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Collecting Silences: Entrepreneurs, energy efficiency, carbon emissions and de-growth markets

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Abstract

Energy markets are diversifying. Secondary markets for white certificates, flexibility and carbon emission reductions are growing while an increasing range of entrepreneurs provide market access. This paper analyses the ability of entrepreneurs to define, assetize and trade property rights relating to energy demand and carbon emission reductions to facilitate the trade of white certificates, flexibility and carbon emission reductions. Using insights from transaction cost economics, this paper suggests that the combination of market-based instruments, business model innovation and technological innovations facilitate the assetization of energy demand and carbon emission reductions property rights for subsequent trade by enabling all aspects of energy (non-)use to be monitored and time-stamped (collecting silences). This provides the basis not only for flexibility (flexiwatts) and energy demand and carbon emission reductions (negawatts) to compete on equal footing with units of delivered energy (megawatts) but also the foundation for de-growth markets.

Keywords

Negawatt; Flexiwatt; Degrowth; Market-Based Instrument; Business Models; Entrepreneurs; Transaction Costs; Assetization; Property Rights

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: 98). In this manner Murke, the protagonist of Heinrich Böll's short story 'Murke's Collected Silences' (Böll 1963), collects silences that are usually cut out and discarded from broadcast tapes. In effect, Murke assigs value to silences. *Noise*, by analogy, represents energy consumption by means of burning fossil fuels and emitting Greenhouse Gases (henceforth carbon). *Silence*, by analogy, is the absence of fossil fuel being burnt through energy efficiency improvements (energy demand reductions) and carbon savings (carbon emission reductions).

This paper considers the *collection of silences* (energy demand and carbon emission reductions) an issue of property rights and transaction costs. If we want to succeed in increasing energy efficiency and reducing carbon emissions, we need to create, capture and protect the value of *silences* by defining and assetizing energy demand and carbon emission reduction property rights for subsequent trade in white certificates, flexibility and carbon emission reduction markets (adapted from Anderson and Parker 2013). Such markets are the result of public policy defining market-based instruments (MBIs) which make use of 'market mechanisms with transferable property rights to distribute the burden of public policy' (Bertoldi 2011: 2). Whether such markets can resolve issues resulting from high energy demand and carbon emissions depends on the transaction costs of defining, allocating and trading associated property rights.

This paper analyses the interplay of entrepreneurial and technical innovation alongside regulated MBIs to establish how the transaction costs of defining and allocating property rights regarding energy efficiency, flexibility and carbon emission reductions are being lowered through assetization and at what point the benefits of doing so exceed the costs. This point marks the emergence of de-growth markets.

The specific objectives are:

- Evaluate which market-based instruments for energy efficiency, flexibility and carbon emission reductions encourage the *collection of silences*
- Establish the role of entrepreneurs in lowering transaction costs for *collecting silences* by producing and assetizing property rights of energy demand and carbon emission reductions
- Explore whether market-based instruments and entrepreneurs facilitate the emergence of de-growth markets

This paper is structured as follows: Section 2 provides a brief overview of relevant MBIs; entrepreneurs; assetization; and emerging technologies. Section 3 provides examples of how energy efficiency, flexibility and carbon emission reductions are being assetized through a combination of MBIs, entrepreneurialism and technology lowering transaction costs of doing so. Section 4 provides an outlook by contextualising these examples in the context of de-growth markets. Section 5 concludes.

2 Market-based instruments and environmental entrepreneurs

Market-based instruments (MBIs), according to Stavins (2001: 1), 'are regulations that encourage behaviour through market signals rather than through explicit directives'. Compared to conventional 'command-and-control' regulations, MBIs are more likely to encourage the adoption of new business models and technologies because they are not prescriptive regarding delivery mechanisms and the measures to be used (Stavins 2001; Anderson and Parker 2013; IEA 2017a). Yet, overarching problems such as climate change require a range of solutions, ranging from policy tools to help mobilise incremental resources and 'command-and-control' regulation to MBIs (UNFCCC 2015; Stua 2017a; IPCC 2018).

Due to costs and complexity, MBIs are not a preferred policy choice or 'silver bullet' to solve such overarching problems and there is no conclusive proof that such MBIs deliver outcomes more cost-effectively than non-MBIs. However, there is evidence that MBIs, with the right institutional framework which enable MBIs to interact with other policy instruments that enhances the overall policy mix, can promote environmental protection and deliver efficiency gains at lower aggregate cost than conventional standards (Dales 1968; IEA 2017).

This paper focuses specifically on MBIs where *silences* can be generated by third parties and traded through intermediaries and on spot markets. In the language of New Institutional Economics (Coase 1998), it is assumed that such markets can contribute to the resolution of overarching problems such as climate change if they enable entrepreneurs to *collect silences* by producing well-defined and tradeable energy savings and carbon emission reductions property rights (adapted from Anderson and Parker 2013). Entrepreneurs, in turn, combine environmental entrepreneurship with the definition and enforcement of property rights to reduce the transaction costs of *collecting silences* through assetization.

It is hereby assumed that entrepreneurs and regulated markets can increase energy efficiency and reduce carbon emissions because of the omnipresence of transaction costs (Sorrell 2007; MacKenzie 2009; Nolden and Sorrell 2016; Nolden et al. 2016; 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: 15). The transaction costs either of defining property rights or of trading well-defined and enforced property rights prevent optimal resource allocation by preventing transactions that would be carried out in a pricing system without such costs (Coase 1960; Anderson and Parker 2013).

Entrepreneurs are increasingly combining business model innovation with technological innovations to lower the transaction costs for creating, capturing and assetizing energy demand and carbon emission reductions property rights (*collecting silences*). Regulated MBIs provide the space for these entrepreneurs to trade transferable property rights. Rather than conventional MBIs that convey limited property rights on to polluters which grant the 'right to emit' within the limits of the permit and turn pollution into a valuable quasi-private good that may be transferred to someone else (Bowers 1997), this paper is concerned with turning the reduction of pollution into a private good (Stua 2017a). Rather than trading *noise*, such MBIs facilitate the *collection and trading of silences* through market design combined with energy efficiency, flexibility or carbon emission reduction targets (Aldrich and Koerner 2018; Walker and Kragh-Furbo 2018; Stua 2017a).

2.1 Entrepreneurs and the assetization energy demand and carbon emission reductions

A focus on entrepreneurs as reducers of transaction costs, according to Anderson and Parker (2013: 265), 'helps us to understand how markets can improve environmental quality'. Entrepreneurs are the driving force behind the evolution of property rights because they establish new forms of organization, production processes and business methods (Schumpeter 1934). Entrepreneurs 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 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: 263).

Therefore, entrepreneurs produce property rights if the benefits of producing them is lower than the transaction cost. By defining and enforcing property rights and by reducing the transaction costs of production, entrepreneurs open new markets and reorganize industry (Schumpeter 1934; Williamson 1985; North 1990; Anderson and Parker 2013). In this context, the benefits depend on the value of energy demand and carbon emission reduction 'property rights'. Energy service entrepreneurs aim to create property rights where they previously did not exist to create value and capture rents relating to their ownership and trade. By identifying new uses with higher values that have not been recognized or captured by existing owners (i.e. turning energy demand and carbon emission reductions into a private good for subsequent trade of white certificates, flexibility and carbon emission reductions in secondary markets), such entrepreneurs succeed in lowering the costs of defining and enforcing energy demand and carbon emission reduction 'property rights' (Anderson and Parker 2013).

Given the 'intangibility' of energy demand and carbon emission reductions (Clark and Knox-Hayes 2011; Aldrich and Koerner 2018), assigning property rights to energy efficiency increases and carbon emission reduction requires their assetization. Assetization is 'the turning of things into an asset' (Birch 2017: 462), a process of making things work on new ways in existing systems using a strong market logic (Dreyfuss and Frankel 2015; Walker and Kragh-Furbo 2018). Value, valuation and the ability to capture rents result from a process of assetization (Dreyfuss and Frankel 2015; Birch 2017). Turning energy demand and carbon emission reductions properties into data (*collecting silences*), and that data into knowledge and evidence with value (Leonelli 2014; Kargh-Furbo and Walker 2018) is essential for their management and commodification (Walker and Kragh-Furbo 2018). By monitoring all aspects of energy (non-)use, flexibility and energy demand and carbon emission reductions can be assetized.

The costs of monitoring these aspects and reorganizing this knowledge and evidence by delineating property rights are a function of available technologies as well as political and legal challenges of initiating institutional change (Anderson and Parker 2013). Material qualities of existing monitoring equipment as well as socio-technical configurations determine the granularity of energy demand and carbon emission reduction data and manageability for assetization (Kragh-Furbo and Walker 2018; Walker and Kragh-Furbo 2018).

2.2 Emerging digital and distributed ledgers technologies and assetization

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. Increasingly sophisticated metering using emerging digital technologies (EDT) such as smart meters, smart grids and a range of technologies associated with the Internet of Things (IoT) such as sensors as well as Big Data gathering and analytics enable such (non-)flow to me measured, translated and evaluated through data infrastructures and ledgers (Walker and Kragh-Furbo 2018; World Bank 2018).

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). Data can be released from such smart meters at time-stamped minute down to (sub-)second intervals (Walker and Kragh-Furbo 2018). Big Data qualities materialise through use of such EDTs alongside increasing analytical capabilities. Big Data energy enables responsibility to be apportioned by making it relevant and visible to those responsible for it (Kitchin 2014; Kragh-Furbo and Walker 2018). Organisations such as the World Bank (2018) expect that EDT will have their greatest impact in combination with distributed ledger technologies (Deloitte 2017: 8):

> *Distributed ledger technology (DLT) is a type of database that is spread across multiple sites, countries, or institutions. It is decentralised in nature, eliminating the need for an intermediary to process, validate, or authenticate transactions. Each party (e.g. individual, organisation, or group) is represented by their computer, called a node, on the network. Each node keeps its own copy of all transactions on the network, and nodes work directly with one another to check a new transaction's validity through a process called consensus. Each of these transactions is encrypted and sent to every node on the network to be verified and grouped into time-stamped blocks of transactions*

The functionality of DLTs such as Blockchain is enhanced through smart contracts which shift DLT 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; RMI 2017). By embedding transactional terms and conditions in computer code, relevant transactions can be automatically executed once these terms and conditions have been fulfilled.

EDT, DLT, Big Data analytics and smart contracts facilitate data assetization. In combination, governance (e.g. standards, policy, measuring, reporting, verification, data sources and commercial terms) can be internalised in the medium of exchange. This helps prevent negative consequences such as leakage, inhibits opportunism in the marketplace and ensures environmental integrity of the market (World Bank 2018).

Although many of these technologies are still in their infancy, energy service entrepreneurs are increasingly utilising them to explore cost-efficient ways of monitoring, reorganizing and assetizing data to delineate property rights.

The following section provides an overview of this interplay between MBIs and entrepreneurial and technical innovation to establish how energy demand and carbon emission reductions are being assetized and at what point the benefits of delineating property rights for subsequent trade in white certificate, flexibility and carbon reduction markets exceed the costs. This point marks the emergence of de-growth markets.

3 Assetizing energy demand and carbon emission reduction property rights

In the energy sector, business models are increasingly split, with organisations placing greater emphasis on their core (asset owning) business while non-core (trading) services are being outsourced (Lay et al. 2009; Steinberger et al. 2009; Spinks et al. 2017). An increasing range of energy service entrepreneurs including energy service companies (ESCOs) and intermediaries specialise the supply of these non-core services which include energy supply, energy efficiency, demand-response and, increasingly, secondary market access services (Lay et al. 2009; Steinberger et al. 2009; Nolden and Sorrell, 2016; Boza-Kiss et al. 2017; Day and Walker, 2018).

This shift towards service delivery and secondary market access is associated with lower economic, energy and environmental costs (Stahel 1997; Steinberger et al. 2009; Nolden and Sorrell 2016; Anderson and Parker 2013; Boza-Kiss et al. 2017). Because of the invisibility of energy demand and carbon emission reductions (*silences*), defining and assetizing relevant property rights for subsequent trade (*collecting silences*) has been identified as an opportunity for MBIs to contribute to the resolution of environmental problems (Pei et al. 2012; Anderson and Parker 2013; Stua 2017a).

The energy service market oriented towards energy demand and carbon emission reductions encompasses a range of MBIs. In defining MBIs for energy efficiency, the International Energy Agency differentiates between obligations such as white certificates and auctions such as tendering programmes. By 2016, there were 52 MBIs for energy efficiency in place which stimulated around USD26bn investment in 2015 which accounted for 12% of the USD221bn invested in energy efficiency globally (IEA 2017a). In this section, the following three MBI that facilitate trading are analysed for *silence collecting* entrepreneurial activity:

- White Certificate markets where entrepreneurs may assetize energy demand reduction property rights

- Flexibility markets where entrepreneurs may assetize secondary conversion equipment idleness as property rights by remotely switching such equipment off
- Carbon markets where entrepreneurs may assetize carbon emission reduction property rights

3.1 White Certificate property rights

White certificates or energy savings certificates usually represent MWhs of energy savings ('negawatts'). White certificate markets enable such certificates to be traded among regulated entities. White certificate schemes mandate regulated organizations to accelerate the diffusion of energy efficient technologies (Giraudet et al. 2012; IEA 2017a,b; Aldrich and Koerner 2018). Such schemes have been in place in the UK since 2002, in Italy since 2005 and in France since 2006 (Giraudet et al. 2012). The basics for such a system to work include (adapted from Aldrich and Koerner 2018):

- A baseline of energy usage which serves as project boundary and serves as a counterfactual
- A regulated entity that reduces energy demand
- A regulated entity that monitors and verifies energy demand reductions as white certificates
- A regulated entity that ensures fungibility throughout the market
- A regulated entity that tracks and retrieves white certificates to comply with legislation

Their origin can be traced back to cap-and-trade markets and bear similarities to carbon and Guarantee of Origin trading in that associated certificates are supposed to guarantee a specified amount of energy demand reduction, carbon emission reduction or renewable electricity generation respectively. Unlike carbon and Guarantee of Origin trading, however, white certificates are traded in national markets with country-specific rules and regulations. Despite significant discrepancies between countries, white certificate schemes have nevertheless proven to be cost-effective and economically efficient (Giraudet et al. 2012; IEA 2017b; Aldrich and Koerner 2018).

The Italian white certificate market, which is widely regarded as the most successful energy efficiency MBI (Giraudet et al. 2012; IEA 2017a,b; Aldrich and Koerner 2018), embeds 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. The complexity of such markets, however, implies that business models of energy service entrepreneurs engaging in white certificate trading are risky (IEA 2017a).

A problem that concern all these approaches to *collecting silences* is the difficulty with public perception of these intangible commodities. Nevertheless, white certificate markets allow energy savings generated by utilities or energy service entrepreneurs such as ESCOs to be traded (IEA 2017b) and most energy savings are created by such entrepreneurs who sell white certificates to electricity suppliers (Giraudet et al. 2012; Aldrich and Koerner 2018). Rather than performing actual energy upgrades, these entrepreneurs tend to focus on completing necessary paperwork to define white certificate property rights.

The IEA foresees digitalization playing an important role in facilitating the measurement of energy efficiency impact at increasingly granular levels (IEA 2017b). Energi Mine's (2018) Energy Token platform provides an example of how this might work in practice. Rather than white certificates, the company combines of a peer-to-peer marketplace with a reward platform for trading tokenised energy savings. Based on the Ethereum ERC-20 Blockchain, measured, reported and verified energy savings are awarded EnergiTokens (ETK):

> *Actions such as buying energy-efficient appliances, taking public transport and using less energy at home will be rewarded with ETK. The tokens will have a market value and can therefore ultimately be exchanged for fiat currencies or held to pay for future energy bills/ EV charging (Energi Mine 2018: 13)*

Via enhanced data analytics, business process automation, faster settlement, new products and innovative market structures, DLT innovations such as Blockchains can help energy service entrepreneurs to unlock the value hidden in energy saving data through assetization (Energi Mine 2018).

3.2 Flexibility markets

Uncertainty and variability have always been a feature of matching supply and demand but with increasing intermittent renewable energy penetration, power grids and systems are exposed to increasing levels of risk. To counteract such risk, uncertainty and variability, flexibility is encouraged. Flexibility on the supply side includes components such as flexible generation, grid frequencies, networks, interconnectors and storage. What is more important in the context of this paper is demand-side flexibility ('flexiwatts') to reduce peak loads through load shifting 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).

When flexibility is unavailable, market prices might turn negative because inflexible generators are unable to reduce output, demand cannot absorb excess supply or there is limited transmission capacity. Price volatility is likely to increase again due to limited transmission capacities, limited ramping availability, insufficiently fast response or limited ability to reduce demand. Flexibility has multiple attributes such as capacity, ramp rate, duration and lead time and an increasing range of energy service entrepreneurs provide demand response, aggregation and storage. There is an expectation that such entrepreneurs will constitute important sources of demand-side flexibility in increasingly decarbonised power systems (Boscan and Poudineh 2016; Ofgem 2017).

Research from 2013 in the UK, which is generally considered leading on flexibility, suggests that stand-by generation capacity is preferred to load shifting (Gruenewald and Torriti 2013). With the launch of National Grid's Balancing Mechanism the UK now has real-time flexible electricity market to balance supply and demand with increasing emphasis on load shifting. Energy service entrepreneurs such as Flexitricity incorporate flexibility of industrial, commercial and public-sector energy uses directly into the Balancing Mechanism which allows some of the profits from this premium market, worth around £350m/a with prices reaching £2,500/MWh compared to around £50/MWh in wholesale markets, to be passed on to its customers (Ross 2018).

Rather than owning their own assets, such entrepreneurs generate revenue from existing assets. For flexible generators this implies that they are paid to reduce generation in times of high renewable energy penetration while Short-Term Operating Reserve services and Triad management include fully automated and aggregated demand reduction alongside increasing generation (Flexitricity 2018a). The example of Norish Cold Storage indicates how Flexitrictiy turns down Norish's cooling plant for short periods to reduce the stress on the electricity network while ensuring that the integrity of the stored product is guaranteed (Flexitricity 2018b).

This example indicates how Flexitricity unlocks value by assetizing and defining property rights of using less energy which allow both Norish and Flexitricity to earn revenues without disruptions to the former's normal business operation. Assetizing energy savings 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 (Walker and Kragh-Furbo 2018). Along similar lines, the development of a fit-for-purpose flexibility trading platform to assetize transactive flexibility is being supported by National Grid and Siemens in the UK (open energi 2018).

Such markets are still in their infancy but there is increasing political commitment to increase flexibility uptake using MBIs. In the UK for example, the National Grid (2017) as well as the Department for Business, Energy and Industrial Strategy in partnership with the regulator Ofgem (2017) recognise the limitations of current flexibility markets such as the Balancing Mechanism. They are committed to providing a wide range of demand aggregation and demand-side response entrepreneurs with a viable route to market while entrepreneurs themselves are already combining EDT with DLT and Big Data analytics to reduce the transaction costs of participating in such imbalance markets by reducing demand (Imbault et al. 2017; open energi 2018).

3.3 Carbon 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: 27). 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 GHG emissions (Calel 2013).

Most of these carbon markets are cap-and-trade emission trading schemes (ETS) based upon compliance systems and managed through allowance allocation systems. They vary according to sectors, methodology regarding distribution of the 'cap', magnitude of the 'cap' and stakeholders involved (Stua 2017a). According to the ICIS Carbon Markets Almanac (2017) there are four national ETS (China, Kazakhstan, New Zealand and South Korea), one interregional ETS (the Regional Greenhouse Gas Initiative – RGGI in North-eastern USA), one transnational ETS (Western Climate Initiative – WCI across California (USA) and British Columbia, Ontario and Quebec (Canada)), one city ETS (Tokyo) and one multinational ETS (EU-ETS). The Clean Development Mechanism (CDM) stands out because it was truly international by facilitating exchange of Certified Emission Reductions for money between participating countries (Stua 2013; Stua 2017a).

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; Stua 2017a). Such ETS cap-and-trade systems represent 'rights to emit' and are associated with high entry barriers, regulatory barriers and high costs along with high transaction costs which limit current emissions trading activity to heavy industries, market incumbents, the financial service industry and specialised trading organisations. Small, less specialised organisations and individuals are practically excluded from this market (Castellanos et al. 2017; RMI 2017; Stua 2017a).

In response, energy service entrepreneurs are either lowering entry barriers through aggregation for accessing existing carbon markets, especially CDM, or developing voluntary carbon markets, such as the Gold Standard. Associated emission reductions are traded by companies, non-governmental organizations and individuals typically to meet neutrality targets. Voluntary markets in particular serve as testing grounds for new rules, regulations, standards, procedures, methodologies and technologies. The Gold Standard takes this a step further by bridging voluntary carbon markets with the CDM (Stua 2017a).

An increasing number of organizations are currently developing specialized assetization and trading platforms with the aim of reducing transaction costs for a multitude of small-scale generators (see DAO IPCI 2018; EWF 2018; WEF 2018). Through smart contracts such platforms automatically record provenance, create property rights, assetize through tokenization, track ownership and timestamp location, time, source and type of carbon emissions. The combination of DLT, and Blockchain in particular, with EDT promises unprecedented transparency, integrity and detail by providing granular and automated near-real-time carbon accounting data (DAO IPCI 2018; EWF 2018; WEF 2018; World Bank 2018).

As a response to this emerging potential the UNFCCC has launched the Climate Chain Coalition (2018) to establish how EDT, DLT and Big Data can help mobilize climate finance and enhance Measurement, Reporting and Verification. In practice this implies the lowering of transaction costs by increasing transparency and fungibility of carbon emission reductions. Taking this a step further, Stua (2017b) suggests the linking of crypto currencies to the production of carbon emission reductions to create fungible assets.

4 Outlook

MBIs for *collecting silences* work best when the attribute being sold and traded is uniform in nature and easily tracked (MacKenzie 2009; Stua 2017; IEA 2017a). If energy savings can be assetized as 1 MWh of energy saving = 1 white certificate, market liquidity can be enhanced. On the other hand, treating all savings as uniform commodities only encourages low-cost savings as opposed to high-value savings such as delivering savings to low-income households or delivering savings that coincide with peak loads on the gird (IEA 2017a).

MBIs for flexibility, on the other hand, facilitate the assetization of much more time and space specific aspects of energy savings by enabling entrepreneurs to lower the transaction costs of real-time demand-side response services. Emerging carbon markets can facilitate more holistic approaches where carbon emission reductions are automatically assetized alongside increases in energy efficiency. These three examples also show how DLT, EDT and Big Data analytics facilitate assetization and trading of energy and carbon savings by lowering transaction costs of monitoring and assetizing energy (non-)use data (adapted from Walker and Kargh-Furbo 2018; WEF 2018; World Bank 2018). This facilitates the emergence of de-growth markets because *silences* can not only be collected but also traded.

Proposals for post-2020 carbon markets take this step further by removing trading limitations such as those of the CDM and its differentiation between countries with carbon emission reduction requirements (Annex-1) and countries (non-Annex 1) that do no (Stua 2017a; World Bank 2018). For some energy savings projects, the guaranteed CDM market revenue stream nevertheless covers installation costs of energy saving equipment. Rather than 'rights to emit' markets, these markets therefore resemble degrowth economies because their existence and growth depends entirely on *collecting silences*.

By putting markets to work for saving energy and reducing carbon emissions, energy service entrepreneurs work towards the legal recognition of their beneficial use. The ultimate aim is to prompt burgeoning markets for energy efficiency, flexibility and carbon emission reductions. Creating degrowth markets and economies with carbon negative jobs thus hinges on the successful interplay between energy service entrepreneurs and MBI regulators to create new legal institutions by lowering the transaction costs of enhancing and creating associated property rights.

Regarding carbon emission reductions it is necessary to overcome some of the technical and institutional difficulties of excluding free riders. With improving technology, especially EDT, DLT and Big Data analytics, the feasibility of recording data increases while the costs of doing so decreases, which enables carbon emission reducers (*silence* collectors) to be rewarded appropriately for their efforts. 'Entrepreneurs who lessen the free-rider problem by innovating and using new technologies are rewarded by capturing the rents from better defined and enforced property rights' (Anderson and Parker 2013: 272).

Despite the focus on markets, this paper does not dismiss the importance of government regulation. Property rights evolve through a co-evolution of entrepreneurial production of property rights and government regulation thereof. Although entrepreneurs are the economic forces behind this evolution, the role of institutional innovators and entrepreneurial state should not be underestimated (Mazzucato 2013). White Certificate Markets, flexibility markets and several carbon markets (with the notable exclusion of Gold Standard VERs) have been actively shaped and created by national and international regulation.

By monitoring, time-stamping and assetizing all aspects of energy (non-)use and associated carbon emission reductions are turned into a private good with property rights. This paper proposes a combination of regulated MBIs, entrepreneurialism and target driven markets based on energy demand reduction, demand-side response and carbon emission reduction requirements that enable 'market transactions to bring an optimal utilization of rights' (Coase 1959: 27; Anderson and Parker 2013). Although this paper relies heavily on Coase's definition of property rights, it contradicts Coase on two points of his suggestions that:

> *the aim of such regulation should not, of course, be to eliminate smoke pollution but to bring about the optimum amount of smoke pollution. […] The conditions which make such regulation desirable do not change the nature of the problem. And, in principle, the solution to be sought is that which would have been achieved if the institution of private property and the pricing mechanism were working well.* (Coase, 1959: 29)

The argument here is that the optimum amount of pollution when it comes to carbon emissions (and elsewhere) is not only its elimination but also its sequestration to bring atmospheric carbon concentrations down a level more conducive for human habitation (UNFCCC 2015; IPCC 2018). At the same time, the institution of energy demand reduction, demand-side response and carbon emission reductions as private goods is dependent on regulated, target driven markets based on positive carbon pricing. This implies demand for absolute energy demand and carbon emission reductions by assigning these reductions property rights which enables their trade as private goods that can contribute to the resolution of climate change.

5 Conclusion

Thanks to MBIs, business model innovation and the application of EDT, DLT and Big Data analytics, the transaction costs of *collecting silences* are being lowered. With increasing granularity and near real-time data capturing abilities, property rights can be assigned to energy demand and carbon emission reductions through assetization for subsequent trading. Although this might appear to be a contradiction of terms, this marks the emergence of de-growth markets by facilitating trading platforms for flexiwatts, negawatts and carbon emission reductions because the reduction of energy demand and carbon emissions is turned into a private good for subsequent trade.

At the same time, it is worth bearing in mind that Böll's short story on Murke's Collected Silences also contains a satirical critique of a broadcasting house and indirectly of the (information and communication) technology revolution of Germany's post-World War II 'Wirtschaftswunder'. The silences Murke collects and takes home to measure are his protest against this absurd world where ash trays receive Good Design Awards and 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 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 without losing sight of the absurdity of the situation we find ourselves in where the *collection of silences* for subsequent trade and monetization in de-growth markets ranks among our best options to avoid catastrophic climate change within the dominant socio-economic growth paradigm.

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