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Review

Collecting silences: creating value by assetizing carbon emission mitigations and energy demand reductions

Colin Nolden[1,2,*]

[1] Environmental Change Institute, University of Oxford, Oxford, United Kingdom
[2] Law School, University of Bristol, Bristol, United Kingdom

* **Correspondence:** Email: colin.nolden@ouce.ox.ac.uk.

Abstract: This paper reviews circumstances where governance arrangements and organizational innovations assign value to carbon emission mitigations or energy demand reductions. The creation of such value hinges upon 1) the effective governance of financial mechanisms to create demand; and 2) the ability of organizations to assetize and supply carbon emission mitigations and energy demand reductions as commodified private goods. To analyse the political and organizational governance of such demand and supply systems, this paper uses insights from transaction cost economics. On the demand side, transaction costs are reduced through the innovative governance of markets at national level, such as white certificate markets for energy savings, and international level, such as baseline-and-credit systems for carbon emissions reductions. Strict rules regarding accountability, transparency, measurement, reporting, verification, and inclusion reduce transaction costs for organizations to assetize reductions and mitigations on the supply side. Despite limited success to date, these innovations provide the basis for international carbon emissions mitigation governance through climate clubs based on Article 6 of the Paris Agreement. This paper concludes that such clubs provide the basis for creating consistent demand for carbon emission mitigations and associated energy demand reductions through the positive pricing of mitigation actions.

Keywords: financial mechanisms; transaction costs; assetization; governance; energy demand reduction; carbon emission mitigation; climate clubs

JEL Codes: Q4, Q5

Abbreviations: CDM: Clean Development Mechanism; CERs: Certified Emissions Reductions; EEOs: Energy Efficiency Obligations; ESCO: Energy Service Company; EUAs: European Allowances; EU-ETS European Union Emissions Trading Scheme

1. Introduction

“Silences,” said Murke, “I collect silences… When I have to cut tapes, in places where the speakers sometimes pause for a moment… I don’t throw that away, I collect it” (Böll, 1963). In this manner Murke, the protagonist of Heinrich Böll’s short story *Murke’s Collected Silences* (*Doktor Murkes Gesammeltes Schweigen*, Böll, 1963), collects silences that are usually cut out and discarded from broadcast tapes. In effect, Murke assigns value to silences. *Noise*, by analogy, represents energy consumption by means of burning fossil fuels and emitting Greenhouse Gas emissions (henceforth carbon emissions). *Silences*, by analogy, are “negawatts” (Steinberger et al., 2009), the non-flow of energy and the carbon emissions that do not happen as a result of not burning fossil fuels, the consequence of fossil-fuel powered machines not running and internal combustion-propelled journeys not taken. *Silences*, in short, are energy demand reductions and carbon emissions mitigations.

An increasing body of literature points to the value and multiple benefits of both energy demand reductions and carbon emission mitigations (IPCC, 2014; Fawcett and Killip, 2018; Penasco et al., 2021). Some scholars make specific links between the two (Creutzig et al., 2018; Grubler et al., 2018; Barrett et al., 2021). According to Eyre and Killip (2019) “more than 90% of the progress in breaking the relationship between carbon emissions and economic growth globally has come from reducing the energy intensity of the economy”.

Subsets of these literatures focus on market mechanisms which attribute quasi-property rights to energy demand reductions and carbon emissions mitigations (Bertoldi, 2011; Stua, 2013). Increasing focus lies on the governance of such market mechanisms (Michaelowa, 2012; Giraudet et al., 2012) and the necessary shift from costing pollution (polluter-pays-principle) towards valuing the reduction thereof (reducer-receives-principle) (Sirkis et al., 2015; Stua, 2017; Nolden and Stua, 2021). A separate body of literature deals with ways of making things valuable (Aspers and Beckert, 2011; Kornberger et al., 2015). However, we have not identified any publications focusing specifically on the top-down governance of financial mechanisms to assign value to reductions and mitigations and to facilitate their assetization through bottom-up organizational innovation. This paper seeks to address this gap in the literature by focusing specifically on where and how the governance of such financial mechanisms and organisational innovation support value creation through reductions and mitigations.

As such value creation is counterintuitive and runs against our tendency to pursue additive as opposed to subtractive solutions (Adams et al., 2021), and arguably contradicts the dominant accumulative value creation paradigm, such governance arrangements have had limited success to date. Nevertheless, the sophisticated governance of White Certificate Markets has succeeded in facilitating the assetization of energy demand reductions as private goods. This process turns such reductions into unique and traceable commodities that carry “a property right over a certain amount of additional savings and guarantees that the benefit of these savings has not been accounted for elsewhere” (Bertoldi and Rezessy, 2006). Further examples of energy demand reduction assetization analysed in this paper include governance and organisational innovations underpinning flexibility and energy performance contracting markets.

Assetization of carbon emission mitigations has been primarily enabled through governance innovations underlying carbon markets. Such markets facilitate the assetization of “rights to emit carbon emissions” (carbon permits) or emission reductions (carbon credits) as “property” (Peskett and Brodnig, 2011; Pei et al., 2013). This allows either carbon permits or credits to be definable, identifiable by third parties, capable of assumption by third parties, have permanence and stability and continue “to exist in a registry account until transferred out either for submission or sale” (Morris, 2012). This paper focuses on the governance innovations underpinning the only international baseline-and-credit system to date, the Clean Development Mechanism, and the institutional and organisational innovation it supported, especially in China.

To analyse these governance arrangements and organisational innovations which assign value to reductions, this paper uses insights from transaction cost economics derived from Coase’s theorem (Coase, 1959, 1960, 1998). It is assumed that efficient resource allocation depends on well-defined and enforced (quasi-)property rights along with efforts to minimize transaction costs. Accordingly, financial mechanisms which facilitate the assetization of carbon emission and energy demand reductions by enforcing such rights through commitments and obligations can potentially shift demand from carbon emitting activities (*producing noise*) to those that reduce carbon emissions (*collecting silences*) with organizational innovation facilitating their supply.

Smart meters, sensor technologies, smart technologies (e.g., Internet of Things), distributed ledger technologies (e.g., Blockchain), Artificial Intelligence and Big Data have the potential to lower transaction costs by supporting “spatiotemporally granular” energy and carbon data measurement, reporting and verification (MRV) (Kragh-Furbo and Walker, 2018; World Bank, 2018). Capturing (time-stamping) such reductions relative to baselines facilitates their assetization as private goods with well-defined and enforced quasi-property rights (Pei et al., 2012).

However, the limited success of the abovementioned market mechanisms to date suggests that governance innovation is necessary to move beyond dominant paradigms underpinning forms of investments and solutions that inadvertently sustain systems of demand for polluting activities (*noise*) which are incompatible with the 1.5 ˚C target (Rinkinen et al., 2021). This paper suggests that governance through climate clubs (Weischer et al., 2012) within the framework of Article 6 of the Paris Agreement on Climate Change represents such an innovation. Such clubs can operationalize financial mechanisms capable of enabling all measurable, reportable, verifiable and assetized carbon emission mitigations to be treated as private goods for supply, trade and accumulation (Sirkis et al., 2015; Stua, 2017a; Stua et al., 2022).

This paper is based upon information compiled between 2014 and 2021 from primary and secondary literature, attendance at conferences and workshops and interviews with energy and climate market experts. Documentary sources were identified through web searches of journal databases and expert recommendations. Around 9 key expert interviews as part of four separate academic inquiries helped shape the trajectory of inquiry (3 in 2014–2015; 1 in 2016; 1 in 2018; 3 in 2020 and 1 in 2021). These interviews were recorded and transcribed. Given the finalisation of the Paris Agreement Article 6 rulebook in 2021 it is a critical moment to examine and consolidate what we know about market structures which assign value to energy demand reductions and carbon emission mitigations.

This paper sets out to address this gap in the literature by addressing the following three objectives:

Evaluate how commitment or obligation-driven governance of financial mechanisms for energy demand reductions and carbon emission mitigations creates demand for *silences.*

Establish the role of organizations in supplying *silences* by lowering transaction costs of assetizing energy demand reductions and carbon emission mitigations as private goods.

Explore the potential of international climate club governance of financial mechanisms to overcome the limitations of current governance arrangements.

The aim of this paper is to paint a picture of what we already know about such governance arrangements, map existing knowledge, and highlight opportunities for governance innovations regarding climate clubs. Rather than attempting an exhaustive, systematic and definitive review of such arrangements or a pathway towards their implementation, the focus lies instead on the identification of transaction costs associated with the creation of value through reduction. Its modest ambition is to improve our understanding of how financial mechanisms can be governed to create such value by lowering transaction costs through the assetization of energy demand reductions and carbon emissions mitigations.

This paper is structured as follows: Section 2 introduces the governance of financial mechanisms which create demand for *silences*. Section 3 provides an insight into how organisational innovation reduces transaction costs of supply by assetizing *silences*. Section 4 highlights the importance of measuring, reporting and verification to ensure integrity of such demand and supply systems. In section 5, examples form international and national markets indicate how such systems work in practice. Section 6 discusses their limitations and introduces governance through carbon clubs to overcome them. Section 7 concludes.

2. The governance of financial mechanisms

Market-based instruments to facilitate decarbonisation are often synonymous with financial mechanisms (Sirkis et al., 2015). Such mechanisms, according to Stavins (2001), "are regulations that encourage behaviour through market signals rather than through explicit directives". Compared to conventional "command-and-control" regulations, such mechanisms are more likely to encourage the adoption of new business models and technologies because they are not prescriptive regarding delivery instruments and the measures to be used (Anderson and Parker, 2013; IEA, 2017a; Rosenow et al., 2019; Stavins, 2001).

Fundamentally, such mechanisms aim to close the gap between private and social costs of market activities undertaken by private agents. The most prominent approaches to align private and social costs are taxes and subsidies on the one hand, and attribution of quasi-property rights on the other (de Serres et al., 2010). These can be traced back to the works of Pigou (1932) and Coase (1960) respectively and generally take the form of environmental taxes and systems of tradable pollution emission permits, with associated principles of distributive fairness (Table 1; Ringinus et al., 2002; Sergson, 2013; Nolden and Stua, 2021).

Table 1. Mechanisms to close the gap between private and social costs of market activities undertaken by private agents and associated principles of distributive fairness (de Serres et al., 2010; Sergson, 2013; Nolden and Stua, 2021).

Taxes and subsidies	Examples	Underlying principle
Taxes and charges directly applied to the pollution source	Carbon taxes	Polluter-pays-principle
Taxes and charges applied on input and/or output of a production process causing environmental degradation	Vehicle fuel taxes	Polluter-pays-principle
Negative taxes or subsidies for environmentally friendly activities	Industrial pollution control	Beneficiary-pays-principle
Deposit refund systems	Can and bottle deposit refund system	Polluter-pays-principle
Tradable pollution emission permits/credits	Examples	Underlying principle
Cap-and-trade systems	EU Emissions Trading Scheme (EU-ETS)	Grandfathering-principle
Baseline-and-credit system	Clean Development Mechanism (CDM	Reducer-receives-principle

Taxes and trading systems provide different means of pricing negative externalities (such as pollution). In the absence of other failures such as transaction costs, such costs are supposed to encourage polluters to search for abatement solutions which cost less than the pollution tax or the cost of a pollution permit (Stavins, 2001; de Serres et al., 2010).

While there are many benefits of taxes from an economics perspective, such as the generation of public revenues that can be recycled and used to reduce distortive taxation (known as double-dividends, examples of which include British Columbia's revenue neutral carbon tax), the slow adaptation of such taxes suggests that in many countries they are politically contentious and potentially unfeasible. Cap and trade systems, on the other hand, are limited by the caps within which they trade (Sirkis et al., 2015). Such systems have also been criticised for maintaining the status quo without tackling the root problems of climate change (Böhm and Dabhi, 2009; Böhm et al., 2012; Knox-Hayes, 2010; Lohmann, 2012).

Rather than focusing on the cost of carbon emissions and assigning value to "rights to emit" such emissions, this paper is concerned with the intrinsic social and environmental value of carbon emissions mitigation and energy demand reduction. This value is enshrined in Paragraph 109 of the Paris Agreement on Climate Change (UNFCCC, 2015) which "recognises the social, economic and environmental value of voluntary mitigation actions and their co-benefits for adaptation, health and sustainable development" as well as its Article 6 which states that (highlights added):

"Parties shall, where engaging on a voluntary basis in cooperative approaches that involve the use of *internationally transferrable mitigation outcomes* towards nationally determined contributions, promote sustainable development and ensure environmental integrity and transparency, including in governance, and shall apply robust accounting to ensure, inter alia, the avoidance of double counting, consistent with guidance adopted by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement."

According to Sirkis (in Sirkis et al., 2015):

“The rationale for recognizing carbon reduction as a source of true value… is based not only on the worldwide political recognition of its social value but also upon an undeniable economic fact: a global loss being inflicted on the world economy by climate change, the damages are growing and the loss can be consistently quantified… Once governments agree on this officially, the value of each ton of CO_2-equivalent reduction can be priced accordingly. The recognition by 195 governments that mitigation actions equal value is the political green light for the subsequent establishment of instruments that can translate this new convertible unit of value into action.”

The financial value of carbon emission reductions (credits) is entirely artificial. Without financial mechanisms such as the CDM that underlie and create demand, their value ceases to exist (Knox-Hayes, 2010). To move beyond the limitations, flaws and failures of previous and current mechanisms such as the CDM, climate clubs have been suggested as a suitable mechanism (Das, 2015; Nordhaus, 2015; Weischer et al., 2012; Stua, 2017; Pihl, 2020). Such clubs enable ambitious countries to converge towards shared objectives, such as the establishment of an internal carbon tax (Pihl, 2020) or a common demand-and-supply system for carbon emission reductions (Stua, 2017; Stua et al., 2022).

As such, they offer flexibility and harbour transformational potential as fewer and voluntarily participating countries make for easier negotiation and higher ambition. The San José Principles which were established by Costa Rica and Switzerland together with nine other countries at the 25th Conference of Parties (COP25) is an example of a proto-climate club which seeks to move beyond the Paris Agreement’s Nationally Determined Contributions’ “pledge and review” approach by combining it with common and shared objectives among ambitious countries. To enable such clubs to fulfil their full potential, including the positive pricing of carbon emissions reductions (positive carbon pricing—Sirkis et al., 2015; Stua, 2017), further common principles need to be established (See Table 2).

Positive carbon pricing shifts the emphasis from the cost of limiting the environmental impact on what is assumed to be the non-exhaustible resource of the atmosphere towards the value of minimising impact upon what is agreed to be an exhaustible resource of atmospheric carbon carrying capacity (Stua, 2017).

Table 2. Comparison of the San Jose Principles climate club and climate clubs embedded in Article 6 to facilitate positive carbon pricing (Sirkis et al., 2015; Stua, 2017; Stua et al., 2022).

Principles of climate clubs	San Jose principles	Article 6 climate clubs
Increase overall ambition in global carbon emissions (overall reduction in carbon emissions)	X	X
Prohibit the transfer of carbon emission allowances and units from previous mechanisms (such as the CDM	X	(X)
Avoid double counting of carbon emission reductions and ensure that use of markets is subject to corresponding adjustments (when a carbon emission reduction unit (carbon credit) is sold from one country to another, the carbon emissions on the buying country do down while those of the selling country go up	X	X
Apply principles of transparency, accuracy, consistency, comparability and completeness (to avoid fraud and increase trust	X	X
Assigning value to carbon emissions reductions by recognising the atmospheric carbon-carrying capacity as an exhaustible natural resource		X
Establishing a timetable in which this exhaustible natural resource needs to be safeguarded		X
Creating demand for actions to protect this exhaustible natural resource		X
Fair sharing of the remaining budget		X

3. Organisational innovation

Energy demand reductions through the decoupling of energy demand from economic activity, on the other hand, have been the main driver of carbon emissions reductions (IPCC, 2014). Various scenarios suggest that increasing emphasis on energy demand reduction by placing greater emphasis on end-user engagement and decent living standards, as opposed to technological substitution and supply side innovation, promises socially, economically and environmentally more viable decarbonisation pathways (Grubler et al., 2018; Barrett et al., 2021). Multiple benefits of such a focus on energy demand reduction translate into social, economic and environmental value (Fawcett and Killip, 2018).

Assigning value to energy demand reductions, however, has proven difficult. Like carbon emission reductions, energy demand reductions are intangible assets (Clark and Knox-Hayes, 2011; Aldrich and Koerner, 2018). Such savings and mitigations also tend to be absent on domestic and corporate accounts. The result is that such savings and reductions are undervalued while increases in revenues are overvalued. To complicate matters, recent research in psychology suggests we default to searching for additive solutions at the expense of subtractive transformations (Adams, 2021).

Nevertheless, there are examples of market governance arrangements which encourage organisational innovation to identify the most cost-effective means of identifying and assetizing such savings and mitigations which are explored in greater detail below. It is assumed that such markets can encourage a diverse range of organizations to *collect silences* by creating demand for assetized energy demand reductions and carbon emission mitigations (*silences*) as tradeable private goods with well-defined quasi-property rights (adapted from Anderson and Parker (2013) and Sirkis et al. (2015)). Such organizations, in turn, benefit from entrepreneurial innovation to define and enforce quasi-property rights associated with these private goods to reduce the transaction costs of *collecting silences* through assetization.

It is assumed that such organizations are encouraged to reduce energy demand and mitigate carbon emissions because of the omnipresence of transaction costs (MacKenzie, 2009; Nolden et al., 2016; Sorrell, 2007; World Bank, 2018). Transaction costs, according to Coase (1960), are the costs incurred "to discover who it is one wishes to deal with, to inform people that one wishes to deal and on what terms, to conduct negotiations leading to a bargain, to draw up the contract, to undertake the inspection needed to make sure that the terms of the contract are being observed, and so on" (Coase, 1960). According to this school of thought, the transaction costs either of defining private goods or of trading well-defined private goods and enforcing rights prevent optimal resource allocation through transactions that would be carried out in a pricing system without such costs (Coase, 1960; Anderson and Parker, 2013).

A focus on organizations as reducers of transaction costs, according to Anderson and Parker (2013), "helps us to understand how markets can improve environmental quality". Organizations are the driving force behind the evolution of private goods because they establish new forms of organizing, producing and conducting business (Schumpeter, 1934). They first recognize "new gains from trade, hire other inputs to carry out ideas, and capture the returns associated with transaction cost savings" and consciously produce property rights relating to private goods by devoting "effort and other inputs to the definition and enforcement of those rights when the expected benefits of definition and enforcement exceed the expected costs" (Anderson and Parker, 2013).

Therefore, organizations produce property rights for private goods if the benefits of doing so is lower than the transaction cost. By contributing to the definition and enforcement of such property rights and by reducing the transaction costs of production, such organizations open new markets and reorganize industry (Anderson and Parker, 2013; North, 1990; Schumpeter, 1934; Williamson, 1985). In this context, the benefits depend on the value of energy demand reductions and carbon emission mitigation property rights and the ability of financial mechanisms to provide commitment or obligation-driven demand for the supply, trade and accumulation of these private goods and the execution of property rights. Given their intangible nature, such property rights at best amount to quasi-property rights for quasi-private goods which are entirely dependent on tight regulation and target-setting to ensure market integrity and adherence to zero emission targets (Knox-Hayes, 2010).

Yet, market governance structures need to ensure sufficient flexibility to allow a wide range of organizations to create such private goods where they previously did not exist to create value and capture rents (profits) relating to their ownership and trade by exercising private (quasi-)property rights. By identifying new uses with higher values that have not been recognized or captured by existing owners (i.e., turning energy demand reductions and carbon emission mitigations into private goods for subsequent trade in secondary markets), such organizations succeed in lowering the costs of assetizing energy demand reductions and carbon emission mitigations as private goods within target-driven market structures (Anderson and Parker, 2013; Stavins, 2001).

Given the abovementioned "intangibility" of energy demand reductions and carbon emission mitigations (Aldrich and Koerner, 2018; Clark and Knox-Hayes, 2011), their definition as private goods requires assetization. Assetization is “the turning of things into an asset” (Birch, 2017), a process of making things work in new ways in existing systems using a strong market logic (Dreyfuss and Frankel, 2015; Kragh-Furbo and Walker, 2018). Value, valuation and the ability to capture rents result from a process of assetization (Birch, 2017; Dreyfuss and Frankel, 2015). Turning energy demand reduction and carbon emission mitigation properties into data (*collecting silences*), and that data into knowledge and evidence with value (Kargh-Furbo and Walker, 2018; Leonelli, 2014), is essential for their management and commodification (MacKenzie, 2009). By measuring, monitoring and accounting all aspects of energy (non-)use, energy demand reductions and carbon emission mitigations can be assetized.

4. Measurement, reporting and verification

The costs of measuring, reporting and verifying these aspects and reorganizing this knowledge as evidence by delineating quasi-property rights are a function of available technologies as well as political and legal challenges of initiating institutional change (de Serres et al., 2010; Anderson and Parker, 2013). Material qualities of existing measuring, reporting and verification equipment as well as socio-technical configurations determine the granularity of energy demand reduction and carbon emission mitigation data and manageability for assetization (Kragh-Furbo and Walker, 2018; UNEA, 2019).

At the same time, electricity meters and an increasing array of digital technologies generate increasingly granular quantified accounts of the (non-)flow of electrons arising from the functioning and idleness of secondary conversion equipment such as lights, pumps, motors, heaters etc. Sophisticated metering using smart meters, smart grids and a range of digital technologies associated with the Internet of Things (IoT) such as sensors as well as Big Data gathering and analytics coupled with cloud computing and Artificial Intelligence enable such (non-)flow to be measured and monitored using digital ecosystems combining data evaluation infrastructures and (distributed) ledgers (World Bank, 2018; UNEA, 2019).

Smart meters, for example, “offer a range of intelligent functions” by providing “near real time information on energy use”, which enables consumers to “be billed for the energy [they] actually use” (UK Government, 2018). This consequently also enables consumers to be awarded for energy they have not used and carbon emissions they have not emitted relative to comparators and baselines as data can be released from such smart meters at time-stamped (sub-)second intervals (Kragh-Furbo and Walker, 2018). Big Data qualities materialize through the use of such digital innovations alongside analytical capabilities enhanced by Artificial Intelligence. Big Data energy enables responsibility to be apportioned by making it relevant and visible to those responsible for it (Kitchin, 2014). Organizations such as the World Bank (2018) expect that these digital innovations could have significant impact in combination with distributed ledger technologies.

The functionality of distributed ledges such as Blockchain is enhanced through smart contracts which shift distributed ledgers from database to automation. Smart contracts are self-executing, auditable agreements working on the “If-Then” premise that exist as pieces of code stored on a distributed ledger which guarantee robust rule implementation by defining the rules of how trade occurs (Chapron, 2017; Christidis and Devetsikiotis, 2016). By embedding transactional terms and conditions in computer code, relevant transactions can be automatically executed once these terms and conditions have been fulfilled.

Purportedly, digital ecosystems combining sensors, smart meters, IoT, distributed ledgers, Big Data analytics, Artificial Intelligence and smart contracts allows data to be assetized and governance (e.g., standards, policy, measuring, reporting, verification, data sources and commercial terms) internalised in the medium of exchange. This should help prevent negative consequences such as leakage, inhibit opportunism in the marketplace, and ensure environmental integrity of the market, although the integrity always depends on the quality and reliability of nodes and primary information (Born, 2018; World Bank, 2018). Despite the immaturity of many digital technologies, entrepreneurial organizations are increasingly utilising them to lower the transaction costs of measuring, monitoring, verifying and assetizing data.

The next step is to apply these capabilities to the delineation of energy demand reductions and carbon emission mitigations as private goods. At the same time, improving remote sensing capacities enables a very wide range of carbon emission to be measured and monitored remotely. Such sensors include ground-based, airborne, ship-borne, balloon-borne, and space borne carbon sensors (Palmer et al., 2018). Their increasing sophistication enables the identification of point-source pollution which may enhance the integrity of accounting systems underlying financial mechanisms. These might enable the assetization of land-use data for similar purposes as the ones outlined in relation to energy demand reduction and carbon emission mitigation markets in the following sections.

These sections provide an overview of how this interplay between financial mechanisms and organizational innovation is creating capability for energy demand reduction and carbon emission mitigation assetization (*collecting silences*). Crucially, these examples indicate at what point the benefits of assetizing *silences* for subsequent trade in energy demand reduction and carbon emission mitigation markets exceed the costs. This point marks the emergence of the positive pricing of reductions (positive carbon pricing).

5. Demanding and supplying silences

In this section, the following two categories of financial mechanisms are analysed:

- International markets encompassing cap-and-trade and baseline-and-credit systems which create demand for carbon emission mitigations assetized as private goods
- National markets encompassing energy efficiency obligation and flexibility markets on the one hand, and energy service companies and procurement frameworks on the other, which facilitate the assetization of energy demand reductions as private goods

Their success hinges on accurate measurement, reporting and verification (MRV) vis-à-vis a baseline of consumption/demand which serves as both a project boundary and a counterfactual.

5.1. International markets

Carbon markets can be traced back to Coase (1959, 1960). If property rights are properly delineated, he argued, “it can be left to market transactions to bring an optimum utilization of rights” (Coase, 1960). Nowadays, an increasing number of national, and increasingly also transnational carbon markets are in place. The EU-Emission Trading Scheme (EU-ETS), for example, covers over 10,000 installations and nearly half of the EU’s carbon emissions. Since its inception in 2005, emissions have been cut by 42.8% across targeted sectors (power and heat generation and energy-intensive industrial installations). Rising carbon prices resulted in auction revenues of €14-16bn/a between 2018 and 2020, around 70% of which is spent activities tackling climate change, down from 85% of revenues in 2015 (Marcantonini et al., 2017; EC, 2021).

Cap-and-trade ETS are based upon the compliance-based governance of allowance management and allocation systems. They vary according to sectors, methodology regarding distribution of the "cap", magnitude of the "cap", and stakeholders involved (Stua, 2017). Under these cap-and-trade systems, a cap is defined by a regulatory authority, allowances are allocated to participating stakeholders or target sectors, and in successive timeframes the regulatory authority reduces the number of allowances to ensure a progressive lowering of the "cap" (Calel, 2013).

Such ETS cap-and-trade systems trade "rights to emit" as quasi-property rights. As mentioned above, EU Allowances (EUA), or "rights to emit", in the EU ETS have been judged as "property". Although this lowers transaction costs, they remain prohibitive for most organisations other than heavy industries included in the ETS as well as market incumbents, the financial service industry, and specialised trading organizations where emissions trading activity is concentrated (Bowers, 1997; Knox-Hayes, 2010).

Such cap-and-trade systems are thus associated with high entry barriers, regulatory barriers and high (transaction) costs. Voluntary carbon markets have emerged in recent years to lower such barriers and transaction costs. According to Ecosystem Marketplaces (2021) Global Carbon Survey, the value of such markets amount to around $1bn/a with the first eight months of 2021 recording close to 60% increase in value from the previous year. However, following the finalisation of the Article 6 rulebook at the 26th UNFCCC Conference of Parties (COP26), it is unclear how such markets will relate to commitment or obligation-driven mechanisms under Article 6.

Such mechanisms bear similarities to the Clean Development Mechanism (CDM) which is considered the predecessor of Article 6 baseline-and-credit systems (Stua, 2017). Compared to cap-and-trade system, the CDM facilitated the exchange of Certified Emission Reductions (CERs) (rather than "rights-to-emit") for money between participating countries. By including timetables and targets to mitigate carbon emission alongside rules and regulations regarding additionality, it assigned value to CERs and created a system of demand for carbon emission mitigations, which are the prerequisites for positive carbon pricing (Sirkis et al., 2015; Stua, 2013; Stua, 2017).

In this case, "carbon rights", according to Peskett and Brodnig (2011), are associated with the right to the underlying asset, activity or resource. Whether these amount to quasi-property rights regarding the emissions reduction depends on how they are legally defined (Luttrell et al., 2013; Pei et al., 2013). As intangible properties, CERs are "only worth the value of the information [they] represent" (Worthington, 2007; in Pei et al., 2013). Depending on the jurisdiction, CERs are considered intangible movable property and therefore "qualify to be an object of property right in law" (Pei et al., 2013).

Although there are lots of issues associated with the CDM, especially its baselines as a "carbon counterfactual" and the concept of "additionality" (see Böhm and Dabhi, 2009), it was "immensely successful in some areas" (Lütken, 2017). Appropriate certification channelled finance towards investments that applied CDM approved certified and quantified carbon emission mitigation methodologies vis-à-vis a baseline. The CDM's most prominent success was the development of entire technological innovation systems around wind energy in China (Stua, 2013). A commitment-driven market combined with an entrepreneurial state approach saw China develop a world leading wind energy innovation system from scratch with the help of 1480 CDM projects (nearly half of China's total of 3642 CDM projects), which succeeded in reducing China's carbon emissions by around 1%

(Stua, 2013; Karltorp et al., 2017). In total, the CDM in China avoided/prevented 324mt/CO_2 emissions with total investments amounting to nearly $217bn between 2004 and 2012 (Stua, 2013)

Despite the CDM's success in supporting the deployment of renewable energy in China, it failed to deliver energy demand reductions. Its contributions to energy efficiency involved either the construction of new coal fired, co-generation, natural gas power plants to replace old and less efficient cold fired power plants, or the improvement of processes in the iron and steel sector (Stua, 2013). In countries where the CDM is still applicable, on the other hand, pay-as-you-go carbon emission mitigation reporting, assetization and trading has emerged as a means to decarbonise through energy demand reduction. Examples from developing countries where biogas stoves replaced more traditional cooking methods with support through the CDM, although fraught with difficulties, suggest that fuel consumption was reduced by 84–94% (Clemens et al., 2018).

Table 3. Comparison between the EU-ETS cap-and-trade system and the CDM baseline-and-credit system as applied in China.

	EU-ETS cap-and-trade system	CDM baseline-and-credit system
Transaction costs	High	Medium
Energy demand reduction potential	High	Medium
Carbon mitigation assetization potential	Medium	High

To conclude, the EU-ETS cap-and trade system is associated with high transaction costs and entry barriers, but its market structure has proven conducive to energy demand reduction (Table 3). Its carbon mitigation assetization potential is limited due to its aforementioned emphasis on trading "rights to emit" as opposed to carbon emission reductions themselves. The CDM, on the other hand, has higher carbon mitigation assetization potential and lower transaction costs compared to the EU ETS. Its energy demand reduction potential is ambiguous as it depends on countries' sectoral and technological innovation system priorities. However, the initial inclusion of hydrofluorocarbons created perverse incentives which ruined its reputation while providing valuable lessons for the design of more inclusive and effective mechanisms (Schneider, 2011).

5.2. National markets

Energy efficiency obligations (EEOs), which encompass energy savings obligations, energy efficiency resource standards, energy efficiency performance standards, and White Certificates are financial mechanisms which require utilities to deliver energy savings without specifying the delivery route. By setting firm targets, obligations have shown to deliver energy savings. It is estimated that around $26bn/a of investment in energy savings, which amounts to more than 10% of global annual energy savings investments, are delivered through these mechanisms (Rosenow et al., 2019) Of particular interest in this context are White Certificates which are "tradable certificates declaring that a certain reduction of energy consumption has been attained in accordance with the rules of an EEO" (Rosenow et al., 2019).

White certificates bear similarities to carbon credit and Guarantee of Origin trading in that associated certificates are supposed to guarantee a specified amount of energy savings, emission reduction, or renewable electricity generation respectively. This similarity also extends to their legal definition (see Introduction). Certified energy savings can thus be traded among obligated parties to help them fulfil their obligation (Giraudet et al., 2012).

White Certificates, unlike carbon credit and Guarantee of Origin trading, are traded in national markets with country-specific rules and regulations. Such markets can resemble "over-the-counter" markets' or, in the case of Italy, "spot" markets. Despite significant discrepancies between countries, White Certificate schemes have proven to be cost-effective and economically efficient (Aldrich and Koerner, 2018; Giraudet et al., 2012; IEA, 2017b). They are also considered fair in that the cost of savings does not disproportionately burden low-income households (Penasco et al., 2021). This is particularly evident in Italy where the obligation to save energy was placed upon 30 regional electricity and gas distribution monopolies (Giraudet et al., 2012).

The scheme covered all end-use sectors with deemed measures for the household sector and 22 standardised actions such as insulation, efficient lighting, appliances, and heating systems. Energy demand reductions were calculated in savings of primary energy and issued over a lifetime of 5 years. Its White Certificate market is widely regarded as the most successful example by embedding the costs of trading in fees proportional to the amount of energy saved. This ensures that trading only takes place when it is of value (Aldrich and Koerner, 2018; Giraudet et al., 2012; IEA, 2017a, 2017b). At the same time, intermittent renewable energy penetration and changing patterns of demand are exposing power grids and systems to increasing levels of risk. To counteract such risk, the emphasis of financial mechanisms is increasingly shifting towards flexibility. Flexibility on the supply side includes components such as flexible generation, grid frequencies, networks, interconnectors and storage. Of particular interest to this paper is demand-side response ("flexiwatts"). This encompasses demand reduction as well as load shifting to reduce peak loads which allows a reshaping of the demand curve to better match the profile of intermittent renewable energy generation (Boscan and Poudineh, 2016; Ofgem, 2017; Parag and Butbul, 2018).

In the EU, the Electricity Directive states that all customer groups should have access to electricity markets to provide and trade flexibility, for example through storage, demand response, and demand reduction (EU, 2019). Unlike White Certificates, however, flexibility does not have the properties of a unique and traceable commodity that carries a quasi-property right. It can nevertheless be procured either through bilateral contracts or through a market-based approach by signalling the need for flexibility and acquiring it in a cost-effective manner. The latter could lower transaction costs if it was done via a platform (CEER, 2020).

Energy service or performance procurement frameworks do so by simplifying and standardising the process of negotiating, developing, and implementing associated energy savings contracts, such as Energy Performance Contracts with Energy Service Companies (ESCOs), which offsets associated fees. Such contracts enable investments in energy savings, covering primary and secondary conversion equipment as well as fabric improvements, to be offset by savings relative to an agreed baseline. Furthermore, such contracts provide an incentive to maintain and improve performance, and thereby reduce energy demand over time, as profit for the ESCO rises with increasing energy savings (Sorrell, 2007; Nolden et al., 2016).

Such contracts are often based on "asset-heavy" arrangements where large balance sheets mitigate against performance risk. The trade of such reductions, however, is restricted to mechanisms such as White

Certificate markets. Flexibility and demand response, on the other hand, usually involve organizations generating revenue from existing assets (Kondzielle and Bruckner, 2016; Nolden et al., 2016). Assetizing energy demand reduction in flexibility markets thereby enables the sweating of assets by not working them because the time they are not in use is assetized and monetized (Kragh-Furbo and Walker, 2018).

This is increasingly facilitated by flexibility trading platforms which enable organisations to assetize transactive flexibility. Such markets are still in their infancy but there is increasing political commitment to increase flexibility uptake using financial mechanisms. Many involved organizations are "asset-light" by combining digital innovations with Big Data analytics and Artificial Intelligence to reduce the transaction costs of reducing demand (Imbault et al., 2017; UNEA, 2019).

Table 4. Comparison between Energy efficiency obligations, White Certificates, Flexibility markets, and Energy performance contracting.

	Energy efficiency obligations	White certificates	Flexibility markets	Energy performance contracting
Transaction costs	Low	Medium	Medium	High
Energy demand reduction potential	Medium	Medium	Low	High
Carbon mitigation assetization potential	Medium	High	Low	High

The success of energy efficiency obligations is the result of low transaction costs (Table 4). The complexity of White certificates, on the other hand, is similar to that of cap-and-trade systems at international level. This increases transaction costs which results in risky business models and a tendency towards large trading volumes (IEA, 2017a). Successful deployment of such markets has consequently been limited to specific sectors as a result of such transaction costs as well as shifting priorities in energy and climate policy regarding uncertainty and variability. Emergent flexibility markets by themselves are associated with variable transaction costs and relatively low direct energy demand reduction and carbon mitigation assetization potential. Their full potential lies in value stacking in combination with other mechanisms (Mears and Martin, 2020). Energy performance contracting is associated high energy demand reduction potential and carbon mitigation assetization but generally constricted to specific sectors such as the public sector due to high transaction costs (Nolden et al., 2016).

6. Climate clubs and positive carbon pricing

Creating demand for *collecting silences* as tradable commodities thus hinges upon the governance of financial mechanisms and associated legal framework to create transferable quasi-property rights out of the value of the information that energy demand reductions and carbon emissions mitigations represent. Where this is the case, transaction costs for their supply, trade and accumulation can be significantly reduced.

In practice, however, the abovementioned examples, while demonstrating at national level that energy demand reductions and international level that carbon emission mitigations can be assetized and traded as private goods if an appropriate governance framework is provided (Aldrich and Koerner, 2018; Giraudet et al., 2012; IEA, 2017a, 2017b; Sirkis et al., 2015; Stua, 2013; Stua, 2017), are severely compromised. Firstly, these examples suggest that energy demand reductions can only be traded nationally in specific sectors while carbon emission mitigations can only be traded internationally among designated buyers (so-called Annex 1 countries and sellers (so-called non-Annex 1 countries). Combined, they have hardly made a dent on unsustainable emissions and energy demand trajectories. Secondly, using the example of China, carbon emission mitigation trading under the CDM supported technological substitution rather than system change (Stua, 2013). By shifting responsibly to increase efficiency or reduce emissions to market actors or sectors where it was the most economically viable, China in some cases replaced old fossil fuel power plants with new ones, thus inadvertently sustaining a system which is inherently unsustainable (Rinkinen et al., 2021).

Although this financial mechanism is considered "demand-side" it has been used for economic growth which can be part of the problem if it sustains increases in material and energy throughput (Steinberger et al., 2009). The underlying politics entail tacit commitments to preserving systems of supply, structures of power, and standard of living ambitions which support path-dependent trajectories of innovation and investment (Shove, 2018). While markets and organisational innovation around assetizing carbon emission mitigation and energy demand reduction and flexibility have demonstrated innovation and ingenuity in creating supply (Giraudet et al., 2012; Nolden and Sorrell, 2016; Parag and Butbul, 2018, CEER, 2020), they have therefore not succeeded in bringing about the radical changes necessary to reduce demand and carbon emissions. Nor have they succeeded in redirecting financial flows effectively towards decarbonisation and energy demand reduction. At worst, they sustain if not escalate energy-intensive ways of life in rich countries while facilitating land grabs and the increasing financialization of life in poor countries (Böhm and Dabhi, 2009; Böhm et al., 2012; Knox-Hayes, 2010; Lohmann, 2012).

To avoid such pitfalls and achieve total reductions in line with the 1.5˚C objective of the Paris Agreement (UNFCCC, 2015) and recommendations by IPCC (2018) and UNEP (2018), a different value creation system is necessary. Several commentators have argued that climate clubs present the most promising governance arrangement to commit countries to reduce carbon emissions and to overcome the free-rider problem at an international level (Das, 2015; Nordhaus, 2015; Weischer et al., 2012; Stua, 2017; Pihl, 2020; Stua et al., 2022). The principle is simple: the club is an agreement among countries to collectively harmonise their emission reductions. This could be achieved by harmonising domestic carbon prices over time. Such a price could be reached through carbon taxation or cap-and-trade systems. As mentioned above however, taxes are always difficult to implement while cap-and-trade systems are limited by the caps within which they trade (Sirkis et al., 2015).

"Shifting the trillions" requires a different approach (Sirkis et al., 2015). To this end, Stua (Stua, 2017; Stua et al., 2022) proposes a climate club governance arrangement based on Article 6 of Paris Agreement to harmonise emission reduction trajectories while raising ambition through a baseline-and-credit mechanism based on effort-sharing. By unifying bilateral, market and non-market systems within Article 6, a joint mechanism could be established to certify any form of measured, reported and verified carbon emission mitigation among countries willing to develop such a club based on Article 6.1 which enables voluntary cooperation for higher ambition. Combined with border carbon adjustments, issues of freeriding, non-compliance with ambitious targets of the club, and carbon leakage can be addressed, and excludable environmental, economic and social benefits ensured.

Such border carbon adjustments involve levying carbon tariffs or taxes on imported goods according to the carbon intensity of their supply (Mehling et al., 2018; Pirlot, 2021). Such delineation enables the establishment of shared yet ambitious targets and the creation of a homogenous demand-and-supply system for carbon emission reductions among the members of such a club. Similar to the CDM, such reductions can be assetized as carbon credits by shifting emphasis from the price or cost of reducing carbon emissions to the value of increasing carbon emission mitigations (Stua, 2017; Stua et al., 2022).

If the common principles identified in Table 2 were adopted (see Stua, 2017; Stua et al., 2022), such a governance arrangement would create a positive carbon pricing environment supported by the recognised "social, economic and environmental value of voluntary mitigation actions and their co-benefits for adaptation, health and sustainable development" of the Paris Agreement. This would enable quasi-property rights regarding carbon emissions mitigations to become a source of value in and of themselves. Under such a scenario, our quantified and exhaustible carbon budget between current emissions and the zero emissions target by 2050 to limit anthropogenic climate change below 1.5 ˚C would be transformed into a commodity (Stua, 2017; Stua et al., 2022).

Creating financial mechanisms demanding the assetization of carbon emission mitigations alongside reductions in energy demand while factoring in common but differentiated responsibilities and respective capabilities therefore depends on underlying governance arrangements (Stua, 2013, 2017; Stua et al., 2022). By governing demand under the auspices of climate clubs, the basis for organizations to lower transaction costs by working towards the legal recognition of their beneficial use is provided.

To establish the potential of such climate clubs to lower transaction costs, encourage energy demand reduction, and facilitate carbon mitigation assetization (see Tables 3 and 4), further research and validation is required. Firstly, this needs to involve game-theoretical modelling of decarbonization trajectories (see Coulon and Stua, 2015). Secondly, compatibility with existing mechanism described in Table 1 needs to be verified (see Stua, 2017). Thirdly, the appropriate application of digital innovations and ecosystems to enhance equity and fairness in the distribution of benefits and burdens of energy demand reductions and carbon emission mitigations needs to be explored (see UNEA, 2019).

7. Conclusions

In August 2021, the German finance ministry announced the intention to create an ambitious, bold, and cooperative climate club (BMF, 2021). It emphasized the need for border carbon adjustments, market mechanisms, and harmonised carbon pricing to address carbon leakage both within the club and externally and to achieve the objectives of the Paris Agreement. Thanks to the ability of financial mechanisms outlined in this paper to create demand and facilitate supply activity, the transaction costs for arranging club objectives around *collecting silences* have been significantly lowered. With increasing granularity and near real-time data measuring, monitoring, and accounting abilities facilitated by digital innovations, an increasing range of energy demand reduction and carbon emission mitigations can be assetized as private goods for supply, trading, and accumulation to help such a club shift towards its ambitious zero-carbon emissions target.

With appropriate governance structures in place, such a club can potentially create a positive carbon pricing environment. Such governance needs to combine long-term and flexible targets with strong institutions and governance structures that align markets, finance, and banking with ambitious, bold, and cooperative target setting in order to "shift the trillions". Supply in turn hinges upon a huge carbon emission accounting and sharing effort to create organisational capacities to assetize emission reductions and socio-political capacities to mitigate against monopolising rent capturing tendencies.

At the same time, it is worth bearing in mind that Böll's short story *Murke's Collected Silences* also contains a satirical critique of the information and communication technology revolution of Germany's post-World War II "Wirtschaftswunder". The silences Murke measures and collects to enjoy at home are his protest against this absurd world where the precision of time calculation (a ride on the paternoster lift lasts 4 ½ seconds) is the leitmotif. Yet this precision in time calculating and keeping which creates demand for *silences* also provides Murke with the satisfaction of *collecting silences*.

If we want to stand any chance in addressing overarching problems such as climate change, we need to assign greater value to the *collection and trading of silences* we have at our disposal. In this process, however, we should not lose sight of the absurdity of the situation we find ourselves in, where creating demand for the *collection of silences* by creating quasi property-rights out of the value of the information regarding reductions and their subsequent supply, trade, and accumulation through positive carbon pricing ranks among our best options to avoid catastrophic climate change.

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Conflict of interest

The author declares no conflict of interest

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