Electricity Production and Greenhouse Gas Emissions Trading

Woerdman, Edwin; Zeng, Yingying

Published in:
Energy Law, Climate Change and the Environment

DOI:
10.4337/9781788119689.IX.30

Publication date:
2021

IX.30 Electricity production and greenhouse gas emissions trading

Edwin Woerdman
Professor of Markets and Regulation, Groningen Centre of Energy Law and Sustainability (GCELS), Faculty of Law, University of Groningen, The Netherlands

Yingying Zeng
Associate Professor, Zhongnan University of Economics and Law, Wuhan, China

Abstract
Producing energy by burning fossil fuels leads to the emission of greenhouse gases, such as CO_2. These emissions can be reduced in a cost-effective manner by implementing an Emissions Trading Scheme (ETS). An ETS allows legal entities, such as power companies and/or energy-intensive industries, to buy and sell emission rights under an increasingly stringent reduction target. There are three basic design variants of an ETS: cap-and-trade (allowance trading), performance standard rate trading, and project-based credit trading. These variants perform differently in terms of effectiveness and efficiency. The number of ETSs around the world is slowly increasing, with most of Europe, parts of North America, Kazakhstan, China, South Korea and New Zealand now covered. Only a limited number of ETSs have been linked, with some linking taking place within (though not yet between) continents. Emissions trading is an emerging regulatory instrument to efficiently protect the environment, but there remains a long way to go before a global carbon price is realised.

Keywords
Energy production, fossil fuels, greenhouse gases, climate change, carbon pricing, emissions trading, cap-and-trade, credit trading, carbon market linking, international harmonisation

Contents

IX.30.1 Introduction

Producing energy through the combustion of fossil fuels leads to the emission of greenhouse gases (GHGs), notably carbon dioxide (CO_2) but also methane (CH_4), nitrous oxide (N_2O) and fluorinated gases (F-gases), which contributes to climate change.[1] The three main categories of instruments to reduce those emissions are direct regulation, taxation and emissions trading.[2] This chapter focuses on the latter, in the context of reducing GHG emissions from energy production.

Emissions trading is a market-based instrument which aims to achieve emissions targets in a cost-effective way by allowing legal entities, such as power companies, to buy and sell emission rights.[3] Although 'emissions trading' is an umbrella concept for several legal design variants (which will themselves be discussed in turn), 'ETS' as an initialism is commonly used to refer to any 'Emissions Trading Scheme'.

There are currently 20 different ETSs in force around the world, covering 27 jurisdictions – including most of Europe, parts of the United States (US) and Canada, China, Kazakhstan, South Korea and New Zealand.[4] Several other jurisdictions (*e.g.* Ukraine and Mexico) are preparing to implement a national ETS, or are considering adopting one (*e.g.* Chile and Vietnam). Linking these systems would help to increase trading opportunities and allow for a global carbon price to develop.

This chapter is organised as follows: section IX.30.2 sketches the basic regulatory elements of an ETS; section IX.30.3 analyses three legal design variants of emissions trading in terms of effectiveness and efficiency; section IX.30.4 briefly describes a number of ETSs around the globe; and section IX.30.5 discusses some of the economic opportunities and legal barriers to linking those schemes internationally. Section IX.30.6 concludes.

IX.30.2 Emissions trading as a regulatory instrument

In theory, emissions trading requires the government to allocate an annually declining number of transferable emission rights to polluters. Polluters will trade those increasingly scarce emission rights on a market, thus ensuring 'that the required reduction [. . .] will be achieved at the smallest possible cost to society'.[5]

Emissions trading is sometimes compared to a waterbed. If one company buys emission rights and is allowed to emit more than its allocated quota, the company selling the emission rights must reduce its emissions by an equal amount to make these rights available for sale.[6] The government can thus be certain, provided there is adequate monitoring and enforcement, that the emissions of all companies falling under the ETS will not exceed the number of emission rights allocated during a certain period. This makes emissions trading an effective tool for achieving a quantitative emissions target. Emissions trading is also efficient, because companies can look for the cheapest way to fulfil their emission reduction obligations. When a government imposes emission caps, there will be some emitters for whom it is relatively cheap to reduce emissions, while there will be other emitters for whom it is relatively expensive. If the latter can purchase

---

1 United Nations Environment Programme (UNEP) (2018) 4–6.
2 Baumol and Oates (1988).
3 Woerdman (2014) 1–10.
4 Santikarn and others (eds) (2019) 18.
5 Dales (1968) 107.
6 Woerdman (2015) 43–75.

emission rights from the former, who must then reduce more emissions, the same emission reductions are achieved at lower compliance costs.

To implement an ETS, the legislator has to, among other things, create tradable emission entitlements usually called 'allowances', distribute these among the targeted polluters, and facilitate a liquid and transparent market. Subsequently, a designated regulator must monitor emissions per source, track the entitlements, check compliance over the past year, and penalise cases of non-compliance with a fine (that should be set at a multiple of the market price of the emission rights).[7]

Emissions trading is a 'quantity-based' instrument: emissions are priced on the market based on the trading of emission allowances by regulated entities under a cap, which usually defines a fixed and declining level of permitted emissions. This contrasts with emissions taxation, a 'price-based' instrument, where the government sets a price on emissions. There is a large body of literature on quantities versus prices, discussing the pros and cons of emissions trading and emissions taxation under different circumstances.[8] Instead of opting for one or the other, legislators may combine both instruments for a particular set of polluters simultaneously (quantities *and* prices). A few countries – such as the United Kingdom (since 2013) and the Netherlands (as of 2021) – have legislated to combine carbon trading for electricity producers with a levy operating as a carbon price floor. This essentially creates a hybrid system, with the potential to raise the carbon price. A higher price (due to such a price floor) has the disadvantage of increasing the costs of reducing carbon emissions, but has the potential advantage of creating a stronger incentive for low-carbon innovation.[9]

IX.30.3 Legal design variants of emissions trading

Instead of designing an ETS based on an emissions cap (*cap-and-trade*), it is also possible to trade emissions based on an emissions standard (*performance standard rate trading*) or an emissions baseline (*project-based credit trading*).[10] Differences between these three legal design variants will be explained below.

IX.30.3.1 Cap-and-trade

Cap-and-trade, also referred to as *allowance trading*, imposes a cap on the annual emissions of a group of companies for a number of years. Emission rights, referred to as *allowances*, are allocated to established companies for the entire period either for free, or are auctioned annually. Newcomers and companies seeking to expand must purchase allowances from a government reserve or from established companies, while a company closing a plant can sell its allowances. Banking and borrowing of allowances creates additional flexibility by allowing firms to spread abatement over time. While companies may be allowed to bank (relatively low-priced) allowances for later use to make future compliance cheaper, borrowing allowances from prospective allocations increases the

7 Tietenberg (1980); Nentjes and others (2002); Greenstone, Sunstein and Ori (2017).
8 Weitzman (1974) pioneered the academic discussion of this topic.
9 Wood and Jotzo (2011).
10 Nentjes and Woerdman (2012).

risk of future non-compliance. Banking is therefore allowed in most ETSs, but borrowing is usually limited or impossible.[11]

An example of a cap-and-trade system, the EU ETS for GHG emissions, was launched in 2005.[12] The Guangdong CO_2 emissions trading pilot scheme in China, established in 2013, also utilises a cap-and-trade system.[13]

Cap-and-trade is environmentally effective as it imposes an absolute limit on total emissions. Provided that emissions are adequately monitored and non-compliance measures enforced, cap-and-trade systems should prove effective. The success of a cap-and-trade system is therefore dependent on the institutional capacity of the country concerned.

In theory, cap-and-trade also has 'superior' efficiency properties, meaning that any given reduction target can be achieved at the lowest total abatement cost.[14] Each emission unit has a price (even in the case of free allowances), and any reduction in these units is profitable. A company's decision to use its free rights to cover its emissions comes at an 'opportunity cost' – the opportunity foregone to sell its allowances and generate sales revenues – which constitutes a part of the product's cost price.[15]

IX.30.3.2 Performance standard rate trading

Performance standard rate trading, also referred to as *credit trading*, is different from cap-and-trade in several key ways. A system of credit trading is based on a mandatory emissions standard adopted for a group of companies, rather than on an emissions cap. The emissions standard dictates permitted emissions per unit of energy consumption or per unit of production output (such as electricity or steel). In this system, emission reduction credits can be earned by emitting less than what is prescribed by the emissions standard. After this relatively complex calculation, these credits can be sold to companies that can use them to cover their excess emissions.

If the economy grows, the supply of credits also increases, because companies do not operate under an absolute emissions ceiling but must observe a relative emissions standard. An energy-intensive company that expands production, or a newcomer entering the industry, therefore has a right to new emissions, providing it conforms to the emissions standard. This means that absolute emissions will grow as the economy grows. To keep total emissions in check, the emissions standard must then be tightened.

A system of tradable nitrogen oxide (NOx) emission reduction credits was in place for energy-intensive companies in the Netherlands between 2005 and 2013,[16] while the city of Shenzen in China has been piloting a similar system as a means of regulating CO_2 emissions since 2013.[17]

---

[11] Fell, Moore and Morgenstern (2011).

[12] Directive 2003/87/EC of the European Parliament and the Council [2003] OJ L 275/32.

[13] People's Government of Guangdong Province, '碳排放权交易试点工作实施方案的通知' Guangdong Government Letter (2012) No. 264.

[14] Tietenberg and others (1999).

[15] Woerdman, Arcuri and Clò (2008).

[16] Environmental Protection Act (*Wet Milieubeheer*) (NL), Titel 16.3 Stikstofoxiden en NOx-emissierechten (repealed 1 January 2014).

[17] Shenzhen Special Economic Zone ETS Bill (深圳经济特区碳排放管理若干规定) (CN).

Performance standard rate trading may have difficulties in reaching an absolute emissions level for the industry to which the relative standard applies. As production and energy consumption rise, the emissions of companies bound by the emissions standard rise proportionally. Regulators seeking to achieve an absolute emissions level must therefore subsequently tighten the emissions standard.[18] This opens the door to firms lobbying against such a sharper emissions requirement – though this in turn could be mitigated by placing conditions for such increases into the ETS, automatising the correction process.

Performance standard rate trading improves cost-effectiveness, but also contains an important inefficiency. Although the emissions standard limits the emissions, the emissions within the limits set by the emissions standard remain without a price.[19] The reason for this is that emissions do not have opportunity costs: when a company shuts down its installations, it does not have to obey the emissions standard anymore, and has no ability to sell leftover allowances. Moreover, provided companies meet the relative standard, absolute emissions are even allowed to rise if production or energy consumption increases. Therefore, to reach the same level of environmental protection, performance standard rate trading leads to higher total emission reduction costs compared to cap-and-trade.[20]

IX.30.3.3 Project-based credit trading

Project-based emissions trading, such as Joint Implementation (JI) and Clean Development Mechanism (CDM) projects that operate until 2020 under Article 6 and Article 12 of the 1997 Kyoto Protocol, is a variant of credit trading.[21] JI relates to emission reduction projects in industrialised countries and countries in transition, particularly those in Eastern Europe, whereas the CDM refers to such projects in developing countries. The 2015 Paris Agreement facilitates the use of more or less similar international emission reduction projects under Article 6, informally referred to as Sustainable Development Mechanism (SDM) projects.[22]

While both credit trading and emission reduction projects allow for the transfer of credits, projects usually require pre-approval to check the environmental integrity of the project baseline. Credit trading is a top-down system, requiring a relatively strong administrative infrastructure. In contrast, the above-mentioned emission reductions are tied to specific projects that accrue bottom-up, which – while necessitating micro-project management – is less demanding in terms of institutional capacity.[23]

The issues of additionality, leakage and permanence cast doubt on the environmental integrity of credits generated from project-based offset programmes. Quantifying what would happen in the absence of a project is inherently difficult and uncertain, raising

---

18 Dewees (2001); Weishaar (2007) 29–70.
19 Nentjes and Woerdman (2012).
20 De Vries, Dijkstra and McGinty (2014).
21 Kyoto Protocol to the United Nations Framework Convention on Climate Change (adopted 11 December 1997, entered into force 16 February 2005) 2303 UNTS 162 (Kyoto Protocol).
22 Paris Agreement (adopted 12 December 2015, entered into force 4 November 2016) No. 54113.
23 Phuong (2009).

the risk that (some) offset credits may represent emission reductions that are not real, because they are temporary or would have materialised anyway.[24] An offset project may even induce higher emissions in other locations or sectors, an effect commonly referred to as *leakage*.

Although project-based credit trading improves cost-effectiveness, it also suffers from relatively high transaction costs, such as information costs, contract costs and enforcement costs.[25] Baseline standardisation, through the development of business-as-usual scenarios for several project types and regions, has the potential to improve this.

IX.30.4 Emissions Trading Schemes around the globe

Led by the US in the 1990s, a group of countries pushed for the inclusion of emissions trading in the Kyoto Protocol, requiring 37 industrialised nations to reduce their GHG emissions. Article 17 of the 1997 Kyoto Protocol enables government-to-government emissions trading, with the annex on emissions trading in the subsequent Marrakech Accords allowing governments to authorise legal entities to transfer and/or acquire emissions.

Although never ratified by the US, the Kyoto Protocol raised awareness of emissions trading in Europe and beyond. European politicians decided in 2003 to implement an ETS on an EU-wide scale to reduce GHG emissions, initially covering only CO_2, but expanding to include N_2O and perfluorocarbons since 2013.[26] The entities covered by this ETS account for 45 per cent of GHG emissions in the EU, mainly including emissions from power and heat generation, as well as commercial aviation and other energy-intensive industries. Switzerland operates its own ETS, while Ukraine is preparing for emissions trading following the ratification of their Association Agreement with the EU.

GHG ETSs have also emerged in North America, with the Regional Greenhouse Gas Initiative (RGGI) and the linked California-Quebec ETS in operation in parts of the US and Canada.[27] New Zealand boasts Oceania's sole ETS in operation (the NZ ETS), with Australia abolishing their own Carbon Pricing Mechanism (ACPM) following a change of government.[28] China established eight pilot ETSs between 2013 and 2016, with the roll-out of a national ETS that was launched politically in December 2017 and started operating in February 2021.[29] Other ETSs in Asia include the Korea ETS (K-ETS), Tokyo's Cap-and-Trade Program and an ETS in Kazakhstan that (after temporary suspension) was re-launched on 1 January 2018.[30] Moreover, six jurisdictions (including Mexico and Colombia) are officially scheduled to implement a carbon ETS, while 12 others (including Brazil, Russia and Indonesia) are considering adopting one.[31]

Currently, there are 20 ETSs up and running around the world, initially covering 8

---

24 Trexler, Broekhoff and Kosloff (2006).

25 Woerdman (2001).

26 Directive 2009/29/EC of the European Parliament and the Council [2009] OJ L 140/63.

27 The RGGI includes the US states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont.

28 Climate Change Response Act 2002 (NZ) ss 54–178.

29 Ministry of Ecology and Environment of the People's Republic of China (2017, 2020).

30 International Carbon Action Partnership (2019).

31 For a regularly updated overview see: 'ETS Map' (*International Carbon Action Partnership*) <https://icapcarbonaction.com/ets-map> accessed 18 March 2021.

per cent of global GHG emissions but rising to 14 per cent when China's national ETS became fully operational.[32] Within these national or regional ETSs, power companies and/or energy-intensive industries are able to trade carbon allowances. These ETSs differ in their design choices related to, *inter alia*, the emissions cap, the allocation of allowances and cost-management measures.

An absolute cap is applied in the EU ETS, the K-ETS and the California-Quebec Cap-and-Trade System. However, some other systems, such as the Chinese national ETS, prefer the imposition of a relative emission reduction target, determining the level of GHGs emitted per unit of Gross Domestic Product (GDP).[33] China opted for a cautious rollout by initiating its national ETS only within the electricity sector, and opting to allocate allowances for free by using 'benchmarking', stating the desired level of CO_2 emitted per product. By contrast, allowances are now largely auctioned in the EU ETS and in the California-Quebec ETS – albeit with exemptions under the EU ETS for industrial sectors that carry a risk of carbon leakage, to whom allowances may be freely allocated.

Various cost-management measures are applied within the ETSs. A price floor acts as a minimum price, which can support low-carbon innovation if the allowance price is lower than expected. This can be achieved by setting a reserve price in allowance auctions (as in the California-Quebec ETS), or through a government commitment to buy back allowances (as in the Beijing pilot ETS).[34] A price ceiling is a pre-determined maximum price, preventing allowance prices from rising above a certain level. The Cost Containment Reserve (CCR) of the RGGI in the US, through which additional allowances can be auctioned off if the auction clearing price passes a certain threshold, is an example of such a system in action. Some ETSs (*e.g.* the Beijing Pilot ETS) have both a price floor and price ceiling, while others (*e.g.* the EU ETS) have neither. Although the EU ETS does not regulate prices directly, it does employ a quantity-based Market Stability Reserve (MSR), which takes in or spits out allowances depending on allowance scarcity.[35] Most of the ETSs allow banking and forbid borrowing, except for the K-ETS, which allows intra-phase borrowing of allowances for compliance.[36]

In many ETSs, some of the carbon abatement obligations can be 'offset' by designated GHG emission reduction units outside the ETS, known as *project-based carbon offsets*. Different ETSs may set varied restrictions on either the sources or the quantity of offsets that can be used for compliance. For instance, in the EU ETS, Certified Emission Reductions (CERs) from CDM projects in least-developed countries registered after 2012 can be used during the compliance period 2013–2020 but not thereafter.[37] The K-ETS also has offset restrictions, including its requirement that only up to 5 per cent of international offsets can be used for compliance purposes.[38]

---

32 Santikarn and others (eds) (2019) 6–7, 21.
33 Zeng, Weishaar and Couwenberg (2016).
34 Beijing Carbon Trading Regulation (Trial) (北京市碳排放权交易管理办法(试行)) (CN).
35 Directive (EU) 2018/410 of the European Parliament and the Council [2018] OJ L 76/3.
36 Act on the Allocation and Trading of Greenhouse-Gas Emission Permits, Act No. 14839, (KR) (2012 Korean ETS Act).
37 Directive 2003/87/EC art 11a(4).
38 Enforcement Decree of the Act on the Allocation and Trading of Greenhouse Gas Emission Permits, Presidential Decree No. 27953 (KR).

IX.30.5 International linking of Emissions Trading Schemes

National (or regional) ETSs can also be linked internationally. Linking enables participants in one ETS to use emission entitlements from another scheme for compliance purposes.[39] The CDM (or SDM) is an example of a unilateral link in which one scheme accepts (project-based) emission entitlements from another scheme but not *vice versa*. Most of the linking literature, however, focuses on bilateral (or multilateral) examples, in which both (or more) ETSs accept each system's emission entitlements.[40]

Linking brings various economic advantages.[41] A bigger emissions market increases market liquidity, reduces market power and enhances cost-effectiveness by increasing low-cost abatement opportunities. Linking also stimulates the formation of a global carbon price, lowers carbon leakage and makes emissions trading politically viable for small countries whose independent schemes would be too costly. Moreover, linking matches with the 'bottom-up' approach of the Paris Agreement by voluntarily expanding international climate policy based on governments' nationally determined contributions (NDCs).

However, potential legal and political problems arise when different ETSs are linked.[42] Firstly, linking will likely have the effect of increasing the allowance price in the ETS with a lower original allowance price, and decreasing the allowance price in the scheme with a higher original allowance price. This will probably trigger industry lobbying, in particular by net buyers in the former scheme in which the allowance price goes up. Secondly, '[. . .] linking is easier if the system designs are similar'.[43] As regulatory differences could make one particular ETS more favourable for companies to engage in allowance transactions than another, some degree of coordination is required. However, full or maximum harmonisation is not necessary for linked markets to work. A distinction can be made between (a) design aspects that require harmonisation, (b) those whose harmonisation would be desirable, and (c) those whose harmonisation is not necessary.[44]

In principle, harmonisation is necessary with respect to the nature of the emissions targets (absolute versus relative), the stringency of the emissions caps (to avoid the trading of emission rights that do not represent real emission reductions, referred to as 'hot air'), borrowing provisions (to avoid the postponement of emission reduction efforts, especially in the case of potential de-linking), carbon offset types and limits (to maintain environmental integrity), and allowance price ceilings or floors (which affect the carbon prices of both linked systems).

Harmonisation is desirable in order to lower transaction costs and smoothen the operation of the linked systems with respect to monitoring, reporting and verification (MRV), registry design, banking provisions, penalties in case of non-compliance, and compliance periods (although different compliance periods have the potential advantage of increasing market liquidity). Market oversight rules may differ, but harmonisation avoids the risk of the lowest standard evolving to dominate the linked system.

---

39 Ranson and Stavins (2016); Tiche, Weishaar and Couwenberg (2014).
40 Tuerk and others (2009).
41 Grüll and Taschini (2012); Haites (2016).
42 Weishaar (2014).
43 Haites (2016) 256.
44 Kachi and others (2015).

Harmonisation is not necessary with respect to sector coverage (with a variety of sectors expanding abatement opportunities), point of regulation (although double counting must be avoided), and opt-in or opt-out provisions. Political preferences could nevertheless lead to more regulatory harmonisation than economically required, perhaps also in relation to allowance allocation, which could lead to inefficiencies.

Further legal and economic research is required, for instance in relation to differences in competitiveness safeguards and carbon leakage measures, the treatment of new entrants and (voluntary or forced) plant closures, privacy regulations, tax liabilities regarding allowances, and remedies in the event of loss or theft of allowances.

The numerous issues listed above suggest that there will always be differences between ETSs that may impede linking. To make linking politically acceptable, policymakers could also opt for limited (instead of unlimited) linking, for example by quantitatively restricting trading or by applying an exchange rate when emission rights go from one (less stringent) ETS to the other.[45] Unfortunately, this would also raise complexity and limit some of the benefits of linking, particularly regarding cost-effectiveness.

Although linking is subject to political debate and requires years of legal preparation, it has proven to be possible. In North America, the California Cap-and-Trade Program was, in 2014, linked to the Cap-and-Trade System in Québec. The RGGI in and of itself can be seen as a linked system of (as of 2019) nine eastern US state emissions trading markets.[46] In Europe, Article 25 of the amended EU ETS Directive allows for future linkage between the EU ETS and compatible mandatory ETSs with absolute emissions caps established in other countries or regions. The finalised link between the EU ETS and the Swiss ETS as of 2021 serves as an additional example. Several more recent carbon markets also envisage linking: the Korean ETS Act of 2012, for instance, provides that the Korean government should make efforts to link the K-ETS to the international carbon market, through linking the K-ETS with ETSs that credibly measure, report and verify emissions.[47]

Given the political willingness and the potential opportunities that linking provides to create bigger markets with more efficient abatement opportunities, more linkages can be expected in the future. Currently, however, linking occurs within continents. It remains to be seen whether this regional orientation can be transcended by creating links between ETSs from different continents. Although this is not entirely impossible, it appears to be rather difficult due to legal differences and divergent political preferences.

Take the hypothetical example of linking the EU ETS with China's nascent national ETS, which would be the two largest ETSs in the world in terms of emissions coverage. Next to the absence of an absolute emissions cap and leakage problems in China,[48] linkage also appears hardly acceptable to Europeans given China's weak enforcement of environmental law.[49] Moreover, the EU may not want to link to a Chinese ETS that could be inflicted by excessive ad-hoc government interventions and ex-post adjustment

45 Quemin and De Perthuis (2019).
46 New Jersey and Virginia are likely to join the RGGI in 2020, bringing the number of linked US states to 11.
47 2012 Korean ETS Act.
48 Zeng, Weishaar and Vedder (2018).
49 Xu and Faure (2016); Deng, Wu and Xu (2019).

of, for example, the pre-allocated allowances.[50] Another notable obstacle is that linking with China could lead to a lower allowance price and higher allowance price volatility in the EU, while a number of EU Member States actually aim to raise and stabilise the allowance price to further incentivise low-carbon innovation (such as France and the Netherlands). It can be surmised that an EU-China linkage is not impossible in the long run, but unlikely to materialise in the near future.

IX.30.6 Conclusion

Producing energy by burning fossil fuels leads to the emission of greenhouse gases, such as CO_2. These emissions can be reduced in a cost-effective manner by implementing an Emissions Trading Scheme (ETS). An ETS allows legal entities, such as power companies and/or energy-intensive industries, to buy and sell emission rights under an increasingly stringent reduction target. There are three basic design variants of an ETS: cap-and-trade (allowance trading), performance standard rate trading and project-based credit trading. These variants perform differently in terms of effectiveness and efficiency. The number of ETSs around the world is slowly increasing, with most of Europe, parts of North America, China, Kazakhstan, South Korea and New Zealand now covered. Only a limited number of ETSs have been linked, with some linking taking place within (though not yet between) continents. Emissions trading is clearly an important regulatory instrument for efficient environmental protection, but there remains a long way to go before a global carbon price is realised.

Bibliography

Baumol W and Oates W, *The Theory of Environmental Policy* (2nd edn, Cambridge University Press 1988).

Dales J, *Pollution, Property & Prices: An Essay in Policy-making and Economics* (1st edn, University of Toronto Press 1968).

Deng Y, Wu Y and Xu H, *Political Connections and Firm Pollution Behaviour: An Empirical Study* (1st edn, Bank of Finland 2019).

De Vries F, Dijkstra BR and McGinty M, 'On Emissions Trading and Market Structure: Cap-and-Trade Versus Intensity Standards' (2014) 58(4) Environmental and Resource Economics 665.

Dewees D, 'Emissions Trading: ERCs or Allowances?' (2001) 77(4) Land Economics 513.

Fell J, Moore E and Morgenstern RD, 'Cost Containment under Cap and Trade: A Review of the Literature' (2011) 5(4) International Review of Environmental and Resource Economics 285.

Greenstone M, Sunstein C and Ori S, 'The Next Generation of Transportation Policy' (2017) Hamilton Project Policy Proposal 2017-02 <https://www.hamiltonproject.org/assets/files/next_generation_transportation_policy_pp.pdf> accessed 2 December 2019.

Grüll G and Taschini L, 'Linking Emission Trading Schemes' (2012) 1(3) Economics of Energy & Environmental Policy 115.

Haites E, 'Experience with Linking Greenhouse Gas Emissions Trading Systems' (2016) 5(3) Wiley Interdisciplinary Reviews: Energy and Environment 246.

International Carbon Action Partnership (ICAP), 'Kazakhstan Emissions Trading Scheme – ETS Detailed Information' (ICAP 2019) <https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=46> accessed 6 December 2019.

Kachi A and others, 'Linking Emissions Trading Systems: A Summary of Current Research' (ICAP 2015) <https://icapcarbonaction.com/en/?option=com_attach&task=download&id=241> accessed 2 December 2019.

Lo AY (2016), 'Challenges to the Development of Carbon Markets in China' (2016) 16(1) Climate Policy 109.

Ministry of Ecology and Environment of the People's Republic of China (MEE), 'Work Plan for Construction of the National Emissions Trading System (Power Sector)' (MEE 2017) <http://qhs.mee.gov.cn/tscjs/201904/P020190419528391772305.pdf> accessed 6 December 2019.

---

[50] Zeng, Weishaar and Couwenberg (2016); Lo (2016); Tang and others (2018).

Ministry of Ecology and Environment of the People's Republic of China (MEE), 'Measures for the Administration of National Carbon Emissions Trading' (MEE 2020) <http://www.gov.cn/zhengce/zhengceku/2021-01/06/content_5577360.htm> accessed 9 February 2021.
Nentjes A and others, *National and International Emissions Trading for Greenhouse Gases* (1st edn, NRP 2002).
Nentjes A and Woerdman E, 'Tradable Permits Versus Tradable Credits: A Survey and Analysis' (2012) 6(1) International Review of Environmental and Resource Economics 1.
Phuong L, 'The Development of Instruments for Environmental Policy: Can Developing Countries Learn from Developed Countries?' (PhD thesis, University of Groningen 2009).
Quemin S and De Perthuis C, 'Transitional Restricted Linkage between Emissions Trading Schemes' (2019) 74(1) Environmental and Resource Economics 1.
Ranson M and Stavins RN, 'Linkage of Greenhouse Gas Emissions Trading Systems: Learning from Experience' (2016) 16(3) Climate Policy 284.
Santikarn M and others (eds), 'Emissions Trading Worldwide: Status Report 2019' (1st edn, ICAP 2019) <https://icapcarbonaction.com/en/?option=com_attach&task=download&id=625> accessed 2 December 2019.
Tang R and others, 'Key Challenges for the Establishment of the Monitoring, Reporting and Verification (MRV) System in China's National Carbon Emissions Trading Market' (2018) 18(S1) Climate Policy 106.
Tiche, FG, Weishaar, SE and Couwenberg, O, 'Carbon Leakage, Free Allocation and Linking Emissions Trading Schemes' (2014) 8(2) Carbon & Climate Law Review 97.
Tietenberg T, 'Transferable Discharge Permits and the Control of Stationary Source Air Pollution: A Survey and Synthesis' (1980) 56(4) Land Economics 391.
Tietenberg T and others (1999), 'International Rules for Greenhouse Gas Emissions Trading: Defining the Principles, Modalities, Rules and Guidelines for Verification, Reporting and Accountability' (1999 United Nations Conference on Trade and Development) <https://unctad.org/en/docs/pogdsgfsbm6.en.pdf> accessed 2 December 2019.
Trexler M, Broekhoff DJ and Kosloff LH, 'A Statistically-Driven Approach to Offset-Based GHG Additionality Determinations: What Can We Learn?' (2006) 6(2) Sustainable Development Law & Policy 30.
Tuerk A and others, 'Linking Carbon Markets: Concepts, Case Studies and Pathways' (2009) 9(4) Climate Policy 341.
UNEP, *Emissions Gap Report 2018* (1st edn, United Nations 2018).
Weishaar SE, 'CO_2 Emission Allowance Allocation Mechanisms, Allocative Efficiency and the Environment: A Static and Dynamic Perspective' (2007) 24(1) European Journal of Law and Economics 29.
Weishaar SE, *Emissions Trading Design: A Critical Overview* (1st edn, Edward Elgar 2014).
Weitzman M, 'Prices Versus Quantities' (1974) 41(4) Review of Economic Studies 477.
Woerdman E, 'Emissions Trading and Transaction Costs: Analyzing the Flaws in the Discussion' (2001) 38(2) Ecological Economics 293.
Woerdman E, 'Emissions Trading' in Backhaus JG (ed), *Encyclopedia of Law and Economics* (1st edn, Springer 2014).
Woerdman E, 'The EU Greenhouse Gas Emissions Trading Scheme' in Woerdman E, Roggenkamp MM and Holwerda M (eds), *Essential EU Climate Law* (1st edn, Edward Elgar 2015).
Woerdman E, Arcuri A and Clò S, 'Emissions Trading and the Polluter-Pays Principle: Do Polluters Pay under Grandfathering?' (2008) 4(2) Review of Law and Economics 565.
Wood P and Jotzo F, 'Price Floors for Emissions Trading' (2011) 39(3) Energy Policy 1746.
Xu G and Faure MG, 'Explaining the Failure of Environmental Law in China' (2016) 29(2) Columbia Journal of Asian Law 1.
Zeng Y, Weishaar SE and Couwenberg O, 'Absolute vs. Intensity-based Caps for Carbon Emissions Target Setting: A Risk Linking the EU ETS to the Chinese National ETS?' (2016) 7(4) European Journal of Risk Regulation 764.
Zeng Y, Weishaar SE and Vedder HB, 'Electricity Regulation in the Chinese National Emissions Trading Scheme (ETS): Lessons for Carbon Leakage and Linkage with the EU ETS' (2018) 18(10) Climate Policy 1246.