effects of climate change with a view of contributing to sustainable development in order to achieve the dual temperature (1.5 and 2 degrees C) goals of Article 2 of the Paris Agreement.

Obtaining a thorough understanding of climate financing is complicated by the different levels of obligation on "Parties" to the Paris Agreement. The intention here is to broadly outline current financing in relation to the "estimated" annual cost of tackling climate change:

- Individual developed countries have no legal obligation to provide (base level) funding either as a specific amount or percentage of Gross Domestic Product or Income(GDP/GNI).
    - This is in sharp contrast to the 1970 commitment of developed countries to provide at least 0.7% of the Gross National Income (GNI) towards Overseas Development Aid (ODA) albeit, in practise, this target was not met apart for a limited few countries.
- Collectively, the developed countries have a political, rather than legal, obligation to provide at least USD 100 billion per year towards developing country climate finance.
    - According to a 2018 OECD report, Climate finance mobilized for developing countries rose to USD 78.9 billion but still USD 20 billion short.
    - The EU, its member states and the European Investment Bank are together the biggest contributer of public climate finance to developing countries, giving 21.7 billion euro in 2018 alone as well as 75.2 billion euros of Official Development Aid in 2019[29].
    - The European Investment Bank (EIB) announced late 2019 that it aims to unlock 1 trillion euros in investments in the decade to 2030[30].
- "Parties" may also voluntarily pledge climate finance (Paris Agreement Article 9.2).
    - In 2015, China pledged USD 3.1 billion to a "South-South Climate Fund" on top of USD 2.0 billion towards development aid.

In context of the UNEP 2019 Emissions GAP Report, annual energy supply-side investments alone of between 1.6 trillion and 3.8 trillion USD will be needed and these figures appear quite modest to the global Covid-19 related fiscal spending of USD12 trillion.

It is abundantly clear that climate finance fulls far short of that needed with economists agreeing [31] that carbon pricing would be the most effective way to reduce emissions. However, pricing via established carbon markets has already been shown to be less than effective so is worthwhile exploring how the application of the CTM would compare.

Any approach must satisfy a number of objectives, not least obtaining enough CAT revenue to provide sufficient funding for meaningful CRV monetization as well as reserves to fund investment into long term climate mitigation initiatives to reduce overall emissions to meet the Paris goals. The level of CRV equivalence in CO2-eq tonnage must also satisfy the multiple aims of ensuring the burdon of carbon taxation falls on those most responsible for emissions while providing proportionate benefit to the less wealthy and opportunities to improve well-being for those in poverty. It is acknowledged that basing CRV tonnage equivalence on a per capita GHG emissions figure, whatever emissions figure is used, will mask wide disparities in emissions responsibility both within and without nations and that only a proportion of total emissions may be directly attributable to consumer (direct and indirect) consumption. It is for these reasons that CRV tonnage equivalence must be progressively scaled down and CAT rate raised while

avoiding an unintended consequence of actually countering emissions decrease by straightforward CRV monetization. Governments and other organisations would have a critical role to play by incentivising, indeed popularising, CRV utilisation towards achieving greater benefits beyond face value CAT rate monetization.

In this context and in the absence of any detailed financial modelling, it is appropriate to adopt an unapologetic straightforward approach of nominally linking CRV distribution to CAT revenue raised from a base level of 36 billion tonnes CO2-eq energy sector (2019) emissions. CAT revenue raised from less quantifiable GHG emissions resulting from land use, farming and forestry amounting to approximately 13 billion tonnes may be nominally considered as uncommitted capital for, inter alia, funding and investment into long term climate mitigation projects.

For our purpose, different levels of realisation are explored assuming:

- an initial (first year) CAT Rate of USD 75 per tonne of GHG emissions.
- adoption of the UNEPs annual emissions reduction target of 7.6%. as a reserve, uncommitted, CAT revenue proportion.
- Energy sector emissions of 36 billion tonnes CO2-eq (2019)
- Total global emissions of 56 billion tonnes CO2-eq (2019) including, inter alia, land-use change.
- Approximately 23% of global emissions result from agriculture, foresty and other land use amounting to 13 billion tonnes CO2-eq.
- A Global Emissions Intensity of 0.64 kg/ USD based on a (2019) global GDP of USD 88 trillion.
- 6 tonnes CO2-eq Carbon Relief Voucher (CRV) distribution per person aged 16 or over.

Following this, global adoption of the CTM requires putting into context of the political dimension.

6.2.1. Global Population

At the highest level, the CTM requires consideration in terms of the global population.

The (first year) CAT revenue potential amounts to USD 3675 billion assuming realisation of:

- USD 2700 billion from 36 billion tonnes energy sector GHG emissions with disbursement prioritised towards funding Carbon Tax Relief Vouchers (CRVs).
- USD975 billion from 13 billion tonnes from products and services resulting from Land Use, Land-Use Change and Forestry (LULUCF).

In reality and at best (ignoring geo-political and other barriers raised), CAT revenue raised would comprise that related to energy sector (direct burn) emissions while life-cycle emissions including those sourced from land use, land-use change and forestry are formalised and implemented internationally. Accordingly, CAT revenue resulting from 33.26 billion tonnes (36 billion -7.6%) CO2-eq emissions would be used to fund CRV utilisation amounting to USD 2495 billion leaving USD 205 billion for uncommitted climate financing doubling the Paris Agreement developed countries obligation.

It is important to understand the elasticity between income and energy use / emissions. Research by Justin Carron and Thibault Falley show that as income increases, energy consumption rises but in a rather distorted (asymmetric) "upturned-U" relationship with the most energy consumption rise being for middle income groups. Taking a worst case relationship between income and emissions as 0.8kg CO2 per dollar

expenditure for the total USD 2495 billion worth of CRVs, then the additional CO2 emissions becomes 2 billion tonnes or 3.6% of the total for 2019. Clearly, such a worst case scenario is unlikely, but it does highlight the importance that CRV utilisation must be channelled towards adoption of renewable energy sources and overall reduction in emissions.

6.2.2. Global Poverty

Carbon inequality is inextricably linked to poverty and for this reason the CTM may be considered a major mechanism to tackle the dual issues of climate change and worldwide poverty.

Indeed, poverty is not exclusive to the least developed countries. Per capita CO2 emissions range from 18 metric tonnes (Saudi Arabia) to 0.2 (Sierra Leone). Similarly, per capita income (based on GDP) varies between USD 275 (South Sudan) to over USD 115,000 (Luxembourg). It is no surprise that both South Sudan and Sierra Leone are two of the 47 Least Developed Countries. Beyond the disparity between nations, inequalities also exist within nations: 2011 figures for Sierra Leone show 52% of its population were living in extreme poverty (i.e. those living with a daily "poverty line" income of less than USD 1.9) while 1.2% (2016) in the United States also shared similar deprivation. By population, that is approximately 4 million in both Sierra Leone and the US.

- According to the World Bank Poverty Overview, 43.6% of the world's population lived on less than USD 5.50 a day in 2017 - that is USD 2000 for the year.
    - While World Bank "poverty lines" are measured by "monetized" income and consumption[32], three criteria used by UNCTAD for state qualification as a LDC is based on income, a human assets index (derived from measures of nutrition, health, schooling and literacy) and an economic vunerability index.
- According to Oxfam, the poorest 50% of humanity is responsible for just 10% of (fossil fuel derived) carbon emissions amounting to a 1 tonne per capita average.

In broad terms and based on a per capita CRV redemption, half the world's population would receive USD375 representing a 19% annual income boost and achieving two primary objectives of CRVs by:

- offsetting the costs of carbon added taxation up to an annually adjusted GHG emissions tonnage threshold.
- empowering the world's poorest the ability to finance sustainable (low carbon) developments according to local collective needs.

Exactly how CRVs are distributed and redeemed for both offsetting personal CAT charges and mobilizing excess capital for financing sustainable development would be highly dependant on the extent and effectiveness of both national and regional governance and cooperation with community organisations including NGOs. A critical factor would depend on early recognition of deficiencies in community organisation and infrastructure and subsequent mitigation that would undoubtedly be more challenging in more remote, difficult to access, regions.

6.2.3. The Political Dimension

Adoption of the CTM must be considered in context of a political dimension.

At its most basic, would governments' world-wide be willing to implement the CTM as a means to provide predictable and sustained climate financing significantly above and beyond that (politically) obliged by the Paris Agreement on developed countries?

The answer lies in the identification of barriers that will differ substantially between parties to the Paris Agreement and how those barriers may be overcome to incentivise world-wide acceptance.

Climate finance resulting from CAT revenue would bypass conventional institutions and public purse. However, governments would be required to create departments to transparently manage CAT revenue collection and disbursement on behalf of, and under external audit by, the Climate Finance Authority (CFA) quite separate from conventional taxation. Such loss of sovereignty over CAT would undoubtedly raise political difficulties but would have to be considered in the wider context of CRV distribution with the aim of restricting the additional burdon of taxation on those that can most afford it and improving the wellbeing for the poorest.

CRV mobilization must not be regarded as aid or loan, it would be merely intended to relieve individual recipients of additional taxation up to a prescribed threshold while providing the energy poor benefits in terms of provision of clean energy while reducing GHG emissions, improved health and education. It would be financed directly from CAT revenue beyond the politicization and preference of private financial institutions and national governments. CRV mobilization would necessarily be tailored to, inter alia, national, sub-national circumstances and where appropriate strengthen existing energy saving initiatives.

Climate change mitigation schemes, whether financed directly by CRV monetization or focussed recycling of uncommitted CAT revenue into internationally agreed government programs, must encompass political, institutional, socioeconomic, technological and environmental considerations that may influence ultimate success or failure.

Indeed, the Paris Agreement is destined to fail in its present form simply by the lack of any mechanism directly linking carbon pricing to GHG emissions reduction. The Paris Agreement's reliance on differentiated responsibility exacerbates this problem further by enabling developed countries to continue to outsource emissions to less developed, developing, countries while reducing their national reliance on fossil fuels. It is instructive to examine China's role regarding outsourced emissions:

Enshrined in China's first NDC, it is stated that "Developed countries shall, in accordance with their historical responsibilities, undertake ambitious economy-wide absolute quantified emissions reduction targets by 2030"[33]. The reality is that China:

- remains a developing country despite it being the world's second largest economy. In 2015, 0.7% (100 million) of its population were classified as being in extreme poverty.
- is the world's largest GHG emitter at over 10 billion tonnes in 2019 having based its huge, recent history, (post-Kyoto) economic growth on fossil fuel based energy production.
- has become the world's manufacturing hub and by consequence a huge upstream source of GHG emissions. "China emitted about 1.6 billion tonnes of carbon dioxide making products it exported elsewhere in 2012, about 16% of its total"[34].

For all countries, not only developed countries, to achieve "absolute quantified emissions reductions", then outsourced emissions (carbon leakage) must be accountable as part of the their contribution to GHG emissions.

Quantification by CAT would:

- refocus carbon taxation in a universal fair and equitable manner across the world's population to achieve a measured reduction of GHG emissions in tonnes of CO2-eq.
- refocus carbon taxation to achieving measurable reductions of GHG emissions in tonnes of

CO2-eq rather than simply achieving improved energy efficiency.

- dually refocus and positively link climate financing to actual GHG emissions resulting from consumption and loss of carbon sink by environmental degradation.
- provide separation and transparency from excise taxation and other forms of discretionary climate change taxation that typically embed complicated exemptions and discounts.
- enable a more holistic approach to NDC preparation by providing the means to focus on outsourced emissions reduction as a bilateral responsibility between both exporting and importing nations.
- enable governments within the broadened scope of GHG emissions taxation to couple industry wide incentive schemes aimed at reducing emissions as part of their NDCs.
- facilitate avoidance of potential double counting of outsourced emissions between exporter and importer.
- enable governments to discount issues regarding international competiveness that incentivise emissions outsourcing in absence of compensating free allowances and / or (carbon) tax reductions.
- enable governments to use CAT returns for accurate periodic GHG emissions reporting and analysis by both sector and region.

When considering CAT in conjunction with the financial safety net of CRVs:

- enable governments to remove energy subsidies that disincentivise transition of carbon fuel based electricity generation to less polluting alternatives.
- enable governments to incentivise a switch of domestic energy consumption to more efficient, less polluting alternatives.

It is possibly far too simplistic to assume that the benefit afforded by a CRV surplus to possibly over 40% of the world's poorest would excert a powerful grass-roots influence on the geo-political landscape towards universal adoption of the CTM. Much would depend not only on the strength of political voice of the poor and that of those most likely to gain by improvements in their dimensions of poverty but on the political objectives of the state, irrespective of being democratic or authoritarian, and extent, depth of effective governance.

CRV benefits would bypass bilateral and multilateral paths of aid avoiding potential political capture and syphoning of funds. The challenge would be to improve the domestic landscape in as most effective manner possible and how this might be achieved would depend on differing circumstances of developed, developing and least developed countries in terms of political, economic and financial risk ratings as well as regional, social, religious and ethnic divides.

It is the least developed countries that have the greatest proportion of their populations living below the poverty line and also least responsible for GHG emissions with energy poverty a major factor driving and maintaining deprivation.

Although smaller proportions of their populations, wealthier countries should not be overlooked: the US, an OECD member, has 4 million living in extreme poverty, 100 million in OECD partner China, and 19.2 million below the poverty line in Russia. Globally, 40% of the world's population living with very low incomes would benefit most by their respective government's signing into the CTM.

It is questionable whether there is any future relevance of Emissions Trading Schemes (ETS / otherwise known as Cap and Trade). By its own, albeit dated, 2016 figures, the OECD attributes carbon pricing, the Effective Carbon Rate (ECR), to Emissions Trading Schemes, excise taxation and carbon taxes. With 93.1% attributed to excise taxes and just 5.3% to emissions trading, endorsement of the proposed CTM by the OECD would signal a game change in establishing an explicit carbon price which, in effect, would become the same as the periodically reviewed CAT rate. Such a shift of emphasis would establish a transparent carbon pricing mechanism beyond both the vagaries of market trading and national self interest in the application of excise and carbon taxes.

National self interest potentially presents the greatest barrier to acceptance and adoption of the CTM. National self interest may encompass different political priorities including establishing and maintaining internal social stability, maintaining and increasing economic efficiency and maintaining and improving security against external threats whether, inter alia, affects of climate change disrupting food supply, to economic security and from disease. The CTM may elleviate threats according to country circumstances:

- CRVs, however mobilized, would enhance social stability by providing the most disadvantaged a means to improve their quality of life.
- Economic efficiency would be enhanced by the most disadvantaged becoming economically empowered by sustainable developments.
- Climate mitigation would improve security against effects of climate change.
- Replacement of fossil fuel derived energy use and (electricty) generation by renewable (low carbon) energy alternatives would enhance economic security against fossil fuel import interruption.
- Climate mitigation and sustainable developments would reduce the possibility of disease outbreak.

With OECD member countries responsible for about 35% of the worlds fossil fuel derived GHG emissions, collective adoption would send a powerful message of wealthiest country resolve to keeping the global temperature rise below 2 deg C as well as promoting sustainable development. Such a message would also signify a break from conventional (many say broken) economics which has resolutely failed to explicitely quantitise and incorporate the cost of environmental externalities into product and service supply chain pricing.

With 164 members, support by the World Trade Organisation (WTO) would be vital to gather political traction for the CTM while in return reverse currently failing WTO efforts to reform fossil fuel subsidies that promote wasteful GHG emitting consumption while discouraging adoption of renewable energy. It has been estimated that such is the distortion in trade caused by these subsidies, successful reform could possibly achieve a 6% emissions reduction by 2025.

It is clear that the CTM would require to have adaptive implementation strategies to accomodate differing country circumstances to maximise world-wide traction across 195 (approx) states.

6.2.4. Global Adaptive Implementation

Achieving the CRV 6 tonne CO2-eq mobilization target assumes full energy sector (36 billion tonnes) emissions capture within the CTM. However politically and economically unrealistic, energy sector emissions are readily quantifiable and must be regarded the priority target. The wider objective to encompass the more difficult quantisation of 13 billion tonnes of emissions resulting from land-use, land-use change and forestry must be allocated equal prioritisation not simply for hollistic reasons but also

for (carbon) offsetting purposes for those economic sectors that find difficulty in reducing emissions by alternative (low carbon) technology adaption in the short term.

A number of scenarios may be envisaged into how CTM emissions capture would be harnessed into CAT revenue:

1. No CAT revenue.
2. CAT revenue insufficient to support viable CRV mobilization.
3. CAT revenue sufficient to support viable CRV mobilization but at a lower level of tonnes CO2-eq equivalence.
4. CAT revenue sufficient to support the 6 tonnes CO2-eq CRV mobilization target.
5. CAT revenue surplus over that required to support 6 tonnes CO2-eq CRV mobilization.

It is clear that a range of CTM adaption options would be necessary to overcome the situation where CAT revenue is insufficient to fund safety net CRV distribution and promoting decarbonisation via sustainable developments. A review of the worst case situation of no CAT revenue is instructive in searching available options towards incentivising adoption of the CTM.

6.2.4.1. CTM Adaption Options

The worst case No CAT Revenue scenario suggests a complete absence of CTM traction and may reflect political unwillingness and / or impractibility to implement broad carbon taxation reforms that in the short to medium term may unbalance established economies and multilateral trade patterns. For those countries which have a significant proportion of their population living in various levels of poverty and likely to benefit most by the CTM, reluctance may simply stem from the absence of traction from those countries that are responsible for the highest levels of GHG emissions. The CTM must therefore allow states to declare an intention to fully implement the CTM following an adaptive pathway involving possibly 4 phases.

For many countries, if not all, full implementation of the CTM would be impractical without a lead-in time to establish legal, financial and product / service GHG valuation infrastructures. The rise in atmospheric GHG accumulation cannot be put on hold while the CTM is established, so intermediate levels of CTM implementation must be available and adaptable to the circumstances of any state. Quantification and valuation of outsourced emissions within a state's overall GHG emissions balance provides an intermediate, time limited, avenue of consideration. A further avenue would necessarily involve emissions resulting from Land Use, Land-Use Change and Forestry and how climate mitigation projects may be used to incentivise CTM adoption by providing a revenue stream beyond energy sector carbon taxation. It is instructive to consider energy sector emissions first and then place into context actual international (import / export) trading.

With energy sector emissions most accountable, a country's emissions may be broadly expressed as equal to Domestic Emissions + Imported Emissions + Exported Emissions where (for bilateral trading partners), the exported emissions for one become the imported emissions for the other.

1. As a phase 1 adaption and assuming absence of accurate GHG valuations for products and services within a state, emissions accountability would be initially based on its emissions intensity as tonne (or sub-unit such as kilogram) GHG emissions per USD of GDP. Such a system would favour exports from those states with low emissions intensity that may mask significant socio-economic-emissions disparities particularly in developing and least developed countries.
2. Timely progression to a phase 2 adaption would be needed to more accurately reflect product and

service emissions at a coursely granulated, economic sector, level and may be expected to rebalance carbon taxation towards the more polluting activities.

3. Phase 3 would involve finer economic granulation by detailed GHG valuation for individual products and services enabling application of CAT. Sectors involved in bulk product supply such as crude oil and petroleum products would be expected to transition to CAT levies in advance of more difficult emissions quantifiable products and services.

4. Although phase 4 would signify full adaption and implementation of CTM on all products and services, it would be expected that the division between phases of adaption be blurred with the accountability of some economic sectors being realised within different timeframes. Accordingly, declarations of intent should include a granulated economic sector breakdown of phased compliance for CAT purposes against a realistic timeframe.

In all circumstances, mobilization of carbon tax revenues would fall to the responsibility of a Climate Finance Authority (CFA) overriding state sovereignty within the terms of CTM engagement. As priority and irrespective of CTM adaption phase, the CFA would strive for the early implementation of Carbon Combustion Tax (CCT) applied to end-use GHG emitting fuels.

A further CFA responsibility would be to counter negative carbon taxation balances resulting from CTM adaption on Least Developed Countries and lower income developing countries by a strategyofprioritisation of CRV distribution, distribution of uncommitted carbon taxation revenue and carbon taxation relief subject to strict adherance to the guidelines regarding preferential trading.

Indeed, the CFA would be required to establish a department specifically dedicated to overseeing adherance to the guidelines regarding preferential trading, unfair pricing strategies and complaints by and from within signatory parties.

6.2.5. CTM Realisation

It is clear that CTM adaption would occur at different rates between countries being largely dependent on their specific circumstances with CFA infrastructure support prioritising CRV monetisation and distribution.

The least developed countries would have the most to gain in terms of socio-economic benefits while the developed countries would incurr the highest burden of costs simply based on their (historic) dependence on fossil fuels and disproportionate GHG producing consumption. However, all countries would potentially gain in the long term by the CTM from much increased funding of sustainable developments to counter the rapidly rising costs of climate change and its mitigation. In particular, strengthened engagement with sub-saharan African countries via the CTM would potentially provide a further boost in funding and sustainability of the Great Green Wall project above and beyond recent pledges of $14 billion.

Those developed and developing countries most responsible for GHG emissions with well established banking and taxation infrastructures would be expected to transition quite rapidy to full CAT implementation in tandem with a balanced CRV distribution to bias the taxation burden towards those in the populations with higher consumption based carbon footprints. Remaining CAT revenue would contribute to the global reserves for CRV mobilisation.

Only a few countries responsible for high levels of GHG emissions would be needed to provide CAT revenue sufficient to support full (the suggested 6 tonne) CRV mobilisation. With limited CTM membership comprising the 37 OECD member countries and 46 LDCs, broad brush calculations based on population and emissions statistics obtained from the World Bank suggest achievement of a full CRV mobilisation target based on a collective 2 billion adult population and GHG emissions of 12 - 13 billion tonnes. In contrast, if the USA excluded itself from the CTM, then 7.6 billion tonnes worth of CRVs would be available with first

call distribution to the reduced 0.75 billion OECD adult population and remaining balance of 4 billion tonnes worth of CRVs for the LDCs achieving a diluted (4 tonnes CO2-eq) realisation. Even at this diluted level, CRVs amounting to 4 tonnes would still represent 40% (USD 300) of the extremely poor annual income.

In advance of explicit CAT based on GHG valuation on goods and services, carbon taxation would default to emissions intensity based levies based on cost. Although raising broadly similar amounts of revenue, emissions intensity based taxation would unadvoidably mask significant disparities between products and services causing differing levels of GHG emissions.

6.2.6. CTM, End-use Fuels and Transport

GHG emitting end-use fuels would be subject to different emissions intensity based carbon taxation to that applied to general goods and services during CTM adaption. The main purpose of this would be:

- to avoid unrealistically low levels of carbon taxation based on state specific emissions intensity differences.
- to minimise intentional cross-border fueling of international transport to take advantage of carbon taxation differences.
- to encourage as fast as possible CTM adaption to the Carbon Combustion Tax (CCT) form of end-use CAT.

As comparison between the two methods of carbon taxation, CCT based on GHG emissions resulting from the combustion of 1 litre of automobile gas (petrol) would be approximately USD 0.17 USD whereas the tax becomes $0.30 in the United States based on the suggested World Emissions Intensity, currently 0.3, and a United States (2021) USD 1/litre cost. It is clear that emissions intensity based carbon taxation would be very dependent on regional cost of fuel within and between states.

It is particularly pertinent to examine the role of the aviation sector that contributed approximately 2% of total GHG emissions and 12% of transport overall in 2019. The lifecycle emissions for jet aviation include not only that from direct jet fuel combustion and indirect upstream emissions resulting from oil extraction, refinement etc but also an additional Radiative Forcing (RF) high atmosphere environmental impact that is estimated as a virtual doubling of combustion emissions. It is the Radiative Forcing aspect that emissions intensity based taxation would leave unaccounted highlighting the need to rapidly transition to the leveling CCT. Furthermore, the cost of jet fuel is significantly lower at typically (2021) 50% of automobile fuel attracting only USD 0.15 emissions intensity based carbon taxation further accentuating the need for rapid transition.

Using the 2020 DEFRA GHG Reporting Conversion Factors, the air travel emissions for an economy class passenger flying 1500 kilometres (London UK to Stockholm Sweden) would total 265kg CO2 equivalent attracting CAT/CCT of USD 19.88.* In contrast, basing carbon taxation on a global (World) Emissions Intensity, then the same journey would attract USD 7.8 from the cost of 52 litres of fuel per passenger.**

*This ((0.152980) + (0.0880 * 0.27)) * 1500 calculation is based on 0.152980 kg/passenger.km with RF and indirect emissions based on 0.0880 kg/km direct emissions without RF factored by a mid-point upstream 27% loading.

** ((0.088 x 1500) / 2.53) * 0.5 ($/litre) * 0.3 where 2.53 is the kg CO2 emissions per litre of fuel.

It is clear that carbon taxation would radically lift transport base costs and underlines the reasoning that a closed group of commercial enterprises would be able to offset CAT/CCT liability resulting from their internal value chain by Carbon Additionality Certificate (CAC) purchase. Crucially, CAC based offsetting

would be subject to strict conditions of verification, measurement and pricing in order to overcome the wide criticism that besets the currently established carbon offsetting "industry".

In a wider context, there would be no restriction for commercial enterprises to become directly involved in Carbon Additionality Schemes to generate carbon additionality certificates. Indeed, it may be envisaged that involvement between, as example, the overseas travel industry and, in particular, least developed countries would be of mutual benefit.

6.2.7. CTM in context of NDC Financial Support

Article 9 of the Paris Agreement maintains the exclusive obligation of developed countries to mobilize USD 100 billion annually by 2020 for developing countries to meet their NDC targets. While a large amount of finance, a fully realised global CAT taxation regime would potentially raise USD 2700 billion based on energy sector emissions alone.

It is instructive to return to Ghana as an example of how the CTM could potentially contribute to its Intended Nationally Determined Contribution (INDC) financing needs. With predicted emissions of 37.8 million tonnes CO2eq in 2020 , the national carbon taxation (CAT) burden would approach USD 3 billion. With an adult population of over 20 million and 6 tonne CRV allowance per adult, the net balance would become USD 6 billion at 4 tonnes CRV (USD 300) distribution per adult. However this balance be invested whether raising the quality of life either by household, community, sub-national or national schemes or consolidated into direct emissions reductions, USD 6 billion in a single year amounts to over 35% of the of international support Ghana has requested over a 10 year period to drive its enhanced climate action plan. The inclusion of Carbon Additionality Schemes into its action plan would potentially further enhance many of Ghana's ambitions towards achieving sustainability and long term employment.

It is clear from Ghana's INDC (heading 5. Fairness and Ambition) that its aspirations are tempered by its circumstances as a developing country with its "lack of fiscal space to finance priority issues"[35]. To this end, the CTM would potentially alleviate this restraint allowing faster adaption of its goals.

Regarding Ghana's AFOLU (Agriculture, Forestry and Other Land Use) sector projections within the INDC, it is noted that these were based on IPCC accounting rules based on the 100 year Global Warming Potential. This is at variance with the proposed 20 year time horizon to be used within the CTM in order to address undervaluation of methane and other climate damaging pollutants. Furthermore, the CTM proposes the use of a more rigorous methodology regarding the measurement uncertainty of both emissions and mitigation activities such as AFOLU initiatives. The net effect would be that the CTM would undoubtedy increase mitigation costs in some sectors but in context of increased funding not impose prohibitive barriers.

6.2.8. CTM and the End of Supply Chain Purchaser

Much has already been discussed regarding the CTM in terms of finance - ultimately, it is the end-of-supply -chain purchaser that would be bearing the cost.

Individuals with a carbon footprint exceeding the 6 tonne CO2eq emissions relief threshold would pay a net balance of CAT accumulated throughout the supply chain. Those with carbon footprints not exceeding the emissions threshold would proportionately benefit according to the extent that their carbon footprint is below the emissions threshold.

Organisations such as public / government institutions (hospitals, schools etc) would pay end of supply chain carbon tax much as individuals except without any relief threshold - these organisations, along with a defined set of private enterprises would be permitted to offset their CAT liability via direct involvement in Carbon Additionality Schemes generating Carbon Additionality Certificates or by direct CAC purchase.

Whereas rail travel in some countries has historically been low carbon by nature of electrification coupled with supply from, in some circumstances, purpose built hydro-electric schemes, the path to reducing overall emissions associated with aviation will be long term particularly if, beyond the coronovirus pandemic, the rate of increase in aviation resumes. Airline operators would have the option to absorb CAT duties arising from internal (scope 1) operations via carbon additionality reducing, in context of the previous London to Stockholm flight example, CAT duty on the passenger fare to USD 2.7 from USD 19.88. The coronavirus pandemic has highlighted the willingness of investors to plough extrordinary amounts of finance into supporting aviation while much of the world's aircraft was grounded so why not into carbon additionality to demonstrate a verifiable commitment to offsetting emissions.

It is worthwhile revisiting beef production. Ruminent livestock such as cattle are a major source of highly damaging methane (CH4) emissions. In context of IPCC accounting rules based on the GWP 100 year time horizon, previous calculations indicated that 1 kilogram of beef produces an average total supply chain GHG emission of 60kg amounting to USD 4.5 CAT and USD 0.45 for a recommended healthy eating 3 ounce (100 gram) portion. Adopting the proposed CTM approach of using a GWP 20 year time horizon, the increased emphasis on methane increases CAT to USD 10 for 1kg production and USD 1 for a portion.

A litre of petrol, the (Oil) well to wheels would attract carbon taxation of USD 0.22 comprising two components:

1. 2.31kg (USD 0.17 CAT as end-use CCT) direct emissions from combustion
2. 0.64kg (USD 0.05 CAT) upstream emissions using an estimated 27% loading based on an average between 15 and 40 percent of combustion emissions.

Ultimately, the amount of carbon tax paid by the individual would be to a greater or lesser extent a question of personal choice towards diverting expenditure to less GHG emissions intensive products and services. Similarly, carbon taxes paid by end purchaser organisations would fall onto the shoulders of their governing bodies and stakeholders to shift to less emissions intensive operations and upstream supply chains. With the CTM beyond individual government control, their role would be as domestic policy influencers to transform their countries in such a way as to meet realistic climate change commitments.

Much as the CTM through its carbon added taxation would provide transparency of GHG emissions resulting from products and services, the reaction and level of acceptance of the CTM would reveal the level of commitment of individuals, the corporate world and governments their resolve in tackling climate change.

7. World Government and Environmental Inequality

The underlying message surrounding the worldwide failure in halting the rise of atmospheric greenhouse gases provides stark contrast to truly national environmental (e.g. Minimata Poisoning) disasters that may be overcome with appropriate political will. The Climate Crises requires genuine leadership and coordinated action on a global scale. Sadly and to the detriment of the less developed nations, the world's richest nations have very different political, economic and territorial agendas that continue to obstruct worldwide action on a scale befitting the nature of the climate emergency.

It is inevitable that implementation of the CTM involving CAT and CRV distribution would become heavily politicised both within and between nations. A working agreement between all nations would be required with dissenting nations subject to border carbon taxation tariffs just as non-compliant organisations would be penalised. Furthermore, CRV distribution to the same dissenting nations would need to be withheld.

It is instructive to compare the proposed value of CRV issue against the the 2019 OECD figures for Official Development Assistance (ODA): Grants totalled 149.1 billion US Dollars whereas the proposed CRV issue totals 2538 bililon. Although a large proportion of the CRV distribution would be used to simply offset

personal CAT charges, it is those with low incomes and/or living within subsistence economies such as populations within the Least Developed Countries (LDCs) that would benefit - according to the UN-OHRLLS statistics for 2017, the overall LDC population was approximately 1 billion with per capita CO2 emissions of 0.342 metric tonnes(2016) according to the World Bank. Even if the adult population was 75% of the total, then the CRV per capita distribution of 6 tonnes CO2-eq at a CAT rate of $75 per tonne amounts to over 300 billion USD representing a doubling of that granted to all ODA recipient countries while at the same time avoiding the heavy cost of tied aid.

Arguments for a World Democratic Governing Body to manage all aspects of GHG reduction and, on a wider basis, the tackling of Environmental Destruction and historic Environmental Inequality are compelling. However, it is clear that opposition to such a body would be fierce judging by the climate denier sponsored misinformation regarding the 1992 United Nations Rio Declaration on Sustainable Development. Also known as Agenda 21 (updated to 2030), it has been described as a "Utopian Socialist Nightmare". In contrast to the resistance to Agenda 21 and the failure to agree "UN Global Pact for the Environment" in Nairobi in 2019, the formation of a new Global GHG Emissions Control body to include the governance and oversee of Emissions Trading, Carbon Offset schemes and application of Carbon Added Taxation appears a small step but giant leap for all life on planet earth - if it is good enough idea for the former UK Prime Minister Gorden Brown to call for the creation of a temporary Global Government in March 2020 to tackle the coronavirus pandemic then such a body must be possible.

It remains to be seen if the next UN Climate Change (Conference of the Parties - COP26) Conference now rescheduled for November 2021 in Glasgow, UK will lead to a reversal from the past failures to halt the rise in atmospheric GHG emissions. indeed, the current UK Prime Minister, Boris Johnson , infamous at least in the UK if not internationally for his U-Turns on response to Covid-19 should endeavour a much needed U-Turn in these talks to achieve real progress towards climate change mitigation.

8. Conclusion

The front cover headlines of the Climate Crisis issue of the Ecologist Apr/May 1999 are as resounding now as they were in 1999. With the editorial by Edward and Zac Goldsmith, the Ecologist publication made unimaginably grim reading then and even grimmer now in 2020 in the context of current world events - a return to business as usual following the Covid-19 pandemic will just raise the stakes even further for climate catastrophe. Even if the the target of 2050 to become carbon neutral is achievable it is simply too late - The Club of Rome's The Limits To Growth 1972 report modelled various scenarios including a "Nature-Imposed Limitation to Growth" model that ultimately leads to an "uncontrollable decrease in population and capital". With the continual increase in Gross Domestic Product (GDP) remaining an economic goal, it appears that increasing natural environment change and destruction will be a certainty with the consequent impact on human life irrespective of race, colour or creed.

All Life Matters.

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Bibliography

2008. A Comparison of Carbon Offset Standards. [online]. [viewed 12 November 2020]. Available from: https://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/A_Comparison_of_Carbon_Offset_Standards_lang.pdf

2011. AFOLU sectors and Climate Change in Nigeria. [online]. [viewed 05 March 2021]. Available from: http://www.fao.org/fileadmin/templates/ex_act/pdf/case_studies/Agric_NV2020_LC2020_EX-ACT_Carbon_balance_May_4-rev-lb.pdf

2013. Accounting of Scope 2 Emissions. [online]. [viewed 28 April 2021]. Available from: https://recs.org/download/?file=carbon-disclosure-project_accounting-of-scope-2-emissions.pdf&file_type=documents

2013. Environmental Reporting Guidelines. [online]. [viewed 03 November 2020]. Available from: https://www.gov.uk/government/publications/environmental-reporting-guidelines-including-mandatory-greenhouse-gas-emissions-reporting-guidance

2013. Marginal Abatement Cost Curves (MACCs): Important Approaches to Obtain (Firm and Sector) Greenhouse Gases (GHGs) Reduction.. [online]. [viewed 09 November 2020]. Available from: https://core.ac.uk/download/pdf/11050257.pdf

2014. Avoiding the Risk of Double Counting Emission Reductions under UNFCCC. [online]. [viewed 11 November 2020]. Available from: https://mediamanager.sei.org/documents/Publications/Climate/SEI-WP-2014-02-Double-counting-risks-UNFCCC.pdf

2014. Estimating Greenhouse Gas Emissions in Agriculture. [online]. [viewed 09 April 2021]. Available from: http://www.fao.org/climatechange/41521-0373071b6020a176718f15891d3387559.pdf

2014. Guidelines for Developing a Marginal Abatement Cost Curve. [online]. [viewed 22 December 2020]. Available from: https://walga.asn.au/getattachment/Policy-Advice-and-Advocacy/Environment/Climate-Change/Climate-Change-Resources/Guidelines_for_Developing_a_MACC_tool_Feb2016.pdf.aspx?lang=en-AU

2014. Policy Risk In Renewable Energy Investments in Developing Countries. [online]. [viewed 10 May 2021]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/380928/DECC_PRI_FINAL.pdf

2015. A holistic comparative analysis of different storage systems using levelized cost of storage and life cycle indicators. [online]. [viewed 22 December 2020]. Available from: https://core.ac.uk/download/pdf/82492446.pdf

2015. Explainer: Why 'differentiation' is key to unlocking the Paris climate deal. [online]. [viewed 18 January 2021]. Available from: https://www.carbonbrief.org/explainer-why-differentiation-is-key-to-unlocking-paris-climate-deal

2015. Ghana's intended nationally determined contribution (INDC). [online]. [viewed 04 January 2021]. Available from: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Ghana%20First/GH_INDC_2392015.pdf

2015. World's richest 10% produce half of carbon emissions while poorest 3.5 billion account for just a tenth. [online]. [viewed 13 January 2021]. Available from: https://www.oxfam.org/en/press-releases/worlds-richest-10-produce-half-carbon-emissions-while-poorest-35-billion-account

2016. Carbon pricing efforts are falling short, but even modest collective action can deliver significant progress. [online]. [viewed 04 February 2021]. Available from: https://www.oecd.org/tax/carbon-pricing-efforts-are-falling-short-but-even-modest-collective-action-can-deliver-significant-progress.htm

2016. Report of the Conference of Parties on its 21st Session. [online]. [viewed 20 November 2020]. Available from: https://unfccc.int/resource/docs/2015/cop21/eng/10.pdf#page=30

2017. 65 Years On from the Great London Smog. [online]. [viewed 02 November 2020]. Available from: https://www.theguardian.com/commentisfree/2017/dec/05/smog-day-warning-18000-die-london-great-smog-1952-air-pollution

2017. Building Blocks for a Robust Sustainable Development Mechanism. [online]. [viewed 05 November 2020]. Available from: https://carbonmarketwatch.org/wp-content/uploads/2017/05/BUILDING-BLOCKS-FOR-A-ROBUST-SUSTAINABLE-DEVELOPMENT-MECHANISM_WEB-SINGLE_FINAL.pdf

2017. Fossil Fuel Subsidies Reform Ministerial Statement. [online]. [viewed 11 February 2021]. Available from: https://docs.wto.org/dol2fe/Pages/FE_Search/FE_S_S009-DP.aspx?language=E&CatalogueIdList=240841,240845,240847,240848,240824,240821,240788,240773,240787,240774&CurrentCatalogueIdIndex=2&FullTextHash=371857150&HasEnglishRecord=True&HasFrenchRecord=False&HasSpanishRecord=False

2017. Is the Paris climate deal legally binding or not?. [online]. [viewed 29 December 2020]. Available from: https://www.climatechangenews.com/2017/11/02/paris-climate-deal-legally-binding-not/

2017. LDC - What is a least developed country. [online]. [viewed 15 January 2021]. Available from: https://unctad.org/press-material/ldc-what-least-developed-country

2017. Members Call for WTO to Play a Central Role in Ending Inefficient Fossil Fuel Subsidies. [online]. [viewed 11 February 2021]. Available from: https://www.iisd.org/articles/members-call-wto-play-central-role-ending-inefficient-fossil-fuel-subsidies

2017. Role of terrestrial biosphere in counteracting climate change may have been underestimated. [online]. [viewed 29 November 2020]. Available from: https://www.birmingham.ac.uk/news/latest/2017/01/terrestrial-biosphere-climate-change.aspx

2018. Reducing Carbon Footprint made easier with new international standard. [online]. [viewed 11 April 2021]. Available from: https://www.iso.org/news/ref2317.html

2018. Regulation (EU) 2018/84. [online]. [viewed 02 December 2020]. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.156.01.0001.01.ENG

2018. Unbundles Renewable Renewable Energy Certificates (RECs). [online]. [viewed 10 November 2020]. Available from: https://www.epa.gov/greenpower/unbundled-renewable-energy-certificates-recs

2019. CRYOBattery. [online]. [viewed 21 December 2020]. Available from: https://highviewpower.com/news_announcement/highview-power-unveils-cryobattery-worlds-first-giga-scale-cryogenic-battery/

2019. Emissions Gap Report. [online]. [viewed 12 November 2020]. Available from: https://wedocs.unep.org/bitstream/handle/20.500.11822/30797/EGR2019.pdf?sequence=1&isAllowed=y

2019. Greenhouse Gas Emissions Factsheet: Nigeria. [online]. [viewed 05 March 2021]. Available from: https://www.climatelinks.org/resources/greenhouse-gas-emissions-factsheet-nigeria

2019. How renewable energy credit prices are set. [online]. [viewed 04 November 2020]. Available from: https://www.energysage.com/other-clean-options/renewable-energy-credits-recs/renewable-energy-credit-prices/

2019. Land Management Practices for Carbon Dioxide Removal and Reliable Sequestration. [online]. [viewed 27 November 2020]. Available from: https://www.nap.edu/read/25037/chapter/1#2

2019. LCOS - A Key Metric for Cost of Energy Storage. [online]. [viewed 21 December 2020]. Available from: https://www.nexant.com/resources/lcos-key-metric-cost-energy-storage

2019. Reducing energy poverty through education. [online]. [viewed 31 January 2021]. Available from: https://www.esi-africa.com/industry-sectors/future-energy/reducing-energy-poverty-through-education/

2019. Transmission Losses. [online]. [viewed 27 April 2021]. Available from: https://www.nationalgrideso.com/document/144711/download

2020. [online]. [viewed 19 November 2020]. Available from: https://www.greenclimate.fund/

2020. Afforestation and reforestation as adaption opportunity (2019). [online]. [viewed 02 December 2020]. Available from: https://climate-adapt.eea.europa.eu/metadata/adaptation-options/afforestation-and-reforestation-as-adaptation-opportunity

2020. Aid by DAC members increases in 2019 with more aid to the poorest countries. [online]. [viewed 28 December 2020]. Available from: https://www.oecd.org/dac/financing-sustainable-development/development-finance-data/ODA-2019-detailed-summary.pdf

2020. APA Item 3:UNFCCC. [online]. [viewed 11 November 2020]. Available from: https://unfccc.int/process/bodies/subsidiary-bodies/ad-hoc-working-group-on-the-paris-agreement-apa/information-on-apa-agenda-item-3

2020. Carbon footprint of tropical timber. [online]. [viewed 30 November 2020]. Available from: https://www.idhsustainabletrade.com/publication/carbon-footprint-of-tropical-timber/

2020. Climate Change Agreements scheme extension and reforms for any future scheme. [online]. [viewed 23 January 2021]. Available from: https://www.gov.uk/government/consultations/climate-change-agreements-scheme-extension-and-reforms-for-any-future-scheme

2020. Climate Economics - costa and benefits. [online]. [viewed 22 November 2020]. Available from: https://eciu.net/analysis/briefings/climate-impacts/climate-economics-costs-and-benefits

2020. Climate financing for developing countries rose to USD 78.9 billion in 2018. [online]. [viewed 07 January 2021]. Available from: https://www.oecd.org/newsroom/climate-finance-for-developing-countries-rose-to-usd-78-9-billion-in-2018oecd.htm

2020. Contronting Carbon Inequality. [online]. [viewed 14 January 2021]. Available from: https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621052/mb-confronting-carbon-inequality-210920-en.pdf

2020. Cut Global Emissions by 7.6% per year for the next decade to meet 1.5 deg C Paris target. [online]. [viewed 03 December 2020]. Available from: https://www.unenvironment.org/news-and-stories/press-release/cut-global-emissions-76-percent-every-year-next-decade-meet-15degc

2020. Delivering the $100 billion Climate Finance committment. [online]. [viewed 14 June 2021]. Available from: https://wwf.panda.org/wwf_news/?1182266/climate-finance-100bn-hope

2020. EV100: The Climate Group. [online]. [viewed 07 November 2020]. Available from: https://www.theclimategroup.org/project/ev100

2020. Evaluation of second Climate Change Agreement Scheme. [online]. [viewed 23 January 2021]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879633/cca-evaluation-synthesis-report.pdf

2020. Factsheet: 0.7% Aid Target. [online]. [viewed 28 December 2020]. Available from: http://devinit.org/wp-content/uploads/2013/08/Factsheet-0-7%25.pdf

2020. GHG Data from UNFCCC. [online]. [viewed 07 December 2020]. Available from: https://unfccc.int/process-and-meetings/transparency-and-reporting/greenhouse-gas-data/ghg-data-unfccc/ghg-data-from-unfccc

2020. Going faster on global ambition to tackle climate change. [online]. [viewed 06 November 2020]. Available from: https://www.gov.uk/government/speeches/going-faster-on-global-ambition-to-tackle-climate-change-ahead-of-cop26

2020. Good Practice Guidline for Land Use, Land-Use Change and Forestry. [online]. [viewed 07 December 2020]. Available from: https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

2020. Introduction to Climate Finance. [online]. [viewed 19 November 2020]. Available from: https://unfccc.int/topics/climate-finance/the-big-picture/introduction-to-climate-finance

2020. IPCC Special Report on Climate Change, Desertification, Land Degredation.....Summary for Policy makers.. [online]. [viewed 01 December 2020]. Available from: https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/

2020. Land Use, Land Use Change and Forestry. [online]. [viewed 02 December 2020]. Available from: https://unfccc.int/topics/land-use/workstreams/land-use--land-use-change-and-forestry-lulucf/land-use--land-use-change-and-forestry

2020. Making Finance Flows Consistent with the Paris Agreement. [online]. [viewed 18 November 2020]. Available from: https://sdg.iisd.org/commentary/policy-briefs/making-finance-flows-consistent-with-the-paris-agreement/

2020. Mandatory and Voluntary Offset Markets. [online]. [viewed 13 December 2020]. Available from: https://www.offsetguide.org/understanding-carbon-offsets/carbon-offset-programs/mandatory-voluntary-offset-markets/

2020. Methodological Tool: Demonstration of addionality of small-scaled project activities. [online]. [viewed 08 June 2021]. Available from: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-21-v13.1.pdf

2020. Nationally Determined Contributions (NDCs). [online]. [viewed 10 November 2020]. Available from: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/nationally-determined-contributions-ndcs

2020. Offsets and RECs: Whats the difference?. [online]. [viewed 06 November 2020]. Available from: https://www.epa.gov/sites/production/files/2018-03/documents/gpp_guide_recs_offsets.pdf

2020. Pandemic Status. Dutch Elm Disease. [online]. [viewed 02 November 2020]. Available from: http://archive.bio.ed.ac.uk/jdeacon/microbes/dutchelm.htm

2020. Paris Agreement. Adoption of the Paris Agreement. [online]. [viewed 08 November 2020]. Available from: https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

2020. Paris Agreement: Climate Action. [online]. [viewed 07 November 2020]. Available from: https://ec.europa.eu/clima/policies/international/negotiations/paris_en

2020. Poverty. [online]. [viewed 12 January 2021]. Available from: https://www.worldbank.org/en/topic/poverty/overview

2020. RE100. [online]. [viewed 06 November 2020]. Available from: https://www.theclimategroup.org/RE100

2020. The GHG Protocol for Project Accounting. [online]. [viewed 07 November 2020]. Available from: https://ghgprotocol.org/sites/default/files/standards/ghg_project_accounting.pdf

2020. The Keeling Curve. [online]. [viewed 29 November 2020]. Available from: https://sioweb.ucsd.edu /programs/keelingcurve/

2020. The Least Developed Countries Report 2020. [online]. [viewed 14 January 2021]. Available from: https://unctad.org/system/files/official-document/ldcr2020_en.pdf

2020. The least developed countries report 2020: productive capacities for the new decade. [online]. [viewed 10 February 2021]. Available from: https://unctad.org/press-material/least-developed-countries -report-2020productive-capacities-new-decade

2020. The Minimata Disaster - 50 Years On. [online]. [viewed 02 November 2020]. Available from: https://www.theregister.com/2006/07/14/the_odd_body_minimata_disaster/

2020. Understanding Global Warming Potentials. [online]. [viewed 02 June 2021]. Available from: https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

2020. United Nations Online Platform for Voluntary Cancellation of Certified Emissions Reductions. [online]. [viewed 07 November 2020]. Available from: https://offset.climateneutralnow.org/faq

2020. What are Parties ans non-Party stakeholders. [online]. [viewed 21 November 2020]. Available from: https://unfccc.int/process/parties-non-party-stakeholders/the-big-picture/what-are-parties-non-party-stak eholders

2020. Where does our electricity come from?. [online]. [viewed 02 November 2020]. Available from: https://www.world-nuclear.org/nuclear-essentials/where-does-our-electricity-come-from.aspx

2021. [online]. [viewed 04 February 2021]. Available from: https://iiasa.ac.at/web/home/research/Flagship -Projects/Global-Energy-Assessment/GEA_Chapter2_development_hires.pdf

2021. About the REGO Scheme. [online]. [viewed 28 April 2021]. Available from: https://www.ofgem.gov.uk /environmental-programmes/rego/about-rego-scheme

2021. Carbon Offset Guide. [online]. [viewed 20 April 2021]. Available from: https://www.offsetguide.org/

2021. CDM Catalogue of Decisions: Guidelines to SSC CDM Methodologies. [online]. [viewed 13 June 2021]. Available from: https://cdm.unfccc.int/Reference/catalogue/document?doc_id=000002183

2021. China's First NDC Submission. [online]. [viewed 18 January 2021]. Available from: https://www4 .unfccc.int/sites/ndcstaging/PublishedDocuments/China%20First/China%27s%20First%20NDC%20Submissi on.pdf

2021. Climate Change and the Potential Relevance of WTO Rules. [online]. [viewed 13 July 2021]. Available from: https://www.wto.org/english/tratop_e/envir_e/climate_measures_e.htm

2021. CO2 Emissions - (kt) -OECD Members. [online]. [viewed 06 September 2021]. Available from: https://data.worldbank.org/indicator/EN.ATM.CO2E.KT?locations=OE

2021. CO2 emissions - Least Developed Countries: UN Classification. [online]. [viewed 01 February 2021]. Available from: https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=XL

2021. CO2 emissions (kg per PPP $ of GDP). [online]. [viewed 07 September 2021]. Available from: https://data.worldbank.org/indicator/EN.ATM.CO2E.PP.GD

2021. CO2 Emissions (kg per PPP $ of GDP). [online]. [viewed 23 February 2021]. Available from: https://data.worldbank.org/indicator/EN.ATM.CO2E.PP.GD

2021. CO2 Emissions (kt) - Least Developed Countries - UN Classification. [online]. [viewed 06 September 2021]. Available from: https://data.worldbank.org/indicator/EN.ATM.CO2E.KT?locations=XL

2021. DUKES - 2020 Electricity Chapter 5 Energy Digest. [online]. [viewed 02 June 2021]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904805/DUKES_2020_Chapter_5.pdf

2021. Emissions Intensity. [online]. [viewed 27 February 2021]. Available from: http://pdf.wri.org/navigating_numbers_chapter5.pdf

2021. Environmental taxws, reliefs and schemes for businesses: Climate Change Levy. [online]. [viewed 23 January 2021]. Available from: https://www.gov.uk/green-taxes-and-reliefs/climate-change-levy

2021. Ghana Age Structure from 2009 to 2019. [online]. [viewed 04 January 2021]. Available from: https://www.statista.com/statistics/447521/age-structure-in-ghana/

2021. Global Greenhouse Gas Emissions Data. [online]. [viewed 02 June 2021]. Available from: https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

2021. Global Multidimensional Poverty Index. [online]. [viewed 01 February 2021]. Available from: https://ophi.org.uk/multidimensional-poverty-index/

2021. Good news for Africa's Great Green Wall. [online]. [viewed 05 September 2021]. Available from: https://www.unep.org/news-and-stories/story/good-news-africas-great-green-wall

2021. ICRG Methodology. [online]. [viewed 01 February 2021]. Available from: https://www.prsgroup.com/wp-content/uploads/2014/08/icrgmethodology.pdf

2021. Implications of Using Different GWP Time Horizons. [online]. [viewed 04 June 2021]. Available from: https://www.gti.energy/wp-content/uploads/2019/02/CMR-Implications-Using-Different-GWP-Time-Horizons-White-Paper-2019.pdf

2021. International Climate Finance. [online]. [viewed 07 January 2021]. Available from: https://ec.europa.eu/clima/policies/international/finance_en

2021. IPCCC Common Metrics. [online]. [viewed 07 June 2021]. Available from: https://unfccc.int/process-and-meetings/transparency-and-reporting/methods-for-climate-change-transparency/common-metrics

2021. Main Greenhouse Gases. [online]. [viewed 05 June 2021]. Available from: https://www.c2es.org/content/main-greenhouse-gases/

2021. NDC Registry. [online]. [viewed 04 January 2021]. Available from: https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx

2021. Proposed Guidance on Addressing Bias Uncertainty. [online]. [viewed 08 April 2021]. Available from: https://cdm.unfccc.int/Panels/meth/meeting/08/032/mp_032_an14.pdf

2021. Taxing Energy Use for Sustainable Development. [online]. [viewed 08 February 2021]. Available from: http://www.oecd.org/tax/tax-policy/taxing-energy-use-for-sustainable-development.htm

2021. Technical Annex to SEAP Template. [online]. [viewed 26 June 2021]. Available from: https://www.covenantofmayors.eu/IMG/pdf/technical_annex_en.pdf

2021. The 2020 Global Multidimensional Poverty Index (MPI). [online]. [viewed 01 February 2021]. Available from: http://hdr.undp.org/en/2020-MPI

2021. The General Agreements on Tariffs and Trade (GATT 11947). [online]. [viewed 13 July 2021]. Available from: https://www.wto.org/english/docs_e/legal_e/gatt47_02_e.htm#articleXX

2021. The multilateral trading system and climate change: introduction. [online]. [viewed 13 July 2021]. Available from: https://www.wto.org/english/tratop_e/envir_e/climate_intro_e.htm

2021. Tropical wetlands and methane emissions. [online]. [viewed 03 June 2021]. Available from: https://www.metoffice.gov.uk/research/approach/collaboration/newton/insights/brazil_methane

2021. Type 1 Renewable Energy Projects . [online]. [viewed 02 May 2021]. Available from: https://cdm .unfccc.int/Panels/ssc_wg/SSCWG10_repan_04_rev_AMS_I.A

2021. What is an emission factor?. [online]. [viewed 27 June 2021]. Available from: https://www.climfoot -project.eu/en/what-emission-factor

2021. What's the difference between carbon-neutral, net=zero and climate-positive. [online]. [viewed 07 July 2021]. Available from: https://plana.earth/academy/what-is-difference-between-carbon-neutral-net -zero-climate-positive/

Amazo-Blanco,Ana. et al. 2018. Why is there so much aggressive bidding at renewables auctions - and what the risks are. [online]. [viewed 01 May 2021]. Available from: https://energypost.eu/why-there-is-so-much -aggressive-bidding-at-renewables-auctions-and-what-the-risks-are/

Balcome,Paul. et al. 2018. Methane Emissions: Choosing the right climate metric and time horizon. [online]. [viewed 02 June 2021]. Available from: https://pubs.rsc.org/en/content/articlelanding/2018/em /c8em00414e#!divAbstract

Benoit,Philippe. and Kevin Tu. 2020. Is China Still a Developing Country? And Why It Matters for Energy and Climate. [online]. [viewed 18 January 2021]. Available from: https://www.energypolicy.columbia.edu /research/report/china-still-developing-country-and-why-it-matters-energy-and-climate

Bertoldi,Paolo. et al. 2010. Guidebook "How to Develop a Sustainable Energy Action Plan (SEAP)". [online]. [viewed 29 June 2021]. Available from: https://publications.jrc.ec.europa.eu/repository/handle/JRC57789

Browne, Stephen. 1997. The Rise and Fall of Development Aid. [online]. [viewed 31 December 2020]. Available from: https://www.wider.unu.edu/publication/rise-and-fall-development-aid

Cain, Michell. 2019. Improved calculation of warming-equivalent emissions for short-lived climate pollutants. [online]. [viewed 06 June 2021]. Available from: https://www.nature.com/articles/s41612-019 -0086-4

CDP. 2021. CDP Technical Note: Accounting of Scope 2 Emissions. [online]. [viewed 16 June 2021]. Available from: https://b8f65cb373b1b7b15feb-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms /guidance_docs/pdfs/000/000/415/original/CDP-Accounting-of-Scope-2-Emissions.pdf?1479752807

Chagas,Thiago. et al. 2019. Should forest carbon credit be included in offsetting schemessuch as CORSIA. [online]. [viewed 03 April 2021]. Available from: https://www.climatefocus.com/sites/default/files/Should %20forest%20carbon%20credtis%20be%20included%20in%20CORSIA_0.pdf

Chuang, Jules. 2018. The Relationship between electricty emission factor and renerable energy certificate: The Free Rider and Outsider Effect. [online]. [viewed 20 April 2021]. Available from: https://www .sciencedirect.com/science/article/pii/S2468203918300505

Conniff, Richard. 2018. Greenwashed Timber: How Sustainable Forest Certification Has Failed. [online]. [viewed 05 December 2020]. Available from: https://e360.yale.edu/features/greenwashed-timber-how -sustainable-forest-certification-has-failed

Cook, Kaitlyn.L. 2020. Is There Greenwashing in Renewable Energy Purchasing. [online]. [viewed 05 November 2020]. Available from: https://blogs.brown.edu/haleandhearty/2020/05/22/is-there -greenwashing-in-renewable-energy-purchasing/

Cowern,Nick. and Robin Russell-Jones. 2016. Global Warming Impact of Switch from Coal to Gas-Fired Electricity Generation in the UK. [online]. [viewed 06 June 2021]. Available from: https://www.theccc.org.uk/wp-content/uploads/2016/07/Onshore-petroleum-evidence-submitted-by-Cowern-and-Russell-Jones.pdf

Destradi, Sandra. 2020. Reluctance in Internataional Politics: A Conceptualization. [online]. [viewed 24 November 2020]. Available from: https://journals.sagepub.com/doi/full/10.1177/1354066116653665

Duarte, Mafalda. 2013. Mobilizing Climate Finance: definitions and methods. [online]. [viewed 07 January 2021]. Available from: https://www.oecd.org/env/cc/CCXG%20March%202013%20Mafalda%20Duarte.pdf

Duphy, Siobhan. 2020. Ability of tropical forests to act as a carbon sink is diminishing. [online]. [viewed 29 November 2020]. Available from: https://www.europeanscientist.com/en/environment/ability-of-tropical-forests-to-act-as-carbon-sink-diminishing/

Elliot, Dave. 2019. Curtailment:losing green power . [online]. [viewed 29 April 2021]. Available from: https://physicsworld.com/a/curtailment-losing-green-power/

Evans, Simon. 2017. Solar, wind and nuclear have 'amazingly low' carbon footprints, study finds. [online]. [viewed 21 June 2021]. Available from: https://www.carbonbrief.org/solar-wind-nuclear-amazingly-low-carbon-footprints

Fernando, Jason. 2020. Tertiary Recovery. [online]. [viewed 14 November 2020]. Available from: https://www.investopedia.com/terms/t/tertiary-recovery.asp

Ferreira, Patricia.Galvao. 2018. Climate Finance and Transparency in the Paris Agreement. [online]. [viewed 31 December 2020]. Available from: https://www.cigionline.org/sites/default/files/documents/Paper%20no.195_1.pdf

Frey,Christopher. et al. 2006. Chapter 3 Uncertainties: 2006 IPCC Guidlines for National Greenhouse Gas Inventories. [online]. [viewed 28 March 2021]. Available from: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_3_Ch3_Uncertainties.pdf

Gillenwater, Michael. 2012. How do you explain Additionality?. [online]. [viewed 20 April 2021]. Available from: https://ghginstitute.org/2012/01/25/how-do-you-explain-additionality/

Gowdy, Johnny. 2020. More price transparency is welcom, but can REGOs play a material role to achieve net zero carbon?. [online]. [viewed 28 April 2021].

Guillet, Jerome. 2017. Zero bid auction proves the need for a new support system. [online]. [viewed 01 May 2021]. Available from: https://green-giraffe.eu/blog/zero-bid-auction-proves-need-new-support-system

Harrison, Thomas. 2019. Stop trading renewable energy supply certificates, speed up the transition. [online]. [viewed 10 November 2020]. Available from: https://energypost.eu/stop-trading-renewable-energy-supply-certificates-speed-up-the-transition/

Herz, Steve. 2017. Paris climate deal needs to be polically, not legally, binding. [online]. [viewed 28 January 2021]. Available from: https://www.climatechangenews.com/2017/07/26/paris-climate-deal-needs-politically-not-legally-binding/

Hope, Mat. 2014. How much of China's carbon dioxide emissions is the rest of the world responsible for. [online]. [viewed 20 January 2021]. Available from: https://www.carbonbrief.org/how-much-of-chinas-carbon-dioxide-emissions-is-the-rest-of-the-world-responsible-for

IRENA. 2015. Action Design: Winner Selection Process. [online]. [viewed 01 May 2021]. Available from: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA_RE_Auctions_Guide_2015_5_winner_selection.pdf?la=en&hash=F45C1A24BD68F9AF3F52A264AF6C7B7E11940177

Kelley, Sarah. 2015. What is a Renewable Energy Certificate. [online]. [viewed 10 November 2020]. Available from: https://www.renewableenergyworld.com/2015/08/24/what-is-a-renewable-energy-certificate-rec/#gref

Khor, Martin. 2016. China's Boost to South-South Cooperation. [online]. [viewed 05 January 2021]. Available from: https://www.southcentre.int/question/chinas-boost-to-south-south-cooperation/

Knoth, Gretchen. 2015. A classroom's worst nightmare? Energy Poverty. [online]. [viewed 31 January 2021]. Available from: https://www.one.org/us/blog/a-classrooms-worst-nightmare-energy-poverty/

Kroeger, Kevin.D. 2017. Restoring tides to reduce methane emissions in impounded wetlands. [online]. [viewed 07 June 2021]. Available from: https://www.nature.com/articles/s41598-017-12138-4

Laconde, Thibault. 2018. Fugitive Emissions: A blind spot in the fight against climate change. [online]. [viewed 28 March 2021]. Available from: https://www.climate-chance.org/wp-content/uploads/2019/03/new-fugitive-emissions-a-blind-spot-in-the-fight-against-climate-change.pdf

Levin, Kelly. 2019. How Effective is Land at Removing Carbon Pollution? The IPCC Weighs In. [online]. [viewed 29 November 2020]. Available from: https://www.wri.org/blog/2019/08/how-effective-land-removing-carbon-pollution-ipcc-weighs

Levin,Kelly, Kelley Kizzler, and Mandy Rambharos. 2019. What You Need to Know About Article 6 of the Paris Agreement. [online]. [viewed 02 January 2021]. Available from: https://www.wri.org/blog/2019/12/article-6-paris-agreement-what-you-need-to-know

Lindsey, Rebecca. 2020. Climate Change: Atmospheric Carbon Dioxide. [online]. [viewed 29 November 2020]. Available from: https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide

Maslin,Mark. and Simon Lewis. 2019. Reforesting an area the size of the US needed to help avert climate breakdown, say researchers - are they right?. [online]. [viewed 29 November 2020]. Available from: https://theconversation.com/reforesting-an-area-the-size-of-the-us-needed-to-help-avert-climate-breakdown-say-researchers-are-they-right-119842

Mcleod,Elizabeth. and ..... 2011. A blueprint for blue carbon. [online]. [viewed 05 June 2021]. Available from: https://esajournals.onlinelibrary.wiley.com/doi/full/10.1890/110004

Michaekowa,Axel. et al. 2019. Additionality Revisited: guarding the integrity of markey mechanisms under the Paris Agreement. [online]. [viewed 21 June 2021]. Available from: https://www.tandfonline.com/doi/full/10.1080/14693062.2019.1628695

Mittal,Moti,L, Chhemendra Sharma, and Richa Singh. 2012. Estimates of Emissions from Coal Fired Thermal Power Plants in India. University of South Florida, NPL New Delhi. [online]. [viewed 18 May 2021]. Available from: https://www.researchgate.net/publication/267687877_Estimates_of_Emissions_from_Coal_Fired_Thermal_Power_Plants_in_India

Moerenhout,Tom. and Tristan Irschlinger. 2020. Exploring the Trade Impacts of Fossil Fuel Subsidies. [online]. [viewed 11 February 2021]. Available from: https://www.iisd.org/system/files/publications/trade-impacts-fossil-fuel-subsidies.pdf

Nordgren, Anders. 2016. Climate Change and National Self Interest. [online]. [viewed 09 February 2021]. Available from: https://link.springer.com/article/10.1007/s10806-016-9646-3

Nyman, Paul. 2021. Methane vs Carbon Dioxide: A Greenhouse Gas Showdown. [online]. [viewed 03 June 2021]. Available from: https://www.onegreenplanet.org/animalsandnature/methane-vs-carbon-dioxide-a-greenhouse-gas-showdown/

Patel, Prachi. 2019. How Inexpensive Must Energy Storage Be for Utilities to Switch to 100 Percent Renewables. [online]. [viewed 21 November 2020]. Available from: https://spectrum.ieee.org/energywise/energy/renewables/what-energy-storage-would-have-to-cost-for-a-renewable-grid

Patel, Prachi. 2019. How Inexpensive Must Energy Storage Be for Utilities to Switch to 100 Percent Renewables?. [online]. [viewed 30 April 2021]. Available from: https://spectrum.ieee.org/energywise/energy/renewables/what-energy-storage-would-have-to-cost-for-a-renewable-grid

Pena-Levano,Luis,Moises, Farzad Taheripour, and Wallace E Tyner. 2019. Climate Change Interactions with Agriculture, Forest Sequestration and Food Security. [online]. [viewed 06 December 2020]. Available from: https://link.springer.com/article/10.1007/s10640-019-00339-6

Pineda,Alberto.Carrillo. and Pedro Faria. 2019. Towards a Science-Based Approach to Climate Neutrality in the Corporate Sector. [online]. [viewed 24 March 2021]. Available from: https://sciencebasedtargets.org/resources/files/Towards-a-science-based-approach-to-climate-neutrality-in-the-corporate-sector-Draft-for-comments.pdf

Pugh,Thomas. et al. 2019. Role of forest regrowth in global carbon sink dynamics. [online]. [viewed 05 December 2020]. Available from: https://www.pnas.org/content/116/10/4382

Purdy, Alicia. 2018. What are the Different Types of Land called?. [online]. [viewed 01 December 2020]. Available from: https://sciencing.com/different-kinds-land-called-8533115.html

RE100 Technical Advisory Group. 2016. Making Credible Renewable Energy Claims. [online]. [viewed 28 April 2021]. Available from: https://www.there100.org/sites/re100/files/2020-09/RE100%20Making%20Credible%20Claims.pdf

Ritchie, Hannah. 2017. How much will it cost to mitigate climate change. [online]. [viewed 18 November 2020]. Available from: https://ourworldindata.org/how-much-will-it-cost-to-mitigate-climate-change

Roser, Max. 2020. Forests. [online]. [viewed 06 December 2020]. Available from: https://ourworldindata.org/forests

Roser,Max. and Esteban Ortis-Ospina. 2013. [online]. [viewed 14 January 2021]. Available from: https://ourworldindata.org/extreme-poverty

Sato,Ichiro, Paige Langer, and Fred Stolle. 2019. NDC Enhancement: Opportunities in the Forest and Land-use Sector. [online]. [viewed 03 December 2020]. Available from: https://www.wri.org/publication/ndc-enhancement-opportunities-forest-and-land-use-sector

Schiermeier, Quinn. 2020. Global methane levels soar to record high. [online]. [viewed 05 June 2021]. Available from: https://www.nature.com/articles/d41586-020-02116-8

Smith,Danna, Chad Hanson, and Matthew Koehler. 2020. Logging is a Lead Driver of Carbon Emissions from US Forests. [online]. [viewed 30 November 2020]. Available from: https://www.earthisland.org/journal/index.php/articles/entry/logging-carbon-emissions-us-forests/

Symons,Elizabeth, John Proops, and Philip Gay. 1994. Carbon Taxes, Consumer Demand and Carbon Dioxide Emissions: A Simulation Analysis for the UK. [online]. [viewed 12 March 2021]. Available from: https://www.ifs.org.uk/fs/articles/symons_may94.pdf

Thwaites,Joe. et al. 2018. Aligning Finance is the Forgotten Goal of the Paris Agreement, But it is Vital to Successful Climate Action. [online]. [viewed 18 November 2020]. Available from: https://www.wri.org/blog

/2018/12/aligning-finance-forgotten-goal-paris-agreement-it-vital-successful-climate-action

Timperley, Jocelyn. 2018. How climate finance "flows" around the world. [online]. [viewed 04 January 2021]. Available from: https://www.carbonbrief.org/interactive-how-climate-finance-flows-around-the-world

Tyler, Emily. 2007. Renewable Energy Certificates and Carbon Certificates: Can One Project Self Both. [online]. [viewed 06 November 2020]. Available from: https://www.ctc-n.org/sites/www.ctc-n.org/files/resources/10307023_3.pdf

Tyler, Emily. 2007. Renewable Energy Certificates and Carbon Certificates: Can One Project Sell Both?. [online]. [viewed 06 November 2020]. Available from: https://www.ctc-n.org/sites/www.ctc-n.org/files/resources/10307023_3.pdf

Valatin, Gregory. 2011. Forests and Carbon: a review of additionality. [online]. [viewed 08 June 2021]. Available from: https://www.forestresearch.gov.uk/documents/240/FCRP013_ySIQFWf.pdf

Warne, Ibrahim. 2019. Effectiveness of the Paris Agreement. [online]. [viewed 07 November 2020]. Available from: https://www.researchgate.net/publication/335383949_Effectiveness_of_the_Paris_Agreement

Xuepeng, Tang. 2008. China's post Kyoto roadmap. [online]. [viewed 28 January 2021]. Available from: https://chinadialogue.net/en/pollution/2560-china-s-post-kyoto-roadmap/

Zwick, Steve. 2019. As Emissions Rise, Cost of Fixing Climate Soars. [online]. [viewed 22 November 2020]. Available from: https://www.ecosystemmarketplace.com/articles/thanks-to-past-inertia-it-will-now-cost-between-1-6-and-3-8-trillion-per-year-to-fix-the-climate-mess/

Endnotes

1 Environmental Reporting Guidelines (DEFRA, 03 November 2020)<https://www.gov.uk/government/publications/environmental-reporting-guidelines-including-mandatory-greenhouse-gas-emissions-reporting-guidance>.

2 Ibrahim Warne, "Effectiveness of the Paris Agreement " (07 November 2020)<https://www.researchgate.net/publication/335383949_Effectiveness_of_the_Paris_Agreement>.

3 Building Blocks for a Robust Sustainable Development Mechanism (Carbon Market Watch, 05 November 2020)<https://carbonmarketwatch.org/wp-content/uploads/2017/05/BUILDING-BLOCKS-FOR-A-ROBUST-SUSTAINABLE-DEVELOPMENT-MECHANISM_WEB-SINGLE_FINAL.pdf>.

4 Where does our electricity come from? (World Nuclear Association, 02 November 2020)<https://www.world-nuclear.org/nuclear-essentials/where-does-our-electricity-come-from.aspx>.

5 Sarah Kelley, "What is a Renewable Energy Certificate " (Renewable Energy World, 10 November 2020)<https://www.renewableenergyworld.com/2015/08/24/what-is-a-renewable-energy-certificate-rec/#gref>.

6 "Unbundles Renewable Renewable Energy Certificates (RECs) " (EPA/Green Power Partnership, 10 November 2020)<https://www.epa.gov/greenpower/unbundled-renewable-energy-certificates-recs>.

7 How renewable energy credit prices are set (Energy Sage, 04 November 2020)<https://www.energysage.com/other-clean-options/renewable-energy-credits-recs/renewable-energy-credit-prices/>.

8 Kaitlyn L Cook, Is There Greenwashing in Renewable Energy Purchasing (05 November 2020)<https://blogs.brown.edu/haleandhearty/2020/05/22/is-there-greenwashing-in-renewable-energy-purchasing/>.

9 Thomas Harrison, Stop trading renewable energy supply certificates, speed up the transition (Energy Post , 10 November 2020)<https://energypost.eu/stop-trading-renewable-energy-supply-certificates-speed-up-the-transition/>.

10 "Offsets and RECs: Whats the difference? " (The Green Power Partnership, 06 November 2020)<https://www.epa.gov/sites/production/files/2018-03/documents/gpp_guide_recs_offsets.pdf>.

11 "RE100 " (The Climate Group, 06 November 2020)<https://www.theclimategroup.org/RE100>.

12 EV100: The Climate Group (The Climate Group, 07 November 2020)<https://www.theclimategroup.org/project/ev100>.

13 "Going faster on global ambition to tackle climate change " (Dept for Business, Energy and Business Strategy , 06 November 2020)<https://www.gov.uk/government/speeches/going-faster-on-global-ambition-to-tackle-climate-change-ahead-of-cop26>.

14 Nationally Determined Contributions (NDCs) (UN FCCC, 10 November 2020)<https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/nationally-determined-contributions-ndcs>.

15 "Avoiding the Risk of Double Counting Emission Reductions under UNFCCC " (11 November 2020)<https://mediamanager.sei.org/documents/Publications/Climate/SEI-WP-2014-02-Double-counting-risks-UNFCCC.pdf>.

16 "The GHG Protocol for Project Accounting " (WRI and World Business Council for Sustainable Development, 07 November 2020)<https://ghgprotocol.org/sites/default/files/standards/ghg_project_accounting.pdf>.

17 "LCOS - A Key Metric for Cost of Energy Storage " (Nextant, 21 December 2020)<https://www.nexant.com/resources/lcos-key-metric-cost-energy-storage>.

18 "A holistic comparative analysis of different storage systems using levelized cost of storage and life cycle indicators " (Elsevier, 22 December 2020)<https://core.ac.uk/download/pdf/82492446.pdf>.

19 "Marginal Abatement Cost Curves (MACCs): Important Approaches to Obtain (Firm and Sector) Greenhouse Gases (GHGs) Reduction. " (Canadian Center of Science and Education, 09 November 2020)<https://core.ac.uk/download/pdf/11050257.pdf>.

20 "Emissions Gap Report " (United Nations Environment Programme, 12 November 2020)<https://wedocs.unep.org/bitstream/handle/20.500.11822/30797/EGR2019.pdf?sequence=1&isAllowed=y>.

21 "A Comparison of Carbon Offset Standards " (World Wildlife Fund Germany, 12 November 2020)<https://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/A_Comparison_of_Carbon_Offset_Standards_lang.pdf>.

22 CDP, "CDP Technical Note: Accounting of Scope 2 Emissions " (CDP, 16 June 2021)<https://b8f65cb373b1b7b15feb-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/guidance_docs/pdfs/000/000/415/original/CDP-Accounting-of-Scope-2-Emissions.pdf?1479752807>.

23 "Policy Risk In Renewable Energy Investments in Developing Countries " (DECC/CEPA, 10 May 2021)<https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/380928/DECC_PRI_FINAL.pdf>.

24 Paolo Bertoldi et al. , "Guidebook "How to Develop a Sustainable Energy Action Plan (SEAP)" " (Publication Office of the EU, 29 June 2021)<https://publications.jrc.ec.europa.eu/repository/handle/JRC57789>.

25 Joe Thwaites et al. , "Aligning Finance is the Forgotten Goal of the Paris Agreement, But it is Vital to Successful Climate Action " (World Resources Institute, 18 November 2020)<https://www.wri.org/blog/2018/12/aligning-finance-forgotten-goal-paris-agreement-it-vital-successful-climate-action>.

26 Patricia Galvao Ferreira, "Climate Finance and Transparency in the Paris Agreement " (CIGI, 31 December 2020)<https://www.cigionline.org/sites/default/files/documents/Paper%20no.195_1.pdf>.

27 "What are Parties ans non-Party stakeholders " (UNFCCC, 21 November 2020)<https://unfccc.int/process/parties-non-party-stakeholders/the-big-picture/what-are-parties-non-party-stakeholders>.

28 United Nations Online Platform for Voluntary Cancellation of Certified Emissions Reductions (United Nations, 07 November 2020)<https://offset.climateneutralnow.org/faq>.

29 "International Climate Finance " (EU, 07 January 2021)<https://ec.europa.eu/clima/policies/international/finance_en>.

30 "Making Finance Flows Consistent with the Paris Agreement " (IISD / SDG Knowledge Hub, 18 November 2020)<https://sdg.iisd.org/commentary/policy-briefs/making-finance-flows-consistent-with-the-paris-agreement/>.

31 Steve Zwick, "As Emissions Rise, Cost of Fixing Climate Soars " (Ecosystem Marketplace, 22 November 2020)<https://www.ecosystemmarketplace.com/articles/thanks-to-past-inertia-it-will-now-cost-between-1-6-and-3-8-trillion-per-year-to-fix-the-climate-mess/>.

32 Max Roser and Esteban Ortis-Ospina , (Our World in Data, 14 January 2021)<https://ourworldindata.org/extreme-poverty>.

33 "China's First NDC Submission " (UNFCCC Unoffical English Translation, 18 January 2021)<https://www4

.unfccc.int/sites/ndcstaging/PublishedDocuments/China%20First/China%27s%20First%20NDC%20Submission.pdf>.

34 Mat Hope, "How much of China's carbon dioxide emissions is the rest of the world responsible for " (CarbonBrief, 20 January 2021)<https://www.carbonbrief.org/how-much-of-chinas-carbon-dioxide-emissions-is-the-rest-of-the-world-responsible-for>.

35 "Ghana's intended nationally determined contribution (INDC) " (04 January 2021)<https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Ghana%20First/GH_INDC_2392015.pdf>.