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Future Trends and Scenarios

REPORT

Private Sector and Climate Change

A Case Study of Carbon-Based Governance

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Summary

Global greenhouse gas emissions are the main contributor to anthropocentrically-induced climate change and have risen 41% since 1990. We are still yet to reach peak emissions. A large share of those emissions result from private sector activity. At the same time, the private sector possesses major resources which should be harnessed to scale up funding and emissions reduction technologies to benefit the

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climate. Since the Paris Climate Agreement in 2015, there has been an upsurge in private sector activity on climate change, especially in the corporate sector. Researchers have suggested that this groundswell of private sector activity especially in reduction of carbon emissions holds out the promise of plugging conspicuous public governance gaps. But while this surge in private action since the Paris Climate Agreement is to be encouraged, and indeed has been formally welcomed by global public climate governance actors under the UNFCCC, the measurable success of private, public-private and "hybrid" climate governance arrangements on reducing emissions remains unclear. Through an in depth empirical investigation of the actors and initiatives that play a key role in this emerging domain of bottom-up climate change governance, this study finds that, despite a groundswell in private activity, zones of fragmentation among a multiplicity of private actors, initiatives and standards is stymying progress: while key actors are increasingly networked, key metrics remain severely fragmented; while substantial resources have been dedicated to governing carbon emissions, greenhouse gas emissions keep rising. These observations are demonstrated through an empirical analysis of the "carbon-based" governance regime, which we define as the governance of climate change through a unitary focus on carbon measurement, disclosure, and verification. So far, the ultimate goal of carbon-based governance to reduce emissions is far from being realized. Whether this regime can be repurposed to fulfil this crucial function remains an open question.

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Executive Summary/Preface

This paper is a deliverable for the GLOBE project (Global Governance and the EU: Future Trends and Scenarios). It is funded by the European Commission's Horizon 2020 programme. The project recommends strategies on how the EU might proceed in global governance for climate change. The main purpose is to provide a comprehensive analysis of the growing role of the private sector in climate change governance. This is important because the private sector has substantial resources to meet the equally substantial needs for climate governance. Further, and especially since the Paris Climate Agreement, prominent actors within the private sector have made clear their commitment to greenhouse gas reduction.

The focus of this project is on the actors, initiatives, processes, and standards which have emerged from 1990 to 2020 within the global climate change regime. While the focus is on the private sector, from a global governance perspective, the methods developed in this paper could be adapted to examine more historical trends, cross-sectional studies, and different company and industry samples. Three main research tasks are carried out: (1) a mapping of private "carbon-based" governance actors; (2) a taxonomy and lexicon to define and understand these actors, their functions, embeddedness, network centrality, and relationships; and (3) empirical analyses to understand the growing prominence of private and hybrid "carbon" governance actors throughout the corporate sector. Finally, policy advice is provided through a synthesis of the theoretical and empirical research.

Highlights:

- An overview of key private-sector actors in "carbon-based" climate change governance
- A new taxonomy to assess, validate, and defragment these actors
- A machine-enhanced network analysis of key actors and standards
- An automated content analysis of 500 corporate sustainability reports in order to demonstrate the key actors in carbon governance with respect to companies.

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Main Findings:

- A handful of prominent private “governors” exert an outsized influence on Climate Change governance, and these actors are particularly focused on carbon governance
- To galvanize collective, bottom-up action from the private sector, deep decarbonisation might be required as a new metaphor, in contrast to the current outsized role played by carbon mitigation focus
- Carbon-based governance might be siphoning much-needed climate mitigation resources.
- There are a handful of initiatives and organisations that feature prominently throughout corporate sustainability reports, which suggests the power these organisations impart on the private sector.

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List of Abbreviations

°C Degrees Celsius
ACR American Carbon Registry
API/IPIECA Oil and Gas industry standards for GHG inventories
CCS Carbon capture and storage
CDM Clean Development Mechanism
CDP Carbon Disclosure Project
CDSB Carbon Disclosures Standards Board
CER Certified Emission Reduction
CERES The Coalition for Environmentally Responsible Economies
CO2 Carbon dioxide
CO2e Carbon dioxide equivalent
COP Conference of the Parties
CORSIA Carbon Offset and Reduction Scheme for International Aviation
CPLC Carbon Pricing Leadership Coalition
EP100 100% Electric Vehicle Corporate Commitment Coalition
EV100 Alliance to Save Energy Commitment Coalition
ETS Emissions Trading System
EU European Union
French Bilan Carbon standard in France
GGIRCA Greenhouse Gas Industrial Reporting and Control Act
GHG Greenhouse gas
GtCO2e Giga-ton of carbon dioxide equivalent
GHG Protocol Most widely used GHG Management inventory tool for corporates
HFC Hydrofluorocarbon
IEA International Energy Agency
IETA International Emissions Trading Association
IPCC Intergovernmental Panel on Climate Change
J-VER Japan Verified Emission Reduction
JCM Joint Crediting Mechanism
JI Joint Implementation
KliK Climate Protection and Carbon Offset Foundation
KOC Korean Offset Credits
ktCO2e Kiloton of carbon dioxide equivalent
MRV Monitoring, Reporting and Verification
MtCO2e Megaton of carbon dioxide equivalent
NAZCA Non-State Action Portal for Climate Change
N2O Nitrous oxide
NACAG Nitric Acid Action Group
NACAP Nitric Acid Climate Auctions Program
NDC Nationally Determined Contribution

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OMGE Overall Mitigation in Global Emissions
PFC Perfluorocarbon
PMR Partnership for Market Readiness
RE100 100% Renewable Energy Commitment Coalition
REDD Reducing Emissions from Deforestation and Forest Degradation
REDD+ Extends REDD by including sustainable forest management, conservation of forests, and enhancement of carbon sinks
RGGI Regional Greenhouse Gas Initiative
SBTi Science Based Targets initiative
SDG Sustainable Development Goal
t Ton (note that, unless specified otherwise, ton in this report refers to a metric ton = 1,000 kg)
TCAF Transformative Carbon Asset Facility
TCFD Task Force on Climate-related Financial Disclosures
tCO2 Ton of carbon dioxide
tCO2e Ton of carbon dioxide equivalent
TIER Technology Innovation and Emissions Reduction
UNFCCC United Nations Framework Convention on Climate Change
VCS Verified Carbon Standard
VCU Verified Carbon Unit
VER Verified Emissions Reduction
WBCSD World Business Council for Sustainable Development
WRI World Resources Institute
WTO World Trade Organization
WMB We Mean Business
WWF World Wide Fund for nature

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The Private Sector and Climate Change: A Case Study of Carbon-Based Governance

1. Introduction

The existential threat of climate change remains despite three decades of collective, multilateral efforts spearhead under the auspices of the UN Framework Convention on Climate Change. Greenhouse gas emissions are the main cause of anthropocentrically induced climate change and have risen 41% since 1990, with 73% of the total coming from energy production (https://www.wri.org/our-work/project/climate-watch). Governance initiatives to combat climate change, while not very successful so far, have undergone substantial expansion in the past three decades, not least of all with the inclusion of the private sector as a key vector for progress, in particular following the much heralded Paris Climate Change Agreement of 2015.

In the 1990s, climate governance lay largely in the hands of public authorities and top-down emissions control mechanisms (e.g. the EU's Emissions Trading System or EU-ETS). Some of the earlier "command-and-control" carbon emissions governance structures were deemed inadequate, ill-suited to the demands of the market (Markussen & Svedsen, 2005). However, these largely experimental public governance approaches have improved over time (Hoffmann, 2011). Significantly, emissions have stabilised in the EU, which can be partially attributed to the EU-ETS (Bruninx et al., 2020). Also, some industries have made substantial progress in lowering their emissions on aggregate.

The Paris Climate Agreement formalised engagement with the private sector. This is logical given that the transboundary threat of global emissions is mirrored by the transboundary scope of many private sector firms. Moreover the private sector, especially in developing countries, is seen as better equipped than the public sector to bring major organisational and financial resources to bear on the problem (Kok & De Coninck, 2007). The climate crisis demands rapid action on an unprecedented scale. Many have welcomed the private sector's "institutionalisation" into the climate

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change governance system (Hale, 2017; Victor, 2016). Indeed, much hope is pinned on the "groundswell" of non-state climate *action* (Chan et al., 2019; Hale, 2016; Van Asselt, 2016; Hsu et al., 2015). Consequently, sustained attention in a burgeoning climate change regime scholarship has been paid to mapping the diversity of global climate change actors, their actions and motivations within a "regime complex" (Keohane & Victor, 2011), and the ecosystem of transgovernmental climate change initiatives (TGCIs) has also been mapped, spearheaded by Bulkeley et al. (2014) and updated by Roger et al. (2017) and Michaelowa and Michaelowa (2017). However, despite the contribution of this scholarship, the jury is still out on the measurable impact of private and corporate actors on climate governance (Marx, 2019). Moreover, the shifting composition of private actors in this domain continues to change dramatically with the literature struggling to keep up.

The Kyoto Protocol (KP), in conjunction with the Clean Development Mechanism (CDM) and the EU's Emissions Trading System (EU-ETS), were the first global governance mechanisms which sought to manage emissions through market-enabling mechanisms. These climate governance "experiments" proved largely unsuccessful (Hoffmann, 2011). Nevertheless, much can be learned from these attempts. One main critique is that there were not enough public resources available to meet the monumental tasks put in motion by the KP, the CDM and the EU-ETS (ibid), especially the laborious work of monitoring, measuring, reporting and verifying local and global aggregate emissions. The private sector was therefore quickly enlisted to help manage these "governance gaps" (Green, 2013). As such, capacity deficits on the part of the public sector has been a major driver of the "Cambrian explosion" of private sector actors focused squarely on the mitigation of carbon emissions (Keohane & Victor, 2011).

The culmination of this dramatic private sector entrance into the climate governance regime was the UN's NAZCA Portal (the Non-state Action for Climate Change), launched in 2014, alongside the Global Climate Action summit (Widerberg & Pattberg, 2016; Kuyper et al., 2018; UNFCCC, 2018). The NAZCA Portal, on the UNFCCC's website, lists 18,729 *actors* taking 27,174 *actions* (as of 25/10/2020). It is considered the most comprehensive "registry of bottom-up climate actions and actors" (Hsu et al.,

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2016). These actors, in other words, are located at the national or sub-national level, often comprising local government, city, or private sector entities. Clearly, non-state and private sector initiatives have grown enormously since the Paris Agreement. But the power and centrality of these actors remains uneven (Widerberg & Pattberg, 2017). Meanwhile, as many private actors and initiatives focus on the mitigation of carbon emissions, emissions continue to rise, which suggests that the emerging bottom-up carbon-based governance system possesses flaws similar or different to the earlier top-down climate governance paradigm. From this observation, two key questions arise: (1) Who are the central governance actors within the carbon mitigation-focused governance regime? How do these governance actors interact with the corporate sector?

To answer these questions, we first identify the most important actors – those that exert outsized influence within the carbon mitigation system. We begin with the TGCIs already extensively analysed in the literature (Widerberg et al., 2016; Widerberg & Pattberg, 2017; Hale & Roger, 2014; Roger et al., 2017; Michaelowa & Michaelowa, 2017). Since our focus is specifically on the private sector – their particularly importance explicitly recognized in the Paris Agreement – we then parse out both private and hybrid actors and initiatives from these databases. To complete our network mapping, we then add links (or ties) to represent relationships between the actor-nodes. The result is an original mapping which fully captures the private and corporate sector ecosystem, with respect to climate change governance.

We call this domain the Global Carbon Governance Regime (GCGR) because the central actors tend to focus on carbon mitigation, to the exclusion of other climate governance pillars such as adaptation or loss and damage. This observation is borne out in the mission statements of the central actors. The Carbon Regime mapping is complemented by a network centrality analysis. Consequently, this novel mapping, network analysis, and taxonomy allows for in depth empirical analyses. Operationalising the central actors and their relationships (*actors* and *actions*), as well as the effects these actors have at the corporate level, combined with a measure of their *network embeddedness* allows us to empirically assess the scale of carbon and climate mitigation activities being undertaken by corporations, among other outcomes.

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Our novel construction of a carbon-based governance network map, underpinned by a detailed taxonomy of key governance actors, paves the way for future empirical research on the ability of these actors to exert compliance and efficacy influence over the corporate sector.

To demonstrate how our new Carbon Governance network and taxonomy can improve on current understandings of climate governance of the corporate sector we conduct an empirical analysis of the FTSE-100 companies. We examine not only the centrality of key governance actors within individual corporate reports (e.g. the correlation of internal with external corporate climate change governance initiatives), but also probe how future research might arrive at more robust findings concerning the critical issue of whether membership of voluntary carbon reduction initiatives has an effect on corporate emissions trends. In sum, our novel GCGR mapping, comparative analysis, framework for classification and, finally, empirical analysis, sheds light on the overarching question of how the private sector specifically has become fully "institutionalised" into climate change governance (Hale, 2017). The findings have far-reaching implications for climate governance at all levels.

Finally, these findings suggest where climate change governance is heading – if it is to remain tethered to a carbon-based governance logic – with practical insights for policymakers. The main policy finding is that, should emissions mitigation remain central to governance efforts to confront climate change – and especially as if carbon-based governance is to become more privatised as current trends suggest – then there should be a concerted effort, from both public and private governance actors, to develop transparent and comparable carbon-based metrics. If climate change governance is to remain deeply intertwined with the carbon mitigation imperative, then the system of carbon monitoring, disclosing, pledging, and verifying needs dramatic improvement in order to function effectively. Moreover, emissions data must be consistent, transparent, immutable, and accessible to a much wider range of actors than is currently the case, in the present and into the future.

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2. What is Carbon-Based Governance?

Greenhouse emissions have been the main target of climate change governance since at least the inception of the IPCC and UNFCCC. Indeed, since 1990, the IPCC's science indicated that a reduction of GHGs was paramount to avert the most severe consequences of climate change. Concurrently, the UNFCCC process sought to incorporate the IPCC's science into policy prescriptions. The Kyoto Protocol identified six main gases critical to climate change: carbon dioxide (CO2), methane (CH4), nitrous oxide (N20), F-gases (hydrofluorocarbons and perfluorocarbons) and sulphur hexafluoride (SF6). In order to streamline the governance of these GHGs collectively, "carbon" emissions, the representative gas, have become the central governance focus to confront climate change.

The year 2020 will be remembered for the coronavirus but also for the outpouring of private sector proclamations for emissions reductions and net-zero commitments. "Green New Deals" are apparently tied to both: companies that can demonstrate a low-carbon trajectory are more likely to receive financial stimulus (Cox, 2020). Institutional investors are increasingly clambering to provide investment to sustainably-minded companies. The global pandemic coupled with green growth, indeed, introduces some interesting new metaphors. For example, one primary answer thus far to the coronavirus has been to prescribe face masques—instead of treating the disease, the idea is to stymie the spread of its symptoms. But the coronavirus is quite new; many treatments and vaccinations are under development to explicitly treat or prevent the disease, so this makes sense. However, if governments prescribed face-masques ten years hence, after the development of proven vaccines, it would likely be construed as a governance failure. Likewise, if governments kept track of the number of coughs each day, it would likely not mitigate the virus. With climate change—what could be understood as a virus attacking the Earth's immune system—the production of energy from fossil fuels is the main disease vector. But the main prescription has been, thus far, to count the coughs from activities that produce emissions. This evidently has not worked. Targeting emissions rather than developing vaccines to combat climate change is akin to targeting the symptom but not the disease.

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2.1. Plan of Action: Corporate Commitments to Carbon Reductions

The public governance imperative to reduce emissions as the main solution to the climate change disease has carried over into the bottom-up, mostly private-actor led climate change governance groundswell. Consequently, it has led to *carbon* becoming the point of *action* for private and public actors alike. The private sector has fully integrated this "carbon frame" into future goal-setting activities. This is evident in corporate climate change pledges, carbon reduction plans, internal carbon prices, and participation in carbon trading and carbon finance. For example, over the last few years, corporations have increasingly vocalized "carbon-neutral" and "net-zero" ambitions that are "aligned to the Paris Agreement." For instance, in April, Microsoft declared its intention to become a "net-zero" company by 2030, in part by using "direct air capture" and possibly "new nuclear" technologies. At the same time, Repsol and Total published carbon reduction plans deemed to "align to the Paris Pledge" by the *Transitions Pathways Initiative* (TPI); on the other hand, their industry peer, Shell, has pledged its carbon emissions *intensity* will be reduced by at least 65% by 2050. The latter was deemed unworthy of "alignment to Paris" by the TPI. While these pledges are encouraging—letting alone for a moment the fact that these pledges are distant future promises—they are also incredibly different and very difficult to comprehend. Emissions reductions pledges could be interpreted in many different ways (Ascui & Lovell, 2011). With so many different interpretations, metrics and arrangements, an open question is how governance of carbon will effectively function going forward, especially as bottom-up actors continue to carry much of the momentum.

This example of four companies, three from the same sector, is not unique. Throughout most sectors, carbon reduction pledges and plans differ widely. Goals, targets, plans, and pledges do not align with one another (WEF, 2020). Each have their own timeline for reductions and often convey goals based on the availability of as-yet developed technologies (e.g. Microsoft's direct carbon capture technology). While privately-led organisations such as the CDP (Carbon Disclosure Project), CDSB (Carbon Disclosure Standards Board) and carbon measurement standards such as the GHG Protocol attempt to mend these issues, it appears that there is a long way to

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go. Indeed, over 75% percent of FTSE-100 companies report their emissions to the CDP, most of whom use the GHG Protocols' measurement standard, but over 90% of these companies' emissions continue to rise (see section 6). Moreover, while the CDSB and the CDP call for consistency and transparency, even amongst the FTSE companies which are subject to some of the most stringent climate regulations in the world, there are vastly different carbon inventory disclosures, backed by different methods, presentation, and timing.

Despite efforts to mend private-led carbon governance standards, related questions remain. How exactly will companies achieve these goals? How will emissions be tracked? Will changing the way carbon is measured from year to year, which, as appears to be prevalent, be punished? Carbon-based metrics, as they currently stand, make comparisons among companies—even companies in the same sector—all but impossible (Lovell et al., 2010: 6). It also confuses would-be sustainable investors, which is an issue EU policy-makers have recently recognised (e.g. the proposed Taxonomy on Sustainable Investment and the definition for a net-zero company). Indeed, these are critical questions that are not yet sufficiently addressed (Hsueh, 2019).

Sustainably-minded investors make big bets on companies that show (or claim to be on) a low-carbon trajectory. Indeed trillions of dollars have been earmarked by the institutional investment community for climate change investments (e.g. the Institutional Investors Group on Climate Change or the IIGCC). But much investment is stalled because investors are unable decipher the emissions plans and goals (OECD, 2017). That indicates something: if some of the most valuable institutional investment houses in the world are having trouble comprehending corporate carbon pledges, it is likely many others are equally perplexed. The main negative ramification is stalled investment in much-needed low-emissions technologies and companies, with negative implications for the climate as well. While there is a demand for consistent and transparent corporate carbon emissions pledges, plans, and inventories, there is a dearth of supply.

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Notably, corporate carbon pledges and verification have also perplexed EU policymakers. Earlier this year, for example, European policymakers recognised that "While a growing number of companies are claiming carbon neutrality or a net zero status already [there are] technical concerns as to the verification of these emission reductions" (pg. 10). What is net zero? The meaning of "net-zero" continues to cofound regulators, investors, and other private sector actors alike. Some companies claim they will become net-zero through purchasing carbon credits, but that does not offset global aggregate emissions; others indicate that they will rely on technologies that are almost ready to be deployed, or under development, but that is obviously problematic since it is anyone's guess how such technology will function in practice, and how much it will cost if it indeed becomes available. Evidently, below the excitement about corporate emission's reduction commitments and the growing groundswell of private-sector actors engaged in climate change governance, therefore, lies much confusion about what these targets and pledges really mean, and how accountability will play out. This has particularly salient implications for climate change governance because, should the fragmentation in metrics and disclosures continue, it will likely divert much-needed climate change governance resources from other areas, or worse attract sustainable investments into initiatives, technologies and companies that are making the deep-rooted structural changes required to avert climate change.

In short governments, investors, civil society, as well as companies all have a stake in how "carbon-based" governance should, but doesn't, function. To address climate change through the diagnosis of stopping the cough, while not impossible, requires much more concerted efforts towards standardisation and transparency. This process has a long way to go, demonstrated throughout this report.

2.2. A Brief Introduction to Carbon-Based Governance Actors

Problems with the standardisation, measurement, and tracking of carbon emissions with respect to the corporate sector are not entirely new. Indeed, such issues are being addressed by non-state, hybrid, and public-private climate change governance actors. The aim of these private actors, ostensibly, is to fill the public climate governance—and especially carbon emissions—gaps (Widerberg & Pattberg, 2017).

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The Science-Based Targets Initiative (SBTi)

The Science-Based Targets Initiative (SBTi) ensures that companies create emission's reduction plans that align to the IPCC's scientific consensus. Rather than a confusing panoply of carbon reduction pledges, SBTi addresses underlying issues of consistency and accuracy of company emissions inventories, plans and goals. Pre-empting EU regulation, the SBTi has already defined net-zero emissions as "zero emissions through a company's value chain (Scope 3), over and above Scope 1 and Scope 2 emissions." The "scopes" (1, 2, and 3) refer to the GHG Protocol's carbon measurement standard—another bottom-up "carbon-governance" initiative—that divides the measurement of corporate emissions among (1) direct emissions, (2) emissions from energy, and (3) emissions throughout the entire value-chain. So far, through the SBTi, over 1,000 companies are certified as taking "science-based" climate *action* and 411 companies have an approved "science-based" carbon reduction *target.* All of this science-based target-setting is likely to increase demand for carbon measurement and verification.

The Task Force on Climate-Related Financial Disclosure (TCFD)

Likewise, the Task Force on Climate-Related Financial Disclosure (TCFD) is quickly making inroads into the corporate sector. Many companies fail to account for physical risks from climate change (Farmer et al., 2020), which is one main focus of the TCFD. It has enlisted over a 1,000 companies to disclose climate *risks* (physical, financial, and material). It was inaugurated by Mark Carney and Michael Bloomberg, with Janet Yellen recently climbing on board. Thus, there is a growing private-led ecosystem to support carbon commitments, carbon disclosures, and carbon alignment to the Paris Agreement.

Yet, signing up to take action is one step but actual reductions entails more substantive, rather than merely rhetorical, commitment ((Pope & Waernas, 2016; Talbot & Boiral, 2018). For instance, the TCFD focuses on future *risks* that may arise from climate change, which says very little about what companies are doing to lower

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emissions or create new eco-products. It moreover does not pin them down to much measurable improvement with respect to climate change, such as specific steps to address their emissions. Preparing for climate change regulations, physical risks, and otherwise financial and material risks that a company may face seems to be more about making the correct business plans than about transforming to a low-carbon-orientated company. This might explain the rapid uptake in corporate membership, as companies perceive the TCFD to require soft commitment while it delivers effectively on green branding strategy (Tremblay-Boire et al., 2016)

Actual reduction of emissions and systematic decarbonisations—substantive rather than rhetorical commitment—are what is required to meet the climate crisis. Apart from the risk-oriented frame promulgated by the TCFD among others (Sustainability Accounting Standards Board), detractors point out that these initiatives are yet another example of how private actors create the "rules of the game" (Hoffman & Glancy, 2006). That can give advantages to some actors at the expense of others, or worse water down the rules of a system Such as claim seems at least partially justified for the standardization of corporate-level GHG-carbon measurement and monitoring. For example, the World Resources Institute (WRI) and the World Business Council on Sustainable Development (WBCSD) launched the GHG Protocol in 2001. Although it received some funding and input from public actors (Green, 2013)—making it a "hybrid" climate governance standard (Jordan et al., 2015; Marx, 2019)—it was largely built by private actors, and to this day receives funding from Chevron and BP, which on its own should raise some eyebrows.

Indeed, governance initiatives that are reliant on the standardisation of carbon emissions involves informal rule-making by many diffuse, often privately-led, actors (Bernstein et al., 2010). The GHG Protocol was quickly followed by ISO-14064-1, a separate corporate GHG measurement standard launched by the International Standards Organization (ISO). While ISO could be considered a "hybrid" governance organisation, it can potentially exert more influence over the private sector via its connection to the WTO; it has more regulatory authority (Clapp, 1998). But the ISO GHG inventory standard appears to be going out of favour, as shown in Section 6 of this report. Clearly corporates favour the GHG Protocol because there are no

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enforcement mechanisms attached to it, which therefore allows the greatest flexibility in reporting emissions, even whilst following a common blueprint. While some scholars attest to the ingenuity of the GHG Protocol to allow bottom-up carbon commitments (Hale, 2017)—and it should be recognised as helping with private-led climate change governance experiments (Hoffmann, 2011)others point out the inherent inconsistency in the GHG Protocol's and ISO 14064-1 "Scope" emissions measurement process:

> There is no agreed-on approach or single standard to quantitatively assess [GHG] contributions [...] the scope of emissions covered by different actors (direct or Scope 1 emissions versus indirect or Scope 2 or 3 emissions, per the Greenhouse Gas Protocol/ISO 14064-1 classification), target and base years, and counterfactuals or scenarios used to evaluate additional impact ["baseline"] […] Such scope distinctions are critical, as for many actors' efforts, impacts are considerably greater for indirect (Scope 2 and 3) than for direct (Scope 1) emissions [...] making attribution of emissions and resulting reductions complicated (Hsu et al., 2019: 12).

Following the measurement of corporate carbon emissions, which is the first step in the process of emissions plans and carbon pledges, corporations can verify their emissions data. In some regions and stock exchanges, third-party carbon verification is mandatory. On the other hand, verification (ensuring transparency and consistency of its carbon emissions inventory measurement) is discretionary under voluntary disclosure,. In other words, if firms voluntarily disclose their emissions inventories, there is no easy way to validate the accuracy of the profile. In addition, the following year the same firm is at liberty to use an entirely different reporting or measurement structure, with negative implications for measuring progress over time. In any case, carbon verification remains important to the overall efficacy of carbon-based governance. While carbon verification actors number in the hundreds, depending on local needs and legislation, the Gold Standard (developed by WWF), VER+ (developed by TÜV SÜD), and VCS (developed jointly by ICROA, IETA, and the Climate Group) are considered the top three. Indeed, these three carbon verification actors feature prominently in our network analysis in section 4 below.

After verification of a corporate emissions inventory, the company can choose to disclose emissions. It is estimated that over 80% of corporate carbon disclosures

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worldwide are now voluntary (CDP, 2019). Sometimes these disclosures are made to the public, but often they are not. Indeed, to gather data for this report, we struggled to obtain corporate-level emissions data from open data sources. This is a problem because keeping track of corporate carbon is evidently a key feature of climate change governance. For carbon disclosure, corporations tend to use one of three platforms: the Global Reporting Initiative (GRI), a hybrid arrangement spearheaded by UNEP and CERES, the CDP (a private organisation formerly called the "Carbon Disclosure Project"), or the ISO 14064-2 guidelines (from ISO). The latter two do not provide freely accessible corporate-level data. And while data are freely accessible from the GRI website, the many changes made to the GRI reporting standards—they have updated and revised the standards a handful of times—makes it very difficult to compare companies over time, which severely restricts analysis of emissions at the corporate level(However, we are able to extract these data by mining the text of the corporate reports in section 6). Indeed, in prior literature researchers have shown that, while the GRI is openly accessible, the emissions disclosures embedded within sustainability reports do not supply very dependable information, due in large part to the propensity of firms to alter their reporting guidelines from year to year, and from sector to sector (Boiral, 2008; Boiral & Henri, 2017).

Typically, but not always, corporate carbon emissions profiles are published annually and can be aggregated by sector, country, or stock exchange. Voluntary carbon disclosure itself is not always straightforward, however. For example, even though each are equally acceptable, below are the eight different sector-specific ways carbon emissions can be disclosed to the CDP.

Table 1: The Eight Different ways companies voluntarily report to the CDP

Carbon Metric	Sector
Carbon intensity (gCO2 / RTK)	Airlines
Average new vehicle emissions (grams of CO2 per kilometre [NEDC])	Autos
Carbon intensity (tCO2e / t aluminium)	Aluminium
N/A	Coal Mining
Carbon intensity (metric tonnes of CO2 per MWh electricity generation)	Electricity Utilities

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Carbon Metric	Sector
Emissions intensity (gCO2e / MJ)	Oil & Gas
Carbon intensity (tonnes of CO2 per tonne of pulp, paper and paperboard)	Paper
Carbon intensity (tonnes of CO2 per tonne of steel)	Steel

These different types of carbon reporting silo industries and make comparisons difficult, even for the most astute observer (Busch et al., 2020). An even more critical perspective is that platforms such as the CDP lead to misleading disclosures and false accounts, which undermines institutional and societal goals (Callery & Perkins, 2020). And, despite efforts to amalgamate the many standards by the Carbon Disclosure Standards Board (CDSB), these critical issues for carbon-based climate governance remain. There are simply too many different ways to measure, verify, and report emissions (Callery & Perkins, 2020), and these private organisations have not helped to mitigate the situation. One obvious consequence is a potential race to the bottom—dirty industries will lag on carbon verification and disclosure because there is no inter-industry incentive to change. Simultaneously, industries that are making substantive commitments and improvements will be harder to detect. They might, as a consequence, not receive financing for progress on climate change when they should. To bring the argument forward to the present, government funding from the proposed Green New Deals in Europe, and possibly in the US, might go to companies that do not deserve the funding. This will have negative consequences for investment, innovation, and the global public good dimensions of a clean climate. It does not bode well for bottom-up climate change governance.

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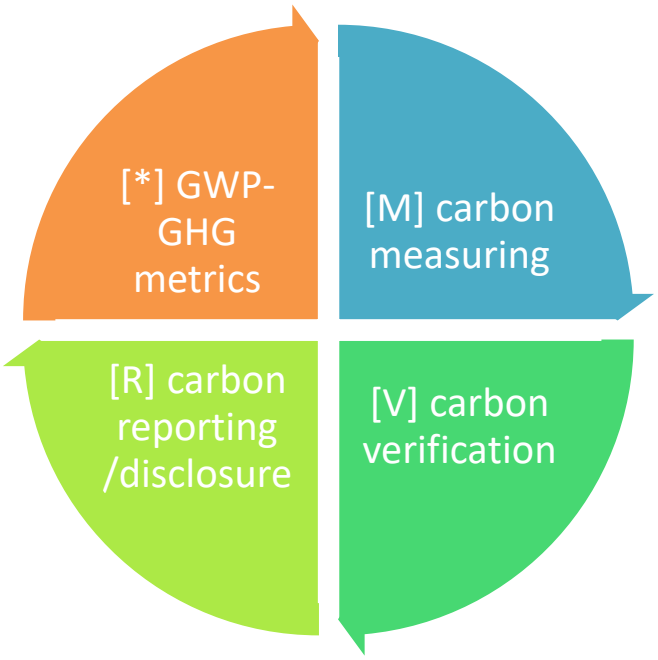
Chart 1: "Bottom-up" Governance of Emissions



This chart depicts the four primary mechanisms for governing carbon emissions: [*] conversion to "carbon-equivalents" [M] measuring carbon emissions at organisational level, [V] verifying the carbon measurement, and finally [R] disclosing these emissions profiles. While Global Warming Potential – GHG metrics remains the remit of the IPCC, yet some private actors such as the SBTi appear to be moving into a more authoritative position here.

Evidently, an explosion of carbon-based, largely bottom-up, governance actors has ensued, with some negative implications for the overall efficacy of the regime. Much competition among private actors exists in monitoring, reporting, disclosing, and verifying carbon emissions (Lovell et al., 2011; Green, 2013).

But the carbon regime is not entirely subsumed by the private sector just yet. Private actors continue to anchor to public governance standards. They also tend to rely on delegated authority from public climate governance actors. They are thus "anchored" to top-down regulatory mechanisms and organisations of the past (Sengers et al., 2020). There is some path dependency here (Unruh, 2000). Indeed, the logic of solving climate change through mitigating the carbon emissions cough draws heavily on IPCC and UNFCCC science and policy recommendations since 1990. Because of the private sector's connection to public climate governance actors, we refer to public climate change governance actors such as the CDM and EU ETS as "anchors". The EU-ETS is a quintessential carbon-based governance anchor: it has created the original rules of the game for companies that produce carbon emissions, and these

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emissions are priced, and how they can be traded across borders and amongst other companies (Texeido et al., 2019). Likewise, the CDM rolled out the initial rules for a global carbon governance scheme, intent on helping lesser developed countries escape the carbon trap and carbon lock-in (Unruh, 2000). The next section deals specifically with these governance anchors and the architecture they blueprinted in the earlier days of climate change governance.

Apart from these multilateral and international climate change anchors, there exist a number of state-level carbon reduction mandates and legislations (for a complete list see climate-laws.org database). Most follow the carbon-based governance logic; that is, the state laws do not indicate GHG, but rather carbon, neutrality or reductions. State-level carbon lock-in mirrors the trends in bottom-up climate change governance lock-in. Indeed, a handful of state-led climate legislation have mandated legally-binding carbon emissions reductions, but fail to mention the other six Kyoto gases. For example:

- Austria (carbon neutral by 2040)
- Brazil (37% reduction by 2025)
- China (carbon neutrality by 2060)
- Denmark (70% reduction of emissions by 2030; carbon neutral by 2050)
- Finland (80% reduction of emissions by 2050)
- Germany (55% reduction by 2030)
- Hungary (40% reduction by 2030)
- Japan (carbon neutrality by 2050)

Differently from private-led and voluntary initiatives, however, state-led efforts usually mandate 3rd party verification. However, verification is largely the the remit of private actors. But. interestingly, only three countries currently accept voluntary private disclosure initiatives (Canada, Switzerland, and the USA). Thus, this remains an unresolved public-private carbon governance issue we are unable to satisfactorily unpack here. Finally, there are stock-market mandated carbon emissions disclosures. For a complete detailed list of these, see the appendices.

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And so “net-zero” carbon emissions is not only a corporate carbon emissions measurement imperative. It also reflects country-level and stock exchange climate change ambitions through carbon mitigation channels. This provides even more research impetus to disentangle what carbon-governance means: the key actors and metrics, how these actors and metrics relate to one another. It also calls into question the functionality of such a highly fragmented system.

2.3. Is Carbon-Based Governance Working?

Yet, while much public legislation is in place, which relies heavily on private actors to measure and track emissions, several critical question remain: why hasn’t carbon-based governance been effective in driving down *greenhouse gas* emissions? What is blocking the delivery of the ultimate global public good: a clean atmosphere with decreasing levels of GHGs? To what extent can carbon governance function without the shadow of the state (Börzel & Risse, 2010)? Worldwide emissions continue to rise, suggesting that carbon governance has been largely unsuccessful. Separately, as shown in the second graph immediately below, other much more noxious emissions are climbing more rapidly than carbon, but these lesser-known Kyoto gases often escape the purview of policy-makers, investors, and corporate actors alike. The trends in emissions are alarming and call into question carbon-centric governance arrangements, metrics, and actors. The solutions and GHG reductions, so desperately needed now rather than hoped for by the year 2040 or 2050, appear nowhere in sight.

Some researchers suggest the penultimate problem lies in misguided incentive schemes; that incentives for the private sector do not align with the public goods benefit of delivering lower emissions (Keohane & Victor, 2016). Others suggest, similarly, that the private sector can only devote limited resources to deal with the collective action problem due to the prisoners’ dilemma problem (Geels et al., 2017; Bernstein & Hoffmann). In other words, a corporation that undertakes costly emissions reductions is not properly rewarded, and thus is likely to take only incremental, low-carbon action, in lock-step with industry peers As such, there is a real worry that carbon-centric governance is just a corporate “beehive” of activity “with few tangible outcomes” (Jones & Levy, 2007: 436).

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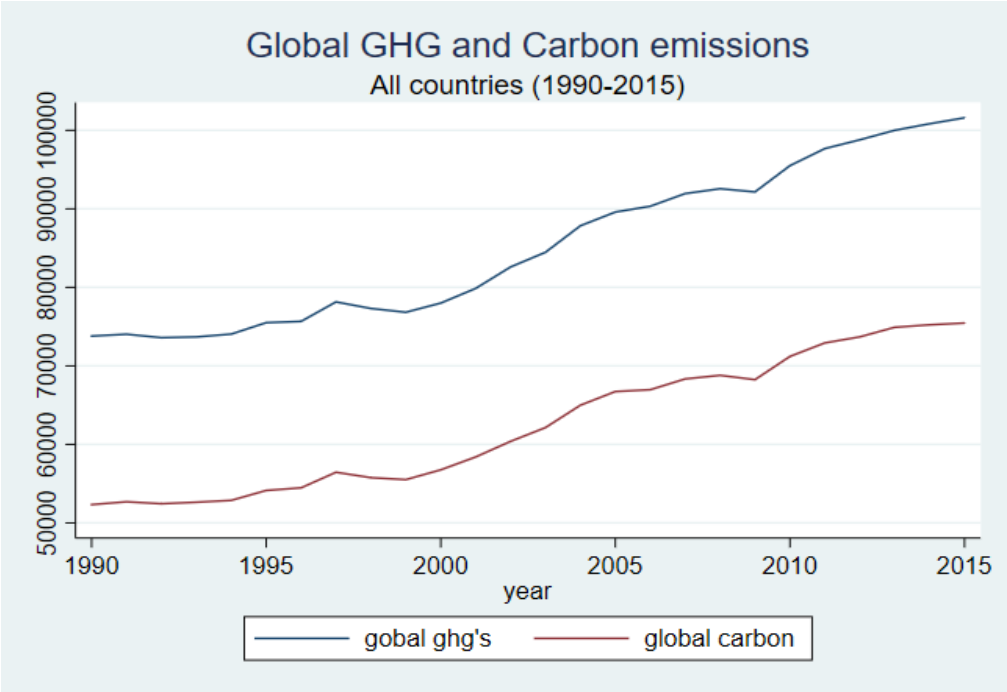
Graph 1: Global Increase in Greenhouse Gases and Carbon Emissions (1990-2015)



These critiques have led to others to call for a "post-carbon" governance transition (Farmer et al., 2019). Indeed, as Bernstein and Hoffmann (2019) contend, carbon as reduction as the guiding metaphor for climate governance might require substantial revision. Indeed, trends in emissions worldwide are cause for much consternation, as shown immediately below and above. In sum, despite the "groundswell" of private action in carbon-based governance, all greenhouse gases continue to rise, with the most potent Kyoto-gases rising the fastest in recent years. The rapid increase in global methane emissions in recent years is particularly alarming given that this gas has a far greater warming potential than carbon. This is depressing news. It suggests that carbon-based governance is largely failing, even with the buzz of private sector initiatives since the Copenhagen COP (Lovebrand et al., 2017; Jordan et al., 2015).

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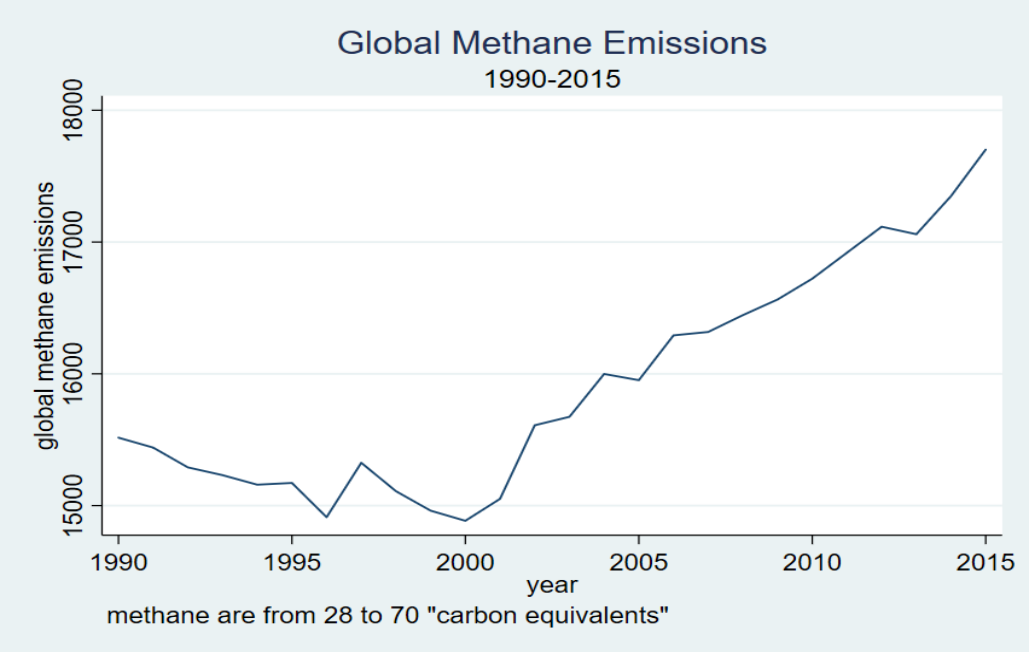
Graph 2: Increase in global methane emissions (1990-2015)



Global emissions trends based on author's rendition of WRI's CAIT and UNFCCC data (total metric tonnes). Notably, the graphs show carbon and methane gases rising in both developed and developing countries. This is highly problematic since methane is estimated to be 84 times more potent than CO2.

2.4. Research Gap: Carbon-Based Governance Actors

Even though the mitigation of carbon emissions is widely accepted as the primary governance instrument to combat climate change, there remains a dearth of systematic research on *carbon-based governance actors*. Knowledge about these actors, their relationships and activities, however, can help illuminate how *carbon lock-in* can be avoided (Unruh, 2002). This dearth of research is particularly acute for standardization of carbon-governance procedures (e.g. how to measure, report, and verify carbon emissions) (Stechemesser & Guenther, 2012; Galik et al., 2009). And, while we acknowledge the important research on the Global Climate Change Regime (GCCR) and Trans-Governmental Climate Initiatives (TGCIs) (Betsill & Bulkeley, 2006; Bäckstrand, 2008; Pattberg & Stripple, 2008; Hoffmann, 2011; Green, 2014; Hale & Roger, 2014; Widerberg et al., 2016), that body of literature does not explicitly focus on the private sector and corporations. Therefore, it faces difficulty explaining the actions of the private sector, in particular for carbon emissions governance With the exception of Green (2013; 2017), who conducts a network analysis of private and public carbon actors, as well as Lee et al. (2013) who examine inconsistencies across

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various North American carbon standardization and markets, there is a “paucity of [carbon governance] literature [which] is remarkable given the high importance [for] consistency in this field” (Lee et al., 2013: 54). Our analysis fills this important research gap.

Moreover, because the Paris Agreement implies that countries shall collect and report NDCs (Nationally Determined Contributions) to global emissions reductions, there is therefore a separate but related research imperative to understand the collective capacity of carbon-based actors to deliver on measurement and reporting of country-level emissions (Hsu et al., 2019: 11). Prior public-led governance experiments encountered much difficulty measuring and monitoring emissions, cited as one reason for the Cambrian explosion of private actors (Green, 2013); and now, it seems, there is a tacit reliance on the private sector to track and collate emissions, even outside of the corporate sphere.

Collating national emissions profiles, especially for developing countries lacking resources to collate these data (Pauw et al., 2020), will increasingly rely on this panoply of private, carbon-based governance actors which we map out below. Even though countries have undertaken emissions inventories for decades, the private sector is responsible for a fair share of global emissions, which have only been estimated thus far. In addition, the collection, dissemination, and disclosure of emissions is becoming ever more the remit of private actors, as shown by the increasingly prominent role of the World Resources Institute’s Climate Data Explorer (CAIT.WRI.org), which imputes data from the UNFCCC and the US EPA. To accurately create NDCs with respect to emissions, therefore, private sector data and participation are absolutely crucial (Pauw et al., 2020). Therefore, a “significant next step for transnational climate governance would be to publish guidelines and best practices for third-party [carbon] monitoring and verification in order to strengthen the link between pledges for proactive action and ultimate follow-through by corporations” (Hsueh, 2019: 24). In sum, the burden of collating greenhouse gas accounts—to enable accurate monitoring NDCs under the Paris Agreement—is likely to rely on the carbon-based governance actors we map out throughout this report. In some respects,

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then, the Paris Agreement's success hinges on the accuracy, transparency, and commitment of these independent actors.

3. The Public Dimension of Carbon-Based Governance

The previous section introduced the cast of private actors we expand on throughout this report, among others. However, these private actors continue to rely on public, top-down governance standards developed by the public actors (Hoffmann, 2011). This section highlights the main architectural elements of carbon-based governance originally drawn up by public actors. It develops a storyline for carbon-based governance and carbon framing under development since 1990. Carbon-based governance is "a clear example of something created, in this instance mostly by public institutions and governments" (Lovell et al., 2010: 19), which means that public actors can still steer the ship if needed. Indeed, this could be an important point of focus for the European Commission, with pending legislation such as the EU Taxonomy on Sustainable Investment. The state can still loom in the background (Börzel & Risse, 2010: 114) and, as such, it is "important to appreciate the implications of [climate governance's] public sector origin" (ibid) because it suggests how these two governance dimensions might meet to improve carbon-based governance through hybrid actor and governance approaches (Jordan et al., 2015; Marx, 2019).

3.1. Anchoring to Carbon: An Outdated Approach?

Sensibly, the dominant frame to combat climate change has revolved around the mitigation of carbon emissions. The IPCC and the UNFCCC have promulgated the science that anthropocentric greenhouse gas emissions are the main cause of climate change. Thus it is now widely agreed that GHGs are the symptom responsible for causing the climate change disease. Under that axiom, the most straightforward solution is, sensibly, to develop policies with the aim to mitigate anthropocentric greenhouse gas emissions. The EU has taken the IPCC's prescriptions one step further by setting up the world's first multi-country carbon trading platform (EU-ETS), as well as introducing the most stringent climate change regulations in the world. But the failure to drive emissions abatement through such carbon-based governance

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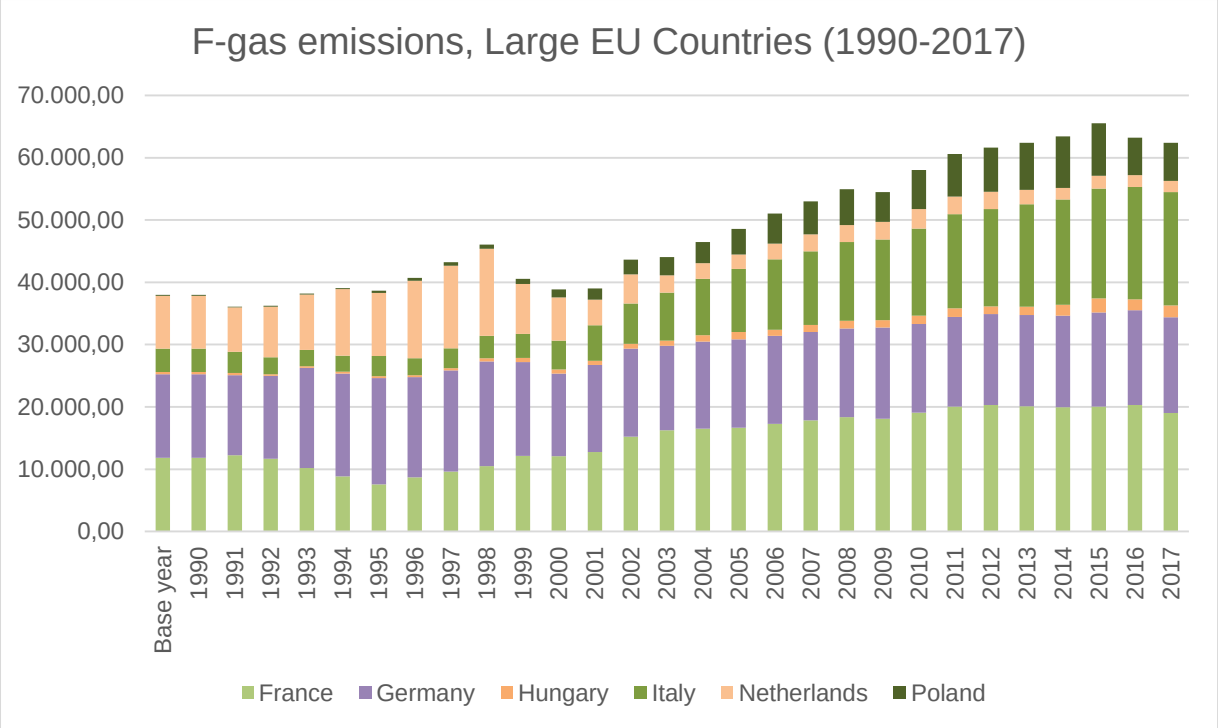
approaches leads one to question if anchoring to carbon—as the central metric to govern the climate—has run its course.

For example, while the public-led goal-setting for emissions reductions has, *prima facie*, worked in some places such as the EU—it has achieved its 2020 emission's reduction targets—it is unclear if carbon-based governance can work elsewhere. Moreover, there is ample evidence to suggest that EU countries have simply "offshored" their greenhouse gas-intensive industries (Cave & Blomquist, 2008) Promising developments such as regulating "carbon-embodied" goods are welcome (EC, 2019). Emissions continue unabated in many parts of the world.

Graph 3: F-Gas Emissions upward trends within top GHG emitting EU countries



F gases include: HFCs (which are between 140 and 14,800 carbon equivalent units); PFCs (5,210 and 18,200 carbon equivalents); SF4 (between 16,300 and 32,600 carbon equivalent units), NF3 (2,300-20,700 carbon equivalent units). A small rise in F-gases thus translates to a precipitous rise in carbon-equivalents. While there seems to be a levelling off from 2014-2017, the emissions inventories need to be carefully understood and governed.

Climate governance experiments such as prescriptive regulations—for instance, prescribing less carbon emissions "coughing"—from top-down governance initiatives did not work very well (Hoffmann, 2011). The carbon "metaphor" may have run its

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course (Bernstein & Hoffmann, 2019). And, while the EU is often touted as a success for climate change governance, a lesser-known fact is that, while *carbon* emissions decreased within the EU, other more deleterious Kyoto gases such as HFCs and F-gases have risen precipitously (see Graph 3). The rise in other GHGs apart from carbon erases much of the progress on greenhouse gas reductions in the EU (since, for example, one tonne of F-gas is equivalent to up to 32,600 tonnes of carbon). Overlooking other Kyoto Greenhouse gases such as F-gases demonstrates the perils and pitfalls that may occur through the unitary focus on carbon for climate change governance. Indeed, *carbon governance* can overshadow governance of other *greenhouse gas* emissions, which could end up being detrimental as other gases experience harmful surges in the coming years. One suggestion is to govern each of the six Kyoto gases individually, rather than converting them all into carbon equivalents which is confusing and appears to open up many loopholes for industry. For example, while the EU touts its carbon reductions since 1990 (it has met its 20% carbon reduction goal), F-gases are on the rise since 2000, as shown above. F-gases are, on average, thousands of times more potent than carbon, in terms of Global Warming Potential (GWP).

Separately, there is strong evidence that carbon emissions tend to shift from EU countries to less stringent carbon regulatory countries—i.e., a relocation of pollution-intensive manufacturing abroad. Indeed, this well-known and empirically supported phenomenon is referred to as the Pollution Haven Hypothesis or PHH (Jaffe et al. 1995; Cole, 2004; Taylor, 2005; Cave & Blomquist, 2008; Cao & Prakash, 2010; Yang et al., 2018). Shifting carbon-embodied production offshore does nothing to lower global aggregate emissions; it does nothing to deliver the global public good of a cleaner climate. In short, other deleterious Kyoto Protocol GHGs have flown under the radar in carbon-based governance. This public climate governance failure was demonstrably exposed in the Volkswagen diesel emissions scandal, discussed in greater detail below.

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3.1.1. An Unstable Foundation for Carbon Governance: Global Warming Potentials

Pollution havens and "creative accounting" aside (Voosen, 2009), few researchers have highlighted the deeply engrained *carbon metric* standardization: Global Warming Potentials (GWPs). GWPs are the greenhouse gas GHG to carbon-equivalents method. This conversion metric was inherited from the IPCC's First Assessment Report (FAR-1990). In that report, IPCC scientists recommended to standardize carbon as the representative greenhouse gas; it further recommended that all other "Kyoto gases" should be converted into carbon equivalents in order to streamline policy. The policy logic was that carbon could serve as a basis for market mechanisms to reduce GHGs. Through a conversion formula called "Global Warming Potentials", (GWPs) each of the six main Kyoto gases are converted into CO2-equivalents (CO2-e). However, revisions to this conversion metric are made with each Assessment Report, which is published every 4-7 years, with important implications for carbon-based governance. Due to these revisions, over time carbon-equivalents succumb to fluctuations in measurement, with consequences for carbon markets as well (O'Neill, 1997; 2003).[1] This serves to undermine the system because it is based on a standardised, but oscillating, conversion metric. For example, shown in the graph below, nitrous oxide's carbon-equivalent—the main culprit of the VW emissions scandal—has gone up and down according to each IPCC report. This has evidently opened up loopholes for industry, while also providing too much leeway for popular politicians.

The chart below depicts the oscillating carbon conversion of Nitrous Oxide, depending on the IPCC report year and policy "time-horizon" chosen by the party responsible for the measurement. For example, in 1996 Methane's carbon-equivalent, with the time-horizon "choice" of 50 years, was "21"; while in the IPCC's 2013 report, it was revised upward to "28" under the same time-horizon policy choice. Of note, the US EPA

[1] [In a report to US Congress in 1991, Bradley et al write: "Note, however, that the GWP coefficients for the gases studied are subject to significant uncertainty and are being re-evaluated through the IPCC process, which could result in substantial changes in reported values" (pg. vi)]. Indeed, this testimony proved prescient, as GWPs were revised with each IPCC report since.

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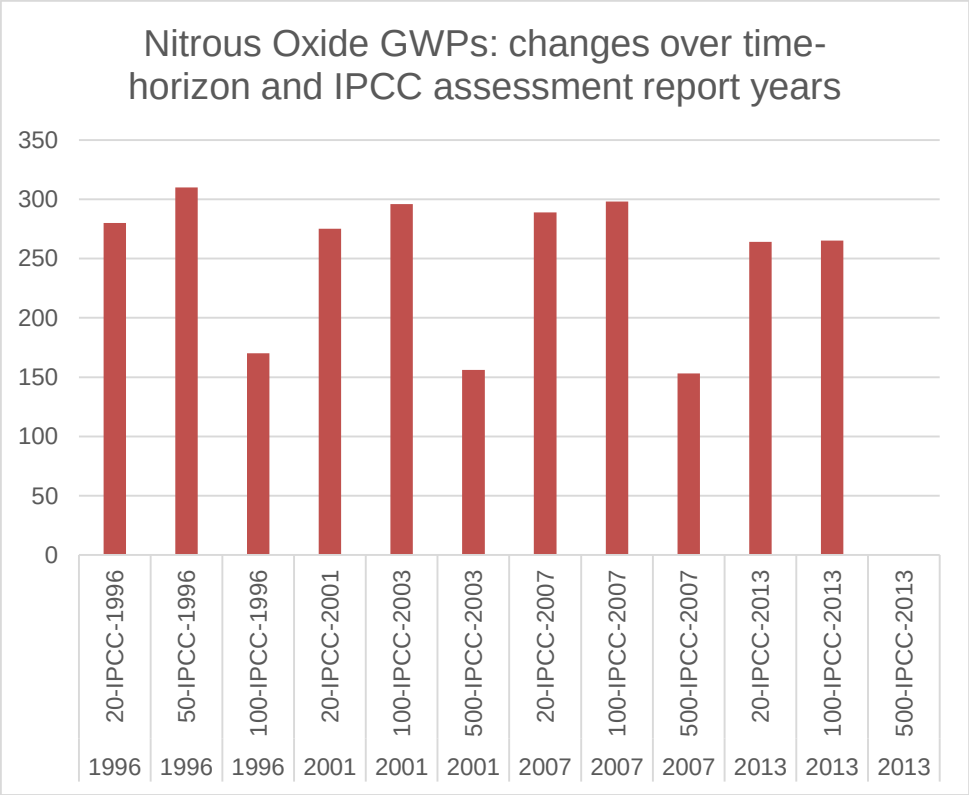
continues to use the IPCC's 2007 conversion. So as the IPCC releases new assessment reports, the bedrock of the carbon governance regime shifts (the conversion of all other GHGs into carbon),. It is difficult to govern carbon based on conversion metrics that are under constant revision. Moreover, from database to database, carbon equivalents use variations of the GWP. This means that, for example, the World Resources Institute emissions inventories, which use the IPCC 2007 GWP conversion, must be converted in order to compare them with the UNFCCC's data, which uses the 2013. The implication of these various "exchange rates" for GHGs for the private sector provides loopholes for corporate "regime-shifting" from one greenhouse gas to another (Breitmeier et al., 2011).

Graph 4: Nitrous Oxide Carbon-Equivalent Conversion, Revisions from 1996-2013



Nitrous oxide's carbon equivalent can change from: 170, 289, 310, 298, 153: 20-year, 100-year-SAR, 100-year, 500-year. In other words, one tonne of nitrous oxide fluctuates between 170 and 310 carbon tonnes, depending on "policy choice". Source: UNFCCC data.

Indeed, as the world witnessed in the VW "diesel-gate" scandal, there are other harmful greenhouse gases that can easily escape detection of regulators. Carbon governance failures arise from the occlusion of gases besides carbon. In that case, VW's diesel cars were found to emit nitrous oxide at 40 times greater levels than found

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in laboratory testing. Because the Global Warming Potential (GWP) of nitrous oxide is, on average, “298” carbon tonnes (according to the latest IPCC report, but is variously converted between 170 and 310 carbon-equivalents shown in graph 4), this marked a serious carbon governance gap. According to estimates provided by the US-EPA, while normal petrol cars emit on average 4,600,000 grams of carbon equivalent per year, VW diesel-gate cars released 46,000 grams of *nitrous oxide per year*. To the laymen, this appears that the diesel autos are indeed much cleaner: however, 46,000 grams of *nitrous oxide* represents 14 metric tons of CO2-e (European Federation for Transport and Environment AISBL, 2018), or nearly four times greater than an average petrol car.

What is worse is that diesel-gate cars also released CO2, so their overall GHG emissions may have been 5 times higher than petrol cars (ibid). At the same time, these autos were sold as “cleaner diesel” and in some instances received generous tax rebates. Clearly, based on these factors alone, it is critical to understand how GWPs impact carbon-based governance. A small error in measurement of C02-e, for instance, could lead to substantial climate change impacts, as demonstrated by the VW scandal. Evidence of carbon lock-in abound (Unruh, 2000), the irony is that more dirty diesel autos have been put on the road since diesel-gate than have been fixed (European Federation for Transport and Environment AISBL, 2018: 33). This also shows the pitfalls of government and industry interdependencies, pointed out elsewhere as detrimental to climate change governance (Newel & Paterson, 1998). Indeed, in the case here, there is much evidence to suggest that both regulator’s over-reliance on industry “self-regulation”, concurrent with the temptation to use carbon-equivalent’s loopholes, led to one of the greatest climate change governance scandals since climate governance began.

Another case of problematic climate governance based on the conversion to carbon equivalents occurred with HFCs (hydrofluorocarbons). From the third to the fourth IPCC report, the carbon equivalent for HFCs carbon conversion rose significantly, giving some investors windfall profits just for holding “carbon” credits that mitigated HFCs (MacKenzie, 2009; Velders et al., 2009) meanwhile, most other carbon offsets and carbon markets became severely distorted due to this change in GWP conversion

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rate. Markets with such inconsistencies are not only unreliable, they are “lose-lose” because they tend to drive away private actors and investors while not driving down greenhouse gas emissions. Even though it was promulgated as a “flexible” and “market-based” solution, for example, the EU has for years artificially propped up and repaired the price of EU-E|TS emissions. This does not seem like a market-based solution. Finally, such changes to the IPCC metrics open up regulators (and scientists) to intense lobbying because a small change in GWPs can lead to potentially exorbitant cost increases to particular sector.

3.1.2. How does the GWP Anchor to the Corporate Sector?

At the corporate level, it is evident that most are largely unaware of other Kyoto gases – whether this is by choice or ignorance is a separate matter. Indeed, the majority of FTSE-100 companies do not mention any GHG besides carbon throughout their reporting. This is borne out in the data we obtained from 500 corporate sustainability reports, discussed in greater detail in section 6. FTSE companies mentioned carbon over 13,000 times, methane only 760 times, nitrous oxide 373 times, while the other three Kyoto gases are mentioned under a hundred times. And, if they do mention these other Kyoto gases, FTSE companies often fail to explicitly demonstrate a systematic and consistent conversion of the other GHGs into carbon-equivalents; in other words, they do not convey which GWP conversion is used, according to what IPCC report, and over what time horizon, 20, 100, or 500 years. It is therefore unclear the extent to which their emissions of other gases apart from carbon are rising or falling.

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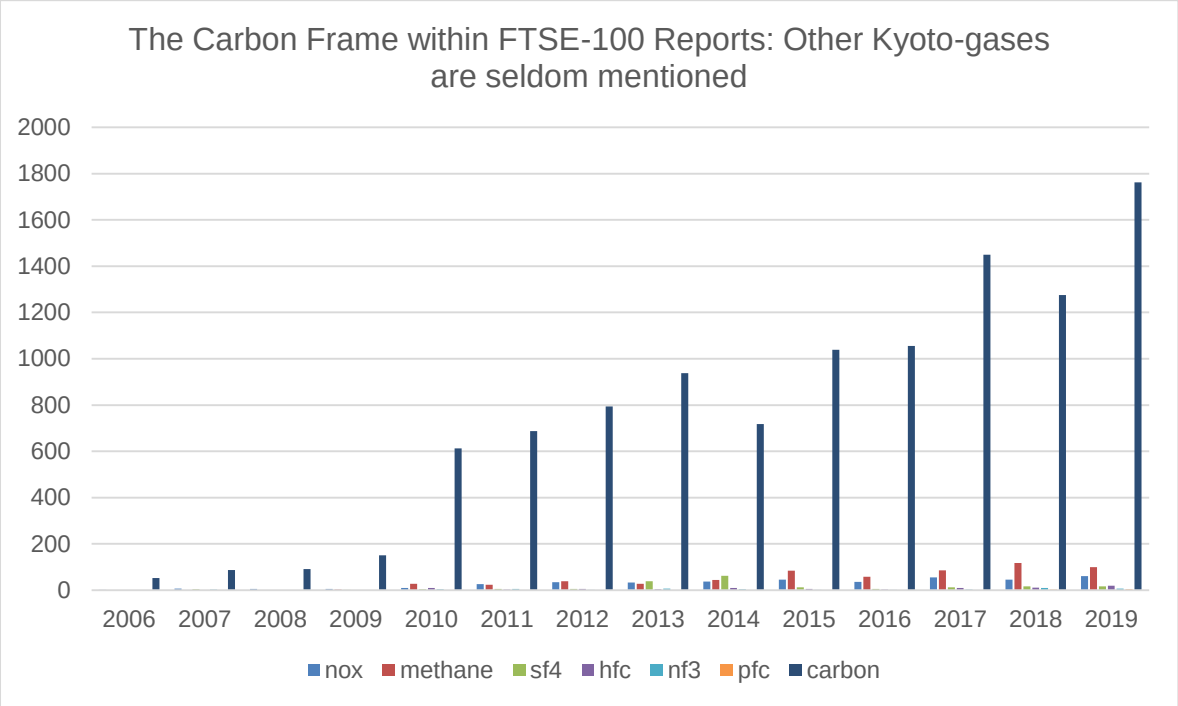
Graph 5: Corporate sustainability focus almost exclusively on carbon dioxide



Total mentions of Kyoto GHGs across 500 FTSE Sustainability Reports. This graphic shows that corporations are heavily vested in the carbon-centric governance frame. However, we know that corporations emit other gases besides carbon, evidenced by "diesel-gate." So ignoring these other gases has important consequences for emissions-based governance.

In sum, the outsized focus on carbon—even within the EU, which is considered the exemplar of climate change governance—seems to have come at the expense of equally if not more important governance efforts to drive down noxious Kyoto Gases. For example, HFCs and F-Gases are thousands of times more potent than carbon, but do not make headlines and are very infrequently incorporated into private sector initiatives for emissions reductions, which are overwhelmingly carbon-centric. To take one example, in the last decade F-gases have risen across the EU and non-EU countries alike. This matters because F-gases are up to 20,000 times more potent than carbon (and even as high as 32,600 carbon equivalents for SF4). Likewise, as shown above with the VW scandal, nitrous oxide emissions are about 300 times more potent than carbon. Carbon may not be the scariest bogeyman after all. A governance suggestion would be to quickly and transparently begin governing each of the Kyoto gases independently, and eventually abandon GWPs, unless the conversion system can be cemented.

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Interestingly, although the private sector has become deeply involved with measuring, monitoring, and verifying emissions, they largely fail to discuss the critical carbon framing role played by the GWP conversion. Indeed, only one prominent private carbon governance actor, Science-Based Targets Initiative (SBTi), details how Kyoto gases are converted to carbon equivalents. Even the Carbon Disclosure's Standard's Board (CDSB), with its main purpose to amalgamate the hundreds of carbon standards, fails to address the issue of GWPs and the alterations to carbon conversion rates over time. Indeed, the periodic revision of GWPs has immense consequences for climate change governance that are largely ignored (O'Neill, 1997; 2003). As a result, many companies do not even disclose other GHGs apart from carbon. As the world witnessed in the VW diesel-gate, however, carbon-based governance, with its outsized focus on only carbon, can lead to egregious emissions scandals with far-reaching consequences for climate change governance, and climate change in general. With gases that have GWP conversions that are thousands of times the potency of carbon, these issues cannot continue to be ignored.

3.2. Carbon frames of the IPCC and UNFCCC: How Did We Get Here?

UNFCCC and IPCC Carbon Framing: Following the success of the global ozone governance, the Montreal Protocol and the Vienna Convention, governments came together to create another intergovernmental body to confront climate change (Benedick, 1998). However, the political, economic, social, and technological processes to manage how GHGs should be mitigated, and their respective levels of longevity and damage in the atmosphere, was of course a unique global governance problem, much greater than ozone depleting substances (Fankhauser, 1994; Kandlikar, 1995; Hammitt et al. 1996). In 1988, the IPCC was created to solidify climate science, largely based on the report "Scientific Committee on Problems of the Environment" (SCOPE), while the UNFCCC was initiated several years later to guide climate policies. They have a symbiotic relationship whereby the line between science and politics is often blurred (Green, 2017). However, while the IPCC is mainly a scientific consensus body, the UNFCCC is an international environmental treaty with the explicit objective to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate

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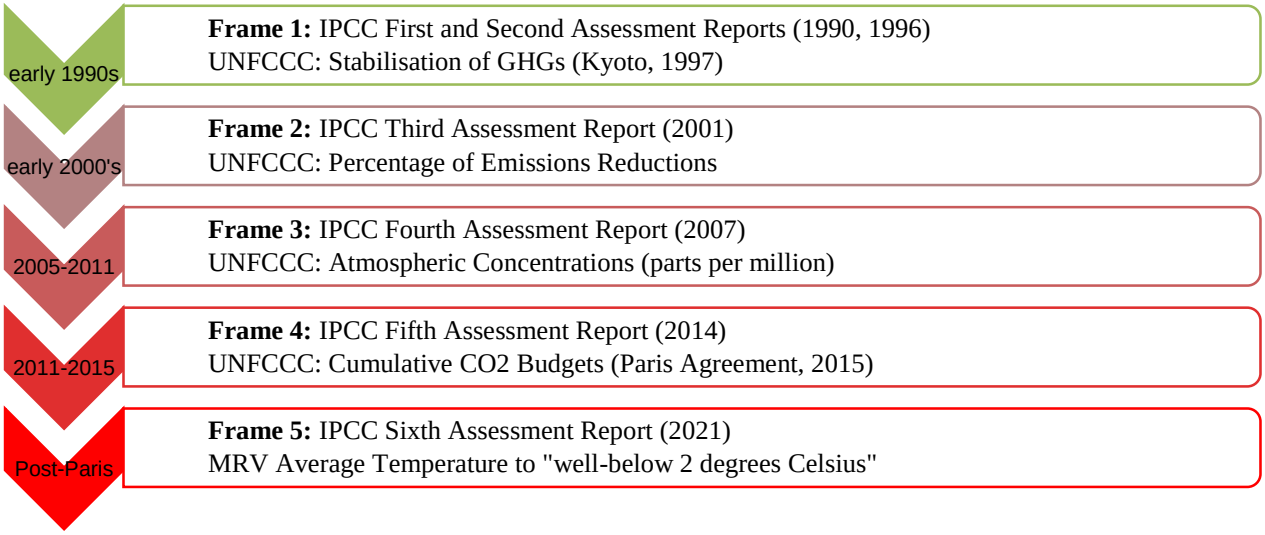
system [to enable] ecosystems to adapt naturally to climate change […] and to enable economic development to proceed in a sustainable manner" (Article 2, The United Nations Framework Convention on Climate Change).

Hence, according to the mandate of the UNFCCC, climate change governance is anchored to sustainable *economic development*. The imperative is thus to drive down greenhouse gas emissions to a scientifically acceptable level without *causing unnecessary economic harm*. As a consequence, market-enabling mechanisms were enshrined in the initial framework, a factor that contributed to the rush to create carbon units in order to expand market-enabling carbon markets (Oberthür & Ott, 1999). Below we expand on the IPCC/UNFCCC issue frames that have largely revolved around carbon-governance, which informs how the Carbon Regime infrastructure exists today (see Chart 2).

Chart 2: The Five GHG/carbon emissions "frames" promulgated by the IPCC/UNFCCC



Scholars have highlighted the impact of framing in policymaking, in particular the framing of "risk" (Thompson & Rayner, 1998; Dayton, 2000). Discursive framing strategies in climate governance can "shape not only what is being discussed (thus setting agendas), but also how issues are discussed [...] and prognostic framing, which advances solutions to a problem [by] advancing certain problem definitions (e.g. climate change as 'market failure')" (Geels, 2014: 269). Indeed, there is a noticeable focus on carbon emissions (the "what") in the IPCC/UNFCCC frames. For example,

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the founding documents of the UNFCCC declared that its remit was to "stabilize *greenhouse gases* in the atmosphere", but by the 3rd frame the IPCC and UNFCCC were directing attention to atmospheric concentration of *carbon*. And this frame was integrated into the Kyoto Protocol—hence Kyoto's CDM largely deals with *carbon reductions through carbon* markets. However, in the fifth and latest frame, the discourse morphed into "keeping global mean temperature rises to well below two degrees Celsius", with the assumption, rather than explicit frame, that driving down carbon emissions should be a main avenue to reach that goal, because each of the five IPCC reports have made that science quite clear already. Future research might explore how the two-degree frame opens up even more space for manoeuvring and flexibility in approaches, and how this could introduce much uncertainty into the system.

One consequence of carbon frames is that, often, they are met with technological solutions or promises. This effect is flagged by some researchers as representing promises of technologies, or "technologies of prevarication" that are only under development and only serve to delay real action on emissions (McLaren & Markusson, 2020; Carton et al., 2020). Unfortunately, these frames are only reinforced by "Integrated Assessment Models" or IAMs, which happily incorporate technologies such as carbon capture in order to eliminate a the gap in emissions reductions plans (McLaren & Markusson, 2020). Below we briefly discuss the major carbon frames promulgated by the UNFCCC and aligned to the scientific assessments published by the IPCC. (*see* appendices for a detailed chart).

GHG Frame: The Stabilisation of GHGs (1990-2000): The IPCC's second assessment report (1996) developed guidelines for country-level GHG reporting guidelines. These were followed by "Good Practice Guidance and Uncertainty" (GPG 2000), and "Good Practice Guidance for Land Use, Land-Use Change and Forestry" (GPG LULUCF). The Kyoto Protocol mandated that these guidelines be followed for Annex-I countries and encouraged that non-Annex-I countries follow them as well. Good practices are defined as: transparency, completeness, consistency, comparability among countries, and accuracy. They define verification of GHGs as: "the comparison of inventory estimates with independent estimates" (IPCC, 2010: 10). These guidelines were again

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revised in IPCC's 2006 report as well as the Expert Meeting on Uncertainty and Validation of Emission Inventories in 2010. One novel measurement idea discussed, but never realized, was to use satellite, aircraft, flux towers, and other land-based monitoring instruments to measure and verify GHG emissions. It should be noted that "Good practices" for measuring GHGs (transparency, completeness, consistency, and comparability) remains a perennial problem in both the public and private sector (Lovell, 2014). Good practice guidelines are mirrored in carbon measurement, disclosure, and verification procedures instantiated by private actors.

Carbon Frame: Atmospheric Concentration of CO2 (2005-2011): In this era, Bioenergy with Carbon Capture and Storage (CCS), or BCCS, became the technological promise (or technology of prevarication). McLaren and Markusson (2020) explain that BCCS is a technology of prevarication because the technology was not, and still is not, fully developed—yet, these technologies became central to IAM modelling. This was due in large part to policy prescriptions of limiting *carbon emissions* which overshadowed other policy guidance such as a concerted and swift switch away from fossil fuel energy production (e.g. treating the cause of the climate change disease rather than the symptoms); or the obvious elephant in the room: global fossil fuel subsidies (Skovgaard & van Asselt, 2018). Furthermore the third Carbon Frame, centred on BCCS technology, had the effect of brining *negative emissions* into the carbon lexicon. Because biofuel emissions could theoretically be sequestered, and biofuel was at the time considered a "renewable energy fuel", it was postulated that BCCS was a "negative emissions" technology. Indeed, the BCCS carbon frame could be partially responsible for the current "net-zero" and "negative emissions" fervour so common in the corporate sector today.

Technocratic Frame: McLaren and Markusson (2020) draw attention to "technologies of prevarication" such as carbon capture and storage (CCS) and negative emissions technologies (NETs), as well as "new nuclear." These refer to "technological promises elicited by climate politics and policy" (pg. 392). Their main critique is that climate governance and climate science under the IPCC suffers immensely because it incorporates technologies that are not yet widely feasible into its models. The carbon policy frames stemming from unproven carbon reduction technologies such as CCS,

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NETs, and BCCS not only delay swift climate action, but also divert much-needed funding and research away from technologies that already exist (such as renewable energy and battery storage). Indeed, several examples of the difficulty, cost, and efficacy of CCS exist: after many years, Chevron opened a $2.5 billion CCS plant in Australia, which plans to inject 100m tons of carbon dioxide underneath a nature preserve; thus it is extremely costly and simply trades one environmental travesty for another. Likewise, in Mississippi, a CCS project budgeted for $3 billion but which eventually cost $7 billion, just came on line after years of delay. To put that in perspective, with the $7 billion it cost to inject carbon into the ground, a 4200 MW wind farm could have been constructed, providing carbon-free electricity to 4.2 million homes (based on recent cost of wind projects in the US).

Carbon frames are costly and also delay action on developing vaccines to the climate change disease, rather than the continuation of “masque-wearing” to mitigate carbon-coughing, while low-carbon technologies exist today. But, more germane to our analysis here, carbon frame are deeply integrated into climate change governance, especially private-led carbon-based governance.

In sum, the techno-scientific emissions reductions policies have locked in carbon to the detriment of real solutions that already exist, such as a swift move away from fossil fuels towards renewable energy and energy efficiency. It is not a matter of “all solutions” are needed because carbon-based governance promulgates hopeful technological solutions that are extremely costly, while also diverting attention away from the real causes of climate change, as well as delaying swift action today. This is one of several key negative implications of the Carbon Governance Regime.

3.3. EU Leadership and Underwriting of Carbon Governance

Early EU Leadership: The EU has touted its own leadership in climate as the “most advanced climate, energy, and environmental legislation in the world” (European Commission, 2019:7). In many respects, it deserves this label, even though some flaws are found within climate change governance experiments of the past. Recent proposals such as the Green New Deal, which is currently being finalized, as well as

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legacy policies such as the Climate 2020, 2030, and 2050 targets, further substantiate its leadership claims. Indeed, the EU ETS is considered the first international climate and energy legislation (Skjaerseth, 2017), and had far-reaching positive benefits for developing country installation of clean technologies (Lema & Lema, 2013). In addition, the EU Linking Directive, which enabled the Kyoto Protocol's CDM to connect with the EU ETS, substantiates the EU's leadership claims. Below we details some of the EU's past and current leadership on climate change, with specific focus on the private sector and emissions reductions policies. Lema, A., & Lema, R. (2013).

The EU Climate and Energy Package: This is considered one of the strongest medium-terms targets from the public dimension of GHG governance developed in 2007. The EU Climate and Energy Package set a 20% reduction target for GHG emissions (14% from 2005-2020). Combined with the EU-ETS, responsibilities were shared regressively among each of the 27 member states through the *Effort-Sharing Directive*.).

EU ETS: At the time of creation, the EU-ETS was a highly innovative, international climate governance instrument. However, while it led to some improvements in governance for climate, it mostly has not lived up to its original hype (Jordan et al., 2012; Branger et al., 2015). Low prices for carbon trading and free "grandfathering" in of permits, are cited as two reasons for the lack of efficacy of the program (Neuhoff et al., 2006; Teixido et al., 2019). More critical observers remark that it is largely unable to drive market-induced changes through incentive-based mechanisms e because it is "fragmented [with] very weak price signals [...] simply not up to the task of a radical restructuring of energy and transportation markets" (Jones & Levy, 2007: 436). However, in line with our arguments throughout this paper, like some other carbon-based governance mechanisms, the EU ETS suffers from "a lack of accounting guidance from standard setters in the period 2005–10 […] The disadvantages are that comparison between companies is not possible" (Lovell et al., 2010: 6). Interestingly, as we learned during research for this report, EU ETS data is not openly available, which makes empirical research difficult. Overall, however, it has not led to a decrease in competitiveness of regulated firms, which was initially cited by the industry as a being the main reason not to introduce the regulatory scheme (Venmans et al., 2020).

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In order for an emissions trading system such as the EU-ETS to become more successful, it should integrate more market-oriented approaches. The fact that the EU Commission is forced to frequently support a price floor indicates it is not a fully functioning carbon market (Flachsland et al., 2020). A fully functional carbon market, would rest on three pillars: (1) consistency and transparency in the conversion of all GHGs into carbon, consistently (e.g. a transparent carbon-equivalent conversion system); (2) limiting carbon information asymmetries (3) fully transparent and accessible data that is comparable across companies, industries, regions and countries.

Addressing these points, recent scholarship has suggested that blockchain technology—which allows for transparent, immutable, and secure contracts, data, and information—might prove to be invaluable for systems such as carbon markets (Reinsberg, 2020). Indeed, based on the widely discussed issues with the EU-ETS, blockchain technology could be an important way forward which the EC should consider. (Bernstein & Hoffmann, 2019; Unruh, 2000).

EU Taxonomy on Sustainable Investment: The EC's Guidelines on non-financial reporting are consistent with the TCFD and, moreover "take particular account" of other standards including the GRI, CDP, CDS, SASB, IIRC, and the EU Management and Audit Scheme (EMAS) (pg. 13). Ideally the proposed legislation can provide much-needed synthesis and rules to govern how green and sustainable investment decisions are made. The complexity in measuring and reporting carbon emissions at the firm level, for example, precludes sustainable investors from making well-time and calculated decisions to provide funding for the low-carbon transition. Essentially, it seeks to embed the taxonomy into an already deeply integrated network of corporate reporting actors.

However, while the draft taxonomy does not mandate emissions disclosures at company level, it does recommend that companies should disclose how their activities might impact climate change, and how they plan to respond to physical changes (i.e. rising sea levels). This seems to echo calls from the TCFD which puts at centre

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planning for climate change “risks”—regulatory, physical and financial risks. But there is a subtle and important difference between current carbon disclosure and future climate risk: company disclosure of risk planning is based on estimates about future actions and reactions while company disclosure about carbon emissions relates to current and past greenhouse gas emissions. In other words, one is a proposed plan and the other is the impact on the climate today.

Moreover, The Taxonomy recommends that companies should disclose how their activities contribute to deforestation and land use changes. Interestingly, it recommends that companies disclose their GHG emissions reductions *targets* (rather than actual emissions), and how those relate to national and international goals (e.g. Paris alignment). Indeed, this also seems to mirror the TCFD. But while making emissions *targets* mandatory in order to enable sustainable investment is important, it can open up ulterior motives for companies to disclose in impartial and non-transparent ways, and it may also undermine the disclosure system by creating unrealistic or unattainable goals (Pinkse & Kolk, 2009). If companies can obtain sustainable investment funding simply by planning for climate risk, they are likely to make a plan, but they may not follow through with the plan, or otherwise reduce emissions.

In order to measure GHG inventories, the Taxonomy recommends that companies use the GHG Protocol or the ISO 14064-1. Thus, this is a tacit delegation of private authority for climate change governance (Green, 2013, Büthe, 2010). However, although the guidelines assert that this will “allow for aggregation and comparability across companies and jurisdictions”, as pointed out elsewhere in this report, there remain fundamental problems with the two measurement standards (ISO and the GHG Protocol), while there are several important issues with the disclosure system in general. In addition, comparison of company’s *plans and targets* should not be the main basis for sustainable investment since it distorts incentives: there will be a higher incentive to promote climate neutral *plans* with much lower incentive to take emissions reductions actions. It may lead to a lot of “talk” but not much “walk” (Tashman et al., 2019). Meanwhile, it remains all too easy to simply alter the metrics from one year to the next (WEF, 2020). Indeed, in a recent influential paper, it has been pointed out

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that emissions consistency remains a perennial problem, and might even be exacerbated by private actors such as the CDP (formerly the Carbon Disclosure Project) (Callery & Perkins, 2020).

But the EU taxonomy does not yet sufficiently address these issues. In short, it should be much more explicit in explaining the difference between future plans and goals, and current disclosures, eco-management, and clean technology innovation, for example. In addition, it needs to more clearly articulate the gaps that remain in bottom-up corporate climate change monitoring and disclosure. It is not enough to say companies should use either the GHG Protocol or ISO-14064-1, because these remain inadequate without further public governance guidance. Scope 3 emissions, for example, while estimated to make up the bulk of corporate emissions, are rarely disclosed (Hertwich & Wood, 2018). Meanwhile, the different scopes offers countless loopholes for companies (WEF, 2020).

But to be fair, the taxonomy has recognised some of the drawbacks of company disclosures, in particular what "net-zero" should mean. This is a promising development. Accordingly, they define a net-zero company as a company that:

> contributes substantially to climate change mitigation as it supports the transition to a climate-neutral economy consistent with a pathway to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels including by phasing out greenhouse gas emissions, in particular from *solid fossil fuels*, where that activity: has greenhouse gas emission levels that correspond to the best performance in the sector or industry; II. does not hamper the development and deployment of low-carbon alternatives; and III. does not lead to a *lock-in in carbon-intensive assets* considering the economic lifetime of those assets. (Taxonomy Regulation Report, 2020: 9).

Although the draft report is heavily criticised for giving an easy out to *liquid fossil fuels* (e.g. oil and gas) (Reclaim Finance Media Briefing, 2020)—indeed the gas and nuclear lobbies spent about 80 million euros to ensure they were considered "green transition sectors" (ibid)—it rightly highlights the importance of escaping carbon *lock-in* embedded within high carbon assets (Unruh, 2000; Bernstein & Hoffmann, 2019). But apparently Macron and France were also dissatisfied with the current draft: it was

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rejected because France demanded nuclear energy also be considered a sustainable investment, a notion that is subject to much debate. Moreover, nuclear energy investment largely diverts much-needed investment and deployment of other proven technologies, which are much safer and entirely carbon free such solar and wind (Sovacool et al., 2020). If this regulation passes as drafted now, certain fossil fuels and nuclear will be framed as part of the solution to get to net zero by 2050. That is a potentially disastrous outcome for climate change mitigation. This relates back to the Carbon Frame because nuclear is considered “low-carbon” while natural gas, “the bridge fuel”, is touted as a lower-carbon alternative to oil and coal, while also seen as a requirement to support renewable energy. However, nuclear energy investment drowns out other low-carbon alternatives such as solar and wind energy (Sovacool et al., 2020); additionally, while natural gas may be low“ carbon”, it is extremely high “methane” (Crow et al., 2019). Indeed, it is interesting that some greenhouse data providers such as the WRI CAIT database use a lower methane-emissions conversion from the IPCC’s 2007 report (CAIT.WRI.org).

To improve the EU taxonomy, it could mandate that company disclosures can only be considered accurate and complete if they *fully disclose scope 1, 2, and 3 emissions*, as well as each one of the Kyoto greenhouse gases and precisely which IPCC GWP conversion metric was used (i.e. the Third or Fourth IPCC report). Indeed, perhaps company disclosures that omit any of the “scope” should not be accepted. Furthermore, to tighten the disclosure of all climate-related information, it should ensure that companies disclose their sources of energy usage (i.e. percent of renewable energy versus percent of fossil fuel used across their operations). It might also provide a platform for innovative firms to market their green technological advances. Lastly, company-level emissions that are reported according to carbon intensity one year and net carbon emissions in the following year, for instance, should be flagged as inconsistent and misleading. Indeed, these companies should be penalised accordingly. One straightforward penalty could be a restriction to green finance or green new deal funds.

In connection the EU taxonomy, the European Commission also updated its guidelines on climate related disclosures (EC 2019/C 209/01: Guidelines on non-financial

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reporting: Supplement on reporting climate-related information). It is consistent with the Non-Binding Guidelines on Non-Financial Reporting (EC, 2017) that enumerate six items that corporate reporting should embody: (1) material; (2) fair, balanced and understandable; (3) comprehensive but concise; (4) strategic and forward-looking (11); (5) stakeholder-oriented; and (6) consistent and coherent. Specifically related to greenhouse gas emissions, the updated guidelines mirror the IPCC guidelines for GHG national-level reporting. In a nod to private authority, however, and notably skipping over of Scope 2 and Scope 3 emissions, the recommendations are as follows:

> Companies should disclose 100 % of their *Scope 1* GHG emissions. This will help to improve the quality of other companies' GHG emissions reporting. If a company cannot collect reliable data for a proportion of its Scope 1 GHG emissions, it should make a reasonable estimate for that proportion in order to arrive at a figure for 100 %. In that case, the company should also disclose (1) the % of emissions for which reliable data have been collected and the % of emissions that have been estimated, (2) the reasons why reliable data could not be collected for a proportion of the emissions and (3) the methodology used to estimate the proportion of emissions for which reliable data could not be collected (EC 2019/C 209/01)

It is too early to tell if companies will report consistently in response to these guidelines, or how investors will react. But as mentioned elsewhere, the guidelines as they are now appear to be too soft because companies are unlikely to feel any threat to their operations (Pieraccini & Novitz, 2020). The incentive to disclose accurately is lower than the incentive to disclose in a way that will benefit their ability to obtain finance.

Yet, taken together, these EU governance initiatives rightly recognize that information asymmetries are a pervasive feature of carbon-based governance systems. Importantly, such initiatives also forebode the possibility of mandatory carbon disclosure regulations at state and EU level, which might be necessary. Indeed, the EU and other state-level regulators have recognized the need to create uniform carbon disclosures because trillions of dollars of sustainable investment is waiting to be deployed, but is currently stagnant because of lack of agreement on metrics and disclosures. Investors need to know if companies are following their pledges, not just disclosing partial emissions inventories. . For instance, the regulation on Low Carbon

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Benchmarks (2018/0180) states that there are “significant differences in how index providers measure carbon footprint” (pg. 6) with negative implications for low-carbon investors and companies. In general, while EU regulators appear aware that carbon metrics are critical to stimulate investment and drive low-carbon technology innovation and diffusion, it seems that the tacit approval of bottom-up carbon governance initiatives will inflict more fragmentation further down the road. This should be mitigated now to avert significant consequences later on. Incomparable and non-transparent carbon metrics could very well stymie critical investment towards decarbonisation, whilst delaying real climate action today. This further substantiates our research imperative here: to unravel the Carbon Regime lexicon and complex.

3.4. Country-Level and Stock Exchange Disclosures Laws and Initiatives

Apart from climate change and carbon governance at the global level, many countries have sought to enforce carbon emissions disclosure through state-level legislation. In the appendices are a summary of requirements and penalties for verification of carbon emission’s inventories at the state and stock market levels. One major critique of state-level and stock market carbon regulations, however, is that “The reporting requirements are too soft in their approach, leaving companies free to decide upon what to disclose and their shareholders free to decide how to respond to those disclosures […] without comparability or any meaningful measurement of the companies’ success rates in reducing their emissions” (Pieraccini & Novitz, 2020: 93). This renders the threat to operations all but non-existent and doesn’t provide impetus to enact technological and structural changes (ibid).

Notwithstanding these critiques, it is evident that the top-down climate change governance informed the framing of problems and solutions around carbon. But the early role of the IPCC in navigating between policies, politics, and science (Zillman, 2009), while the climate change governance experiment may have been the best overall option to deliver the global public good of emissions reductions at that time, appears to be splintering given the fragmentation of carbon-based initiatives in the Post Paris Regime. Evidently, state-level and stock-market legislation surrounding carbon emissions, anchored to the IPCC and UNFCCC guidance, suffer from the

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same carbon framing metaphor (Bernstein & Hoffman, 2019), which has mostly led to inconsistent and uneven reporting across sectors, jurisdictions,(WEF, 2020).

4. The Private Dimension of Carbon-Governance

The previous section addressed public climate change governance actors and, specifically, the frames that have led to the foundations of climate governance becoming firmly grounded in carbon-based governance. In this section, our focus is primarily on the private climate change actors. First we ground our approach in previous literature. Then we construct a novel “private-sector” focused climate governance regime network, which we label the Carbon Regime after observing that the central privately-led actors tend to take an almost exclusive carbon-based governance approach Finally, we contrast our new network with previous scholarship and draw attention to how rapidly these regimes are changing.

As others have observed in global governance scholarship (Ruggie, 2004; Ciepley, 2013), bottom-up and market-based standards and initiatives are now key features of governance. The state-led, command-and-control regimes have given way to flexible and voluntary instruments, which are often orchestrated by private actors. Embedded within these new governance modes are the critical standard-bearers and standard-initiators that exert much power and influence over governance regimes (Davis et al., 2012; Kelley & Simmons, 2019). As a result, much competition exists among private actors to create, manage, and control standardisation (Slaughter & Zaring, 2015; Green, 2017). Central actors gain access to key information and can effectively influence the outcome of informal regulatory mechanisms and standardizing processes (Haufler, 2018; Abbott & Snidal, 2001).

Navigating 21st global governance systems is challenging because it involves multiple actors linked in new and informal ways (Slaughter & Hale, 2011). Ever more, private actors coordinate diverse forms of rule-making and regulatory oversight in these new governance arrangements (Marx & Wouters, 2015); as a consequence, they often emerge as rule-makers, rule-takers, or rule intermediaries (Jordana, 2017; Marx & Wouters, 2018; Hardy & Ariyawansa, 2019). With respect to climate change, voluntary

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programs draw-in firms and in return, offer an environmental branding and reputation opportunities (Tremblay-Boire et al., 2016) that allows participants to signal their environmental stewardship (Potoski & Prakash, 2004). Indeed, we locate many of these same features in climate change governance, especially from the private sector and the focus on standardising carbon measurement, verification, and disclosure

Within the context of sustainability transitions, regimes represent the rules and routines that direct and coordinate the behaviour of actors in a specific socio-technical system (Schot & Kanger, 2018). The Global Climate Change Regime (GCCR), therefore, refers to the governance dimensions of climate change policy: local, regional, national, intergovernmental, and the requisite mechanisms for steering, preventing, mitigating, and adapting to climate change (Jagers & Stripple, 2003; Bodansky, 1995; Bodansky, 2001; Yamin & Depledge, 2004; Fisher, 2004). In hindsight, the top-down apparatus inherited from the Kyoto Protocol is seen as ineffective and "riddled with design problems" (Homsey et al., 2017), and therefore bottom-up solutions are welcomed (e.g. the NDCs) (Rayner, 2010). But, because it has lost its central core the GCCR has become known as the "Climate Change Regime *Complex*." Now it involves hundreds of private and hybrid actors. It has become polycentric (Olstrom, 2009; Keohane & Victor, 2011), especially since the Copenhagen UNFCCC conference (Bäckstrand and Lövbrand, 2016).

As such, the GCCR is further characterized as a decentralized, partially organized web of actors, initiatives, public and private governance rules, norms, and standards (Van Asselt et al., 2008; Bodansky & Diringer, 2010; Keohane & Victor; Abbott & Snidal, 2011; Abbot, 2012). Indeed, it is composed of cooperative initiatives and transnational climate partnerships (Backstrand, 2008), TCGIs (Bulkeley et al., 2014), climate clubs (Weischer et al., 2012), and governance experiments (Hoffmann, 2011). Some scholars have noted that it is a networked, as opposed to a hierarchical, structure (Widerberg & Pattberg, 2015b). Others suggest it may be "heterarchical" (Cumming, 2016). However, despite its strengths, such as in explaining hybrid and polycentric climate change governance, the GCCR does not adequately incorporate the growing role of private actors, in particular the central, powerful private actors. Indeed, Widerberg et al. (2016) claim that 85% of Climate Regime actors are not very effective

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while Michaelowa and Michaelowa (2017) state that the "very weak design of TCG initiatives when it comes to the basic criteria mitigation target, incentives, baseline, and MRV […] do not suggest that their contribution will be substantial" (Michaelowa and Michaelowa, 2017: 150). Ideally, our re-mapping in this section can effectively draw-in stronger, more central actors.

To undertake the research aims here, we therefore create a new climate governance map. But our mapping of the Global Carbon Governance Regime, with an explicit focus on private actors, shares many of the features the Climate Change Regime and Trans-Governmental Climate Initiatives scholarship (Roger et al., 2017). In short, our purpose here is to rebuild the GCCR and TGCI network to fully incorporate the role of the private sector, paying special attention to the key actors and nodes, based on their influence and relationships throughout the rest of the network.

As an additional aim, we seek to analyse this network using tools provided by the global governance scholarship discussed in the beginning of this section. For example, we observe that the WBCSD and the WRI are two central rule-makers that created the GHG Protocol for Corporate Emissions (GHGP), now the carbon measurement standard for most corporations and organizations worldwide (Green, 2010; Wegener et al., 2019). The GHG Protocol directly competes with ISO 14064-1, the latter created by the International Standards Organisation (ISO), which is a unique hybrid organization that partakes in thousands of standardisation processes around the world. Still other private actors coordinate voluntary carbon disclosures standards such as the CDP (Carbon Disclosure Project) and the GRI (Global Reporting Initiative). Taken together, these carbon-based actors exhibit a high propensity for voluntary rather than mandatory regulatory norms (Abbot & Snidal, 2009), while they also help to develop special "contracts among corporate actors" (Caffaggi, 2013; Patterson, 2017). An important first step, following previous literature, is to outline the architecture, then address the functionalities, of these emerging governance actors (Hale, 2017; Bäckstrand et al., 2017).

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4.1. Carving out the Carbon Regime from the Climate Change Regime: Methodology

Developing the initial sample: Thanks to the GCCR data on TCGI actors and standards, provided in the appendices of Michaelowa and Michaelowa (2017) (supplemented by Roger et al., 2017), we need not entirely duplicate efforts in our mapping. For a general mapping of the constituent public and local climate change actors, we refer the reader to the aforementioned research. We begin with a smaller sample of the total 122 *Trans-governmental Climate Governance Initiatives* (TCGIs). In line with global governance scholarship, TCGI actors are partitioned according to their governance dimension (public, private, or hybrid). To be considered in the network, TCGI actors must partake in "steering" and "publicness" (Andonova et al., 2009; Bulkeley et al., 2014; by Hoffmann, 2011; Bulkeley et al., 2014; Hale & Roger, 2014). For our network, to be added an actor must have some important relationships with a current node or actor (e.g., an advisor, board member, funder, or founder). Similarly, in building the climate change governance triangle, Widerberg and Pattberg (2017: 76) connect nodes according to shared membership in other climate initiatives. Hence, they create a social membership network for climate change actors, and display the results with an adapted 'governance triangle' diagram from Abbot and Snidal (2009). We generally follow these data collection and organisational methods. Specifically, we create edges between the nodes based on key relationships: advisors, funders, initiators, and board members. A heavy weight is only applied if there are three or less relationships or edges connected to that node, therwise the weight of the relationship is set to "1." The Michaelowa and Michaelowa dataset contains many of the same climate change actors mapped in Widerberg and Pattberg (2017), therefore we use these terminologies interchangeably below.

Restricting the sample: Because we are concerned with the private sector in this report, in contrast to the TGCI network, our network construction begins with a concerted effort to include corporate and private actors, and subsequently to eliminate local and public actors should they not have any connection to the private sector. Therefore, for the initial sample, we parse out private and hybrid actors from the

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TGCI/GCCR datasets. This means that, for example, we remove initiatives dealing only at the local level such as the Association of Climate Change Officers (ACCO), or actors dealing with only governments and not the private sector, such as the Delta Network. In sum, our initial sample from the TGCI dataset is refined according to the following steps:

1. Remove actors or initiatives that no longer exist or have been subsumed by other organisations.
2. Remove actors that only work with local or public actors
3. Remove actors that do not otherwise deal at all with companies.

Final Parsed Sample from TGCI dataset and literature: The parsing steps above result in an initial sample of 42 of the original 122 public/private/hybrid actors from the GCCR/TCGI scholarship. We use this initial sample of 42 actors to begin building our private-focused governance network. These are shown in the network map below (Chart 3). In the appendices are a full list of initiatives we parsed from the TGCI database. Below is a schematic of the initial sample, with the public anchors at center, hybrid “governors” close to center, and the private actors on the periphery.

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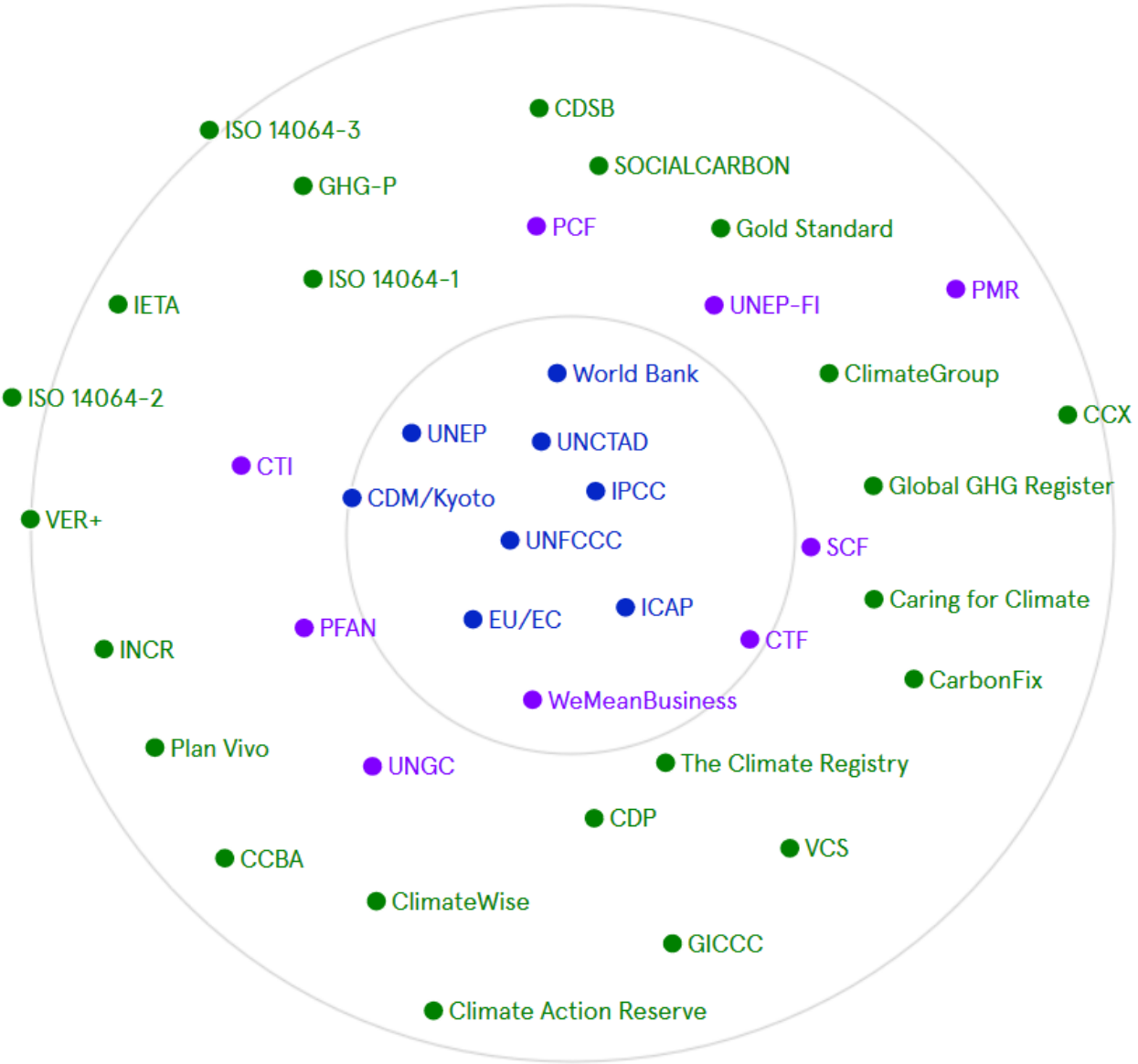
Chart 3: Initial Sample of Climate Change Actors based on previous literature



The final parsed sample from the TGCI literature: we have color-coded public governance actors (blue), hybrid actors (purple), and private actors (green). Notice, many carbon verification and disclosure actors are in green (VER+, CDP, Plan Vivo, Gold Standard).

4.2. Mapping the Carbon Regime Network: Nodes and Edges

Aggregating the Carbon Regime sample: After parsing the initial sample, shown above, we are ready to reconstruct a new network focused on private actors and the corporate sector. The next step is to repopulate this new network with actors that have important relationships with the corporate and private sector, whilst having some relationship with a current node. We did this by individually adding edges and nodes according to relationships with actors already in the network sample. For example,

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The Climate Group recently helped to spawn the RE-100 initiative, which allows companies to commit to 100% renewable energy. We therefore add RE-100 as a new node connected to The Climate Group; if it were the case that The Climate Group was the sole initiator of RE-100, we would weight that relationship "3". Since it is not the sole initiator, it received a standard "1" weighting. We carry on connecting edges (relationships) to introduce new nodes (actors) based on relationships with current nodes, following closely the method employed by Widerberg and Pattberg (2017). The following relationships are used to populate new nodes, and increase the strengths of current node links:

- **Accepts standards** from the other actor (quasi-partner) (i.e., the Gold Standard accepts carbon credits from the Voluntary Offset Standard)
- **Advisor** (i.e., the WWF is an advisor to the Gold Standard)
- **Board Member** (i.e., BP sits on the board of IETA)
- **Donor/Funder** (i.e., BP and Ford are donors to the GHG Protocol)
- **Initiated/Founder** (i.e., the WRI and WBCSD initiated the GHG Protocol)
- **Partner** (i.e., Shell and Chevron are full partners with the Global Gas-Flaring Reduction)

Typically, the websites of the actors explicitly list board members, donors, partners and advisors. Data on donors and funders is more difficult to obtain because some philanthropic organisations operate through many different subsidiaries, while governments have also contributed a fair share of funding to this network.

We continue populating the network until a node "dead-ends" or otherwise ends in an inconsequential or public actor (such as a University). Finally, as discussed above, we weight the edges or relationships as normal ("1") or strong ("3"). Strong relationships means that the node has three or less connections with another node, while a standard relationship means that the node has more than three other relationships. For example, IETA is the sole founder of ICROA, thus this relationship is coded as "3"; the same goes for the ISO greenhouse gas standards (ISO 14064-1), which are initiated solely by the International Standards Organization. On the other hand, the CDSB has many advisors (including the CDP, Earnst and Young, and the WRI), so these advisory relationships (edges) are coded "1".

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After developing the network map according to the previous procedures, we are able to run the machine-learning processes which cluster actors according to the series of relationships. Our new network has 172 unique actors or nodes. This then allows us to reclassify the nodesing beyond the governance dimension classifications from the TGCI scholarship, we add several classifications based on empirical observation. We subsequently expand the definitions of the nodes after revealing the relationships and clusters. While we began with three types of actors in line with the extant literature (public, private, and hybrid), we expand and refine these definitions to create a total of 8 node classifications:

- **Public Climate Change "Anchors"** (i.e. UNFCCC, EU, IPCC)
- **Private "Governors"** (private actors/NGOs connected to at least 10 other nodes)
- **Other / Non-State Actors** (weaker private actors peripherally connected)
- **Company/Corporate/Private Investment Funds** (the corporate sector)
- **Climate Change Actors** (relic of the TGCI that are peripherally connected)
- **Carbon Actors (3):**
    - **Carbon Monitoring and Measuring Actors**
    - **Carbon Reporting and Disclosing Actors**
    - **Carbon Verifying and Trading Actors**

It is in this step that we made an interesting observation, which is why we further classified carbon actors into three separate categories. We observed that carbon actors are typically involved with one of three Carbon Mitigation actions (MRV), and tend to be tightly connected to central carbon-based governance "Governors" and "Anchors." Indeed, for this reason, we sought to classify central actors dealing explicitly with carbon according to the MRV framework for the mitigation of carbon emissions under the Paris Agreement:

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Chart 4: The Three Main Governance Channels of Carbon Actors

In short, three types of central **carbon-governance based nodes** exist in our map:

1. Actors/Initiatives focused on **monitoring and measuring** carbon emissions
2. Actors/Initiatives focused on reporting and disclosing carbon emissions.
3. Actors/Initiatives focused on **verifying, trading and certifying** carbon emissions

Again, these three prominent node classifications are well-connected to key **Carbon Governors** and **Carbon Anchors** (nodes), as shown in the final network maps. Moreover, actors from one of these three MRV channels tend to be centrally located in the new mapping, which suggests that they exert much power throughout the network, in particular influence upon the private and corporate sector.

Final Result of a Private Climate Change Regime (the Carbon Regime): The steps enumerated above result in a novel network, based on a revised version of the Climate Change regime. This network is interactive and it can be viewed with the following link. The first image shows the original network (the raw data), while the second network is remapped with an automated machine-learning algorithm that restructures the network based on link strengths (i.e. relationships and edges) to create clusters of actors. The machine-enhanced transformation leads to the significant improvement of removing much of the human bias in deciding which actors and standards should

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represent the central nodes. Secondly, it reveals the inconsequential actors that are represented as outliers in the network, at least with respect to the private sector.

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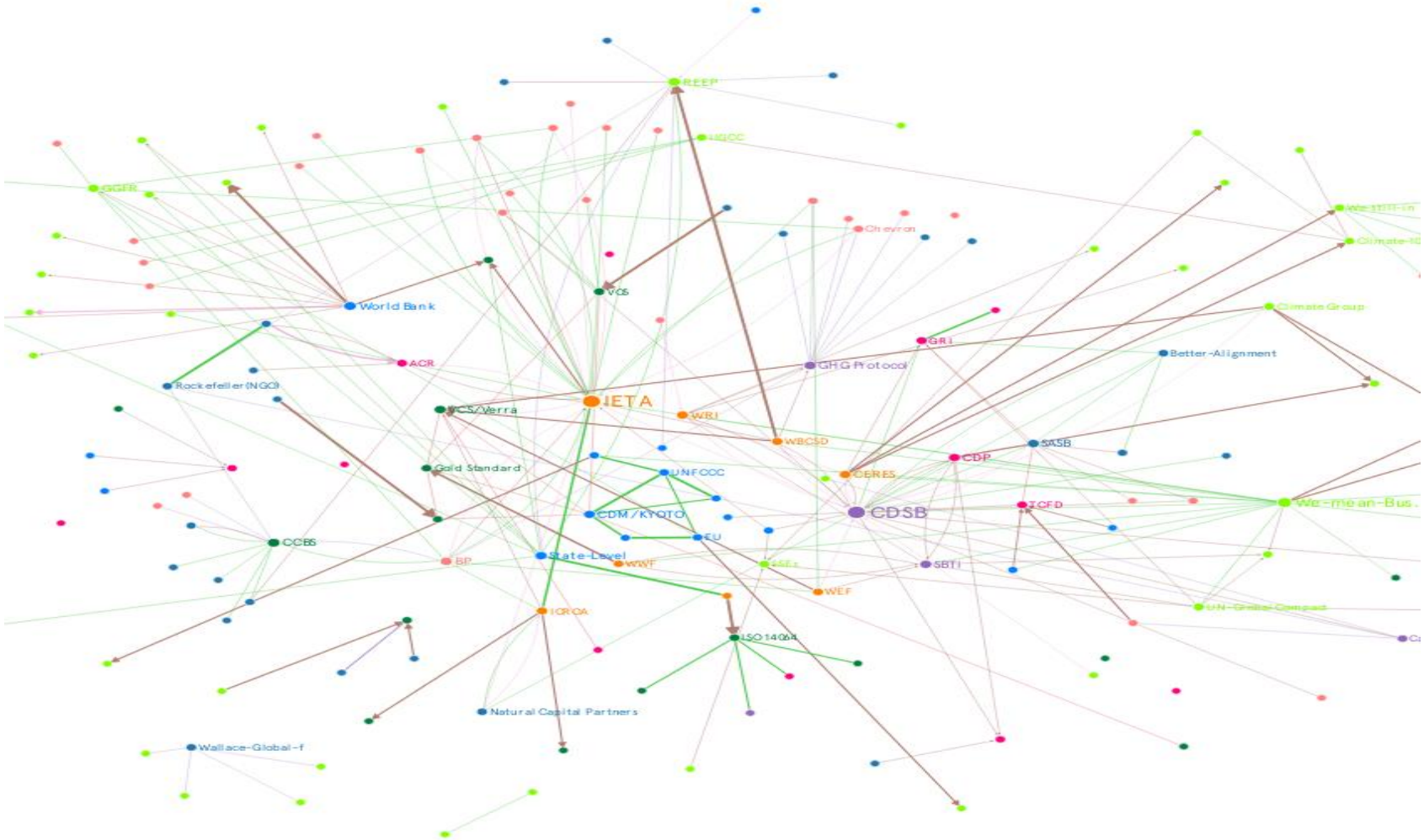
Graphic 1: The initial (pre transformation) Carbon Governance Regime Network



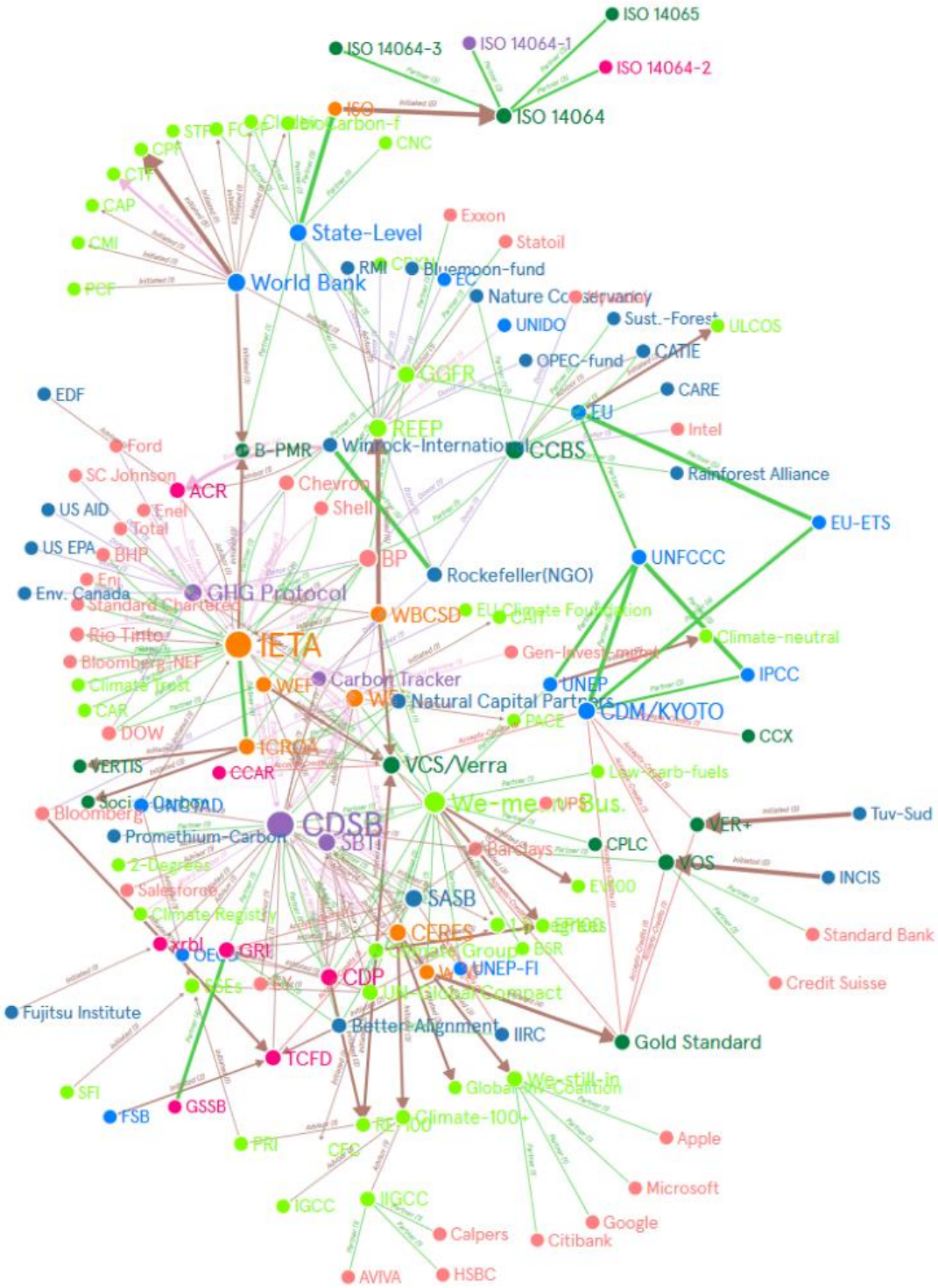
Interactive network map can be viewed online here.

Carbon Governance Network Legend

Node classifications (actor/initiative)
Public Climate Change "Anchors"
Private "Governors"
Other non-state actors
Company/Corporate/Private Investment Fund
Climate Change Actor
Carbon Monitoring and Measuring Actors [M]
Carbon Reporting and Disclosing Actors [R]
Carbon Verifying and Trading Actors [V]

Edge Classifications (relationships)
Accepts standards
Advisor
Board Member
Donor/Funder
Initiated/Founder

Graphic 2: The post transformation Clustering: The Carbon Governance Regime Network



Interactive network map can be viewed online here.

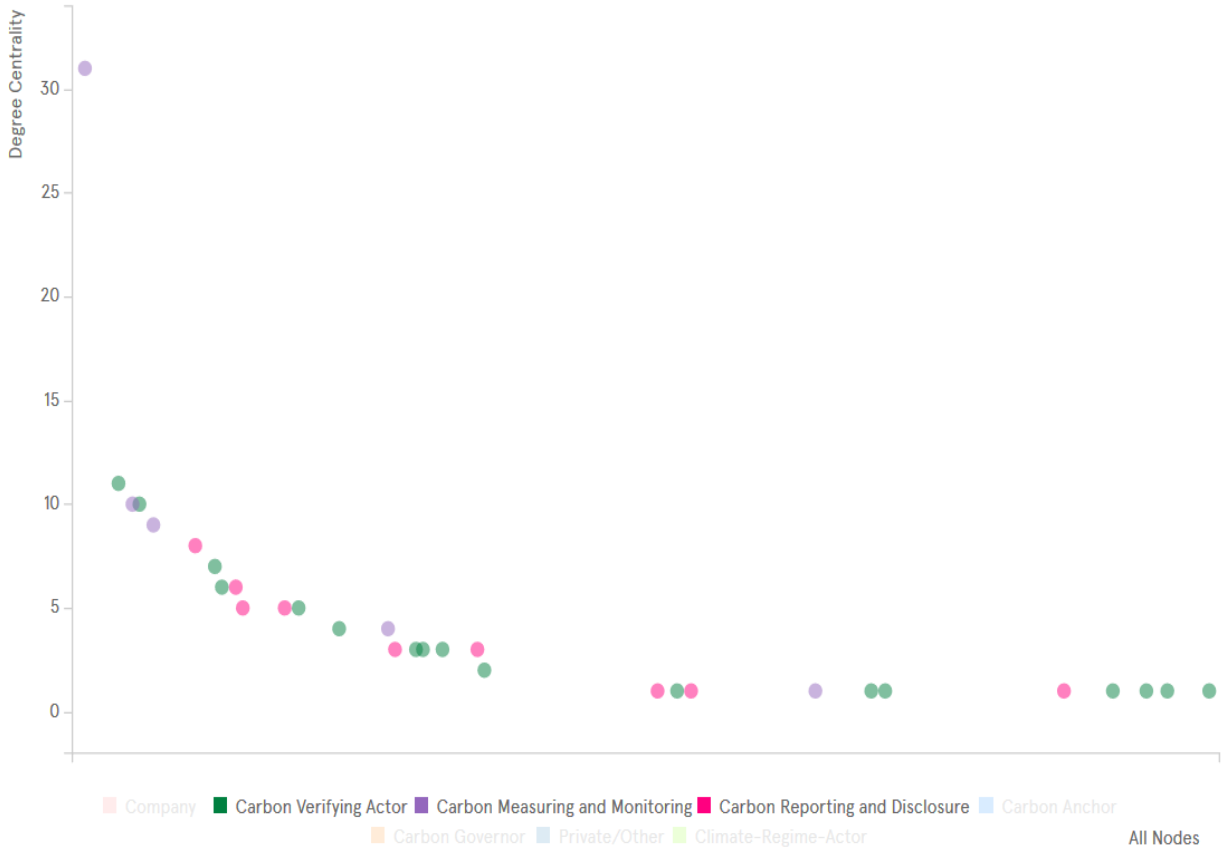
4.3. Centrality Analysis of the Carbon Governance Network

With automated machine-enhanced transformation, we then run an algorithm to extract key nodes and topics of the carbon-based governance actors. A first step is to analyse in-degree centrality. Each node group is analysed individually according to its classification. The following centrality graphs represent the edge centrality data the software relies on to create the transformed network mapping. Since relationships are directional, the following are the centrality computations performed:

- In-degree centrality: extent and weight of edges “pointing” to the node
- Out-degree centrality: extent and weight a node “points” to other nodes
- Between-ness centrality: combination of above.

First, we analyse the three carbon-based governance actors. Indeed, over half of these actors experience strong degree centrality, as shown below.

Chart 5: Edge/Link centrality of “carbon actors” (measuring, reporting, disclosing)



Above: Centrality of three carbon actors types (M, R, V). Actors located towards the left-hand Y-axis exhibit the highest centrality. These include: the CDSB, CDP and Gold Standard have the highest overall degree centrality with all other nodes. In addition, the CDSB, TCFD, and VCS have the highest in-degree centrality. Finally, the CDP, SBTi and Carbon Trust have the highest out-degree centrality.

We then analyse other actors apart from carbon-based actors, including public anchors, private and hybrid “governors”, companies, and other private enterprises. About a quarter of these actors experience high degrees of centrality, with the remainder having much weaker relationships with the overall network, as shown below.

Chart 6: Edge/Link centrality of other actors (governors, anchors, private/companies)

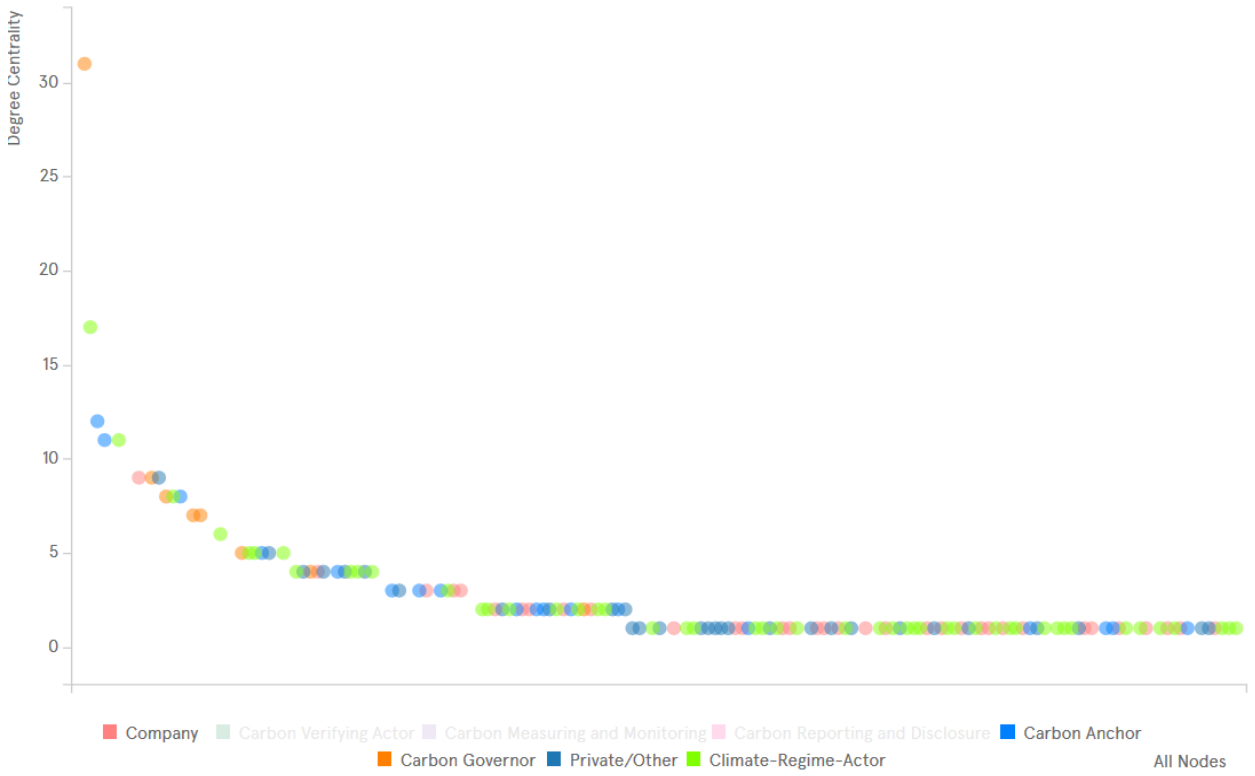
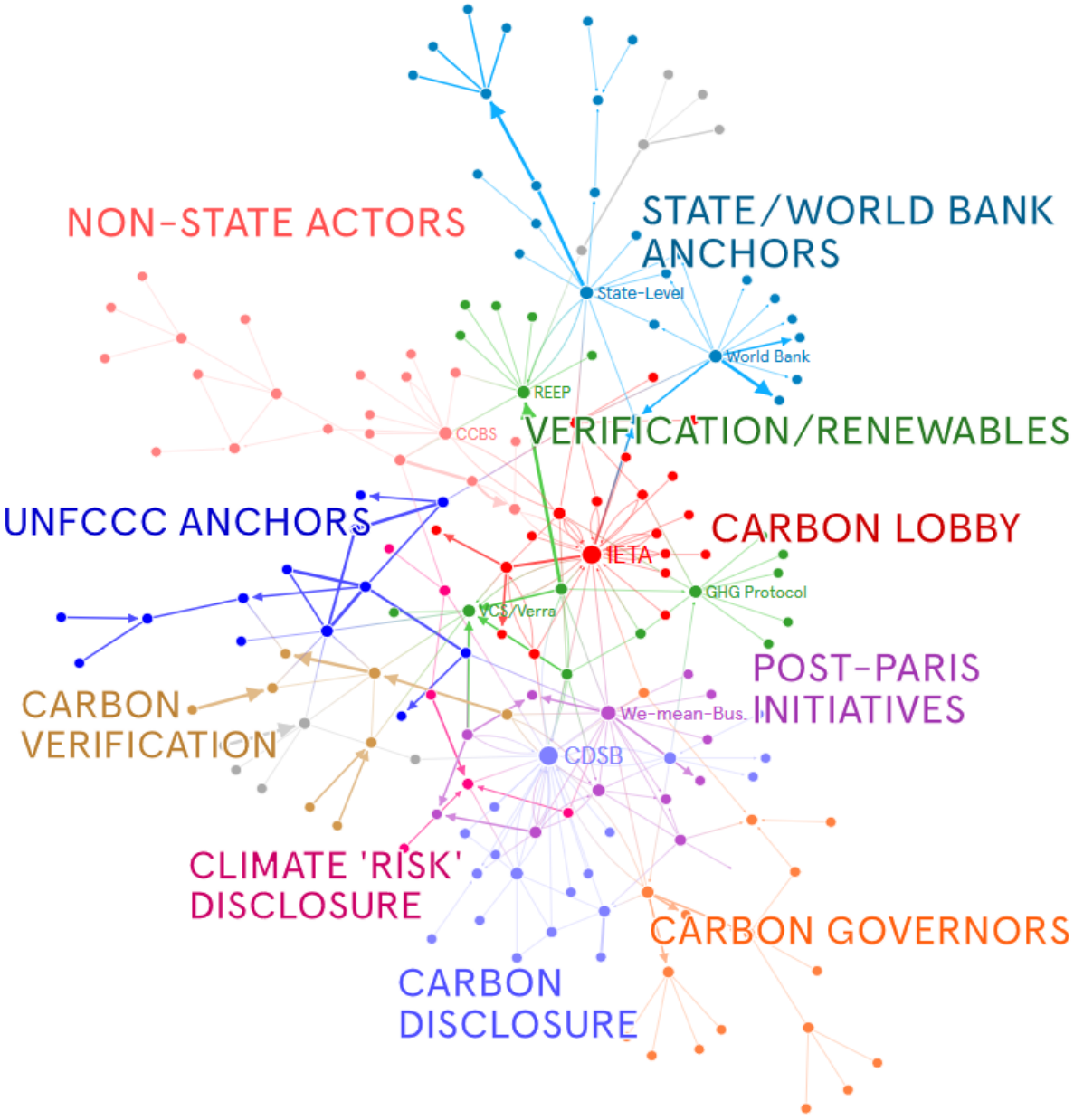


Chart depicting other actors (not specifically carbon-based focus): Highest overall degree centrality are IETA (which we consider a private "governor"), followed by We Mean Business initiative and The World Bank. Highest in-degree centrality are IETA, 1.5 degree Coalition, and EP100. Highest out-degree centrality are World Bank, CERES, WRI, WBCSD, and the Climate Group.

Finally, after gleaning a more nuanced understanding of the network, relationships, and centralities, we are able to run the automated restructuring of the network to show how "networks emerge when patterns of specific network relations are considered" (Hummon & Doreian, 1989: 40). Below is the Carbon Governance Network after machine-aided clustering analysis. It shows the main clusters around a set of nodes and relationships. Ten main clusters are identified. In the remainder of this report, we focus predominantly on the following clusters: carbon verification, climate 'risk' disclosure, carbon disclosure, carbon governors, and post-Paris initiatives. We have labelled the clusters in line with previous literature.

Graphic 3: Cluster Analysis of the Carbon Governance Regime



After applying a machine-learning automatic classifier, a new network emerges with key underlying characteristics of clusters. The Carbon Lobby Group: appears to have a stronghold on

the carbon framing, and could point towards one reason carbon governance has remained the dominant frame.

UNFCCC public anchors: these largely top-down governance actors continue to form the bedrock of the network, and key central actors connect with this cluster.

Climate Risk Disclosure: this cluster tends to frame climate change as a risk disclosure imperative, connecting to investors and the insurance industry specifically, and also the TCFD

Carbon Disclosure: A cluster focused mainly on the disclosure of carbon emissions.

Renewable Energy/Verification: an interesting cluster because renewables are much different than carbon verification. It suggests that carbon verification and renewables are more locally diffuse.

State-Led/World Bank: another anchoring cluster, separate from the IPCC/UNFCCC.

Non-state actors: other philanthropic organisations and companies that are embedded into the network.

Carbon Governors: the prominent organisations such as CERES and WBCSD that organise, instantiate, fund and otherwise lead many other actors throughout the network

Post-Paris Initiatives: a cluster of initiatives that has sprouted since the Paris Climate Agreement The automated classification algorithm sorts outliers as well, including: PAS-2050, Defra, Carbon Trust (group 1); Edinburgh-U, UN-REDD, Plan Vivo. These clusters do not exhibit centrality in the Carbon Regime (they are not shown here).

4.4. Discussion: How does the Climate Regime compare to the Carbon Regime?

By undertaking these empirical steps, we have constructed a revised network based on the original network of actors mapped in the TCGI/GCCR literature. Similarities and differences are expected. One key finding, verified by looking at the new network, is the prominence of carbon-mitigation based actors in our new governance map (MRV actors). This is the reason we label our new network the Carbon Governance Regime, and consequently leads to our focus on these actors throughout the following two sections of this paper. Indeed, the private sector's channel into climate change governance appears to be largely centred on the mitigation of carbon emissions: carbon measurement, carbon reporting and disclosure, and carbon verification. The new network makes this assertion clear. While this may have something to do with the "carbon lobby" cluster, which seems

to favour the further integration of carbon-based governance as the main solution to confront the climate crisis, we leave this for future research.

Even though there are some similarities, the *Carbon Governance Regime* should not be confused with the Climate Change Regime. Rather, the *Carbon Regime* can be defined as a "network of overlapping [standards] with different rules and parties—designed to achieve the common goal of *reducing atmospheric concentrations of GHGs*" (Bluemel, 2006: 1984). We reiterate that our focus is on the private sector and corporations, which naturally excludes some very important climate or even carbon-based public actors, or those otherwise not dealing with the private sector and corporations. This mapping therefore does not provide an exhaustive listing of all climate change actor and initiatives, but rather the actors that are of particular salience for the private sector's role in climate change governance. Nor does it provide a full picture of all the carbon-based actors, such as those that are publicly-led. Future research might expand on our Carbon Regime to include these other public actors, or explore more nuanced versions such as with an or specific regional focus. (A comparison of the initial with the final sample found in the appendices).

4.5. Summing up: The Carbon Governance Regime

In sum, the *Carbon Regime* readily maps the previously fragmented climate change regime with respect to the private sector. The new network appears to be overwhelmingly focused on "carbon governance" (Kolk et al., 2008), demonstrated by the centrality of the MRV carbon actors, after applying machine-learning clustering. By conducting this network construction and transformation, we are now able to conduct further empirical investigations into the private and corporate sector's climate governance roles and the respective impacts that these actors have. As an empirical tool, the new Carbon Regime has identified the central actors, shown a new taxonomy to classify these actors, and therefore can help to drill down on empirical analyses of these actors and their heterogeneous effects on the corporate sector. Such analaysis can subsequently clarify

the extent to which these actors might fill the emissions and governance gaps (Hsu et al., 2020; Lui et al., 2020; Kuramochi et al., 2020)

In this section, we developed a novel Carbon Governance Regime Network with an eye on simplifying the analysis with respect to the private sector. Because private actors have become "institutionalised" within climate change governance since Copenhagen and Paris COPs (Hale, 2017)—duly answered by the explosion of corporate carbon reduction commitments (Keohane & Victor, 2011)—a new mapping of the Carbon Governance Regime was required. In the following section, we expand our analysis of this new network and create a taxonomy to assess their different channels of influence. The tools developed in this and the following section can be very useful for future research because they locate the key actors and provide tools to identify and classify them.

5. A Taxonomy of Carbon Regime Actors

In the previous section, we carved out the Carbon Regime from the broader Climate Change Regime literature. We conducted a network analysis to compute the central carbon-based governance actors and their relationships. We then compared our results with the GCCR. In this section, we further expand on the Carbon Governance Regime taxonomy: a framework to define and classify the carbon regime actors. By classifying these actors, climate change *actions* can be measured against *results* at the corporate level. We operationalise these actors in order to conduct empirical analysis in the final section of the paper.

The remainder of the paper is focused on central carbon actors and (i.e. the private and hybrid organisations such as WBCSD and the IETA, and the MRV actors such as the CDP the CDSB). To provide an analytical lens to assess private carbon actors and their impacts on the corporate sector, we develop a classification system based on the MRV (Measuring and Monitoring, Reporting and Disclosing, Verifying).. We furthermore deploy this framework to more accurately assess how the private sector engages with climate change governance, and flag instances where public governance "anchors" will likely

remain important, and thus represent key governance levers for policy-makers going forward.

5.1. Framework for Carbon Actors and the Carbon Lexicon

Newell and Paterson (2010) delineate carbon actors according to three channels of *action*: (1) greenhouse gas (GHG) standardization (i.e. converting each of the 6 Kyoto GHGs into a carbon unit), (2) carbon monitoring and disclosing (i.e. keeping track of a companies' emissions), and (3) carbon verification (i.e. a third party verifying a company or projects emissions reductions). These definitions are reflected in Green (2013) and Kuramochi et al. (2019; 2020). Climate governance by carbon information monitoring and disclosure, as well as by carbon verification, are now largely the remit of private actors. This is borne out in our network map and indeed embodies they key features of the Carbon-based governance regime

If the carbon frame is central to the underlying logic of GHG mitigation, the antibodies are the governance mechanisms that monitor, report, and verify carbon emissions. The components of the carbon regime require creating metrics, [M] monitoring, [R] reporting, and [V] verifying carbon "units", as these carbon equivalents tie into the public-private governance of GHGs.

During the Paris conference the MRV concept was formalized as a governance mechanism (Bellassen et al., 2015). Originally introduced in the UNFCCC's Bali Action plan, MRV has come to center on three aspects of GHG emissions: measuring reporting and verifying. Due to some initial confusion, the Climate Change Expert Group on Measurement, Reporting and Verification was developed to clarify the terminologies associated with MRV (Ellis & Moarif, 2009). This group suggested that MRV could be used for addressing emissions gaps, projecting emissions baselines for national policy, and tracking long term climate finance (ibid). Experts from the WRI also weighed in: according to Singh and Gerholdt (2016) (researchers at the WRI), MRV after Paris comes in three forms: (1) MRV of GHG emissions; (2) MRV of mitigation actions; (3) MRV of

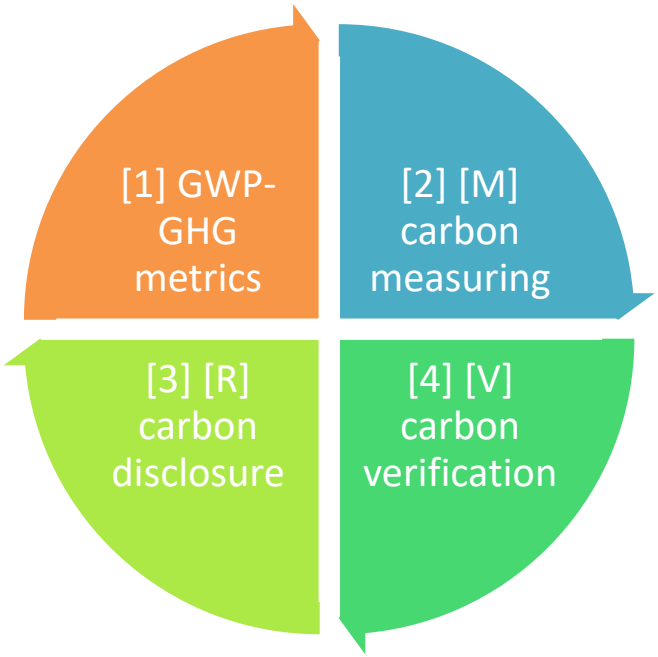
support. In line with these definitions, we find that the Carbon Regime largely revolves around these three channels. While outside the scope of this paper, it is alarming that, beyond the MRV framework, there is no "blueprint" for how countries should measure their emissions in order to compile NDCs (Pauw et al., 2018); however, our mapping of the carbon governance network here can provide some insight into the actors that might take a leading role in coordinating NDCs in the future.

By building on classifications from previous research (Newell & Paterson, 2010; Green, 2013; Singh & Gerholdt, 2016), therefore, carbon actors can be classified according to four main types of carbon-based governance actions:

(1) Carbon Metrics Standardization [top-down governance] [m]
(2) Carbon Monitoring and Measuring Standardization [hybrid governance] [M+M]
(3) Carbon Reporting and Disclosing Standardization [hybrid and private governance] [R + D]
(4) Carbon Verifying Standardization [private governance] [V]

Greenhouse gas conversion to carbon *metrics* standardization (i.e. converting each Kyoto GHG into a carbon-equivalent) remains tied to the *Global Warming Potentials* (GWPs) published periodically by the IPCC. This is discussed in section 3. Therefore, the IPCC remains the predominant actor responsible for anchoring the base metrics for the entire Carbon Regime (i.e. the conversion of Kyoto gases to carbon). However, there are some emerging private actors entering this space. For example, the SBTi has been making important inroads towards ensuring consistency across GWPs. Each MRV process is, consequently, spearheaded by several key actors and governors, which feature prominently throughout our network in the previous section, and also feature throughout corporate sustainability reports in the next section. Importantly, we ground our Carbon Regime taxonomy in the well-known "MRV" framework because, by and large, carbon-based governance actors engage with one of the three MRV channels of governance.

Chart 7: Carbon Governance Actors Taxonomy



The Carbon Regime: Central Anchors (IPCC/UNFCCC/EU), closely circled by main governors; followed by Monitoring and Measuring Standards and Actors (Level 2), Reporting and Disclosing Standards and Actors (Level 3), and Verifying and Trading Standards (Level 4).

The Carbon Regime governors are private organizations that oversee, initiate, or lead carbon actors, while the carbon anchors are typically public actors that have drawn up the architectural blueprints for the Carbon Regime. Governors and anchors do not conform to any MRV channel distinctively, but rather operate throughout these channels of influence Below is a table showing the Carbon Regime actor taxonomy, with example actors in the first column.

Table 3: Four main channels of carbon governance

Actor/Initiative/Standard	Carbon MRV device	MRV	Governance Dimension
[1] metric formulation: IPCC/UNFCCC*	Standardizing carbon-equivalents	Metrics [m]	Public
[2] Measuring: ISO 14064-1, SBTi and the GHG Protocol	Standardizing corporate carbon inventory monitoring	Measuring and Monitoring [M +M]	Hybrid and Private

	and measuring processes		
[3] Disclosing and Reporting: GRI, CDP, Bilan-Carbone, ISO 14064-2, TCFD	Standardizing reporting and disclosing of corporate emissions	Reporting and Disclosing [R + D]	Hybrid and Private
[4] Verifying: Gold Standard, ISO 14064-3, VER+, VOS	Standardizing carbon verifications procedures	Verification** [V]	Private (CDM=Public Anchor)

The IPCC, UNFCCC, and EU are public carbon governance anchors that partake in all instances of carbon governance MRV. The IPCC remains the dominant actor responsible for greenhouse gas to carbon metrics conversion values (GWPs). **Verification actors number in the hundreds (see CDSB, 2015; Jeffries, 2015; IPIECA, 2011), and we do not conduct a complete analysis in this paper.

5.2. Private and Hybrid Carbon Governors [coordinators of MRV]

Apart from the main MRV channels of carbon actors, and the climate governance actors discussed in section 3, there are carbon "governors." We have identified carbon-based "governors" as privately-led organisations with at least ten connections within our Carbon Governance network. They therefore hold central positions within the network. Governors fund, initiate, partner with, advise , and otherwise connect other carbon actors, anchors, companies, and non-state actors throughout the Carbon Governance Regime. They are central actors in the Carbon Regime and form the connective tissue throughout the network. This subsection addresses these carbon-based governance "governors."

The Coalition for Environmentally Responsible Economies (CERES) was founded in 1989 after the Valdez Oil Spill. The global Environmental NGO (ENGO) represents a formative central node within the carbon regime. Its underlying premise is based on the Valdez principles (1990): protection of the biosphere; sustainable use of natural resources; reduction and disposal of waste; wise use of energy; risk reduction; marketing safe products and services; damage compensation; disclosure; environmental directors and managers; assessment and audit. CERES spearheaded the Global Reporting Initiative (GRI), which is now considered the most comprehensive corporate reporting platform (see GRI below). It remains the largest open-source database for carbon emissions data

from the private sector. Indeed, we initially collected exploratory data by using their platform to download corporate sustainability reports of fortune-500 companies. Moreover, CERES also spearheaded the Investor Network on Climate Risk (INCR), which boasts $10 trillion in assets under management, aimed at tackling corporate emissions. Furthermore, it initiated the Net-Zero owner's alliance. With $4.6 trillion in assets, the alliance aims to align companies with the Science-based Targets Initiative—a relatively new initiative that encourages companies to set consistent and scientifically-based emissions reductions pledges and commitments, which is discussed immediately below. Thus, CERES helps mobilize substantial resources towards *emissions reductions* initiatives.

The creation of a reporting initiative, an investor initiative, and a "net-zero" owners alliance provides salient evidence that CERES has, as suggested by researchers elsewhere (Pattberg, 2005), helped assemble private actors to create their own rules and authority, and pre-empt impending public regulation (Hickman, 2017; Jones & Levy, 2009). Moreover, in line with observations elsewhere in global governance scholarship, it has participated in three channels of bottom-up climate change governance: (1) emissions disclosure, (2) emissions goal and target-setting, and (3) investor pressure on corporations. Indeed, CERES is a prominent example that a central non-state actor can "constitute a recognized area of institutional life" and is recognized by its ability to encompass the "totality of relevant actors" (DiMaggio & Powell, 1983: 148).

The World Business Council for Sustainable Development (WBCSD) was inaugurated in the 1990s with the explicit purpose to inform and partake in local and global sustainability policies. By the late 1990s, it teamed up with the World Resources Institute (WRI) to create the Corporate GHG Protocol), which stipulates how companies, organizations, and now cities, should *measure* their GHG emissions inventories. There is some evidence that suggests the GHG Protocol was explicitly set up to pre-empt top-down regulations on corporate-level carbon disclosure, however (Green, 2010). "One former representative of the WBCSD who was involved in the early stages of the Protocol noted that [their argument to corporations at the time was]: if you don't do anything and just leave it to the

regulators, you're stuck with whatever comes out [...] it's much easier to influence regulation at the early stages [than to] undo something that's already been present" (Green, 2010: 8). The GHG Protocol receives some public funding, from the EPA and the US Agency for International Development, for example. While it receives some questionable funding from heavily polluting enterprises such as Alcoa and BP.

The Climate Group was launched in 2004. It works mainly with local and state-level governments. It is the secretariat for the "Under 2" Coalition for regions dedicated to net-zero emissions by 2050 (the under 2-degree coalition is made up mainly of California and Western European regions). The Climate group also has launched three business initiatives: RE100, EP100, and EV100; these corporate initiatives aim for 100% renewable energy , 100% energy efficiency, and 100% usage of electrical vehicles at the corporate level, respectively (and they are under the umbrella of the We Mean Business Coalition, which itself comprises the previous three as well as the SBTi).

The International Emissions Trading Association (IETA) is another key governor in the carbon regime. Indeed, with WEF and the Climate Group, IETA drafted the Voluntary Carbon Standard (VCS), which has become a formative carbon *verification* actor (among hundreds of verification actors). VCS is now one of the top three most popular private carbon *verification* actors worldwide. "[T]he Climate Group together with the IETA (International Emissions Trading Association) have played a key part in coming up with such schemes" (Newell & Paterson, 2010: 153). WBCSD is also part of the VCS Steering Committee. An offshoot of IETA is the International Carbon Reduction and Offset Alliance (ICROA), created in 2008 under the sole discretion of the former. It also has a moderately strong presence in the carbon regime, but has played a more muted role in carbon-based governance at the corporate level, with a more concerted focus on local solutions.

The International Standards Organization (ISO) began as a non-governmental organization in 1947. Its members are the standard's board in each of its 164 member countries. In 2006, this globally diffuse organisation created a standard to specifically address how to calculate and measure corporate carbon emissions. It followed by

introducing ten different standards with respect to carbon governance (*see appendices for a graphic of these*), some of which (such as ISO 14064-3) have fallen out of favour, while others (such as ISO 14000 and ISO 5000) continued to be widely used by companies However, although partially restricted, it remains the few initiatives to provide time-series data, which allows researchers to compare companies, and how their emissions inventories change, over time (Bastianoni et al., 2014).

5.3. Carbon Commitments: How to Monitor and Measure [M + M]

The actors classified in the first MRV channel, monitoring and measuring, mainly deal with private sector emissions inventories, measuring and standardization process. In this subsection we address the privately-led actors that deal with monitoring and measuring private sector emissions.

The GHG Protocol is considered the most widely used private carbon-based governance (Hickmann, 2017). It is now widely used throughout the world by businesses, organizations, local governments, and global institutions such as the World Bank and IMF. It was developed with the help from, among others, BP, GM, Energy Foundation, US AID, the US Environmental Protection Agency, the Chevron Corporation, the Ford Motor Company, International Paper, SC Johnson, Dow and Environment Canada. Indeed, the hand of industry coupled with US organisations seems to have played an outsized role in its development and dissemination. This “measuring and monitoring” instrument is based on a seemingly straightforward concept of dividing up carbon emissions among three “scopes.”

:

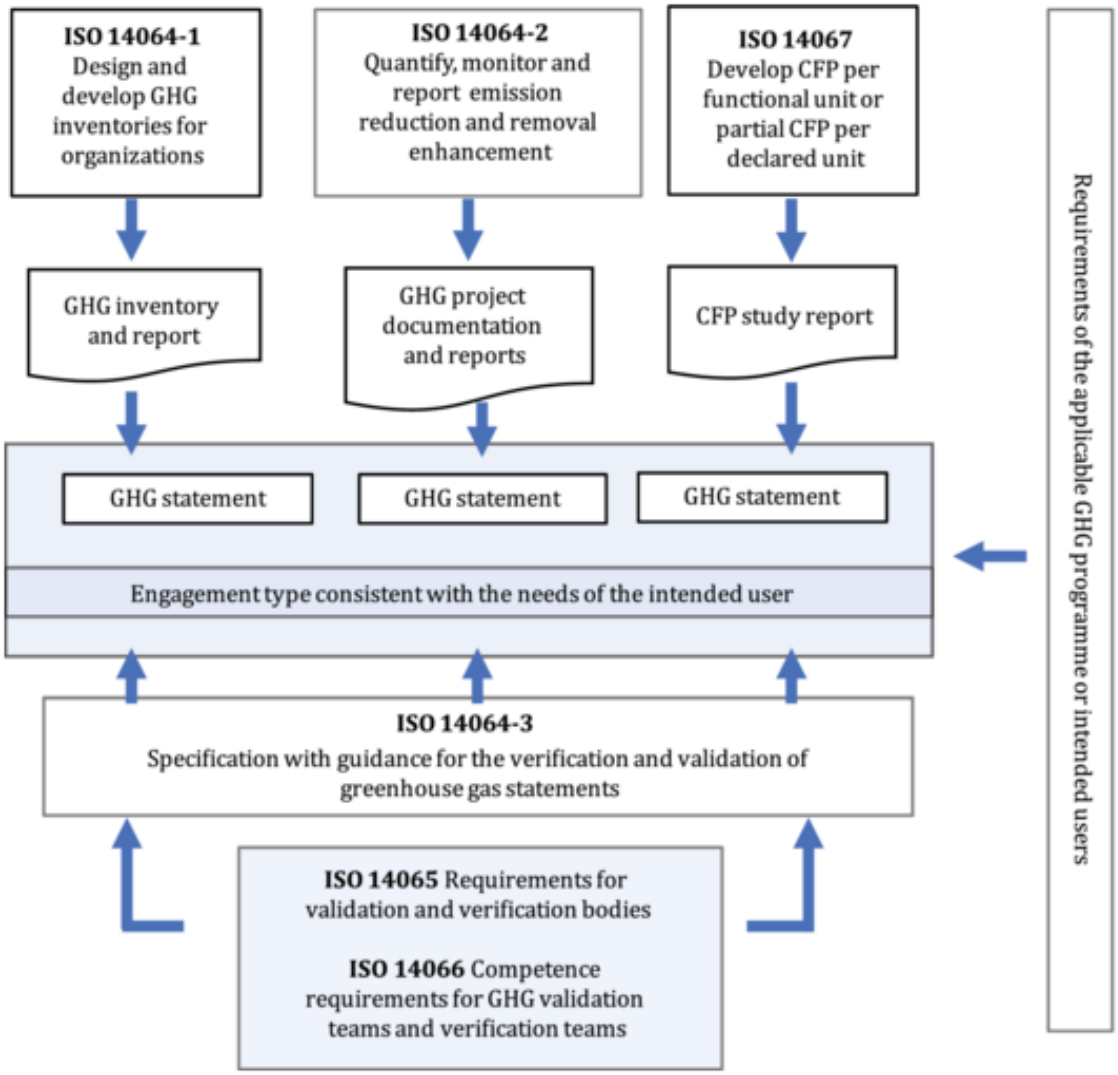
- **Scope 1** emissions are whatever the organization emits directly
- **Scope 2** emissions stem from the electricity supply used by an organization
- **Scope 3** emissions apply to any part of a company or organizations’ value chain, including all corporate or business travel-related emissions.

Because it developed a private sector carbon measurement standard ahead of most mandatory regulation, the GHG Protocol is a prominent example of a private regulatory, rule-setting mechanism (Green, 2010). Indeed, Green (2010) suggests that the GHG protocol emerged as the standard because it was able to reduce transaction costs, it exercised first-mover advantage, and it offered corporations a way to enhance their reputation. However, it is outside the scope of this paper to assess whether WBCSD helped to develop the GHG Protocol to pre-empt regulation, even though it is suggested elsewhere that this is the case (Green, 2010), or if it was developed to fill regulatory void (Hickmann, 2017). One main critique is that the "Scopes" can vary widely from company to company (WEF, 2020). More to the point, the criteria for identifying "relevant" scope 3 activities are qualitative, which leads to ambiguity in their interpretation (see Table 6.1 of the GHG Protocol Scope 3 Standard)(Dalhmann et al., 2019). While built on seemingly straightforward "scope" classifications, the rub is that, on average, Scope 3 emissions "are the largest source of a company's emissions [however] it is unclear how to assign responsibility for these emissions as one company's emissions inventory overlaps with those of [another's]" (Science-Based Targets, 2018: 9).

ISO 14064-1 is very similar to the GHG Protocol. Indeed, they developed largely in tandem (Green, 2010) The main difference is that the former specifies requirements for organization level quantification and reporting of GHG emissions and removals. While this is a carbon measurement standard, the other "14064" ISOs are disclosures or verification standards (ISO-14064-2, ISO 14064-3, for example). Indeed, the ISO 14064-x series are emblematic of the carbon regime ecosystem in that they each take on one of the three MRV responsibilities. While Green (2013) asserts that ISO 14064-1 "mimics" the language of the GHG Protocol, the latter was not formally introduced until 2009, while the former was introduced in 2006. So this is still up for debate. Others suggest that, while ISO developed the ISO-14064-1 standard on its own, it largely "maintains consistency with existing best practice" in order to become more widely adapted (e.g, GHG Protocol)" (Weng & Boehmer, 2006: 16). However, contrary to arguments in favour of the GHG Protocol, which gives slightly more leniency to corporations, other researchers contend that ISO "works" because it has been underwritten by the WTO, which itself works

because it can actually enforce things (*see* Falkner, 2003; Vogel, 2010). Future research might explore in more detail the pros and cons of each corporate carbon measurement standard. Below is a graphic depicting the six ISO GHG standards. In a nutshell, each of these take on a specific MRV task.

Chart 8: ISO Carbon Measurement, Verifying, and Disclosure Standards



ISO has a handful of "carbon-based" governance standards. However, as shown in the following section, several of these are not very popular with corporations (source: ISO website).

The Science-Based Targets (SBTi) is a monitoring and disclosing actor. While it does not set any standards on its own, its general purpose is to clarify and streamline carbon monitoring and disclosing standards. It explicitly aims to ensure corporations develop

emissions reductions targets that “align with the science.” By aligning to science it means, for the most part, aligning to the IPCC reports and the 2-degree scenario under the Paris Agreement. In terms of carbon metrics, it largely adheres to the GWPs set forth by the IPCC’s 2013 report (see section 3). For carbon measurement, it defers to the GHG Protocol. For carbon reporting, it suggests using the GRI or the CDP; and for carbon verification, it suggest companies use Gold Standard.

The SBTi has quickly made inroads into the private sector. Indeed, we show this in the following section by its prominence throughout corporate sustainability reports. By way of another example, in May 2020 corporations have cited the SBTi in calling for governments for a green COVID recovery. In the *United Business and Governments to Recover Better* dialogue, corporate members state: “through the Science Based Targets initiative and its Business Ambition for 1.5°C campaign, we remain committed to do our part to achieve a resilient, zero carbon economy. We are now urging Governments to prioritize a faster and fairer transition from a grey to a green economy by aligning policies and recovery plans with the latest climate science.” In sum, the SBTi plays a central role in corporate carbon emissions goal-setting and monitoring, although more attention should be paid to exactly what the science implies, in terms of emissions, for staying below the 2 degrees target, because such a broad and distant global climate target could be subject to many different scientific interpretations. For instance, a negative implication could be that corporations “align to science” for emissions reductions by 2050—and indeed obtain the rubber stamp from the SBTi—but fail to undertake any meaningful emissions reductions today.

5.4. Corporate Carbon Reporting and Disclosure [R + D]

A large body of scholarship explores the relationship between environmental disclosure and firm-level performance (Hughes et al., 2001; Patten, 2002), between disclosure and firm value (Murray et al., 2006), environmental performance and firm value (King & Lenox, 2001), and manager’s decisions and environmental information disclosure (Barth et al., 1997). In addition, researchers have identified a handful of other, less innocuous factors

that might induce voluntary carbon reporting and disclosure: (1) to pre-empt regulation, (2) to secure first-mover advantages, (3) to respond to investor pressure and (4) to reap reputational benefits to non-profit-driven motivations (Vandenbergh & Gilligan, 2017).

As the EU and other researchers point out, "While a growing number of companies are claiming carbon neutrality" (EU's Climate Transition Benchmarks, 2019: 9), net-zero and carbon reduction commitments from the corporate sector could be merely symbolic (Dahlmann et al., 2019; Ren et al., 2019; Ioannou et al. 2016; Wright & Nyberg, 2017). Moreover, there remains a potential conflict of interest because private actors recognize the importance of becoming standard-setters, which can undermine their activities when creating self-governing mechanisms such as carbon disclosure (LeBaron & Lister, 2015; Davis et al., 2012). In short, corporate carbon disclosure is important but also a highly contested space because standard-setters wield great influence. This competition seems to have resulted in much splintering and fragmentation, with negative ramifications for advancing bottom-up climate change governance, as pointed out elsewhere in this report.

With corporate environmental disclosures, we are not on entirely unfamiliar ground here. Indeed, since the 1970s companies have vowed to be more environmentally conscious and claimed that they could be relied upon to "self-regulate" (Abbot & Monsen, 1979). While in 1971 only 51% of Fortune 500 companies reported on social responsibility in their annual reports, by 1975 this percentage had jumped to 86% (ibid). So environmental disclosure is not a new task for corporations, regulators or researchers. Yet companies' carbon disclosures can only be considered substantive and actionable (Ren et al., 2019; Dahlmann et al., 2019) if the statements contain an "understanding of the goals of the policy, its main principles and the strategy employed to achieve those goals" (*Alliance for Corporate Transparency*, 2018: 24). This effectively precludes net-zero commitments that rely on technologies under development (sorry Microsoft). Technologies under development, sometimes referred to as "technologies of prevarication" (McLaren and Markusson, 2020), "would not qualify under this category unless it was accompanied by an explanation of a target (or ambition) and a means to achieve it, such as increasing the share of renewable energy" (*Alliance for Corporate Transparency*, 2018: 24). In other

words, the statements must be verifiable and based on technology that exists today, not hoped-for-technology under development (such as “new nuclear” or “direct carbon air capture”). Indeed, technocratic solutions seem to have been at the centre of carbon markets, carbon commodifications (MacKenzie, 2009)—and, at least in part, have led to the fragmentation in the carbon-based governance regime we witness today.

To mitigate against dishonest or non-transparent carbon disclosure, however, some backstops have been put in place (although net-zero commitments, being a relatively new and in vogue part of the carbon lexicon, seems to have sidestepped oversight thus far. Should carbon emissions’ information be clouded by ulterior motives, one option is to “name and shame.” This approach is currently being deployed by initiatives such as Climate-100+, which targets the 100 (now about 160) of the world’s highest GHG-emitting companies that are together responsible for 70% of global GHGs. By naming these companies, they become a target for blaming climate change. While this does not avoid dishonest carbon disclosure, it does put more pressure on these companies to disclose their emissions in a transparent manner. However, many of the climate 100+ simply choose not to disclose to avoid further public backlash from their harmful operations. Indeed, although improving in disclosure and transparency, nearly half of CA-100 companies still do not disclose their emissions (based on CDP data). Lastly, many of the CA-100 companies’ shareholders are governments—therefore, an important step to ensure disclosure of these companies would logically come from the government (e.g. from top-down governance initiatives). Indeed, as pointed out in the seminal research by Newell and Paterson (1998), the interdependence of industry and government plays an important role in precluding more meaningful climate change solutions from emerging.

Graph 6: The World's Top GHG-emitting firms, count of disclosure

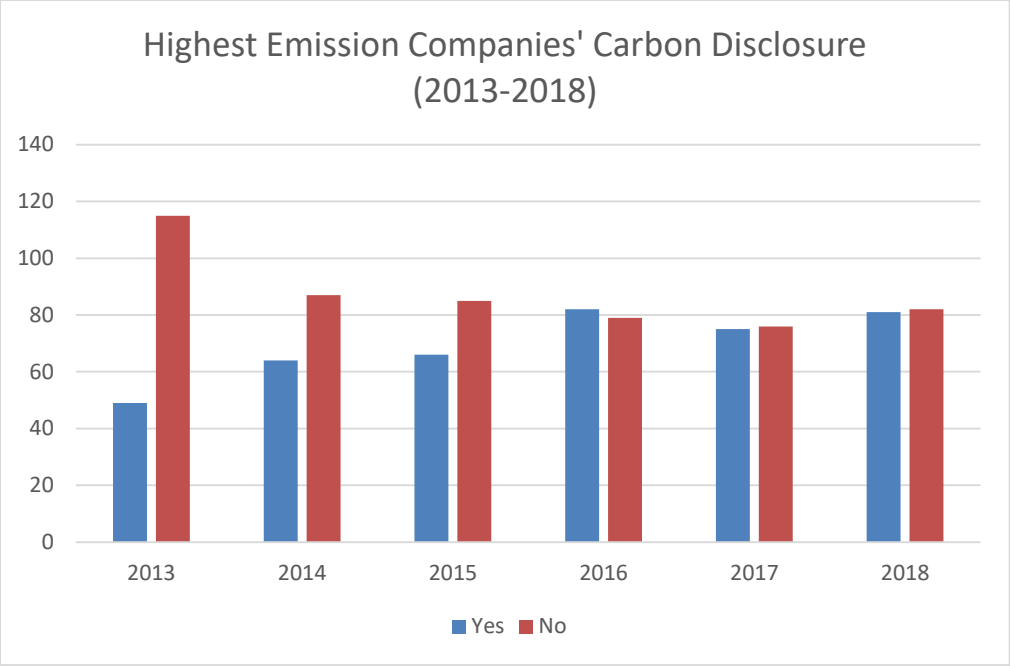


Table based on data from CA-100 website. It shows that the world's highest GHG emissions companies have slowly increased the rate of their carbon emissions disclosure over the last six years. Currently, about half of these systematically high emitters (which make up over 70% of the world's emissions), disclose carbon. In 2013, on the other hand, only about 1/3 of them did so.

Several other largescale "name and shame" campaigns include:

- The Fossil Fuel Divestment Campaign (led by 350.org), which implores organisations (usually Universities) to divest their funds from the fossil fuel industry.
- The Net-Zero Owner's Alliance (initiated by CERES)
- Investor Network on Climate Risk, launched at the Institutional Investor Summit on Climate Risk at the United Nations in 2003.

Importantly, because the Paris Agreement does not have any mandatory mechanisms built in, naming and shaming might eventually extend to the country level (i.e. countries deemed grey or heavily GHG emitting might deter investment). To the same point, the EU should be aware of country-level greenwashing, especially when Green recovery funds are being administered in the next several years.

5.4.1. Carbon Disclosure and Reporting Actors

In an attempt to amalgamate the many carbon disclosure standards the *Climate Disclosures Standards Board (CDSB)* was commissioned in 2009. The CDSB Guiding Principles are as follows: Environmental Information shall be: (1) prepared applying the principles of relevance and materiality; (2) faithfully represented; (3) connected with other information; (4) consistent and comparable; (5) clear and understandable; (6) verifiable; (7) forward looking. It is composed of businesses and Environmental NGOs, with the aim to harmonize hundreds of different emissions reporting rules around the world (Jeffries, 2015). Recognizing the need to bring together the many disparate carbon disclosures "It is the explicit goal of the CDSB not to develop a new and alternative standard, but to merely harmonize what is already out there" (CDSB website). Its board members, some of which feature as "governors" in our Carbon Governance network, include: CERES, The Climate Group, CDP, International Emissions Trading Association, The Climate Registry, World Economic Forum, and World Resources Institute. Its advisory committee is comprised of Shell, Duke Energy, JP Morgan, Tokyo Electric, The Carbon Trust, Rio Tinto, GHG Management Institute, UNEP, IIGC, SUN Group (and 20+ others). Meanwhile, its "technical" advisory group consists of: CERES, WRI, CDP, and the WBCSD. Many of the board members and advisors are also members of WBCSD, thus there is a strong network centrality that pervades the CDSB. Indeed, our Carbon Governance map reveals that it is among the top three in terms of network centrality..

The CDP (formerly the Carbon Disclosure Project) collects, cleans and collates carbon emissions data from over 6000 corporations, 550 cities and 100 states. It is supported by institutional investors with over $100 trillion in assets and also receives support from major banks such as HSBC, Goldman Sachs and Bank of America. It was founded at the World Economic Forum in 2007, with IASB as its model. CDSB, CERES, and the Climate Registry sit on its board. CDP also helped initiate the Science-Based Targets Initiative (SBTi), Carbon Disclosures Standards Board (CDSB), and the Task Force on Climate-related Financial Disclosures (TFCD). It is therefore tightly knit into the Carbon

Governance network. It further helped launch the Carbon Action Initiative with 329 investors now with US$25 trillion in assets, targeting companies in energy intensive sectors such as electric utilities, mining, oil & gas. It reports the top ten emitters as well as “non-responders” and “CDP leadership indices.”

The CDP accepts many carbon verification standards, including the Carbon Trust Standard, the Chicago Climate Exchange Standard, and ISO 14064-3. Other CDP-compliant verification standards include: AA1000AS, ACA, ASAE3000, CCAR, CNCC, GHG ERT, DNV, Earthcheck Certified, Enviro-mark solution’s CEMARS, ERM, IDW PS 821, IDW AsS 821, ISAE 3000, Dutch Standard 2000A, ISAE 3410, ISO 14064-3, JVETS, Korean GHG and energy target management system, NMX-SAA-14064-3-IMNC, RevR 6, Swedish auditors, Saitama ETS, SGS, ICJCE, Swiss Climate CO2 label, Thai TGO, Tokyo ETS, EU-ETS. Indeed, the carbon verification actors are widespread, which is why we cannot offer a holistic analysis of them in this report.

Some critics have noted that, despite alignment with the GHG Protocol, the CDP does not, on its own, mandate a uniformly applied standards for carbon measurement: “This may be a judicious recognition that GHG data simply cannot, as yet, satisfy requirements such as comparability, reliability, and understand-ability. (Andrew & Cortese, 2011: 135). It is an open question whether this dilemma has improved over the last decade. CDP is also critiqued for its lack of global coverage. Out of the millions of corporations worldwide, it only covers 7,000, many based in OECD countries only (WEF, 2020). More problematic, from a carbon governance standpoint, is that only one third provide “full disclosure, only a quarter set any type of emission reduction target, and only an eighth actually reduce their emissions year-on-year” (WEF, 2020). In other words, only about 2200 companies provide full disclosure to the CDP, with slightly under 1000 companies actually reducing emissions. A Climate-KIC analysis further substantiated these claims; in its report, it found that only 20 companies fully disclose 100% of their carbon emissions (e.g. Scope 1, 2, and 3) (Climate-KIC, 2016). In line with several prominent carbon actors, including the CDSB, carbon disclosures should be “consistent and comparable” and “verifiable.” But, as we discovered while preparing this report, company emissions data from the CDP are

not open-access; so there is no way to verify or compare to determine if data are consistent. On top of these setbacks, researchers that have obtained CDP data have noted a plethora of issues related to its internal consistency (Kolk et al., 2008; Rogers et al., 2019; Callery & Perkins, 2020; Busch et al., 2020).

The Task Force on Climate-Related Financial Disclosures (TCFD) is comprised of a 32-member group of experts. It was initiated by the FSB (Financial Stability Board) and is chaired by Michael Bloomberg and Mark Carney. Carney galvanized attention for "climate-related financial risks" to the banking industry in a 2015 speech, coining the term tragedy of the horizon: "the catastrophic impacts of climate change will be felt beyond the traditional horizons of most banks, investors and financial policymakers, who do not have the direct incentives to fix them". This framing of the problem echoes the "ultimate tragedy of the commons" (Paavola, 2012: 417) and "the largest collective action problem that humanity has ever faced" (Jamieson, 2014: 104). It also, however, frames climate change as "risk." Indeed, it harks back to the prisoner's dilemma: "Since climate protection is a public good, private actors (e.g., firms, consumers) have limited incentives to address it" (Geels et al., 2017: 464).

Mainly aimed at four "financial related" sectors (banking, lending, underwriting, asset management) it also works with other sectors including energy, transportation, materials and buildings, agriculture, food and forest products. In its reports, the TCFD offers advice on governance, strategy, risk management, metrics and targets. The main purpose of the TCFD is to:

> enable stakeholders to understand better the concentrations of carbon-related assets in the financial sector and the financial system's exposure to climate-related risks [...] provide a source of data that can be analysed at a systemic level, to facilitate authorities' assessments of the materiality of any risks posed by climate change to the financial sector, and the channels through which this is most likely to be transmitted (Implementing TCFD, 2018: 22).

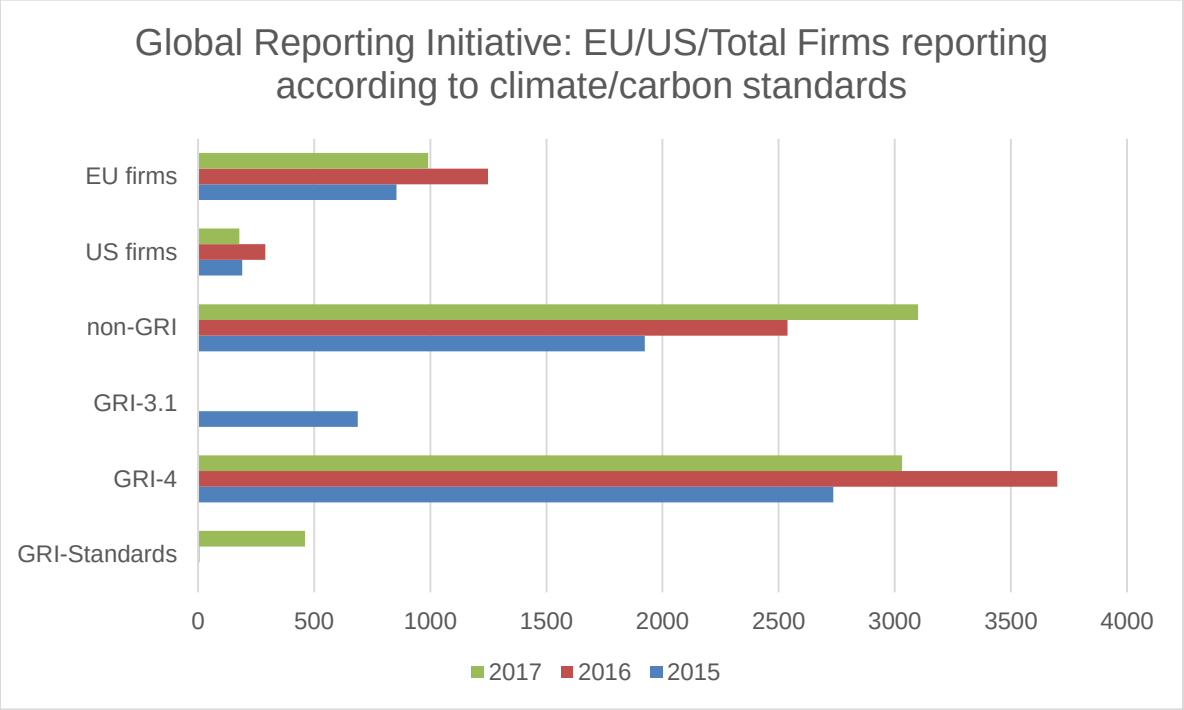
It aligns with other initiatives such as the G20/OECD Principles of Corporate Governance; CDP; GRI; CDSB; International Integrate Reporting Framework, Sustainability Accounting Standard, Enhancing the Risk Disclosures of Banks, ClimateWise Principles, Principles for Responsible Investing. Importantly, it begins to unpack various pros and cons of common carbon metrics including: weighted average carbon intensity; total carbon emissions; carbon footprint; carbon intensity; exposure to carbon-related assets. Despite its relatively recent inauguration, the TCFD has quickly gained a large number of corporate members. This is shown in the following section within corporate reports

The *Global Reporting Initiative* (GRI) was launched in 2000 with the cooperation of CERES, the Tellus Institute, and UNEP. It aims to promote CSR and ESG reporting with the main intention to create a standard for corporate environmental reporting. As of 2017, 75% of the world's top 250 companies reported through the GRI (the data do not currently extend past 2017). One important benefit of the GRI is that it is freely accessible, unlike many other GHG and sustainability reporting schemes. A drawback is that many companies skip years and the GRI often updates its reporting standards, so it does not provide reliable time-series data.

However, the website offers a GRI Indicator Protocol set with Performance Indicators (energy, biodiversity, emissions), as well as 30 Environmental Indicators. Elsewhere researchers have used these data to conduct thorough analysis of corporate sustainability, with mixed results (Boiral, 2007)|. The GRI standards are anchored and networked to ISO standards (ISO 14010, ISO 14011, ISO 14012, ISO 26000). With the explicit purpose to address potential "greenwashing", the GRI has the authority to conduct an independent audit of a company's report. This might have, however, deterred US companies which are afraid of exposing themselves to future litigation. Indeed, in the chart below, it is clear that US companies represent a much smaller percentage of GRI reports than their European counterparts. But this could also be related to EU regulations: in December 2014, the European Commission obligated large multinational corporations to report on "non-financial" data (companies with more than 500 employees), and many

did so through the GRI. Below is a table displaying descriptive data of GRI reporting trends over the last three years of reporting (no data is available after 2017).

Graph 7: Trends in Corporate Reporting to the Global Reporting Initiative



European firms are much more likely that their US counterparts to disclose to the GRI. However, much of the GRI accepted reports are "non-GRI", meaning that they do not meet the GRI standards. This can indicate that the reports are weak, or worse a form of greenwashing.

5.4.2. Critiques of Carbon Reporting and Disclosure

5.4.2. Summing Up: Carbon Disclosure and Reporting Actors

To be considered credible, firms should make absolute emissions reductions commitments grounded by operational and strategic processes (Bui & Villiers, 2017). Carbon disclosure on its own cannot do that. Some of the same critiques of ESG and CSR, going back to the 1970s, look strikingly prescient with regard to carbon disclosure today. Indeed, in 1979 Abbot and Monsen suggested that, in order to affirm a company's statements are actionable and not merely symbolic, "An adequate measure of corporate social activities must be based on a method of data collection in which the investigator

(researcher, public interest group, governmental agency, corporate researcher, etc.) has unrestricted access to data on the full range of activities of the firm" (Abbot and Monsen 1979: 502). Unfortunately for this project we as researchers were unable to gain full and unrestricted access to corporate-level emissions data. We could not obtain data from private sources because they are prohibitively expensive (Bloomberg, Thomson Reuters), hybrid sources because they are completely fragmented (ISO), voluntary NGO databases such as the CDP because the corporate data is expensive even though city-level data is open, nor even the EU ETS (because apparently the EC restricts access to these data).

That the Carbon "Disclosure" Project (CDP) does not grant open access to corporate-level data is a red flag; perhaps it is still an ongoing project, and that is why the data are unavailable. But more alarming is the lack of access to EU ETS data, which certainly does not bode well for carbon-based governance. Thus, we are largely unable to conduct deep statistical analysis on corporate-level carbon emissions, or correlation analysis to ascertain the veracity of emissions inventories disclosed voluntarily or through mandatory mechanisms. While we stop short of calling this "organized hypocrisy" (Krasner, 1999; Keohane & Victor, 2016), which implies that rich companies and countries make vague and rhetorical commitments to CSR (Pope & Waernas, 2016), it is certainly an important topic for further research. Indeed, it seems that some "powerful states have increasingly turned to fragmentation to maintain their control" (Benvenisti & Downs, 2007: 626). Data availability and consistency in carbon disclosure will remain a perennial issue for carbon governance in the years to come.

5.5. Carbon Verification [V]

The three main carbon verification actors are the Gold Standard, the Verified Carbon Standard and the ISO 14064-3. We do not conduct a full analysis of these actors here. Instead, we refer to the reader to a recent report from the World Bank (2020): "State and Trends of Carbon Pricing." In the appendices are a list of the major carbon verification actors we have identified. However, it is worth noting that the centrality and relationships

of the top two carbon verification standards: The Gold Standard and the VCS/Verra. The Gold Standard was initiated by WWF (World Wildlife Fund) while the VCS was initiated by IETA, the WBCSD, the WEF, and the Climate Group, all of whom feature centrally in the Carbon Governance network.

6. Measurable Impacts on the Corporate Sector

In the previous section we walked through a taxonomy of the central carbon-based governance actors and governors. The governors instantiate and manage the three types of carbon-based governance actors. We classified these actors according to their main channel of governance actions within the regime (M, R, V), and discussed their aims and makeup. First, we discussed the governors and anchors; these do not necessarily participate in MRV standards and actions, but they coordinate and ground the initiatives and standards. Then we discussed the MRV carbon-based actors. In this section we operationalise the actors discussed in the previous section in order to glean a more refined understanding of how carbon governance impacts the corporate sector. In order to this, we develop an empirical analysis using a sample of FTSE-100 companies from 2010-2019.

An important concept enshrined in the Paris 2015 Climate Agreement is that corporations have a duty and responsibility to help mitigate climate change (Vandenbergh & Gilligan 2017; Hale, 2017). Now, more than ever before, understanding how the corporate sector engages with climate change governance is of utmost importance because their role is pivotal in meeting the challenges of this “super-wicked” and collective action problem (Lazarous, 2009; Hale, 2017). The hope is that firms can leverage their technological, organizational and financial resources to create “win-wins” for the economy and the climate (Mayrhofer & Gupta, 2016; Boiral et al., 2012). Their corporate carbon pledges, coupled with their increasing commitments to climate change and carbon standards, initiatives, and platforms suggests that they are, indeed, serious about climate change. In this section we seek to understand the degree of seriousness of the corporate sector through operationalising the central Carbon Governance regime actors. We also show

how several key carbon governance actors feature prominently throughout the corporate sector. We use a sample of the UK FTSE-100 companies to do this.

The UK FTSE-100 companies are a representative sample of how the corporate sector participates in climate change governance. First, the UK's Cadbury Code (1992) was among the world's first corporate governance standards (Cuomo et al., 2016; *see* WBCSD *Reporting Exchange*). They are therefore subject to some of the strictest disclosure regulations in the world, in particular for climate policy (Gürtürk & Hahn, 2016; Robertson & Samy, 2015; Levy & Newell, 2000; Varma, 2004; Coen et al., 2020). More specifically, the UK Companies Act (2006) reinforces these provisions, while two reforms in 2013 and 2016 have increased regulation on sustainability reporting (*see Strategic Report and Director's Report*); it also specifies that companies with over 500 employees must report on their environmental, social, and anti-corruption activities. Further, FTSE companies account for 73% of all UK emissions (CDP 4 report) and 81% of emissions from the UK equities market (Okereke, 2007). Finally, they are considered a good indicator of the overall health of the British economy, and tend not to have many economic constraints that might counter climate efforts (Robertson & Samy, 2015). The analysis conducted in this section fills an important research gap: "Only limited assessments of [non-state actor] climate action's net aggregate impact on GHG emissions exist, however" (Kuramochi , 2020: 111).

While our analysis is similar to Kuramochi et al. and Lui et al. (2020), it differs because we examine the membership in climate relationships over the last decade, while Kuramochi et al. and Lui et al. predict how such initiatives might reduce corporate emissions in the next decade. Hence, while ours looks at data from the past, theirs looks at estimated, future projections. Our analysis therefore fills a key gap in the extant literature (Kolk & Levy, 2001, Kolk & Pinkse, 2004, Hoffman, 2006).

6.1. Initial data collection

Data Collection: The data are collected from Thomson Reuters, company and carbon-governance actor's websites. Below, in Table 5, is a summary of the data collected, type and source.

Membership Data Interpretation: To obtain and code data on company membership (binary, yes/no variables), we extract data from the websites of the carbon actors. The intention is to discover which companies have joined which carbon-governance initiatives, and in which year. For the most part, these data are easily accessible. For example, the TCFD lists the companies that have signed up and the month/year. Therefore, in our dataset a company is designated a "1" the year it has joined an initiative and a "0" otherwise. However, in section (6.3), we extract word occurrence and frequency from corporate sustainability reports to glean a more nuanced understanding of these memberships across FTSE100 company reports (e.g. going beyond binary coding). Below the tables show the type of variables we create from the data, their source, and a brief note. This is followed by Table 6, which provides an overview of the percentage of FTSE-100 companies that have joined the prominent carbon-based governors and actor networks (as of November, 2020).

Table 5: FTSE-100 Data Sources

Variable	Source	Type	Note
Scope 1, 2, 3 emission	Thomson-Reuters	Float	Substantial missing data, especially scope 3
FTSE member list	Thomson-Reuters	Categorical/S	FTSE-100 member company names and industry
FTSE Memberships	Carbon actor/governor websites	Binary (0/1)	Governors, initiatives
Firm-level ESG variables	Thomson-Reuters	Binary (0/1)	Includes: climate-risk, fossil fuel divestment, NOX/SOX reduction plans, etc.

Firm-level control variables (financial data)	Thomson-Reuters	Numeric	In line with Hseuy, 2019
Memberships and Standards	FTSE Sustainability Reports	Text	In line with Radu et al. (2020)

Table 6: Carbon Based Governance Actors and FTSE100 Membership (as of November 2020)

Carbon Governors (G) and Actors (A)	**Year Start**	**Centrality / Notes**	**% FTSE (2019/2020)**
+CERES (G)	1991	GRI, INCR, Net-Zero Owner's Alliance,	4%
+WBCSD (G)	1995 (1997)	GHG Protocol, VCS	9%
+IETA (G)	1992	Voluntary Carbon Standard (VCS)	6%
The Climate Group	2004	Has partnered with IETA, WBCSD, and CDP. Spearheaded the last five climate initiatives in this chart.	
ISO (G/A)*	1945	ISO 14064-1, 2, 3	Data NA (88 mentions in all report-years)
ISO/EMAS (A)	2000	ISO 14001 or ISO 5000	58%
CDSB (A)	2011	Board: WEF, WRI, The Climate Group, IETA, WBCSD, CERES, SASB, CDP. Strategic Alliances: Green Finance Platform, CDP, CRD, IIRC, SASB	NA (secondary links are available)
SBTi (A)	2018	Science Base Target Initiative (board: CDP, WRI, WWF)	30%
TCFD (A)	2016	Task Force on Climate-Related Disclosures (Mark Carney and Michael Bloomberg)	35%
GRI (A)	2001	CERES, Tellus Institute initiated	85%
GHG-Protocol* (A)	2005/2009	Greenhouse Gas Protocol from WRI and WBCSD spearheaded, with corporate	NA (but mentioned

		and non-state actors	70 times in 2019 reports, 304 across all report-years)
One Point Five Percent Coalition (A)	2011	We Mean Business	7%
Coalition for 100% Renewable Energy (A) (RE100) (A)	2015	The Climate Group and The CDP Initiated	19%
Carbon Pricing Leadership Coalition (CPLC) (A)	2014	World Bank Group Initiated	10%
The Alliance to Save Energy (EP100) (A)	2015	The Climate Group Initiated	5%
Alliance to Accelerate EV's (EV100) (A)	2015	The Climate Group Initiated	7%

Above: Membership in central carbon governors (Governors have the highest degree centrality in the global Carbon Governance Network Map, in Section 4 above). *Determined by text mining corporate report. While (+) these "governors" are not prominent within FTSE companies, they feature throughout DJI and US companies. Also, they indirectly influence the network through the coordination of actors.

6.2. Membership Trends, FTSE-100 Companies (2011-2020)

We empirically map the membership trends in climate change initiatives and standards because this provides clues to private and corporate sector climate change governance. As bottom-up and privately-led initiatives gain more traction, a key question is how these initiatives and networks can change corporate behaviour with respect to emissions (Kuramochi et al., 2020; Lui et al., 2020) The general membership trends in FTSE companies indicate an overall shift towards hybrid and private-led climate change

governance. Indeed, the private sector appears fully "institutionalized" since the Paris Agreement (Hale, 2017) based on the initial data collection. Going one step further, several key empirical questions follow: Has the increased participation in private and hybrid carbon governance schemes led to improved climate performance? Does membership in one club predict membership in another? Are some clubs predicated on "climate risk" while others target carbon mitigation? Are there differences between mandatory and voluntary initiatives? These are some of the central questions that can be answered with membership and corporate emissions data. In this section, while we are unable to fully answer some of these questions, we open up critical new areas for future research based on related methods.

6.2.1 Static Carbon-Based Memberships

In this subsection, we provide longitudinal data on memberships of several key actors that do no experience membership changes over the ten years in our sample. That is, below are the carbon actors and initiatives that do not change with respect to FTSE membership over time. Since membership in the central governors is relatively static over the last decade, we list each of the companies that are a part of each governor immediately below.

- CERES: Coca-Cola, National Grid and Prudential since 2011; Barclays since 2012
- IETA: BHP, Rio Tinto, Shell, Standard Chartered since 2011
- WBCSD: 3i, BP, BT, Compass, CRH, Phoenix, Shell, Unilever since 2011
- 2 Degrees Coalition: AstraZeneca, BT, Burberry, Diageo, Unilever since 2011, Tesco since 2015, Vodafone since 2019
- Other Carbon-Based Governors: The Climate Group, CDSB. These do not have "corporations as members" *per se*, so we will mine the sustainability reports for data on these governors.

However, while FTSE is not well represented in these governors, two observations are noted. First, other company samples such as the Dow Jones Industrials and S&P

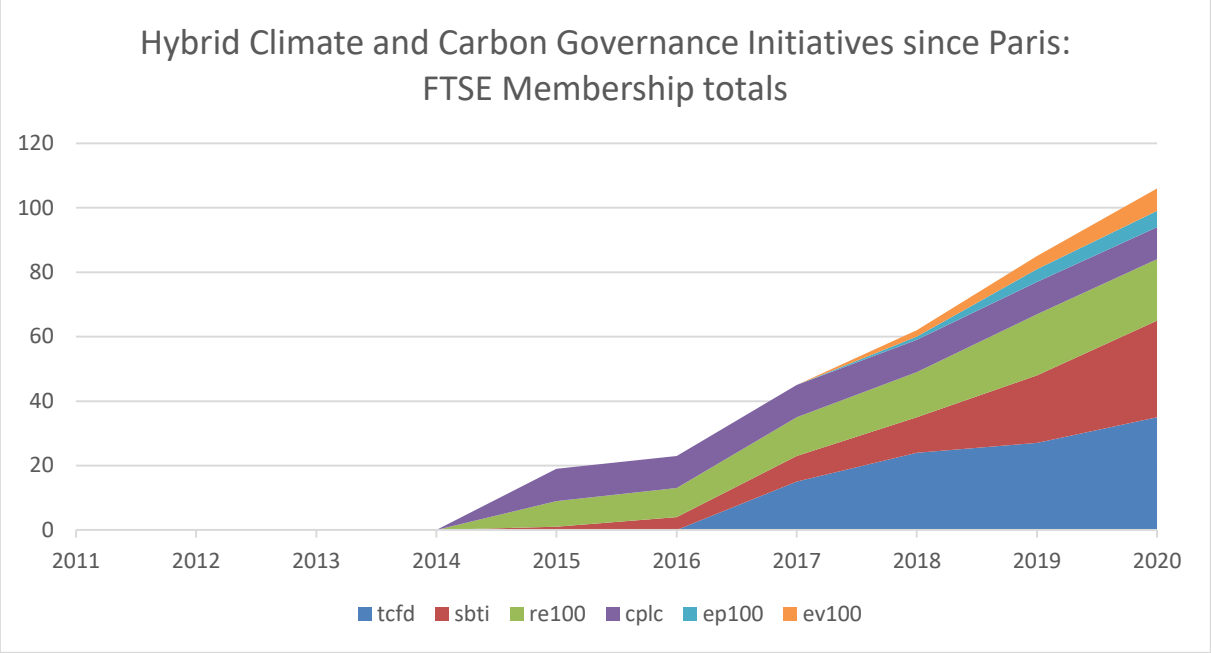
companies might very well feature more strongly, and experience more variation, than the FTSE sample. Second, even though many FTSE companies are not directly engaged with these corporate governors, this does not mean that these governors have no effect on FTSE companies. Indeed, as shown in the Carbon Governance network, CERES, IETA and WBCSD are deeply involved in other carbon actors, the latter in turn have an impact on FTSE companies. In future research, second-degree membership could be analysed to unpack these observations further

6.2.2 Dynamic Membership Trends: A Post-Paris Carbon Governance Explosion?

In this section, we map out the standards and initiatives that have witnessed sharp increase to membership since the Paris agreement. In contrast to the memberships above, these actors show dynamic rather than static membership trends. They have notably grown since 2015, as shown in Graph 8. Immediately below are membership percentage as of November 2020:

- TCFD (Taskforce on Climate-Related Financial Disclosures): 35%
- SBTi (Science Based Targets Initiative): 30%
- RE100 (Commitment to 100% Renewable Energy): 19%
- CPLC (Carbon Pricing Leadership Coalition): 10%
- EP100 (Commitment to 100% Energy Efficiency): 5%
- EV100 (Commitment to 100% EV-car usage): 7%

Graph 8: FTSE-100 Membership trends accelerating since the Paris Agreement



This shows the total FTSE Company membership counts across 6 “carbon-governance” actors. Indeed, FTSE membership across this group of actors has accelerated since the Paris Agreement. The highest rate of increase is seen in SBTi and TCFD, but RE100 appears to be gaining traction. However, with respect to FTSE climate change improvements, these memberships might be too new to assess the potential correlation.

6.2.3. Internal Climate Change Governance Initiatives

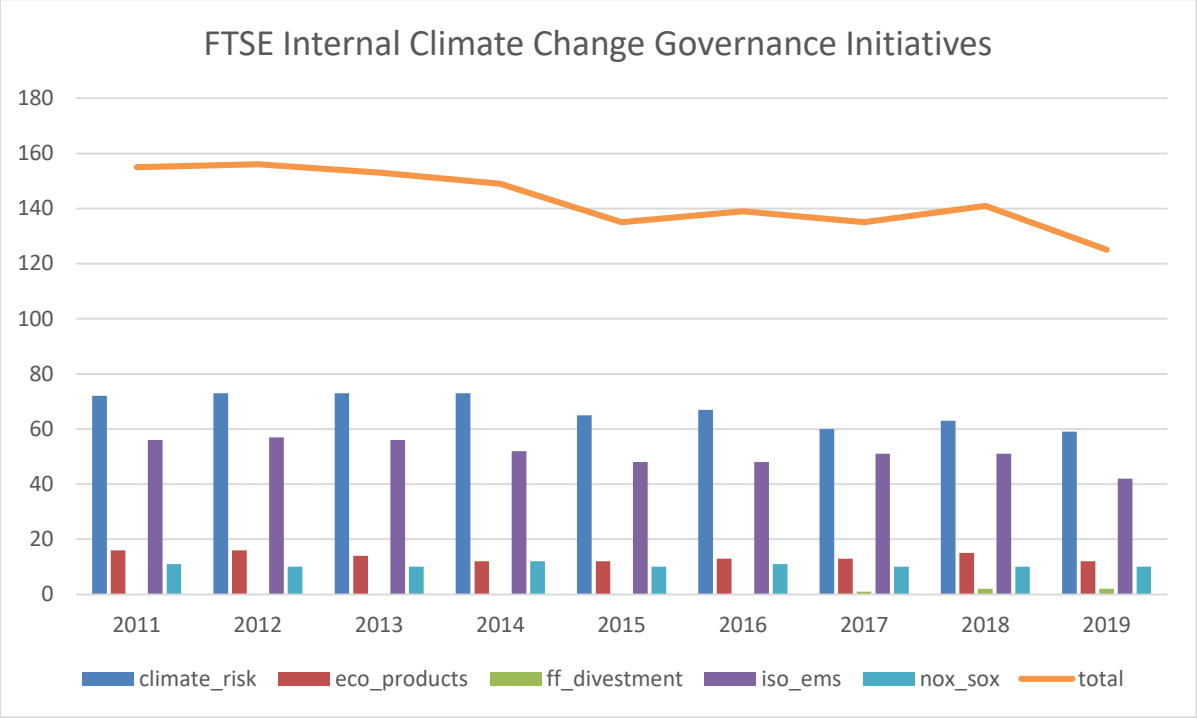
FTSE companies have also developed a series of internal climate change governance initiatives, which are tracked by Thomson Reuters ESG platform. The majority of FTSE companies have “climate risk” governance built into their corporate governance structure. Some general observations are the following: about half participate in ISO or EMAS environmental management certification schemes, while a much smaller percentage have listed ecological product development or fossil fuel divestment internal climate governance initiatives. As of 2019, we report the percentage of FTSE companies that have each of the five internal climate governance initiatives as follows:

- Climate Risk built into Corporate Governance?: 59%

- Eco and green product development?: 12%
- Fossil Fuel Divestment Initiative?: 2%
- Use ISO or EMS environmental management standard?: 42%
- Have Nitrous oxide or Sulphur dioxide reduction in place?: 10%

A large body of previous literature explores the impacts that ISO and EMAS have on corporate environmental behaviour (Prakash & Potoski, 2006; Perez et al., 2009). However, while ISO and EMAS appear to reside within the "climate risk" frame, there is a notable absence in more substantive initiatives such as fossil divestment and nitrous oxide / sulphur dioxide reduction. Similarly, only about 12% report to be involved in eco-products or eco-innovation. This adds weight to our argument that carbon-based initiatives receive the lion's share of attention, and likely resources, from the private and corporate sector, possibly to the detriment renewable energy investment and GHG reductions apart from carbon. This could be a result of the now dominant "climate risk" narrative, which is evidently further cemented by actors such as the TCFD, but may have severely negative implications *for non-carbon and non-risk type internal governance initiatives*. Indeed, there is a 26% correlation between "climate risks" disclosed in internal corporate governance initiatives and the TCFD. This suggests that FTSE companies are fully committed to the "climate risk" frame, shown by the correlation among internal and external "climate risk" governance initiatives. However, there is an even higher 38% correlation between ISO/EMAS and "climate risk" internal governance initiatives, which might suggest that ISO-14001/5000 and EMAS are used to merely "signal" environmental governance (Dragomir, 2012), marking rhetorical rather than substantive behavioural changes (Talbot & Boiral, 2018). These initial findings are important and should be explored more in future research. Finally, in recent years, the overall trend is downward, which means that internal climate change governance initiatives are trending in the opposite direction we would hope, in terms of climate change.

Graph 9: FTSE-100 Internal Climate Change Governance Initiatives



Graph shows Climate Risk and ISO/EMS management standards are the most common internal climate change governance initiatives for FTSE companies, and overall the trends are falling (*Companies that report to Thomson-Reuters that they have an internal carbon price: BP, BHP, Glencore, Shell, Unilever, CRH, Rio Tinto)

6.2.4. Carbon-Based Measurement and Verification Actors?

The GHG Protocol and ISO 14064-1/2/3 corporate carbon emissions measurement standards do not have membership lists. Nor do carbon verification actors such as Gold Standard. Therefore, we must rely on text mining of corporate sustainability reports to glean an understanding of membership trends and participation rates for these standards and actor-memberships. Therefore, in the next section we undertake text mining and automated classification of FTSE sustainability reports.

6.3. Mining FTSE-100 Corporate Sustainability Reports: Content Analysis Method

This section seeks to delve into the details of what FTSE companies disclose through sustainability reports. Previous literature has used sustainability reports to uncover data that is not reported elsewhere (Dragomir, 2012; Boiral, 2007). Corporate reports can illuminate more accurate information on emissions and other environmental governance in comparison to voluntary environmental reporting platforms (Dragomir, 2012). Above, we have collected data on corporate membership in climate initiatives. We assigned “1” to a FTSE company the year it joined an initiative and a “0” otherwise. Here, we go deeper to assess the propensity of FTSE companies to assess membership trends in their sustainability reports. In other words, going beyond a “1” or “0” binary coding, in this section we look at textual data on the frequency climate initiatives are mentioned per year throughout all FTSE sustainability reports. For example, if a company mentioned SBTi 27 times in its 2019 sustainability report, we can change the “1” to “27”, which has beneficial consequences for further empirical investigation.

After mining, cleaning, and making sense of the data, automated textual analysis of corporate reports can offer more nuanced exploratory analysis of corporate-level framing, association, disassociation, localizing, incorporation, commensuration, proselytization; normalizing, purification, dilution, recognised as an important future research topic (Wright & Nyberg, 2017: 1644). With machine-enhanced textual analysis we can begin answering the critical, but highly complex, questions germane to corporate climate change governance, framing, actions and reactions. Taken together, this final part of our empirical analysis responds to another important gap: “Does joining voluntary climate action or carbon disclosure initiatives lead to real changes in firm-level and industry-wide behaviour?” (Hsueh, 2017: 24).

Accordingly, in this subsection, we explore three separate but related research questions:

1. How are FTSE membership strategies communicated through sustainability reports?
2. What are some observed changes over time with respect to “public” and “private” carbon governance actors? And since Paris?
3. Then, on a more granular level, which actors show increasingly more prevalence?

6.3.1. Overview, Sample and Method

Sample and Data Collection: Our sample are the FTSE 100 companies from 2006-2019. However, not all years and companies are available. The total sample includes 500 cases. Many of the reports come only after 2015. Therefore, it is an unbalanced sample. Finally, the reports are variously labelled “CSR”, “ESG”, “Sustainability Reports”, etc., and there is no strict guidelines for how and what companies should report, which means not all reports contain the same information.

Method: Following Radu et al. (2020) and Henderson and Venkatraman (1999), we perform content analysis by constructing “dictionaries” and by using content analysis software to mine the textual information. While Radu et al. create two dictionaries, one for environmental strategy and the other for carbon strategy, we create one dictionary for carbon governance actors and initiatives (we do replicate the Radu study, with results available upon request). An underlying assumption in content analysis is that frequency of keywords indicates importance. Frequency of words occurs within single reports, and across the entire sample. In sum, 7 steps are conducted: (1) obtaining the 500 reports; (2) converting reports into machine-legible data; (3) building the dictionary; (4) running keyword analysis; (5) removal of “bad” words that confuse the software; (6) cluster analysis; (7) categorical analysis.

Classification of Carbon Actors: We impute the constellation of carbon-based actors mapped out in sections 4 and 5 above. Specifically, we build our dictionary around the following classifications:

- Carbon Anchors
- Carbon Governors
- Carbon Actors
- Carbon/Climate Initiatives
- Climate Change Regime Actors
- Carbon and Climate Non-State Actors

Within each category, we populate with actors based on the Carbon Governance Regime from section 4.

Main Results: Three-quarters of the reports mention carbon actors (CDP, TCFD, GHG Protocol); nearly two-thirds mention carbon governors (i.e. IETA, CERES, WBCSD); about half mention carbon anchors (IPCC, UNFCCC); 40% mention TGCI actors; while only 9 percent mention non-state actors, and 8% mention the “Post-Paris” climate initiatives spearheaded by The Climate Group (RE-100, EP-100, EV-100). Indeed, the very same actors that emerged as central after the machine-aided cluster analysis of the Carbon Governance network in section 4 also appear central within the corporate reports.. What this indicates is that FTSE companies recognize the importance of a handful of key governance actors, that those actors act as liasons between climate governance and corporations, and might also that these central carbon-based governance actors in turn wield strong influence over FTSE companies climate change governance profiles (e.g. emissions inventories). These are important observations for policy-makers.

6.3.2. Cluster Analysis

The results of the initial cluster analysis of keywords are shown below. We have run analysis based on the carbon-governance dictionary, and these are the actors that experience the highest hit-rate per 10,000 words. (n=500 reports, t=2006-2019): CDP (Carbon Disclosure Project), ISO (International Standards Organization, GHG Protocol, PRI (Principles for Responsible Investment), Carbon Trust, DEFRA, TCFD, Global Compact.

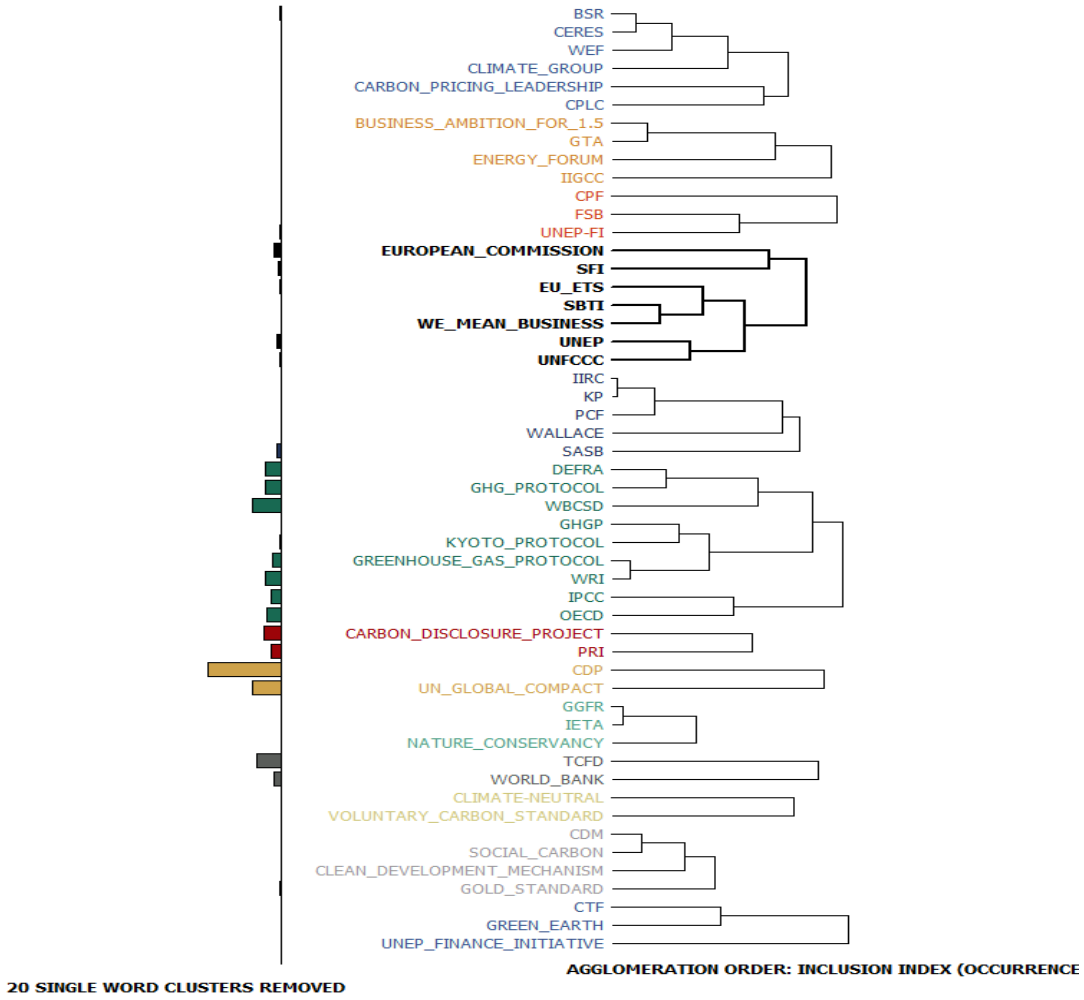
Graphic 4: Top Actors within the text of FTSE Sustainability Reports

Here we notice that ISO (International Standards Organization), WWF (Worldwide Fund for Nature), the CDP (Carbon Disclosure Project), and the UN Global Compact, feature throughout the 500 reports. Secondarily, TCFD, Carbon Trust, and GHG Protocol also are central within reports. The strength of TCFD is notable since it is a relatively new actor.

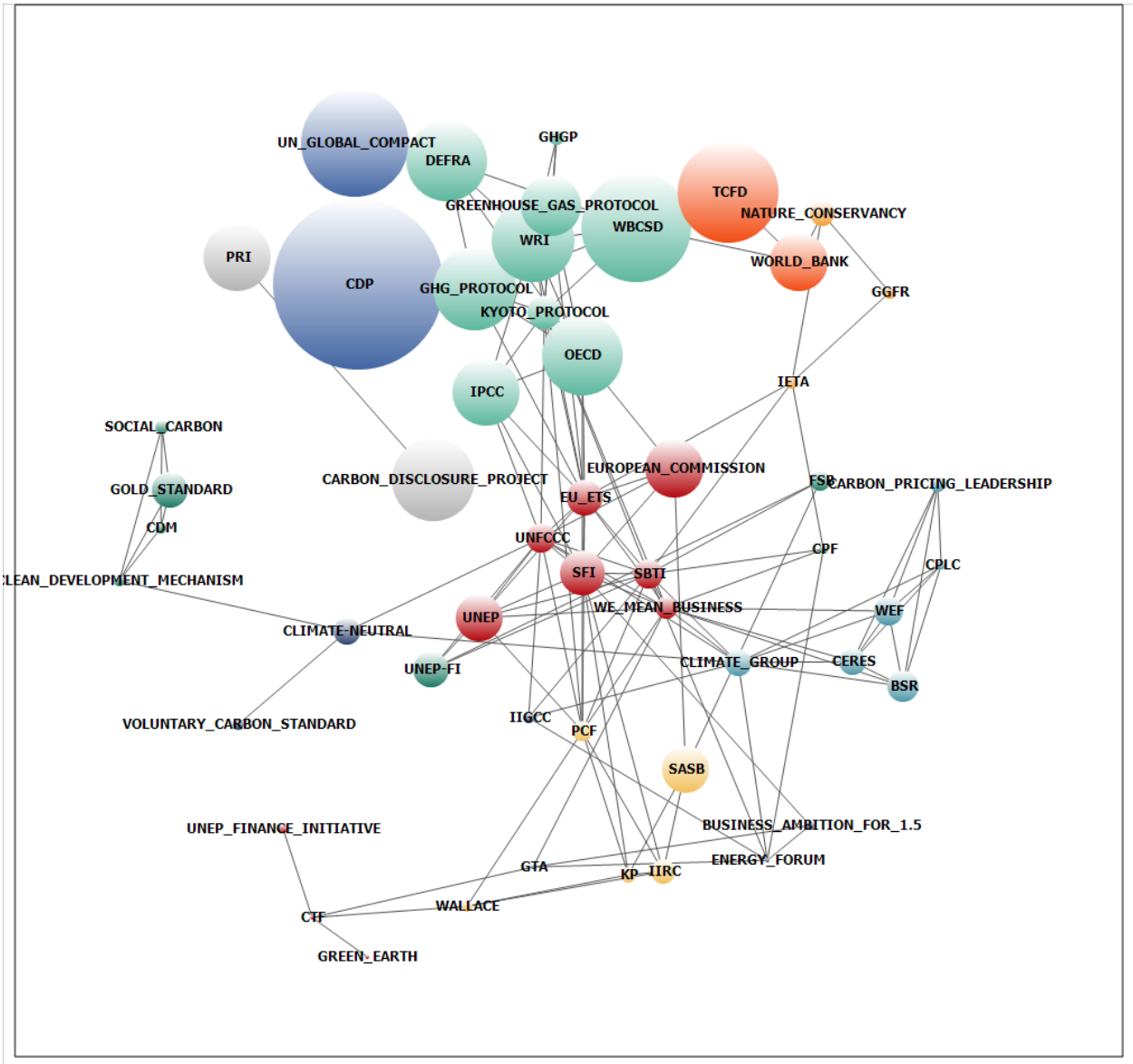
Cluster Analysis: Next, we perform an automated textual cluster analysis enhanced by machine-learning software. The first part of the clustering produces a denogram, which shows the hierarchy and relationships among clusters. In other words, the denogram can be thought of as a family tree of the top keywords across all 500 reports. The links are based on “co-occurrence” within the document and then across the entire document sample. Thus, the denogram conducts a centrality analysis on the keywords already identified. In this instance, we have specified co-occurrence within n=100 words, within

each sustainability report. This means that words –in this case carbon-based governance actors—appearing within 100 words of one another are clustered together in the denogram and the mapping. Finally, single word-clusters are removed to eliminate the possibility of a misspelled actor being clustered with itself. Below are the results of the hierarchical analysis (denogram), followed by the automated mapping. The software applies the co-occurrence link strength and node strength to automatically produce the map. Larger nodes in the map indicate that the keyword occurs across a greater number of individual reports. Below we produce the denogram followed by the cluster map.

Graphic 5: Denogram Hierarchical Cluster Analysis across 500 FTSE Reports



Graphic 6: Cluster Map of FTSE-100 Corporate Sustainability Reports



Cluster Method Specifications: The map above is created with the "Inclusion index (occurrence)" method and Co-occurrence profile (second order). We can see that at least five distinct clusters emerge from the machine-aided analysis. It shows the CDP and Global Compact in one cluster; GHG Protocol and WBCSD, along with IPCC, OECD, Defra and Kyoto Protocol in another cluster; the TCFD and World Bank form the orange cluster. An interesting light orange cluster is made up of GGFR (the Global Gas Flaring Partnership), IETA and the Nature Conservancy; WEF and CERES form a cluster with

BSR and the CPLC; a central red cluster is made up of the Carbon Anchorss, the EC, the EU-ETS, the UNFCCC, UNEP, SFI, and two emerging initiatives, We Mean Business and SBTi. Finally, a Carbon Verification cluster can be identified on the left with Social-Carbon, Gold Standard, and the CDM. Overall, these results show how FTSE-100 companies refer to, and perhaps rely upon, carbon-based governance actors. Moreover, these results provide a larger picture of how the hybrid and public-private climate change governance regime operates at the corproate level.

6.3.3. Carbon-Governance Category Analysis

Finally, we conduct an analysis to understand how our classification of the carbon-based governance actors (discussed in sections 4 and 5) plays out in the FTSE sustainable report's sample. We look at each category of actor-groups individually (anchors, governors, carbon measurement, carbon verification, carbon disclosure). Below are the initial results and keyword occurrences. For details of each of the actors within each category, we refer the reader to our network map in section 4. Further details can be found by viewing the map online here.

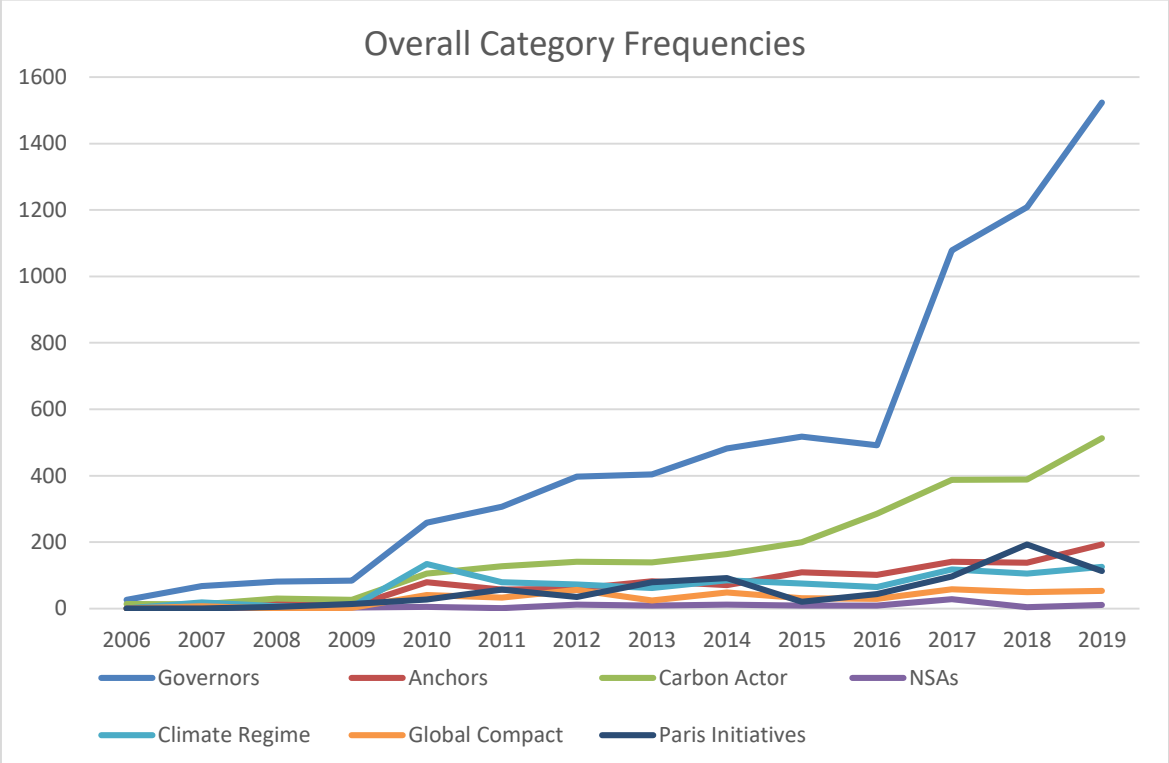
Table 5: Summary of classification results

Carbon Governance Regime	Frequency	# Cases	% Cases	TF • IDF
Carbon Actors (MRV)	3067	366	76.89%	350
Carbon Governors	6998	296	62.18%	1443.8
Carbon Anchors	1146	231	48.53%	359.8
Climate Regime Actors	685	203	39.71%	296.1
Non-state Actors	113	42	8.82%	119.1
Climate Initiatives	85	37	7.77%	94.3

The table displays the results across all corporate sustainability reports. Frequency is the total number of times one of the actors within a category is mentioned. Number of cases refers to the number of corporate reports the category of actors are mentioned. TF*IDF is an indicator of uniqueness, higher indicates more frequency in one document rather than spread across all documents. In this case, carbon governors exhibits a high TF*IDF,

indicating that a few FTSE companies mention governors quite a lot. That likely stems from the FTSE companies that have direct membership in central governors (BP, Rio Tinto, Coca-Cola, Shell), discussed in section 6.2.1 above.

Graph 10: Trends in overall Carbon Governance Categories, FTSE100 reports



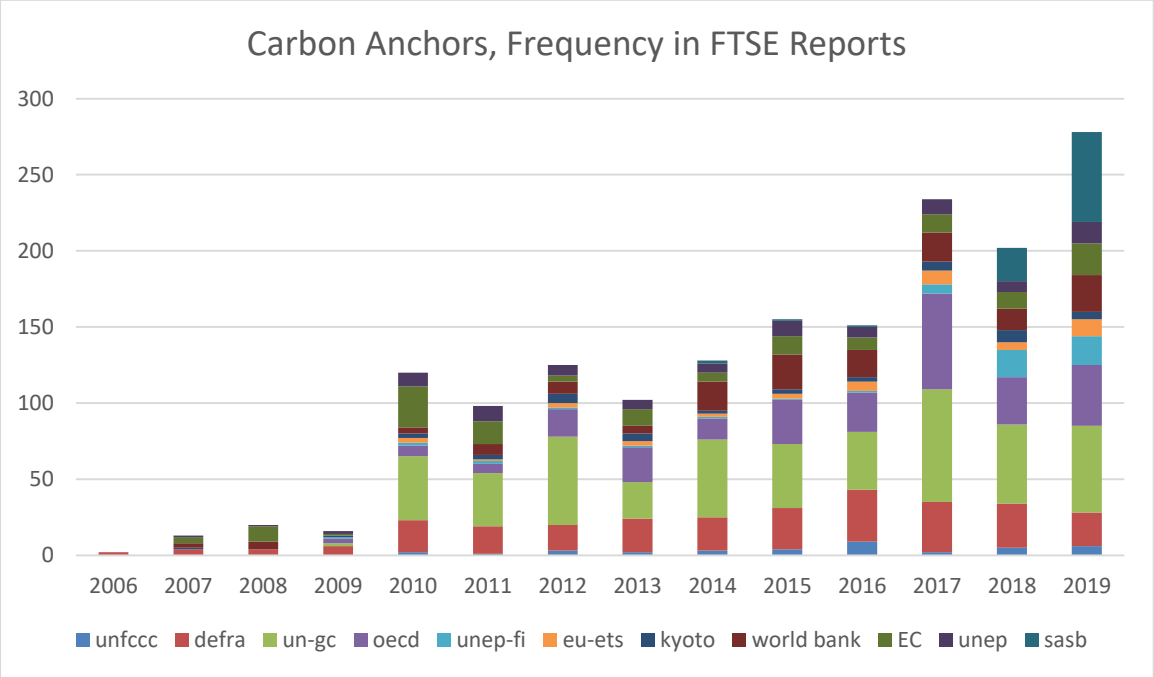
This graph shows total mentions across all reports, each year. Carbon Governors and Carbon Actors feature very strongly across the sample at 62% and 77% of all cases, respectively. These classifications are followed by Climate Change Anchors (UNFCCC, UNEP, etc.) at 40% and vintage Climate Regime / TGCI actors at 40% (but if we remove UN Global Compact, that plummets to only 15%). Finally, NSAs and Post-Paris Climate Initiatives do not feature strongly across all reports at 9% and 8%.

Below, we take a closer look at these results and examine the content of the reports with respect to Carbon Anchors, followed by the Carbon Governors, then the 3 different types of Carbon Actors: Measurement, Reporting, and Verification.

1. Results of Carbon Governance Anchors: Below, trends over time show that "Anchors" are relatively stable throughout corporate reports, with an interesting jump in 2019. A surprising finding is the prominence of the UN Global Compact (light green), and

also DEFRA (red). We did not expect these actors to feature so strongly in the corporate sustainability reports. UNEP Finance Initiative is gaining mentions, which could be related to the TCFD or the emerging EU taxonomy, which build on some of UNEP-FI's central ideas. The SASB has very recently received a lot of mentions, which again is probably tied to the TCFD. A final note of caution is that the sample is not balanced, especially prior to 2015. Therefore, the growth in mentions from 2006-2014 is largely spurious. However, post-Paris, the results hold: there is a noticeable growth in mentions of carbon governance anchors.

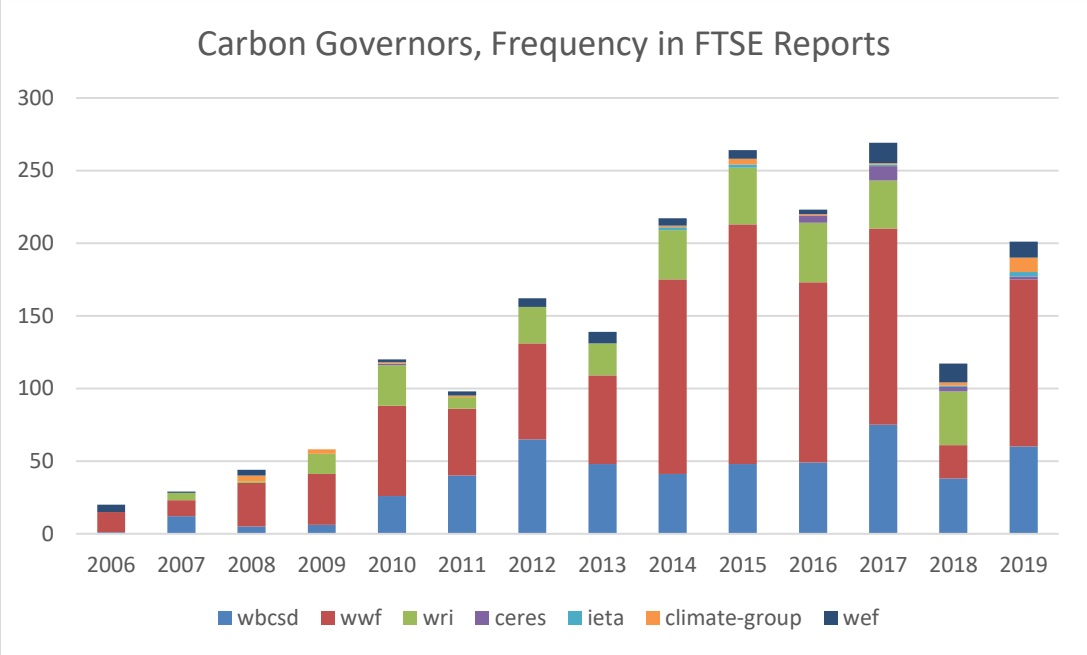
Graph 11: Carbon Anchors' Frequency in FTSE Sustainability Reports



2. Results of Carbon Governors: Below are the key carbon governors found throughout corporate reports. WRI and WBCSD are consistently mentioned. However, they often are mentioned alongside the GHG Protocol, substantiated by the cluster map above. Thus, this is not necessarily indicative of the centrality of the WRI and WBCSD, but rather the carbon measurement standard they oversee and spearheaded.. IETA and Climate Group are infrequently mentioned. The former does not have strong membership from FTSE, so this is largely expected. However, because The Climate Group has launched four different

climate initiatives, we would expect a stronger appearance. We did find that the Climate Group's climate initiatives are prevalent, which is unexpected since they are marketed widely. Further, it is surprising that WWF is the most commonly mentioned carbon governor among the reports. It is perhaps the most credible and neutral out of the governors (i.e. in contrast to IETA, WWF does not usually hold any negative connotations as a trade group). In terms of the overall governance features of the Carbon Governors, they indeed do appear to be "institutionalized" into climate change governance, judging by their prominence in comparison to the public carbon "anchors." Even though the Anchors are comprised of 11 organisations, the seven governors have more mentions throughout the reports (apart from 2018 which shows a downward dip that correlates to a dip in WWF mentions).

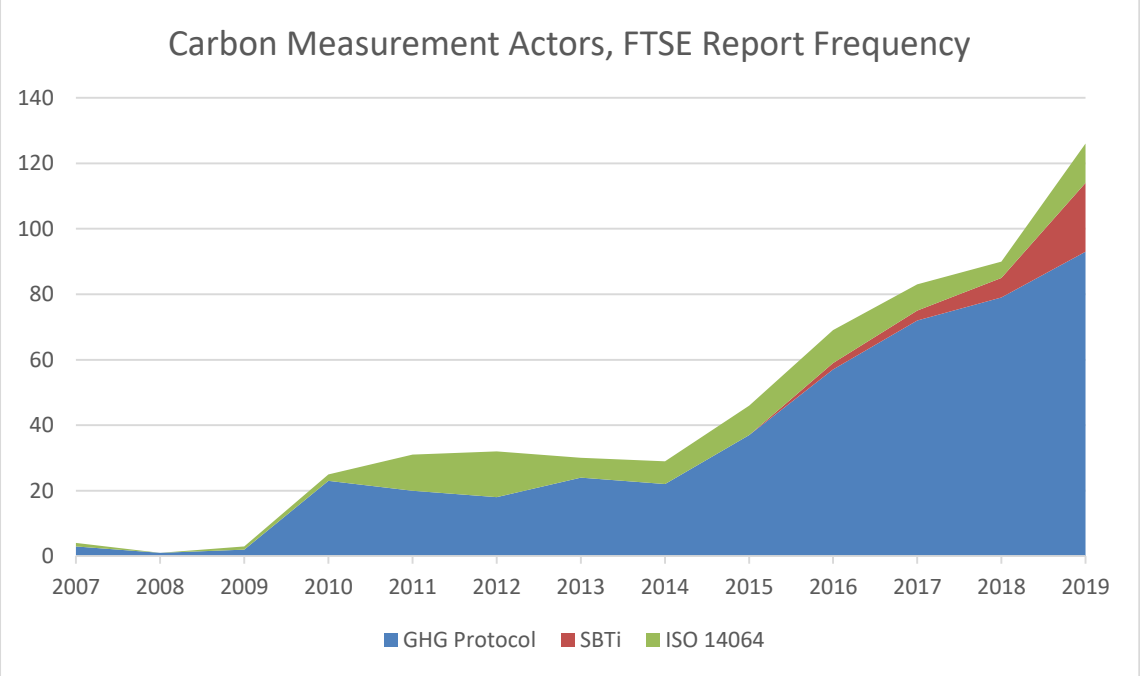
Graph 12: Carbon Governors' Frequency in FTSE Sustainability Reports



3a. Results of Carbon Measurement Actors: Below we compare the prevalence of three Carbon Measurement standards/initiatives. There is a noticeable and precipitous increase in the GHG Protocol at about the same time as the Paris Agreement. Separately, it appears that Science-Based Targets is on the verge of taking off. However, ISO 14064-

1 seems to have gone out of vogue as a measurement standard. Immediately below, we discuss the various ISO standards together.

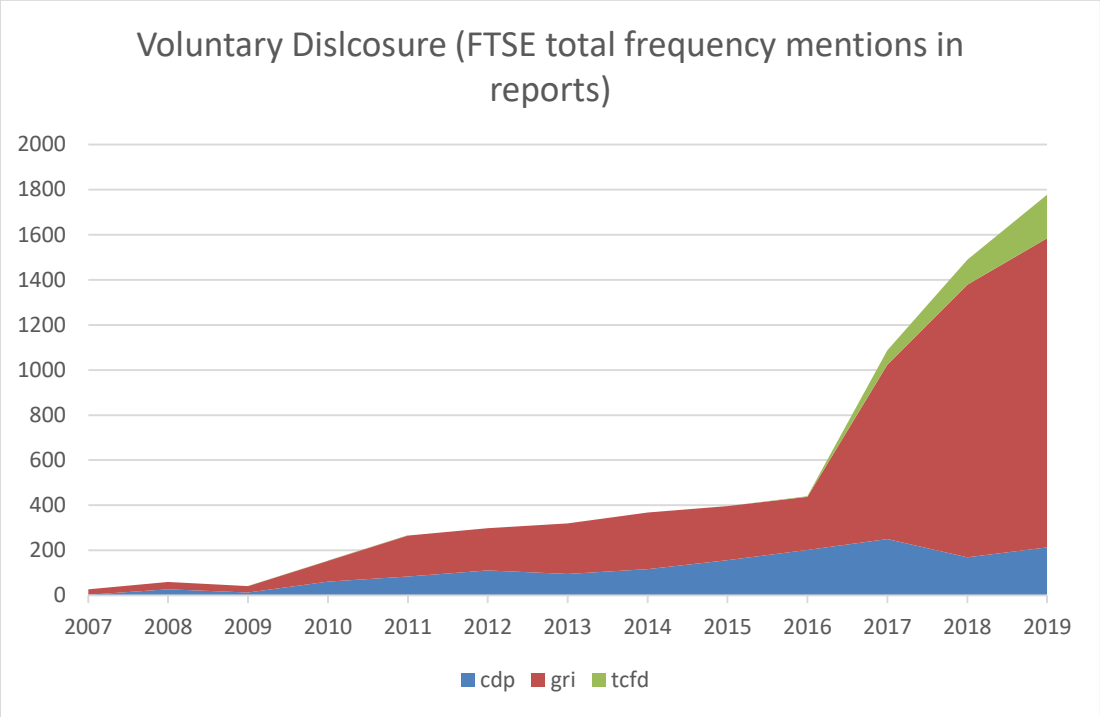
Graph 13: Carbon Measurement Actors' Frequency in FTSE Sustainability Reports



Results of Carbon Disclosure Actors: Below shows strong prominence of GRI (The Global Reporting Initiative) throughout the reports. Although we should expect that the GRI (Global Reporting Initiative) has a strong showing, its enormous prevalence was a surprise. Disclosing to the GRI indeed "ticks the box" for many mandatory environmental reporting legislation, which may be one reason it features so strongly. At the same time, it is surprising that, even though over 75% of FTSE companies report to the CDP, they do not seem to be promoting this voluntary carbon disclosure that much in their sustainability reports in comparison to the GRI. Finally, the TFCD is very new, so mentions of that actor are not picked up yet. In general this shows that (1) hybrid climate and carbon disclosure initiatives are becoming very familiar to FTSE companies; (2) the GRI platform has largely succeeded in filling a governance gap: lack of a central and transparent repository for corporate environmental and climate change disclosure; (3)

mandatory disclosure legislation is pushing FTSE firms to report to GRI, and speak about their reporting to the GRI through their reports.

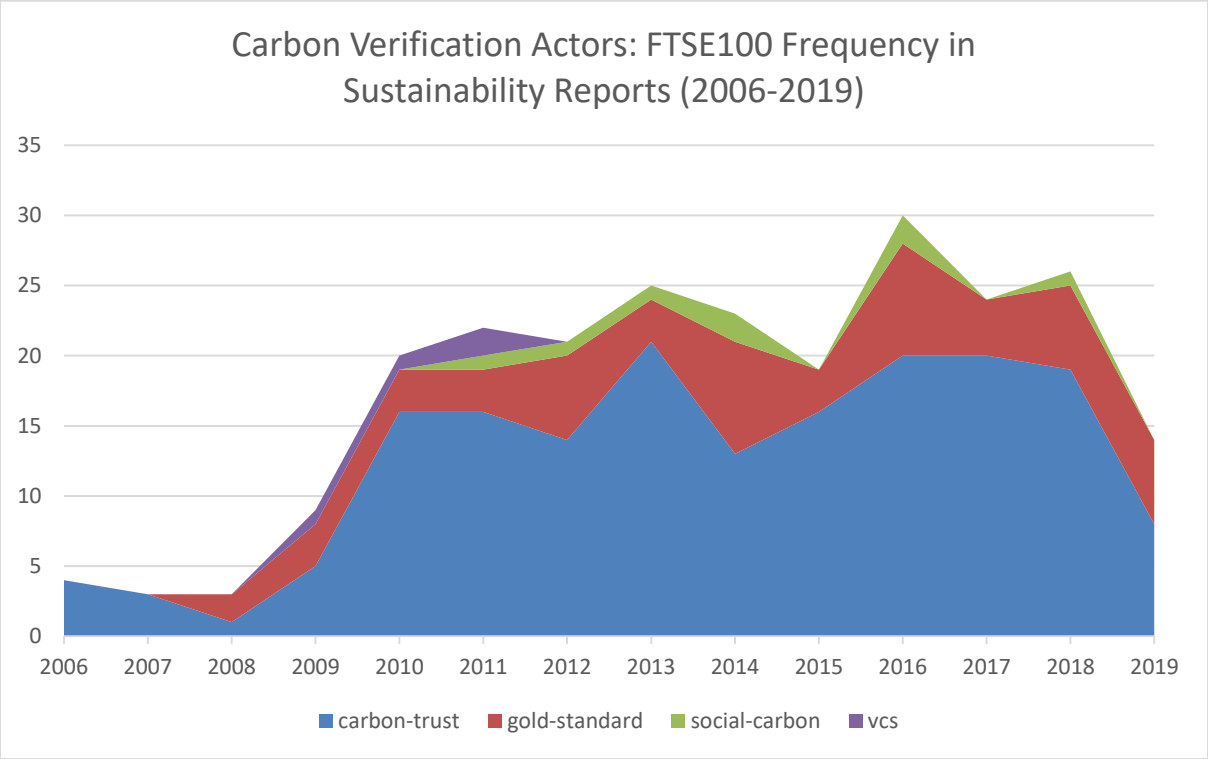
Graph 14: Carbon Disclosure Actor's Frequency in FTSE Sustainability Reports



4. Results of Carbon Verification Actors: Finally, we examine carbon verification actors. It was very surprising that the Carbon Trust standard is very frequently mentioned. We expected the Gold Standard, VER+ or VCS, but that was not the case. In general, it appears carbon verification actors are no longer in vogue, at least from the FTSE perspective. Indeed, the Carbon Trust standard is usually mentioned along with forest protection, so this finding is not directly related to corporate carbon verification, which is our focus here. Perhaps, because voluntary carbon emissions disclosure (to the CDP for example) does not require third party verification, these actors are no longer widely used by FTSE companies. Also to note: the ISO 14064 standards *do require* third party verification; so the GHG Protocol and the CDP winning out against the ISO 14064-1 and ISO 14064-2 may indeed have limited the need for third-party carbon verification through actors such as the Gold Standard. But, finally, corporates now use an array of different

consultancies to conduct third party verification, so it could indicate that there are simply too many actors within the carbon verification to make an accurate assessment.

Graph 15: Carbon Verification Actors' Frequency in FTSE Sustainability Reports



Finally, we present the overall emissions trends in FTSE companies to provide some backdrop to our discussion.

6.4. Discussion: The Carbon Regime and Carbon Lock-in

Although the actors we have identified throughout the FTSE reports paint a picture of bottom-up and privately-led climate change governance performing well, emissions in FTSE companies continue to rise. This further suggests—in line with our claim about public carbon governance not instantiating reduction of emissions at country levels—that carbon based governance is not working for the private governance dimension either. Evidently, there remain deep structural issues with private-led carbon-based governance to meet the goals of the Paris Agreement. Indeed, nation's emissions as well as corporate

emissions, on the whole, continue to rise. Even though private actors react well to market mechanisms, accountability and legitimacy remain key concerns (Andonova & Levy 2003; Lebaron &Lister 2015). It is possible the private sector is not well-equipped to meet the demands of the "collective action" problems (Geels et al., 2017).

Some researchers suggest that an entirely new approach, beyond the outmoded "carbon budgets" that are tied to the emissions reduction's imperative, is required (Peters, 2018; Bernstein & Hoffmann, 2019). Carbon budgets often lead to too many competing calculations that rest assumptions of emissions. This reliance leads to noticeable consequences on other GHGs aside from carbon (Peters, 2018). Indeed, even the public Carbon Regime anchors and standards, such as the IPCC's GWP carbon-equivalent metric conversion, is subject to periodic revision, with grave consequences for carbon-based governance (as detailed in sections 2 and 3). Furthermore, the "scope" definitions remain perplexing. Even though there appears to be a levelling off in FTSE scope 1 and scope 2 emissions, the top-rated disclosing companies fail to sufficiently disclose Scope 3, which is the elephant in the room. Recent research has similarly flagged the multifarious issues that remain unresolved for carbon-based governance:

> There is no agreed-on approach or single standard to quantitatively assess [GHG] contributions [...] the scope of emissions covered by different actors (direct or Scope 1 emissions versus indirect or Scope 2 or 3 emissions, per the Greenhouse Gas Protocol/ISO 14064-1 classification), target and base years, and counterfactuals or scenarios used to evaluate additional impact ["baseline"] […] Such scope distinctions are critical, as for many actors' efforts, impacts are considerably greater for indirect (Scope 2 and 3) than for direct (Scope 1) emissions [...] making attribution of emissions and resulting reductions complicated (Hsu et al., 2019: 12).

Carbon "lock-in" occurs when carbon-centred governance leads to lock-in of conventional energy usage (Unruh, 2000). This has implications for corporate carbon lock-in as well. Intertwined technological, economic, political and social systems continue to work against, rather than towards, eliminating conventional energy, which is responsible for the bulk of the world's greenhouse gas emissions. The Carbon Governance Regime, as it

currently exists, indeed seems to “reinforce dependence on fossil fuels in many places simultaneously” (Bernstein and Hoffmann, 2019: 919). For instance, throughout the 500 reports we analysed, carbon is the dominant greenhouse gas mentioned, to the detriment of the 5 other main Kyoto Protocol GHGs. As the world witnessed with “Diesel-gate”, we have to pay special attention to these other GHGs, or the climate crisis will worsen even whilst a flurry of climate governance activity ensues. It is an open question how climate change governance can continue with such a unitary focus on carbon, and such a large gap in understanding about the deleterious effects of other GHGs. Below we briefly discuss the carbon lock-in issues with respect to each MRV activity, and which private actors are currently responsible for each respective activity.

Carbon lock-in and monitoring and measuring carbon emissions: The monitoring and measuring is now dominated by the Greenhouse Gas Protocol. The ISO 14064-1 carbon measurement standard appears to have fizzled out, at least according to the FTSE sample. One consequence of the GHG-P dominance is that, in contrast to the ISO, the GHG Protocol is free to be used in any way a corporation feels fit. In other words, ISO mandates third party verification and if it is found to violate the standard, the carbon emissions inventory can be revoked. This does not apply to the GHG Protocol, which has no enforcement mechanism. Moreover, both have still not resolved the elephant in the room: Scope 3 emissions (Hsu et al., 2020).

Carbon lock-in issues with reporting and disclosing: In 2011, 60% of FTSE companies reported carbon emissions to the CDP. By 2020, that has grown to nearly 80%. Yet carbon disclosure to the CDP, although widely used by FTSE companies, has not appeared to have had any significant effect on corporate emissions. This is borne out in the emissions data provided by Thomson Reuters. Likewise, while the GRI (Global Reporting Initiative), has done well to help increase the propensity for firms to disclose—and many of the FTSE reports can be found there—over the last ten years it has edited and updated its reporting framework a handful of times; this severely restricts more meaningful time-series and longitudinal analysis. At best only anecdotal empirical analysis can be conducted. The CDSB (Carbon Disclosures Standards Board),

inaugurated with the explicit purpose to amalgamate the many different carbon metrics (measuring, disclosing, and verifying), continues to struggle to come to any real consensus on this matter. While it designates the GHG Protocol and the CDP as carbon measurement and disclosure standards respectively, it fails to recognise the serious limits to scope emissions procedures, the firewall on CDP's data, and the non-binding, unenforced usage of the GHG Protocol. Indeed, while the CDP ranks companies according to full disclosure, even the companies at the top of the list disclose in a wide variety of ways. These observations are substantiated in the corporate sustainability reports. Each sector reports using a different metric for carbon, and that does not begin to assess the completeness of "Scope Emissions" reporting (Scope 1, 2, and 3) or choice of GWP carbon equivalents conversion used (aligned to which IPCC report, and over how many years' time horizon conversions).

Carbon lock-in and carbon verification: Carbon verification has been recognised as a pivotal governance instrument for some time (Gupta et al., 2012). However, interestingly, while 15 years ago there were hundreds of carbon verification actors competing for the same space, now it seems that three or four dominate. This is good in terms of limiting the fragmentation. However, caution should be taken because several key carbon governors appear to wield outsized influence over these three or four actors (WWF, IETA, WEF). This is shown in our Carbon Governance Network map as well as the textual cluster analysis mapping in this section. Thus, while carbon verification is no longer fragmented, there appears to be a monopoly of power encircling the key initiatives.

Summary of carbon lock-in: Incommensurable carbon commitments and reporting make benchmarking difficult for investors, regulators, researchers, and consumers alike. Comparison across companies, due to different reporting standards, different ways to calculate emissions profiles, different future targets, and different plans to get to "net-zero" remains very difficult, with negative implications for leveraging the private sector's resource to combat climate change. Indeed, the shortcomings of the Carbon Regime were recently summed up in a World Economic Forum paper:

> [T]he lack of common reporting standards makes it hard to compare targets. Companies report very different base and end years. When they commit to [carbon] targets, they might be referring to absolute emission reduction, emission intensity, renewable energy use, or any other measure, and the volume metrics they use are inconsistent. As a result, to date no robust way of benchmarking corporate climate action exists *even among industry peers*. This lack of transparency makes it too easy for companies to display policies that are mostly *window dressing* instead of actually investing in meaningful emission reductions (WEF, 2020: 9).

While Carbon Governance Regime actors and central governors are tightly connected, carbon governance itself remains highly fragmented, with negative consequences for large-scale low-carbon and low emissions transitions. The fragmentation is evident in the outputs: the myriad ways carbon emissions are gathered, reported, and verified. There is no longer any formal centre; it is polycentric, but in its metrics rather than actors, which is not what is needed. Standards are widespread, but within each standard much fragmentation exists, largely because of the nebulous nature of measuring, reporting, and verifying carbon emissions. As a result, it is extremely difficult to discern the accuracy and authenticity of a company's emissions inventory, disclosure, or future trajectories and goals. And while many central carbon governors purport to mend this problem, the empirical data suggests that they have not made much of a dent in I, and appear to be more focused on increasing their integration more deeply into the network, rather than resolving key issues that have been identified here.

6.5. Recommendations: Governance beyond Carbon Lock-In

The difficulty in comparing carbon inventories is exacerbated by the restriction on data access to corporate-level carbon emissions. This renders climate change governance which, in terms of the corporate sector, gravitates around carbon emissions mitigation governance instruments and actors, highly unstable. Indeed, the earlier optimism for corporate-level, bottom-up emissions' disclosure as a method to improve climate governance might be unjustified (Talbot & Boiral, 2018). Perhaps, due in part to the carbon regime complex, the reassertion of state-led initiatives and regulatory oversight

might again be called for. This could be an important regulatory gap that the EU, as a climate regulatory pioneer, could fill. But if it does choose to do so, very meticulous oversight should be undertaken to clarify each of the central carbon-based governance metrics and responsibilities: GWP conversion, carbon monitoring, reporting, and verification.

Another option is to move beyond carbon governance lock-in. Moving beyond carbon lock-in requires, in part, a recognition of the limits of carbon-based governance, limits that have been demonstrated above and elsewhere (Mackenzie, 2009). This includes restructuring carbon governance initiatives from both top-down (e.g. EU-ETS) and bottom-up mechanisms (e.g. corporate carbon disclosures such as the CDP). Indeed, this might be an important next step, as it seems the "metaphor of a collective action problem" confronting the "global commons" has not been very effective thus far (Bernstein & Hoffmann, 2019). We have found and presented some initial evidence in support of this view in the empirical analysis in this section. A reorientation of climate change governance away from the carbon trap, and towards innovative inducement of integral clean technologies, offers a promising step and avoids carbon lock-in. Rather than carbon-based governance, climate governance might focus on how to steer companies and investors towards a "strategic reorientation [that] involves exploration of new technologies [and] development of new capabilities, which facilitate strategic change" (Geels, 2014: 272). Indeed, STRN (Sustainable Transitions Research Network) researchers have been working for two decades on long-term, sociotechnical solutions with this view in mind (Kohler e al., 2019)

Meeting the demands of climate change requires socio-technical transformation (Kohler et al., 2019). Governments provide the "dance floor" for such transformations (Geels, 2014). In climate change governance, private actors have evidently encircled carbon-based governance—ostensibly because they are drawn to markets. But it appears that carbon governance still needs public governors (Bernstein et al., 2010: 170), despite the appearance that the private sector has it all under control (Hale & Roger, 2014). Indeed, the pervasive issue of carbon measurement, reporting, and verification remains largely

unresolved. And so it seems that carbon-governance relies on the state to "loom in the background" (Börzel & Risse, 2010: 114).

Emissions reductions, carbon budgets, and carbon measurement remain stuck within both the carbon-trap and a technocratic mindset. For example, frequently emissions reduction promises are dependent on promised technologies that are "coming soon" (such as "new nuclear" and "carbon capture and storage"). Such technologies of "prevarication" continue to siphon off much needed attention, financing, and governance efforts towards a fully decarbonized world economy.[2] Greta Thunberg, the teenage climate activist, recently highlighted the carbon trap:

> Countries are finding clever ways around taking real action […] recently, a handful of rich countries pledged to reduce their emissions of greenhouse gases by so and so many percent by this or that date, or to become climate neutral or even "net-zero" in so many years. This may sound impressive at first glance but even though the intentions are good, this is not leading, this is misleading[3]

As Greta poignantly illuminates, rather than promises for emissions reductions, or "net-zero" future emissions' goals based on technologies that do not yet exist, climate change governance for the corporate sector must effectively drive down emissions in the near future. As a corollary, investors and policymakers need better tools to ascertain which corporations are actually taking the proper steps to move to a low-carbon economy, rather than drafting shiny plans and sustainability reports. Emission's pledges that are based on hopeful technologies or creative accounting should be heavily penalised. They are misleading and very counterproductive to meeting the demands of climate change. Finally, based on the above discussion and empirical analyses, it has become clear that emissions measuring, reporting, and verifying is fraught with complexity. As it stands now, it should not remain a central piece of climate change governance.

[2] https://www.carbonbrief.org/guest-post-a-brief-history-of-climate-targets-and-technological-promises
[3] Greta Thunberg, speech at the Madrid Climate Summit, 2019.

7. Conclusion

In this report, we have developed a new conceptual approach to help grapple with how the private sector engages with climate change governance. A first step was to illuminate how carbon has become a central focus of private actors, anchored to the public policy imperative of reducing emissions. We enhanced our conceptualization of the Carbon Governance Regime by providing a historical backdrop—where and when public governance sought to develop carbon-based governance standards, initiatives, and regulations—that have largely informed how the Carbon Regime's structure exists in its current form. We then developed a taxonomy to help analyse key carbon governance actors on a more granular level. These actors were then delineated according to their main activities: measuring and monitoring, reporting and disclosing, and verifying carbon emissions. Finally, we empirically examined how these actors engage with the corporate sector using a sample of FTSE-100 companies.

The private sector has a critical role to play in meeting the substantial sociotechnical changes required to avert catastrophic climate change. While companies are responsible for much of the world's greenhouse gases, they are also well-equipped to rapidly deploy resources and meet technological demands of a cleaner climate. Meanwhile, climate-aligned investors need to know which companies are proceeding in a low-carbon direction in order to capitalize those companies to drive large-scale decarbonisation. This calls for accurate profiling and analysis of key actors engaged in bottom-up climate change governance.

In order to measure progress, at all levels of governance and throughout the corporate sector, there is thus a growing demand for reliable carbon metrics. Such metrics form the bedrock of carbon-based governance, which itself plays an outsized role in how the corporate and private sectors engage with climate change But, based on the findings of this report, it appears there is an under-supply of consistent and transparent carbon-based metrics, even though much bottom-up activity is engaged with these tasks. It remains to be seen how carbon governance, with such fragmentation and complexity, will

continue to function in the coming years and decades. Serious loopholes currently exist. Perhaps it is not possible to have consistent, transparent, and uniform carbon metrics. Should that be the case, then carbon mitigation might not serve best as the central governance focus for climate change. Carbon governance has failed to reduce emissions and continues to siphon off limited resources needed for a large-scale low-carbon transitions—resources that could be diverted elsewhere.

Perhaps the initial excitement that the private sector would plug the governance and emissions gaps was misplaced (Talbot & Boiral, 2018). Because a clean climate is a global public good, it remains an open question how willing the private sector will be in meeting the demands of climate change. That implies that the state – the shadow of hierarchy – is still required to loom in the background (Börzel & Risse, 2010). What kind of state that is remains an important research avenue for future research. At minimum, policy-makers need to recognise the severe limits to climate change governance through carbon mechanisms. There is a pervasive temptation to free-ride—a phenomena that carries over to countries as well—which diminishes chances that private-led efforts, on their own, will be capable of solving the climate crisis. Apart from the obvious problems with metrics, there are related problems of incentives. Indeed, there is a real possibility that the climate change problem is wrongly structured with misplaced incentives (Keohane & Victor, 2016). Without proper incentives, the private sector is driven away from much-needed investment, innovation, and diffusion of climate change mitigation technologies. The sheer variation in corporate carbon emissions' measurement and disclosure is itself evidence that resources, incentives, and efforts are misplaced.

While much of this report finds negative implications of carbon-based governance, the results of our empirical analysis suggest that there is a silver lining. There is also an important role for policymakers going forward. First, if indeed we are to continue with carbon-based governance, the GWPs need to be set in stone, regardless of how science changes in 5 or 10 years. Another option is to govern each of the six Kyoto GHGs separately. It seems implausible that the pivotal metric, conversion of GHGs to carbon, can change every few years without serious consequences to climate change

governance. Having a carbon exchange rate subject to such variability is severely distortionary for carbon markets and sustainable investment. Carbon markets nor future carbon reduction pledges can effectively function if the market is based on a “floating” carbon-equivalent exchange rate. This has obvious consequences throughout the entire low-carbon economy transition (i.e. low-carbon finance; carbon sequestration through forests, carbon offset programs, carbon trading, etc.).

Second, both the GHG Protocol and the ISO 14064-1 carbon measurement standards need to be revised or otherwise cleared up; this is an onerous task, especially for Scope 3 emissions through a company’s value chain. One solution is to use blockchain technology, which has already been widely deployed throughout the shipping industry (Reinsberg, 2020). In brief, blockchain technology could help create a corporate reporting platform that is widely accessible to analysts, researchers, and policymakers, while also making it much more difficult for companies to change disclosure tactics year on year, because it would be all too easy to pick such rhetorical commitments out. Moreover, blockchain emissions systems could also allow future researchers, policy-makers, and investors unrestricted access to how emissions are managed and measured over time; looking back into the past, the data could be used to see which sectors reacted more dynamically and innovatively, or which ones tended to deploy delay tactics. Finally, the reporting infrastructure should be divided into three main categories: (1) Adaptation focused: disclosure of *potential* climate risks (financial and physical); (2) Carbon mitigation focused: disclosure of carbon emissions; (3) Environmental technology and product innovation: disclosure of other contributions to help mitigate climate change (i.e. development of climate mitigation technologies, usage of renewable energy, and introduction of new low-carbon building technologies). Indeed, each of these three categories of disclosure will hold more or less importance depending upon the industry of concern, and each have a vital, if differentiated, role to play in meeting the climate emergency.

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9. Appendices

IPCC's latest Global Warming Potentials (GWPs) Conversion of GHGs to Carbon:

Industrial Designation or Common Name (years)	Chemical Formula	Lifetime (years)	Radiative Efficiency (W m^{-2} ppb^{-1})	Global Warming Potential for Given Time Horizon			
				SAR‡ (100-yr)	20-yr	100-yr	500-yr
Carbon dioxide	CO_2	See below[a]	[b]1.4x10^{-5}	1	1	1	1
Methane[c]	CH_4	12[c]	3.7x10^{-4}	21	72	25	7.6
Nitrous oxide	N_2O	114	3.03x10^{-3}	310	289	298	153
Substances controlled by the Montreal Protocol							
CFC-11	CCl_3F	45	0.25	3,800	6,730	4,750	1,620
CFC-12	CCl_2F_2	100	0.32	8,100	11,000	10,900	5,200
CFC-13	$CClF_3$	640	0.25		10,800	14,400	16,400
CFC-113	CCl_2FCClF_2	85	0.3	4,800	6,540	6,130	2,700
CFC-114	$CClF_2CClF_2$	300	0.31		8,040	10,000	8,730
CFC-115	$CClF_2CF_3$	1,700	0.18		5,310	7,370	9,990
Halon-1301	$CBrF_3$	65	0.32	5,400	8,480	7,140	2,760
Halon-1211	$CBrClF_2$	16	0.3		4,750	1,890	575
Halon-2402	$CBrF_2CBrF_2$	20	0.33		3,680	1,640	503
Carbon tetrachloride	CCl_4	26	0.13	1,400	2,700	1,400	435
Methyl bromide	CH_3Br	0.7	0.01		17	5	1
Methyl chloroform	CH_3CCl_3	5	0.06		506	146	45
HCFC-22	$CHClF_2$	12	0.2	1,500	5,160	1,810	549
HCFC-123	$CHCl_2CF_3$	1.3	0.14	90	273	77	24
HCFC-124	$CHClFCF_3$	5.8	0.22	470	2,070	609	185
HCFC-141b	CH_3CCl_2F	9.3	0.14		2,250	725	220
HCFC-142b	CH_3CClF_2	17.9	0.2	1,800	5,490	2,310	705
HCFC-225ca	$CHCl_2CF_2CF_3$	1.9	0.2		429	122	37
HCFC-225cb	$CHClFCF_2CClF_2$	5.8	0.32		2,030	595	181
Hydrofluorocarbons							
HFC-23	CHF_3	270	0.19	11,700	12,000	14,800	12,200
HFC-32	CH_2F_2	4.9	0.11	650	2,330	675	205
HFC-125	CHF_2CF_3	29	0.23	2,800	6,350	3,500	1,100
HFC-134a	CH_2FCF_3	14	0.16	1,300	3,830	1,430	435
HFC-143a	CH_3CF_3	52	0.13	3,800	5,890	4,470	1,590
HFC-152a	CH_3CHF_2	1.4	0.09	140	437	124	38
HFC-227ea	CF_3CHFCF_3	34.2	0.26	2,900	5,310	3,220	1,040
HFC-236fa	$CF_3CH_2CF_3$	240	0.28	6,300	8,100	9,810	7,660
HFC-245fa	$CHF_2CH_2CF_3$	7.6	0.28		3,380	1030	314
HFC-365mfc	$CH_3CF_2CH_2CF_3$	8.6	0.21		2,520	794	241
HFC-43-10mee	$CF_3CHFCHFCF_2CF_3$	15.9	0.4	1,300	4,140	1,640	500
Perfluorinated compounds							
Sulphur hexafluoride	SF_6	3,200	0.52	23,900	16,300	22,800	32,600
Nitrogen trifluoride	NF_3	740	0.21		12,300	17,200	20,700
PFC-14	CF_4	50,000	0.10	6,500	5,210	7,390	11,200
PFC-116	C_2F_6	10,000	0.26	9,200	8,630	12,200	18,200

UNFCCC and IPCC Carbon Frames

Years-COP	IPCC Frame	UNFCCC Frame/ Scenario	Science	Technology	Description
1990s and Rio Earth Summit	Six Emissions Scenarios	GHG *Stabilization* [frame 1]	GCMs and the Introduction of IAMs; GWPs	New Nuclear, Ocean Iron Fertilization	Six Emissions Scenarios are released (Legget et al., 1992) for future projections (1990-2100) of Carbon dioxide (CO2), carbon monoxide (CO), methane (CH4), nitrous oxide (N2O), nitrogen oxyde (NOx), and sulphur dioxide (SO2). Known as the IS92 Scenarios, the scenarios were created to fill a gap due to "carbon from fossil fuels" dominating the scenario literature at the expense of other GHGs (Alcamo et al., 1995).
Kyoto Protocol and early 2000s	TAR: SRES; Four Future Storylines	Percentage of CO2 *reductions*	IAMs	Fuel-switching and Carbon Capture and Storage (CCS)	The IPCC develops SRES (Special Report on Emissions Scenarios) Models: focus on GHGs and aerosol "precursor" emissions. Regional, Global, Environmental and Economic narratives, or storylines, are formulated (Nakicenovic et al., 2000). (See IPCC Data Distribution Center)
2005-2011	AR4 RCPs	Atmospheric *Concentration* of CO2	RCPs	Fuel-switching and Biofuel with CCS (BCCS)	The IPCC replaces the SRES with RCPs (Representative Concentration Pathways) in its fith Assessment Report (AR5). The focus is no "time dependent" GHG concentrations and the trajectory each gas takes to reach a certain concentration (referred to as radiative forcing) (IPCC Expert Meeting Report, 2007). Scenarios need to apply the same metrics in order to "hand off" data from one scientific group to another, and in turn give policymakers the tools to create effective policy (IPCC AR5; Moss et al., 2010; van Vuuren et al., 2011). The RCPs are therefore a starting point whereby researchers may download the data, then build upon it to create different future trajectories.
2011-2015	RCPs	Cumulative CO2 *Budgets*	Carbon-budget models, inverted	GGR	Carbon budgets enter the common lexicon in 2014, with the UK acting as the first country to incorporate carbon budgets, updated every five years (UK Climate Change Act, 2008). At the COP in Doha (2012), the frame "carbon budget" replaced "carbon percentage-based targets". Yet, similar to the previous atmospheric concentrations of CO2 frame,

			IAMS; MAGICC		carbon budges implied carbon removal technology (Carbon Dioxide Removal' Negative Emissions Techniques; Greenhouse Gas Removal). More alarming the, as yet, unproven technology of direct CO2 capture and storage led to the frame that such technologies would be needed should there be any "overshoot" of the carbon budget. [Greenhouse Gas Removal from the Atmosphere].
Post-Paris	SSP	Global Mean *Average Temperature*	Linked Earth System Models	GGR, SRM	The carbon budget "frame" leads to the total global average temperature limit of 1.5 degrees Celsius. Carbon budgets and concentrations in the atmosphere gave modelers the tools to develop more accurate "probabilities" of future scenarios with respect to potential global warming. However, the 1.5 degree scenarios are nearly unilaterally reliant on "negative emission technologies" (NETs), which do not yet exist. This leads to widespread framing by businesses and countries that they intend on going "net-zero" carbon. Shared Socioeconomic Pathways (SSPs) emerges, to be used along with RCPs, are "particularly conducive to the consideration of negative emissions" from both technological solutions and biological sinks (pg. 395). "The ambitious IEA 2009 technology roadmap imagined 100 plants by 2020 and 3,000 by 2050 with required investments of US$5–6 billion per year between 2010 and 2020, with roughly two-thirds of the investment coming in developed countries" (Reiner, 2016: 2). Alarming, is the proportion of the *climate budgets* eaten up by promised CCS: the US ($4.9 billion), with $800 million for clean coal initiatives, and $1 billion for FutureGen; Australia ($1.65 billion), with a further $500 fund; Canada ($2 billion); EU ($6 billion) (Reiner, 2016).

Country-Level Carbon Disclosure Legislation

Country	Disclosure Regulation
Australia GHG and Energy Reporting Act (2007)	firms that meet emissions or energy production/consumption thresholds must disclose GHG emissions; regulator can require an audit of the company's disclosures
Denmark	Mandatory for companies larger than 250 employees to report CSR. Falls under UN Global Compact or PRI
European Union (EU Directive 2014/95)	Firms above 500 employees, beginning January 1, 2017, must disclose land use, GHG emissions, materials and energy use
France Energy Transition Law (2015)	Listed firms must report risks related to climate change, GHG emissions and how they plan to contribute to limiting climate change including the GHG emissions associated with assets owned. Requires France-domiciled asset owners and managers to report climate factors and carbon emissions footprints by December 2016. [of note: the compulsory aspect of the law is that they should have a "plan in place" to show how they will address climate change. It does not specify that they must disclose their GHG emissions.
India National Voluntary Guidelines (2011)	Voluntary, all firms; how firms will improve their performance, energy consumption, GHG emissions, and biodiversity.
Japanese GHG Reporting Scheme	Businesses that emit more than 3k tons carbon annually and more than 21 employees must report.
Japan's J-VETS	Voluntary corporate disclosure (2005): over 500 businesses covered (CO_2 from fuel, electricity and heat, waste management, and industrial processes). Over 20 third party "verifiers"
US NAIC Insurers	Insurers over $100m in premiums, general disclosure about climate change related risk (survey)
UK Climate Change Levy (CCL)(2001)	tax on energy use in industry, commerce and public sector…covers 500 companies, refunds back to national insurance contributions
UK Companies Act 2006 (2013 revised)	Quoted companies must disclosre material information defined as "if its omission or misrepresentation could influence economic decisions of shareholders". Information can include future performance estimates, taking into consideration environmental and climate risks and GHG emissions.

Carbon Disclosure mandates at the state-level-several, including China, Brazil, the UK and the US do not require verification by a 3rd party (OECD, 2012)

Country	Verification	Penalties
Australia	Yes	Fines
Brazil	No	None
Canada	Yes	Unspecified
China	No	None
EU	Yes (independent/ accredited)	Fines + name and shame
France	Yes (independent/ accredited)	Comply or explain
Germany	Yes (independent/ accredited	Fines + name and shame
Italy	Yes (independent/ accredited)	Fines + name and shame
Japan	Yes (independent)	Fines
Mexico	Yes (independent/ accredited)	None
South Africa	Yes (independent)	Fines
South Korea	Yes (independent accredited)	Fines
Turkey	Yes (independent accredited)	Unspecified
UK	No	Comply or explain
US	No	Fines

Stock Market/Financial/Other Carbon Disclosure Requirements

Stock market regulations on corporations have drawn considerable attention in recent years because they are considered to have teeth in contrast to purely voluntary corporate carbon disclosure. Should companies disclose emissions in an inconsistent manner, for example, they risk being fined, or worse, restricted from the exchange.

Country	Stock Exchange Disclosure Regulation
Australia Securities Exchange (2014)	Corporate Governance Principles and Recommendations): General disclosure of environmental risks; annual reports must include corporate governance statements.
Brazil Stock Exchange	all firms (voluntary, explain if not); social and environmental information, if an audit is used and by what audit entity: ""Carbon Efficient Index" Stock index together with the Brazilian Development Calculation, based on companies" free floats and mission coefficients. The Index is weighted by companies" GHG emissions (OECD, 2012: 17).

Country	Stock Exchange Disclosure Regulation
China	Shenzhen Stock Exchange (2006): Voluntary for social responsibilities, mandatory for pollutant discharging; disclose waste generation, resource consumption, and pollutants
Singapore	All firms (voluntary, or explain why not): Disclose environmental, social, and governance, performance targets, in annual reports
South Africa	Johannesburg Stock Exchange (2009): all firms (voluntary, or explain why): general sustainability performance in annual report
US S&P Dow Jones Indices	Voluntary: GHG emissions; Sox emissions; energy consumption, waste generation, environmental violations; electricity purchased; biodiversity, mineral and waste management.
US SEC	target is investors, company must quantify its climate-related material risks, which include regulations, business trends, and physical impacts of climate change. U.S. Securities Act Rule 408 and Exchange Act Rule 12b–20 require a registrant to disclose certain non-financial, material information

Section 4 Appendices

Restricting the sample for the Carbon Governance Regime based on previous literature

Variable name	**Main categorical question** [Michaelowa and Michaelowa dataset]	**Assigned categorical value**	**% of dataset**
Orchestration_L	*National Government* or Private IO orchestrated (y/n)?	0/1	45%
Partnered_L	Non-state or *sub-state actor* is a main partner (y/n)?	0/1	8%
Entrepreneurial_L	Non-state actor play a lead role in initiating (y/n)?	0/1	35%
Public_L	*Is it Public initiative?*	0/1	33%
Private_L	Is it Private initiative?	0/1	37%
Hybrid_L	Is it Hybrid initiative?	0/1	24%
Q_Quality	Does it use and define MRV devices ?(mitigation target, incentives, baseline, definition and use of MRV, overall quality)	0/1 0/1/2/3	*See Below*
OTHER	Other categorical variables in the dataset: Type (standard, fund, network, adaptation, technology); Agent (multilateral institution, central gov.,	0/1	NA

	regional gov., municipality, NGO, private sector, research institution); Number of members and Region of membership		

Quality Variable name	Main categorical question	Total Percent "yes" (115 initiatives total)	% Public "yes" (of 37 public initiatives)	% Private "yes" (of 42 private initiatives)	% Hybrid "yes" (of 29 hybrid initiatives)
Q_Mitigation Target	Does the initiative define a mitigation target?	10%	11% (4)	14% (5)	7% (2)
Q_Incentives	Does it offer incentives?	13%	11% (4)	5% (2)	31% (9)
Q_Baseline	Does it provide specification and predictability of baseline?	27%	19% (7)	33% (14)	31% (9)
Q_MRV	Definition and usage of MRV devices?	45%	30% (12)	59% (25)	45% (13)
Q_Quality (1, 2, 3)	Sum of MRV devices	31% total have two; 15% of total have all three	23% have two (9) 16% have all three (6)	38% have two (15) 10% have all three (4)	34% have two (10) 24% have all three (7)

Initiatives Removed	Reason removed from GCCR or after adding to our sample
Oil and Gas Climate Initiative	Only included are the major oil companies
HSBC Climate Partnership	Swallowed by the Climate Group
WWF Climate Savers	Only 12 companies, 3 of which are FTSE
Forest Disclosure Initiative	CDP: data not available as to corporate membership
Climate Savers Computing Initiative	No membership
Collaborative Labelling and Appliance Standards Program	Alliance of labelling schemes, unclear on membership
Climate Knowledge Brokers	No data on membership, not corporations

Quality assurance scheme for carbon offsetting"	Unclear, appears defunct
Networked carbon markets initiative"	defunct
Delta Network	Local/ mitigation focused; seems defunct
Coalition Green-e (Climate Standards)	About 15 companies listed as using “renewable energy”, (All small except Bank of America and P&G)
Integrating Risks into the Financial System: The 1-in-100 Initiative	Membership and initiatve relatively unclear. Possibly defunct
Refrigerants, Naturally! (keep and node into it)	Coca cola, pepsico, Unilever, Redbull, UNEP, Greenpeace
Climatewise (eliminated for now)	Member companies: ABI, Allianz, Aon, Argo International, Aviva, AXA XL, Beazley, Brit Insurance, CII, Chubb, Ecclesiastical, Flood Re, Hiscox, Lloyd's, MS Amlin, M&G, Munich Re, Prudential, QBE, Renaissance Re, RSA, Sanlam, Santam, Swiss Re, Tokio Marine HCC, Tokio Marine Kiln, Tokio Marine & Nichido Fire, The Hartford, Willis Towers Watson, Zurich
Clinton Global Initiative	Very broad, although some things working on climate
Green power market development group (defunct)	Alcoa, Cargill Dow, Delphi Automotive, Dow, DuPont, FedEx Kinko's, General Motors, IBM, Interface, Johnson & Johnson, Pitney Bowes, Staples) and the World Resources Institute "dedicated to building corporate markets for green power" (Zombie)
Association of Climate Change Officers (ACCO)	Grassroots organization, does not deal with companies
Carbon war room	Engulfed by the Rocky Mountain Institute, founded by Richard Branson [think tank]]] could I include?
Business Leaders Initiative on Climate Change (BLICC)	Defunct
Caring for Climate	Need to include, has 500 MNCs. But MOST ARE SMEs [well maybe not GLAXOsmith; Phillips, Orsted;
Edenbee	Defunct
CNC	Carbon neutral coalition-state led
Pew Business Environmental	BP, BHP; DOW; Shell; SPEG; national grid; alcoa; ibm gm, ge, shell ,Toyota

Leadership Council (KEEP)	
Global GHG Register	defunct
Climate Neutral Network	defunct
International leadership alliance for climate stabilisation	defunct
Carbon watch	Defunct?
Slimcity	Defunct (started by WEF)
Prototype carbon fund	Merged with another? (world bank initiated)
climate alliance of european cities with indigenous peoples	Does not deal with private sector
Global Energy Efficiency Accelerator Platform	State-level (CCR exlucsion list)
ICAP	State-level partners and members (CCR exclusion list)

Initial Starting point for our new governance map

Governance Dimension	**Actor/Standard/Initiative**
Public	**UNFCCC** **UNEP** **IPCC** **CDM/Kyoto** **EU/EC** **World Bank** **UNCTAD** **ICAP (International Climate Action Partnership)**
Private	**Plan Vivo** **CarbonFix** **Standard** **Climate Disclosure Standards Board** **VER+** **The Gold Standard** **Climate Action Reserve** **Global Investor Coalition on Climate Change** **ClimateWise** **SOCIALCARBON** **International Emissions Trading Association** **The Climate Group** **Institutional Investors Group on Climate Change** **CCX (Chicago Climate Offset Program)** **Caring for Climate**

	ISO 14064/14065 **Carbon Disclosure Project (CDP)** **Investor Network on Climate Risk** **Greenhouse Gas Protocol** **The Climate Registry** **Verified Carbon Standard** **Global GHG Register** **Climate, Community and Biodiversity Alliance**
Hybrid	**Partnership for market readiness** **Prototype Carbon Fund** **UNEP Finance Initiative (UNEP FI)** **UN Global Compact** **Climate Technology Initiative** **PFAN** **Strategic Climate Fund** **Clean Technology Fund** **We mean business**

Section 5 Appendices

Carbon Governance Taxonomy

Level	MRV Function	Leaders/ Governors	Main Functions	Notes
Level [1]	GHG->Carbon *Metrics* Standardization **[m]**	IPCC, leading climate scientists	To create a scientifically grounded basis to study GHGs with the intent to build forward-looking policies and guidance to limit climate change.	Generally, this standardization process answers the question: *What is the relative global warming equivalent of each respective greenhouse gas, and how to convert these into "carbon equivalents" so that policies and markets address runaway emissions?* The IPCC is the most well-known scientific metrics standardizing actor, (i.e., the "Global Warming Potentials" or GWPs conversion system). GHGs are usually converted according to the IPCC's GWPs into one carbon unit with the intention to govern these gases in global carbon market.
Level [2]	Carbon *Monitoring* and *Measuring* Standardization [M&M]	WRI-WBCS, (GHG Protocol) , , EC, Stock Exchanges	To provide organizations the tools to create GHG emissions inventories. Sample Actors: ISO-14064-1 GHG Protocol	GHG Monitoring Standardization answers the question*: How can our organization (company, city, NGO) measure/record/create an emissions inventory?* While this component of the carbon regime also has strong ties to public governance—the IPCC and the KP detail how country-level GHG emission's inventories should be created—private governance interests swelled as the CDM's first commitment period began in 2002. Two particularly salient GHG Monitoring and Measuring Standardizing actors are the GHG Protocol and the ISO 14064-1.
Level [3]	Carbon *Reporting* and Disclosing Standardization **[R]**	CDP, CERES TCFD (in progress)	To collect GHG from private actors in order to provide stakeholders with a comprehensive assessment of the inventories of private	Reporting Disclosures respond to this question: *How much carbon did your company or country emit*? This component of the carbon regime also has strong ties to the public governance of GHGs, particularly under the CDM in terms of individual project-level GHG reporting, as well as the Kyoto Protocol in terms of mandatory country-level GHG reporting. The CDM codified the way by which private companies should measure and report their emissions inventories in order to obtain credits, as well as to tie into the EU-

			organizations and municipalities. Sample Actors: ISO-14064-2 CDP Climate Registry	ETS, for example. Likewise, the EU-ETS mirrored this approach and mandated that companies follow the CDM's protocol. Reporting and disclosing GHGs, at the corporate level, is now mostly the remit of private actors, however, although some state-level legislation mandates corporate emissions reporting (in France and the UK, for example). While unclear, it appears that there is a pull from public governance actors for corporate-level GHG disclosure standardization, particularly evident in the Task Force for Financial Disclosures (TCFD) spearheaded by former Bank of England governor Mark Carney.
Level [4]	Carbon *Verification* Standardization **[V]**	WWF, CDM	These are developed to enable the functioning of carbon markets, carbon offsets, carbon trading, etc. In the absence of GHG verification actors, carbon markets cannot exist, especially those operating across borders. Sample Actors: ISO-14064-3 Gold Standard	GHG verification standards answer the question: *How can we be sure that a particular carbon offset, trade, reduction, or accounting, is valid*? Public governance of GHG verification was short-lived. Soon after the CDM was introduced, it became evident that public governance actors could not keep up with verifying project emissions' data. Indeed, the "Cambrian Explosion" in private climate change governance, noted by Keohane and Victor (2011), is largely composed of GHG verification standard's actors, and the mechanisms that demand these standards (i.e. carbon markets and offsets). While there are many private actors that verify emissions reductions, abatement, and projects—which itself is a critical component of carbon-market formulation—the diversity of actors belies the underlying network effects; for example, the Voluntary Carbon Standard accepts carbon offsets from the Gold Standard, the CDM, and VER+; similarly, all of the private carbon verification standards readily accept CDM credits. In short, there exists a high level of "fungibility" of verification standardization actors (Callon, 2009). Thus, verification standards are quite fungible, although there is some notable hierarchy that exists.

Carbon Verification accepted at the state-level

Country	Standards	Accepted
Australia	Gold Standard, VCS	Voluntary
Canada	ISO 14064-2, CAR, VCS	Mandatory
Costa Rica	Gold Standard, VCS	Voluntary
Italy	VCS	Voluntary
Japan	ISO-14064-2, ISO-14064-3, ISO-14065	Voluntary
Mexico	VCS, Gold Standard, Plan Vivo, CAR	Voluntary
Netherlands	CarbonFix Standard	Voluntary
S. Korea	ISO-14064-2, ISO-14064-3	Voluntary
Switzerland	Gold Standard	Mandatory
UK	Gold Standard, VCS, CCBS, Plan Vivo	Voluntary
USA	ACR, CAR, VCS, CCX	Voluntary

Carbon Reporting Actors are the following:

Carbon Reporting Actors	Description
ISO 14064-2	details requirements for quantifying, monitoring and reporting emission reductions and removal enhancements from GHG mitigation projects. Under ISO 14064-2, the use of third-party auditors is strongly recommended, but only required if GHG emission reductions are to be made public
American Carbon Registry (1996)	As the first private GHG registry in the world, ACR has set the bar for offset quality that is the market standard today and continues to lead carbon market innovation. In 2012,

Carbon Reporting Actors	Description
	ACR was approved by the California Air Resources Board to serve as an Offset Project Registry (OPR) and Early Action Offset Program for the California cap-and-trade market. ACR's work as a California OPR (US only).
IIGCC	Oil and gas, automotive, electrical utilities: (voluntary): GHG emissions and clean technologies data, energy production.
PAS 2050	Lifecycle GHG reporting for products and services: British Standards Institution (BSI)'s Publicly Available Specification for the assessment of the life cycle GHG emissions of goods and services. The general principles of PAS 2050 are similar to the Product Standard. PAS 2060 is the internationally recognised specification for carbon neutrality and builds on the existing PAS 2050 environmental standard. It sets out requirements for quantification, reduction and offsetting of greenhouse gas (GHG) emissions.
TN-CC-003: 2009-01	GHG reporting standard, related to ISO 14063-3
VfU	GHG inventory reporting standard, now compliant with CDP
Carbon Footprint Ltd	Accepts GHG Protocol for "organizational footprinting", BSI PAS 2050: 2011 and ISO 14001:2015 for "product and service footprinting"; accepts VCS, Gold Standard, CER as "qualifying carbon offset standards"
UK DEFRA	Guidance on how to measure and report GHG emissions
Climate Action Reserve	(also can be verifying instrument): Performance standards used where possible and general project-specific monitoring protocols developed.

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Other Carbon Verifying Standardization Actors:

Carbon Verification Actors	Description
ISO 14064-3	Provides requirements and guidance for the validation and verification of GHG assertions.
The Gold standard	Developed in partnership with WWF and is a direct outgrowth of the CDM. It maintains a special position as the orchestrator of public-private verification instruments. (Managed by the Gold Standards Foundation). Can be use with CDM.
The Verified Carbon Standard (VCS)	A standard for certifying carbon emissions reductions; VCS is administered by Verra, a 501(c)(3) not-for-profit

	organization. (2007). VCS version 1 published jointly with the Climate Group (TCG), IETA, and WEF, later joined by WBCSD. It accepts ISO 14065, CDM, JI, CCAR. Third party auditors can validate and verify the same project, unlike the CDM and Gold Standard. Project validation requires ISO 14064-3. It also uses ISO 14064-2.
The VER+	Follows closely to Gold Standard. It approves all CDM baselines and methodologies. "All CDM-approved baselines and methodologies are allowed. The latest versions of the CDM methodologies must be used. New methodologies are reviewed on a project-by project basis. Project methodologies must be based on 'guidance on criteria for baseline setting and monitoring' as defined for JI activities
ISO 14065	Defines requirements for bodies that validate and verify GHG statements. Its requirements cover impartiality, competence, communication, validation and verification processes, appeals, complaints and management system of validation and verification bodies.
ISO 14066	Specifies competence requirements for validation teams and verification teams. It includes principles and specifies competence requirements based on the tasks that validation teams have to perform
ISO 14067	Defines the principles, requirements, and guidelines for the quantification of the carbon footprint in products….life cycle stags of a product, beginning with resource extraction and raw material sourcing and extending through the production and end-use.
VERTIS	is a unique private GHG emission's verification actor because it was the first to work with the UNFCCC, as part of the Joint Implementation program under the Kyoto Protocol.
VOS	Based on the existing standards promoted by the UNFCCC. It brings the voluntary market up to the level of the regulated and standardized procedures of the (Kyoto) compliance market. VOS endorses the existing gold standard methodology. It meets and at some points exceeds CDM and JI standard. Validated through DOE (CDM)

30 Initiatives and Methodologies widely used for counting carbon (source: IPIECA workshop, 2011)

Title and reference		Summary of method/initiative			
ID No.	Method/initiative title	Region where in use	Method, initiative, or both	Year of current version	Voluntary or mandatory
1	Carbon Disclosure Project (CDP)	Global	Initiative	2010	Voluntary
2	WBCSD/WRI GHG Protocol Corporate Standard	Global	Method	2004 (revised edition)	Voluntary
3	IPCC 2006 GHG Workbook	Global	Method	2006	Voluntary
4	ISO 14064: 2006 (Parts 1 and 3)	Global	Method	2006	Voluntary
5	French Bilan Carbone	France	Method	2007 (version 5)	Voluntary
6	US Regional Greenhouse Gas Initiative (RGGI)	USA	Both	2008	Mandatory
7	US Climate Registry (TCR) General Reporting Protocol	USA	Both	2008 (version 1.1)	Voluntary
8	USEPA GHG Rule	USA	Method	2009	Mandatory
9	EU Emissions Trading Scheme (EUETS)	EU	Both	2007	Mandatory
10	US Securities and Exchange Commission (SEC) Guidance	USA	Initiative	2010	Mandatory
11	Climate Disclosure Standards Board (CDSB)	Global	Initiative	2009	Voluntary
12	Japanese Voluntary ETS (J-VETS)	Japan	Both	FY2009 cycle	Voluntary
13	Japanese GHG Reporting Scheme	Japan	Initiative	2006	Mandatory
14	(Proposed) Australian Carbon Pollution Reduction Scheme (CPRS)	Australia	Initiative	Scheme on hold	Mandatory
15	Australian National Greenhouse and Energy Reporting (NGER) Scheme	Australia	Both	2008	Mandatory
16	UK Department for Environment, Food and Rural Affairs (DEFRA) Guidelines	UK	Method	2009	Voluntary
17	UK Carbon Reduction Commitment (CRC)	UK	Both	2010 (version 1)	Mandatory
18	UK Climate Change Levy Agreement (CCLA)	UK	Both	2001 plus amendments	Voluntary
19	Dutch Energy Covenant	Netherlands	Initiative	2002	Voluntary
20	Californian Climate Action Registry (CCAR)	USA	Both	2009 (version 3.1)	Voluntary
21	International Local Government GHG Emissions Analysis Protocol (IEAP)	Global	Initiative	2009	Voluntary
22	Global Reporting Initiative (GRI)	Global	Initiative	2006 (third version)	Voluntary
23	API/IPIECA GHG Compendium	Global	Method	2009 (third release)	Voluntary
24	The Carbon Trust Standard (CTS)	UK	Initiative	2009	Voluntary
25	US EPA Climate Leaders Inventory Guidance	USA	Initiative	2005	Voluntary
26	Environment Canada GHG Emissions Reporting Program	Canada	Both	2009 (under revision)	Voluntary
27	Chicago Climate Exchange (CCX)	USA	Both	2009	Voluntary
28	WBCSD/WRI GHG Protocol Scope 3 Reporting Standard	Global	Method	2009 (draft)	Voluntary
29	US GHG Protocol Public Sector Standard	USA	Method	2010 (draft)	Voluntary

[1] *Company GHG Emissions Reporting – a Study on Methods and Initiatives.* http://ec.europa.eu/environment/pubs/pdf/ERM_GHG_Reporting_final.pdf

60 other initiatives not widely used (source: IPIECA workshop, 2011)

Name/title of initiative or methodology	
World Bank methodologies for CDM projects	Öko-Institut GEMIS
IFC Carbon Emissions Estimator Tool	California Air Resources Board (CARB) for AB32
UK Regional Development Agency Carbon Assessment Tool	IETA EU MRV Guidelines for New Sectors and Gases
Corporate Register	Chinese Energy and GHG Management Programme
UNEP GHG Indicator Method	International Accounting Standards Board (IASB) Guidance
UNEP/World Bank GHG Standard for Cities	Mexican GHG Program
EBRD GHG Assessment Method	Philippines GHG Accounting and Reporting Programme
UK Local Government Association Nottingham Declaration	Brazilian GHG Protocol Program
CAC40, DAX, NYSE and FTSE Disclosure Rules	Indian GHG Inventory Programme
UK Sustainable Development Commission Guidance	Korea National GHG Registry
UK Voluntary Emissions Trading Scheme	South Africa NBI/BUSA-DEAT Initiative
BSI PAS 2050	WWF Climate Savers Programme
The Carbon Trust Footprint Company	EMEP/CORINAIR EF Guidebook
International Association of Oil and Gas Producers (OGP) Protocol	Respect Europe Business Leaders CC Initiative
New Zealand ETS	WEF Global GHG Registry
Swiss ETS	WBCSD CSI Protocol
CDM Executive Board methodologies	International Forum of Forest and Paper Associations Tool
IETA JI/CDM Validation and Verification Manuals	WBCSD/WRI Cross-Sectoral GHG Tools
South African mandatory GHG reporting scheme	WBCSD/WRI Sector-Specific GHG Tools
Covenant of Mayors Climate Alliance	WBCSD/WRI Product Life Cycle Standard
Spanish MC3 calculation method	International Aluminium Institute Protocol
US/Canada Western Climate Initiative (WCI)	Cement Sector GHG Protocol
US Midwestern Greenhouse Gas Accord	WBCSD/WRI LULUCF Guidance
London Green500 Initiative	WBCSD/WRI Project Protocol
ISO14067	WBCSD Pulp and Paper Sector Calculation Tool
Carbon Trust SME Guidance	Voluntary offset provider tools
US EIA 1605(b) Program	UK Act on CO_2 calculator
ACI Airport Carbon Accreditation Scheme	EpE Protocol for Waste Management Initiatives
German DEHSt Formular-Management-System (FMS)	Beverage Industry Sector Guidance for GHG Reporting
German PCF project	UK DEFRA Offset Provider Code of Practice

Section 6 Appendices

Replication results from Radu et al. (2020)