Towards a global price on carbon: Pathways for linking carbon pricing instruments

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Authors
Constanze Haug, Michel Frerk and Marissa Santikarn (adelphi)

The authors, who also work for the Secretariat of the International Carbon Action Partnership (ICAP), have written this report in their personal capacity; it in no way represents the collective views of ICAP or its members.

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Background report to inform the G7 process

Executive Summary

Climate change is one of the greatest challenges humanity is facing. Limiting risks from climate change urgently requires a comprehensive and ambitious global response. The German government has made carbon pricing a climate policy priority for its G7 presidency in 2014-2015. This report aims to support this process by examining pathways towards globally converging carbon prices in the medium to long term, with a view to facilitating strong climate action.

Carbon pricing enables ambitious climate policy. Direct carbon pricing, through emissions trading systems (ETSs) or carbon taxes, is more cost-effective than regulatory policies. Emitters can choose how to reduce their carbon footprint, enabling them to seek out the most cost-effective mitigation options. By making abatement financially profitable, a carbon price also provides an incentive to reduce emissions beyond a given target. This triggers private sector resources and investment in emissions reduction strategies and technologies. Finally, by fostering mitigation at the least cost to the economy, carbon pricing helps governments set ambitious reduction targets.

Carbon pricing is spreading. By 2015, already 40 countries and over 20 subnational jurisdictions on five continents had put a price on carbon. National and subnational governments in the G7 have pioneered carbon pricing, and other parts of the world, including emerging economies, are following suit. When a national Chinese ETS is established in 2016, it will surpass the European ETS as the world's largest carbon market.

Linking systems makes mitigation more cost-effective and levels the playing field for business. In a world that is trending towards a bottom-up climate regime, linking carbon pricing systems is key to connecting fragmented policy efforts. It further increases the flexibility and cost-effectiveness of market-based mitigation and reduces the risk of carbon leakage. Linking creates room for more climate ambition, enables leadership and enhances the political stability of the combined system.

Linking is possible between heterogeneous climate policy instruments. This report explores three scenarios for globally converging carbon prices: An ETS-only scenario, an ETS-tax scenario, and a scenario where ETS and taxes co-exist and collaborate with regulatory systems. ETS-only and ETS-tax-linking could come about through the direct exchange of units between systems, or indirectly through the use of emissions-reduction credits from a common third system. Linking with a regulatory regime would not involve unit flows, but rather price harmonisation through political coordination; the latter is also an option for linking an ETS with a carbon tax.

Linking ETS delivers the greatest benefits and is the only plausible scenario to lead to a single carbon price. ETS-only linking maximises gains in cost-effectiveness since it allows for the unlimited exploitation of abatement opportunities across the linked system. Unrestricted linking between ETSs would also result in a single price on carbon for all covered entities, with carbon leakage concerns effectively eliminated inside the carbon market. Direct linking requires key design features to be harmonised across systems, which may be politically challenging. Yet this scenario may still be more feasible than the alternatives since it would not require the constant adjustment of price levels post-linkage.

Linking ETSs with carbon taxes or with regulatory instruments is challenging but may still generate significant rewards. In order to link ETS and carbon taxes, parties need to agree on a price band, in addition to harmonising the design of both measures. Linking with regulatory regimes requires coordination of explicit and implicit carbon prices. Given the difficulties of comparing prices from ETSs and carbon taxes with implicit carbon prices arising from regulatory policies, this scenario is politically the most challenging. However, such heterogeneous linking would still generate benefits in terms of cost-effectiveness and reducing carbon leakage.

Political leadership and mutual trust are prerequisites for linking. As carbon pricing systems start collaborating, one or more carbon pricing hubs or standard-setting groups of countries may emerge. Linking processes in this context could take several forms, for instance, moving from political coordination to unrestricted mutual acceptance of units over time. Key to the success of linking is mutual trust among parties through an ongoing process of political dialogue and cooperation pre- and post-linking. A common framework for accounting and tracking units, and robust monitoring, reporting and verification (MRV) standards by the United Nations Framework Convention for Climate Change (UNFCCC) would facilitate the linking process.

The G7 group of countries is uniquely positioned to push for ambitious carbon pricing policies. Building on the efforts undertaken so far at home, G7 members should continue to promote carbon pricing and, if appropriate, scale up to the national level. At the international level, the G7 should campaign for a market-compatible and ambitious outcome at the UN climate summit in Paris at the end of 2015, which provides a basic framework for the effective future coupling of carbon markets, while avoiding any language that would impede or preclude linking efforts.

Strengthening international collaboration and dialogue on carbon pricing and linking is key to building a global carbon market. A voluntary platform bringing together G7 members and other major emitters could provide an appropriate venue for a high-level strategic dialogue on pathways towards a global carbon market. Deliberations on carbon pricing could also be taken forward in the G20 process. The G7 should further lend political support to the ongoing technical work on carbon pricing and linking in the context of the International Carbon Action Partnership (ICAP) and the World Bank's Partnership for Market Readiness (PMR).

Scope and objectives of this report

Climate change has been described as the greatest 'market failure' humanity has ever seen. To effectively address it, a comprehensive and ambitious global response is urgently needed to move the world on a path towards decarbonisation. Delays in taking action will make it increasingly difficult to meet the 2°C objective and will raise climate risks. Thus, there is a **strong case for implementing market-based policies that put a price on carbon** and enable climate targets to be met at the lowest cost to the economy.

In the longer term, **the key to a successful and cost-effective global climate policy will be to connect carbon pricing instruments** around the world, in order to further increase the cost-effectiveness of mitigation measures and level the global playing field for business. The German government has made **carbon pricing and markets a climate policy priority for its G7 presidency** in 2014-2015. The G7 group of countries – consisting of Canada, France, Germany, Italy, Japan, the United Kingdom (UK), and the United States (U.S.) – has previously assumed leadership on climate change and endorsed the need for a strong outcome at the UN climate conference in Paris in December 2015.

The aim of the present report is to support the discussion on carbon pricing and markets in the G7 by examining **pathways** to **how carbon pricing instruments could lead to globally converging carbon prices in the medium to long term**. This process would need to be supported by a harmonisation of carbon markets. The report proceeds as follows: the first sections will outline the rationale for global carbon pricing, lay out how the G7 have pioneered such policy approaches, and describe how these have recently proliferated around the world. Three scenarios will then describe different pathways towards globally converging carbon prices and discuss their advantages and drawbacks, including their functional and institutional requirements. Conclusions and recommendations for action for the G7 follow.

The rationale for global carbon pricing

Pricing carbon is the most effective way for countries to fight climate change. An adequate price on carbon ensures that emitters bear the cost of their actions. Market-based policies address the market failure of climate change by making emitters include the cost of greenhouse gas (GHG) emissions into their decision-making process. They receive an incentive to either reduce their emissions, or pay for them. Thus, with a carbon price, the costs of fighting climate change are borne by those responsible instead of being wholly passed on to future generations.

Carbon pricing is cost-effective. The costs for mitigating climate change vary considerably across emission sources. Market-based instruments provide flexibility to emitters in choosing how they will reduce their carbon footprint and enable them to seek out the most cost-effective options.

A price on carbon facilitates ambitious climate action. By making abatement measures financially rewarding, a carbon price gives emitters an incentive to reduce emissions beyond a given target. This triggers private sector resources and investment in emissions-reduction strategies and technologies. By fostering mitigation at the least possible cost to the economy, carbon pricing helps governments set ambitious reduction targets. It also has the potential to generate a substantial amount of climate finance.[1]

There are different ways to price carbon. Countries can choose the carbon pricing instruments that best suit their circumstances. An explicit price on carbon can be established directly via emissions trading or a carbon tax. Regulations and standards create an implicit price on carbon (see Box 1), though explicit pricing has generally been found to be more cost-efficient (IPCC, 2014). While negotiations on a global post-2020 climate regime continue, governments at different levels, from cities to nation states and even regional organisations, are already taking market-based action on climate change. By refining their policy instruments over time, they will contribute to a better carbon pricing toolbox.

An emissions trading system (ETS) imposes a cap on overall emissions in covered sectors. In order to produce a unit of GHG, emitters must hold an emission allowance, which is issued via free allocation and/or auction by the regulators and can be traded freely on the market. The price for allowances results from trading on the marketplace.

A carbon tax imposes a price per unit of emitted GHG. The government sets the tax rate, i.e., the explicit carbon price, ideally at a level that matches the marginal social cost of emissions, or the external cost of damages resulting from each additional unit of emissions.

Regulatory approaches aim to reduce GHG emissions through provisions that prohibit/permit and ultimately punish pollution (e.g., emissions standards, technology-based mandates or portfolio standards). Regulations give rise to an implicit carbon price facing emitters as they comply with the regulation.

Box 1. Key options for direct and indirect carbon pricing.

Working towards a global carbon market increases the benefits of carbon pricing. A global approach to carbon pricing minimises the cost of climate mitigation. By exploiting a larger range of abatement options, an integrated global carbon market may allow for an additional 40-50% reduction in GHG emissions at the same cost (Lazarowicz, 2009) compared to domestic-only abatement.

A global carbon market levels the playing field and creates room for more climate action. The gains in cost-effectiveness through linking carbon pricing instruments enable countries to establish more stringent policies and make room for more ambitious climate action. A carbon market covering all major emitters in a global economy based on free trade also reduces competitiveness concerns and the risk of carbon leakage. Finally, in a trading-based policy context, more participants benefit from a more liquid market with diminished price volatility. Based on their level of development, countries can participate in a variety of ways in the global carbon market, and can move towards deeper engagement over time.

[1] When carbon pricing systems allow participants to meet part of their compliance obligation through emission reduction credits from developing countries, they may give rise to significant financial flows to the global South, helping build momentum for ambitious global climate action.

The G7 as carbon pricing pioneers

Over the past few years, more and more countries around the world have started implementing carbon pricing instruments, helping to make polluters pay for the cost of their actions. **G7 members have pioneered carbon pricing measures at (supra-)national and subnational levels** and their initiative has been instrumental in its proliferation to other countries and parts of the world (see next section).

The European G7 members: France, Germany, Italy and the United Kingdom

The EU is home to the world's largest carbon market: the **EU ETS**. Covering 45% of EU emissions and over 11,500 industrial facilities and power plants, it is also the EU's main instrument to reduce GHG emissions. The EU ETS operates in the 28 EU countries as well as in Iceland, Liechtenstein and Norway, and the EU is currently negotiating a link with Switzerland. EU leaders and the European Commission are working on a structural reform of the system to address the present oversupply of allowances following the global economic crisis. The proposed 'Market Stability Reserve' (MSR) – the details of which are presently being discussed – will not only reduce the current surplus of allowances and subsequently strengthen the ETS price signal, but also help control extreme supply-and-demand fluctuations in the future. All four European G7 members support the structural ETS reform through the MSR.

The **UK** and **France** have, in addition to the EU ETS, also implemented carbon taxes. France introduced a carbon-content-based levy on coal, heavy fuel oil and natural gas in 2014, which increased from EUR 7/tCO_2 in 2014 to EUR 14.50/tCO_2 in 2015, and will rise to EUR 22/tCO_2 in 2016. French companies participating in the EU ETS are exempted from the tax. The UK implemented a climate-change levy on electricity, gas and fossil fuels in the industrial, commercial, agricultural, and public sector in 2001. Through its carbon price floor, the UK also introduced a charge applicable to electricity generators, topping up the allowance price under the EU ETS. The price floor was set to rise to GBP 30 (EUR 39) by 2020. However, the British government announced in 2014 that it would be capped at GBP 18 (EUR 23.50) from 2016 to 2020 in light of the low prices on the European carbon market.

United States

Carbon pricing is the subject of significant attention at the U.S. federal level. A number of bills proposing the implementation of a national carbon tax or ETS have been introduced in the U.S. Congress over the years, but failed to reach a majority in both the U.S. Senate and House of Representatives. In the meantime, states have taken significant climate action and are leading the way on emissions trading. **California** launched its ETS in 2013 and formally linked it to the Québec ETS in 2014. **The Regional Greenhouse Gas Initiative (RGGI)**, an ETS involving nine Northeast and Mid-Atlantic states, covers emissions from the power sector and reinvests the revenue into clean energy programms. Moreover, the U.S. Environmental Protection Agency (EPA) released its draft 'Clean Power Plan' in June 2014, which calls for the introduction of state-wide emission intensity targets for electricity production. Interest in carbon markets may grow as a result as states debate about how to comply with the regulation.

Canada

As in the United States, carbon pricing in Canada takes place at the subnational level. In addition to the linked **California-Québec** system, **British Columbia** has a successful, revenue-neutral carbon tax of USD 30/tCO_2e, which has been in place since 2008, and is also working with a number of American states as part of the Pacific Coast Collaborative. **Alberta** also has a baseline-and-credit system for large final emitters. Considering the current interest in carbon pricing in other provinces, including **Ontario**, 80% of Canada's national emissions could be covered by carbon pricing instruments by 2016.

Japan

Japan relies on a variety of carbon pricing mechanisms to address climate change. In 2012, the country introduced a revenue-neutral carbon tax, which is currently set at JPY 289/tCO_2 (EUR 2.25). It covers 70% of the country's GHG emissions and applies to the use of all fossil fuels, based on their CO_2 emissions factors. Japan has also considered emissions trading; its Voluntary Emissions Trading Scheme (JVETS) was a pilot system promoted by the government and ran from 2005 to 2014. In the meantime, emissions trading has gained ground on the subnational level in Japan. The **Tokyo** Cap-and-Trade System was the world's first city-level system and addresses emissions from large buildings and industry. Recently, Tokyo linked its system to the neighbouring prefecture of **Saitama**. Finally, Japan is working on further developing its international offset system, the bilateral Joint Crediting Mechanism (JCM).

The international proliferation of carbon pricing

From the pioneering jurisdictions within the G7, **carbon pricing is spreading around the world** (see Figure 1 below). The cumulative value of the world's emissions trading markets alone was EUR 45 billion in 2014 and is expected to grow to almost EUR 70 billion in 2015 (Commodities Now, 2015). Jurisdictions currently operating an ETS represent about 40% of global GDP (ICAP, 2015). Looking at carbon pricing more broadly, by 2014, around 40 countries and over 20 subnational jurisdictions on five continents had put a direct price on carbon, covering around 12% of annual global GHG emissions (World Bank, 2014). Counting those jurisdictions that are currently developing or considering carbon pricing mechanisms, the share of covered emissions rises to more than half of global GHG emissions in 2015.

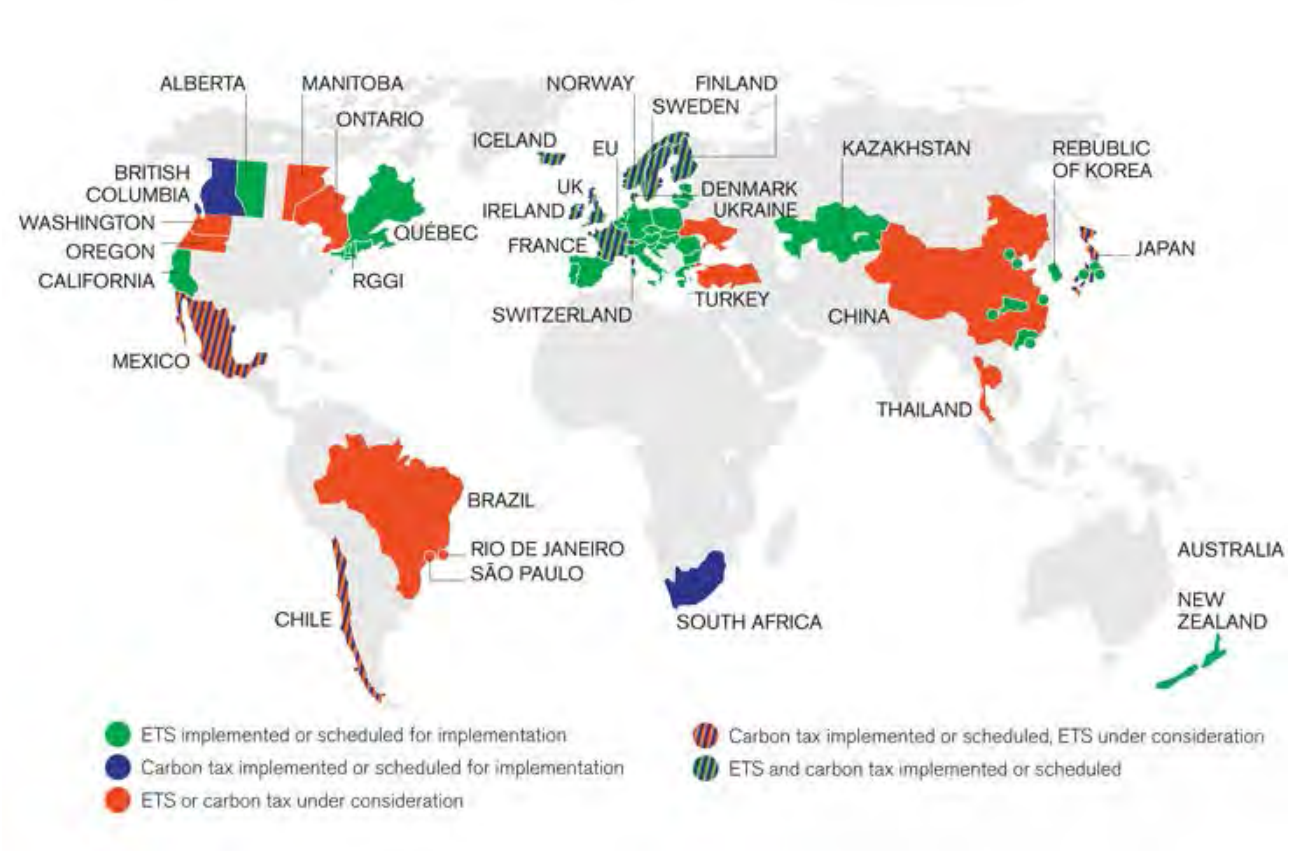

Figure 1. Carbon pricing policies implemented and under consideration (adapted from World Bank, 2014).

Carbon pricing leaders illustrate the flexibility of the policy instrument. While they share a commitment to climate action, jurisdictions leading the way on carbon pricing vary in terms of their economic and emissions profiles, and in the relative size of their economies. Together, they demonstrate that carbon pricing instruments can be designed to suit a variety of political and economic contexts, and can go hand in hand with robust economic development. Taking the example of emissions trading, such systems currently operate on the continental scale in the EU, on a national level such as Kazakhstan, and in megacities like Tokyo. They operate in economies that rely on heavy industry, have advanced service sectors, or even extensive forestry and agricultural sectors.

Carbon pricing is a global phenomenon. While carbon pricing started out in Europe and North America, Asia is fast establishing itself as a new hub, with nine ETSs and a national carbon tax launched over the past three years. **China** in particular is making rapid strides in transitioning from its seven regional ETS pilots to a nation-wide ETS, which would represent the world's largest carbon market in terms of emissions coverage, surpassing the EU. The gradual establishment of a national Chinese carbon market was first announced in China's 12th Five-Year Plan. Recently, Chinese officials confirmed 2016 as the planned start date. The National Development and Reform Commission (NDRC) designated seven cities and provinces as pilot ETS in China, which started operation in 2013 and 2014. While some design features were fixed, the pilots were at liberty to experiment with other elements of their systems, gathering valuable experience ahead of the launch of the national ETS. The NDRC published the interim measures for the national system at the end of 2014, establishing the basic design features and the distribution of responsibilities between the national and provincial levels. Further legislation by the State Council will follow in the course of 2015.

Also in Asia, the **Republic of Korea**, the member of the Organisation of Economic Co-Operation and Development (OECD) with the highest emissions growth rate, started emissions trading at the beginning of 2015. The Korean ETS covers 525 business entities from 23 sectors, accounting for about 66% of national emissions. With a three-year cap of 1.687 billion tCO_2e, it is the second largest carbon market after the EU. **Kazakhstan** started Asia's first national ETS in 2013. The Kazakh government continues to work on improving the regulatory basis of the system, which primarily addresses emissions from the energy and industrial sectors. Other rapidly growing economies like **Thailand** and **Vietnam** are already engaging in or considering market-based climate change mitigation.

Carbon pricing also remains a pertinent political issue in Oceania. **New Zealand** introduced an ETS in 2008, which initially only covered forestry and later expanded to other economic sectors including energy, industry and waste. The system, which will undergo a scheduled review in 2015, currently covers about half of the country's emissions. Carbon pricing also remains on the political agenda in **Australia**. While the current government abolished Australia's Carbon Pricing Mechanism in 2014, the main opposition party intends to campaign for the (re)establishment of an ETS in the run-up to the 2016 elections.

In **Latin America**, Costa Rica, Chile and Mexico have established themselves as carbon pricing frontrunners. **Costa Rica** has taxed carbon pollution since 1997, at a rate of 3.5% of the market value of fossil fuels. Tax revenues flow to a domestic payment-for-environmental-services programme. Chile implemented a carbon tax targeting the power sector as part of a comprehensive tax reform in 2014. Generators operating thermal plants with installed capacity equal to or larger than 50 megawatts (MW) are subject to a tax rate of USD 5/tCO_2 (EUR 4.71) emitted. **Mexico**'s carbon tax, introduced in 2014, covers fossil fuels sales and imports, and is set at approximately USD 3.5/tCO_2e (EUR 3.30). Liable companies may use offsets to fulfil

their obligations. In parallel, the Mexican government is also considering emissions trading. Last but not least, **Brazil** is exploring market-based climate mitigation, through a tax or an ETS.

Several European non-G7 members also have carbon taxes, including **Denmark, Finland, Iceland, Ireland, Norway, Sweden** and **Switzerland**. In these countries, carbon taxes complement the EU ETS by establishing a carbon price that in most cases applies to sectors and firms not covered by emissions trading, such as liquid fossil fuels for transport and heating. **Switzerland** also has an ETS, which became mandatory in 2013, and covers 11% of national GHG emissions. **Ukraine**, by contrast, has committed to developing a national ETS in its Association Agreement with the EU. Finally, **Russia** is currently exploring options to meet its GHG emissions reduction target of at least 25% below 1990 levels by 2020. In April 2014, the Russian government adopted a Climate Change Action Plan which outlines steps and choices on climate action for Russia, starting with the development and introduction of a system for MRV at the company level.

A carbon tax is also the intended instrument of choice in **South Africa**, which will be the first African nation with a carbon pricing mechanism when its carbon tax, set at ZAR 120/tCO_2e (EUR 9.20) and increasing 10% annually, takes effect in 2016. However, tax-free thresholds of 60% to 90% would apply to all participants. The carbon tax will cover an estimated 80% of total GHG emissions. Companies may also use offsets to partly reduce their tax liability.

As the previous sections demonstrate, **carbon pricing has become a global phenomenon**. The momentum for market-based climate action at different levels is growing, **making the vision of global carbon pricing and pathways to get there all the more relevant**. The policy scenarios below illustrate that the **G7**, with their wealth of experience on carbon pricing and their potential for thought leadership at the international level, **is uniquely placed to push for ambitious market-based action** in the fight against climate change **and to help pave the way towards a global carbon market.**

Three scenarios towards converging global carbon prices

There is widespread consensus that a strong and sustainable carbon price signal for all emitters is key to global decarbonisation. For a long time, the **UNFCCC process** operated under the expectation that first industrialised countries and later also other nations would take on binding emissions reductions and stabilisation commitments that would enable the international community to reach its collective goal of keeping climate change below dangerous levels. The Kyoto regime did not prescribe specific policy instruments for countries to reach their targets, but created an international framework for verification and accounting, enabling the transfer of emission units between Parties to the Kyoto Protocol. It also developed international standards for offset credits through the Clean Development Mechanism (CDM) and Joint Implementation (JI). More recently, negotiations on a future climate regime have moved away from a harmonised top-down structure towards a more decentralised, nationally-determined approach to defining countries' commitments and instruments for climate action. This shift increases the relevance of

bottom-up linking of countries' climate policies. By lowering mitigation costs, showing political leadership and building trust, linking will be instrumental to ratcheting up climate ambition at the international level.

Against the backdrop of an increasingly bottom-up international climate regime, the following sections outline **three scenarios** describing how carbon pricing policies across the world could be linked in the medium to long term. For the purpose of this study, **linking is defined as a way of connecting policies with the aim of harmonising carbon prices**. While a single truly global price on carbon would be theoretically the most cost-effective way to reduce emissions, this may rather be a long-term vision, given the existing differences in economic conditions between countries and the variety of instruments presently in use. In the medium term, it is more relevant to explore the convergence of carbon prices at the global level. The following three scenarios pursue this objective.

The **first scenario** describes a world where emissions trading has emerged as the dominant instrument for carbon pricing and where a global carbon market would emerge through the gradual linking between individual systems (**'ETS-only'**). In the **second scenario**, we explore options for heterogeneous linking between ETSs and carbon taxes (**'ETS-tax'**). The **third scenario** looks at a world where market-based and regulatory regimes co-exist (**'ETS-tax-regulatory'**).[2] Figure 3 at the end of this section illustrates the key options for linking under each scenario.

The following sections analyse these scenarios and discuss their specific challenges, as well as possible ways to address them. In a next step, the scenarios are assessed on the basis of the following criteria: the potential for the emergence of a single carbon price; environmental effectiveness; cost-effectiveness; distributional effects; risk of carbon leakage; and political feasibility.

Scenario 1: Linking between ETS ('ETS-only')

Since the launch of the first ETS for GHGs in 2005, emissions trading has spread rapidly around the world. This first scenario examines a world in which emissions trading is the dominant policy instrument to fight climate change. **Linking among ETSs refers to the acceptance of allowances and emissions-reduction credits from other systems for compliance in one's own.** Links between existing ETSs have already been proposed and established on subnational and national levels, such as the bilateral link between California and Québec and the link currently being negotiated by the EU and Switzerland. In this scenario, **more links would gradually emerge between jurisdictions implementing an ETS, forming one or several ETS 'hubs'**. This hub, or series of hubs, would continue to expand, eventually resulting in a global unified carbon market with a single price on carbon. Other jurisdictions would be encouraged to adopt emissions trading in order to gain access to the advantages of market-based emissions abatement in a large, liquid market. In the meantime, ETS aspirants could participate in the global carbon market through crediting approaches, and thereby build the necessary infrastructure and experience for the gradual transition to their own ETS.

Linking ETSs could take two basic forms: Direct and indirect (see Figure 2 below). Direct linking would involve the recognition of allowances from one ETS for compliance in another. This recognition can be **one-way** (i.e., unilateral), where **only one system accepts allowances from the other**, or **two-way** (i.e., bilateral or multilateral), **where both systems accept each other's allowances**. In a one-way link, if the system that accepts the allowances has a higher carbon price, prices will converge at an intermediate level

[2] Theoretically, a globally harmonised system of carbon taxes would also be possible. However, given the political difficulties of international tax harmonisation (Rosenbloom et al., 2014), this option has not been elaborated in this report.

between the two systems. However, if the system that accepts the allowances has a lower carbon price, no inter-system trading will occur as there will be no incentive to do so. The precise impact of a unilateral link depends on the price, design and relative sizes of the linked systems.

In a **two-way link**, the **prices of allowances in both systems will equalise** as a result of the free flow of allowances in both directions. **In order to link, key design elements** of both systems, such as offset and price-containment provisions, as well as the stringency of the MRV systems **need to be harmonised** (Flachsland et al., 2009; Ranson & Stavins, 2013). Where design harmonisation is not possible or undesirable, restrictions on cross-border unit flows, in the form of quantitative limits (e.g., on the number of eligible allowances from the other system), qualitative restrictions (e.g., a ban on certain external credits), or an exchange rate may be a solution. Such limits would however restrict the efficiency gains of linking (Jaffe & Stavins, 2007).

Systems can also **indirectly link if they are connected via the same 'third' system**, for instance **a crediting mechanism**. As a result, both systems compete for credits in the third system. If the price of credits is lower than the price in each of the indirectly linked systems, this could lead to price convergence among all three systems, depending on quantitative limits on offsets. Indirect linking would require less effort in inter-system harmonisation, but could still deliver some of the cost-efficiency gains of direct linking.

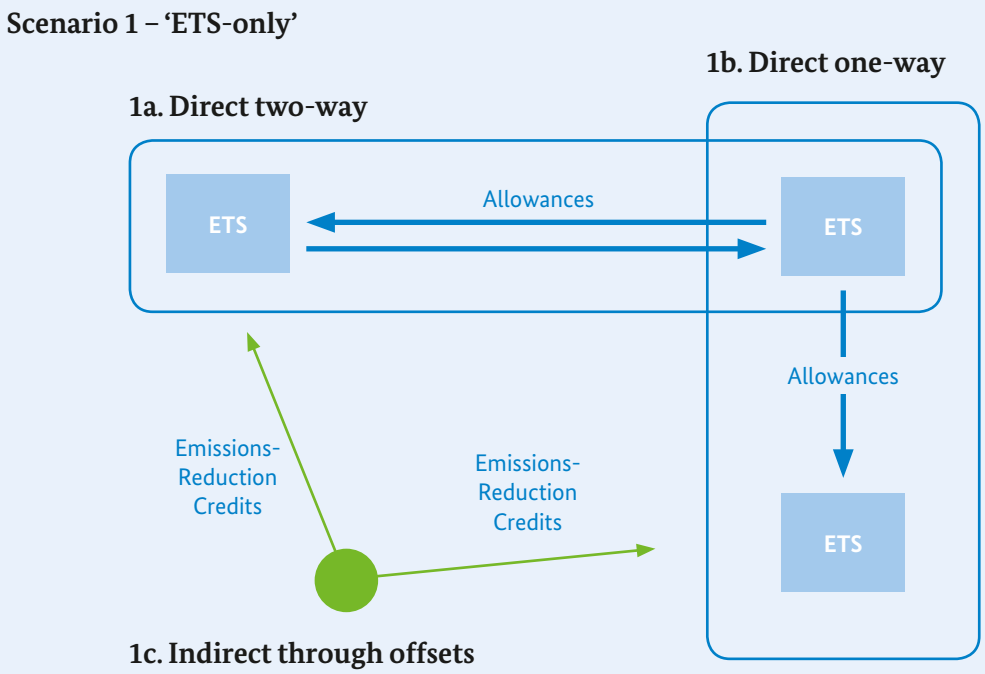

Figure 2. Types of linking in an ETS-only scenario.

Scenario 2: Linking ETSs and carbon tax regimes ('ETS-tax')

More and more countries are working towards the implementation of an ETS or a carbon tax. In this second scenario, we explore a world **where ETS and carbon taxes co-exist**. Here, **carbon prices** would not converge by the means of a market alone, but would **require political coordination** between governments.

In an ETS, prices are 'discovered' through allowance trading on the marketplace. Factors determining the allowance price include the ETS cap, the marginal abatement costs of covered sectors and other market conditions affecting supply and demand. By contrast, there is no such price discovery mechanism in a carbon tax regime where the government sets the tax rate. **Linking an ETS with a carbon tax therefore means connecting a system with a flexible market price to a fixed price.**[3]

Linking ETSs and carbon tax regimes can take various forms (see Figure 3).[4] Links can involve **direct or indirect exchanges of units**, and can be **one-way or two-way** (Bodansky et al., 2014; Metcalf & Weißbach, 2010). Moreover, harmonisation of carbon prices between an ETS and a tax may occur through political coordination without any flow of units between systems. **Both an ETS and a carbon tax can be designed to generate tradable units.** In an ETS, tradable units are a built-in feature. In a carbon tax system, companies could theoretically be allowed to pay more than their compliance obligation and receive tradable carbon tax credits in return. The government could also decide to allocate a number of carbon tax credits for free to compensate households or certain industries. Carbon tax credits in excess of one's own compliance needs could then be traded within the tax regime or with a different system such as an ETS.

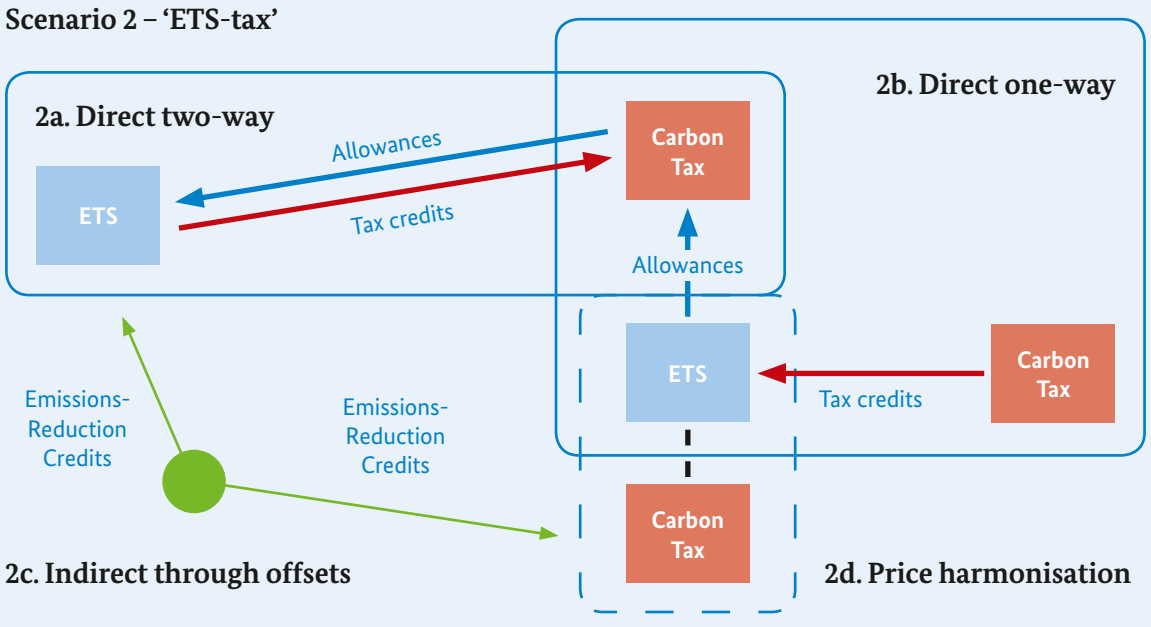

Figure 3. Types of linking in an ETS-tax scenario.

[3] The term fixed price here refers to the tax rate. The de facto price of compliance in the tax regime may however be flexible, for instance if cheaper ETS allowances could be used for compliance.

[4] See Metcalf & Weißbach (2010) for a more detailed discussion.

Direct linking between an ETS and a tax regime implies accepting units from the other system for compliance (see Figure 4). **Quantitative limits on the flow of units across systems seem to be the most plausible design option when directly linking ETSs and carbon tax regimes.** This is because the (possibly unlimited) acceptance of tax credits into an ETS could inflate its cap. Instead of resulting from the number of allowances, the carbon price in the ETS would approach the level of the tax rate, turning the ETS into a de facto carbon tax regime (Metcalf & Weißbach, 2010). Quantitative limits on allowance flows would also contain the budgetary impact of linking for both governments, where the use of ETS allowances under the tax regime or of tax credits under the ETS could reduce tax income or auctioning revenues. However, such limits would prevent full price harmonisation across systems.

As in the 'ETS-only' scenario, ETSs and carbon tax systems could also be **indirectly linked** if both accept the same type of units from another third party for compliance in their own system, for instance through a crediting mechanism. Indirect linking may lead to price harmonisation depending on the quantitative limits for offsets and the price relation between ETS allowances, tax credits and offset credits.

Price harmonisation through political coordination, where two or more governments decide to set a comparable price on carbon, is another option to achieve some of the benefits associated with linking systems. Some price coordination is also important when systems are linked through the exchange of units, as the tax rate and an eventual price band in an ETS would have a direct impact on the supply-and-demand balance between the two systems. The need for political coordination further increases if more than two systems agree to link. The complexity of repeated negotiation rounds to agree on a converging price path would likely require the establishment of a dedicated intergovernmental oversight process or body. It is conceivable that the challenges of continuous coordination may lead participating jurisdictions to switch from a carbon tax regime to an ETS or vice versa to facilitate future collaboration. Should ETSs prevail, scenario 1 would apply. Should there be a global trend towards carbon taxes, links would form by harmonising tax rates.

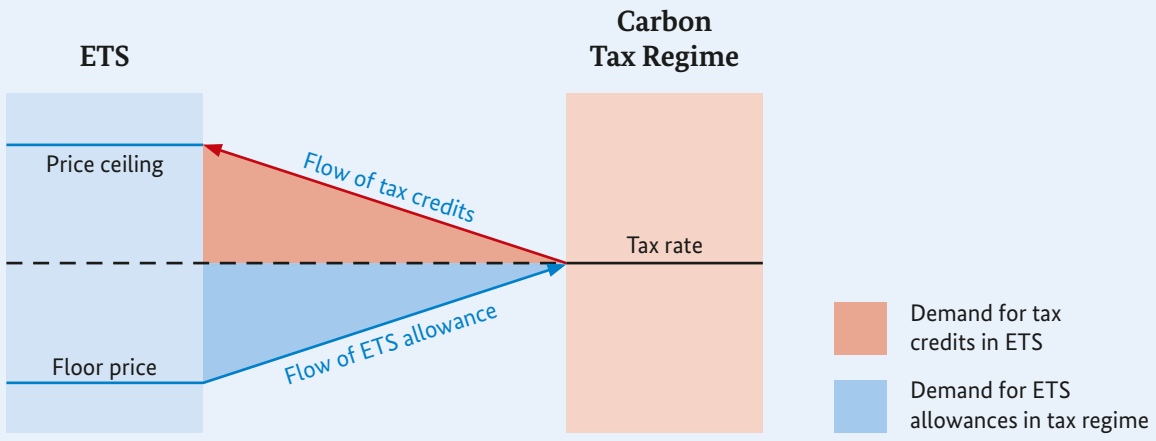

Figure 4. Trading demand between an ETS and a carbon tax regime. When the ETS allowance price is lower than the tax rate, allowances will flow to the tax regime until the price reaches the level of the tax. When the allowance price is higher than the tax, there will be demand in the ETS for the cheaper tax credits until prices for allowances and tax credits temporarily equalise.

Scenario 3: Linking ETSs and carbon tax regimes with regulatory approaches ('ETS-tax-regulatory')

Attempts at price harmonisation are also conceivable in a fragmented world of diverse climate policy regimes. This third scenario describes a world where jurisdictions attempt coordination across a variety of different carbon pricing instruments, including ETSs, carbon taxes, and regulatory measures. In contrast to direct carbon pricing instruments like ETSs or carbon taxes, regulatory measures do not price carbon explicitly. Instead, they result in an implicit 'shadow' price that emitters face as they comply with the respective provisions. **Harmonisation efforts between market-based and regulatory instruments will therefore most likely involve a political coordination process to agree on a desired implicit carbon price or price corridor, and iterative adjustments to the policy provisions in the involved jurisdictions** (see Figure 5). Most plausibly, such harmonisation efforts could be made in an attempt to level the playing field where different policy regimes apply to competing, trade-exposed industries.

Price coordination in such a scenario requires **estimating the implicit carbon price resulting from a regulatory measure**. Transparency and robustness of the methodology and the underlying data for calculating this implicit price are key to this endeavour. An international assessment or oversight body may provide an important contribution by elaborating appropriate methodologies or even conducting the full assessment (cf. OECD, 2013). In a second step, governments would then embark **on political consultations regarding the desired price level across all involved systems**. This process would require regular sessions to review price developments in the market-based systems and trends in the implicit price in the regulatory ones. If a review finds that prices in one or more systems are diverging from the agreed price band, the party concerned would be expected to adjust its policy accordingly, for instance by tightening the regulatory standards or by implementing price or quantity management measures in an ETS.

While price convergence through political coordination seems more plausible for this scenario, **linking could also be based on unit flows between a market-based system and a regulatory one**. The most likely would be a situation where companies could overachieve on regulatory standards, thereby earning emissions-reduction credits that they could then sell to participants in a market-based system. Such a link would be more straightforward for emissions-based standards or mandates than for intensity- or efficiency-based regulations, which would need to be converted to a fixed quantity standard before units could be issued (Metcalf & Weißbach, 2010).

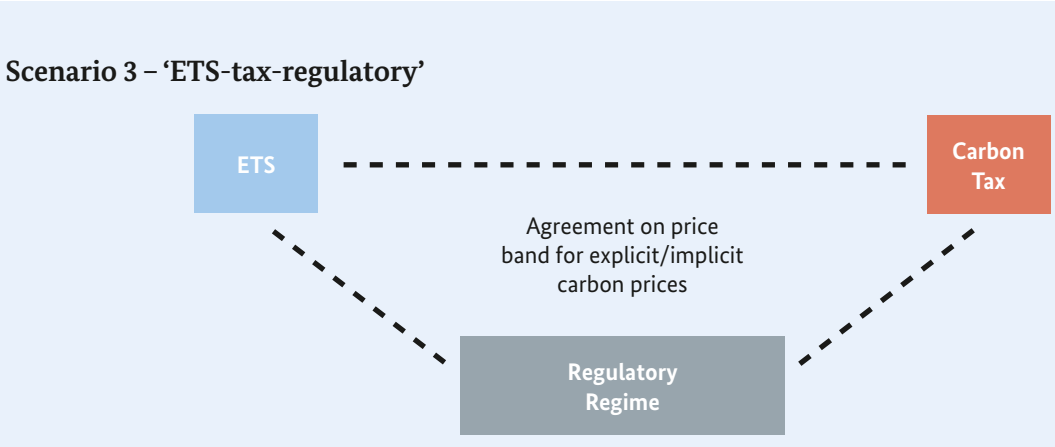

Figure 5. Linking in an ETS-tax-regulatory scenario.

Scenario assessment

The three scenarios developed here describe various options for converging carbon prices in worlds that use differing instruments for climate action. This section assesses these options according to a number of criteria. Table 1 summarises the main results; a more detailed discussion follows below.

	Scenario 1 **'ETS-only'**	**Scenario 2** **'ETS-tax'** (with quantity limits)	**Scenario 3** **'ETS-tax-regulatory'** (through price harmonisation)
Potential for the emergence of a single carbon price	• Fully linked: Yes • Restricted linking or indirect linking: Convergence but not full harmonisation	• No, price band	• No, price band, likely with more fluctuation than in Scenario 1 or 2
Environmental effectiveness	• Direct linking: depends on cap, MRV, enforcement rules and provisions to prevent double counting • Indirect linking through offsets: Also depends on the offset quality (additionality, etc.) and provisions to prevent double counting	• Direct linking: Depends on cap and level of tax rate, MRV, enforcement rules and provisions to prevent double counting • Indirect linking: Also depends on the offset quality (additionality, etc.) and provisions to prevent double counting • Price harmonisation without trading would have a slightly positive impact (due to reduced risk of leakage)	• Depends on design of pricing and regulatory instruments • Slightly positive effect due to reduced risk of carbon leakage
Cost-effectiveness	• Significantly increased • Direct linking most effective	• Increased • Direct linking most effective	• Effect depends on price level in relation to combined marginal abatement costs
Risk of carbon leakage	• Reduced • Indirect linking: less effective prevention	• Reduced • Indirect linking: Less effective prevention	• Reduced
Distributional effects	• Yes, extent depends on design and difference in pre-linking carbon prices	• Yes, extent depends on design and difference in pre-linking carbon price	• No effect
Political feasibility	• Direct linking: design harmonisation as key challenge, continued joint oversight necessary • Indirect linking: Easier	• Direct linking: Design harmonisation plus agreement on price band • Indirect linking: Easier	• Challenging: Continued adjustments likely to be politically highly demanding

Table 1. Anticipated impacts of plausible linking scenarios.

Potential for the emergence of a single carbon price

Comparing the three scenarios, **only a fully linked ETS-only scenario would lead to a single carbon price** applicable to all emitters at all times. In an ETS-only scenario with restricted unit flows, once limits on inter-system trading are triggered, a split market with a price differential would result. The same would be true for an ETS-only scenario where units from different systems are valued differently through an exchange rate.

An ETS-tax scenario would realistically always involve quantitative limits on cross-border unit flows. While the tax rate in the tax regime would remain fixed, prices for ETS allowances and tax credits would be left to fluctuate. In this scenario, carbon prices would converge as a result of linking, but no single carbon price would emerge. Finally, in scenarios without direct unit flows between systems, political coordination would plausibly aim to agree on a price band that allows for some degree of variation between the participating jurisdictions rather than a single carbon price.

Environmental effectiveness

In an ETS-only or ETS-tax scenario involving cross-border unit flows, the **environmental effectiveness** of the linked systems **depends on the stringency** of the ETS cap(s) and the tax rates, the effectiveness of measures to prevent double counting, the accuracy of MRV systems, and effective enforcement measures for compliance. In all three scenarios, when systems are linked indirectly through emissions-reduction credits from a third scheme, lacking additionality of emissions reductions or double counting may compromise environmental effectiveness.

In ETS-tax or ETS-tax-regulatory scenarios without unit flows, **political coordination**, provided it induces a 'race to the top' rather than the opposite, **may help strengthen the environmental effectiveness of all measures**.

Cost-effectiveness

Direct linking in an ETS-only or an ETS-tax scenario would increase cost-effectiveness by creating a larger market with more abatement options. In an ETS-only scenario, linking would also increase liquidity and reduce price volatility in the combined carbon market. While cost-effectiveness gains from linking would be highest when the pre-link prices between systems differ, such linking is politically difficult due to the resulting distributional effects (see below). There would be **no guaranteed gains in cost-effectiveness through price coordination without unit flows**.[5]

Risk of carbon leakage

Linking under all scenarios would significantly reduce the risk of carbon leakage, and would help level the playing field for companies operating across different regulatory contexts. The effect would be **greatest if systems** were **directly linked**, resulting in fully harmonised carbon prices. The impact of converging but not entirely harmonised prices or indirectly linked systems would accordingly be more limited.

[5] Effects in this regard depend on the extent to which the agreed price band reflects the combined marginal abatement costs of both systems.

Distributional effects

Direct linking in ETS-only and ETS-tax scenarios would have a distributional effect across regulated entities. For example, in an ETS-only scenario, net buyers in an ETS with the initially lower allowance price would 'lose out' from linking, having to pay more for allowances post-linking as prices converge across systems, whereas net buyers in the more expensive system would benefit. By contrast, net sellers in the system with initially lower prices would profit from linking whereas net sellers in the higher-price system would lose. Regardless of these effects the overall costs in the linked systems would always be lower than in the unlinked systems.

In an ETS-tax scenario where the tax rate is initially lower than the allowance price, net buyers in the ETS would benefit as they could use tax credits for compliance instead. Tax credit sellers would benefit from selling those credits.

Direct or indirect linking in all three scenarios could also result in shifts in government income from auctioning or taxes, with governments in systems with initially lower allowance prices or tax rates set to benefit. Both effects could be mitigated to some extent by imposing quantitative limits on the number of external units eligible for compliance.

Political price coordination alone, whether in an ETS-tax or ETS-tax-regulatory scenario would not give rise to any direct cross-border distributional effects. Yet there could of course be indirect effects insofar as (big) changes in relative carbon prices may inform investment decisions across borders.

Political feasibility

Any linking venture promises to be politically complex, but there is variation across the three scenarios. **In an ETS-only scenario, linking involves harmonising key design features** across all systems. Unless the ETSs were developed with linking in mind, this process likely involves significant challenges where the pre-linking design is based on hard-won domestic compromises. The same is true for a directly linked **ETS-tax scenario**. However, the relatively **more limited gains** from such linking and the **differing regulatory preferences** may make it even **more politically challenging**. Any direct ETS-tax link also requires the ETS in question to accept that the link with a tax regime effectively ties it to a price band.

The **political 'heavy lifting' in a directly linked ETS-only or ETS-tax scenario** will likely be required in the phase **preceding the link**. In an ETS-tax scenario without cross-border unit flows, the key issue at stake in the linking negotiations would not be design harmonisation, but agreement on a price path acceptable to all parties. Post-linking, continuous joint oversight would be necessary to safeguard the effectiveness and environmental integrity of the linked system.

In an **ETS-tax-regulatory scenario, in addition to reaching (initial) agreement on a price band**, the ultimate **challenge may lie in the permanent steering required to keep prices within this corridor**. Especially for the regulatory system, gaining domestic approval for adjustments to the regulatory measure based on an 'implicit price' argument could prove very difficult. This type of linking may be relevant for jurisdictions with competing, trade-exposed industries. Yet overall, it seems **more effective** to embed such consultations into a **broader discussion on mitigation ambition**, with prices facing emitters as one relevant variable.

Processes and institutions for linking carbon pricing instruments

Linking carbon pricing instruments, as described in the scenarios above, could follow different dynamics, and relevant tasks could be assumed by different institutions. **Geographic proximity, close economic ties and/or a history of policy coordination** are often cited in the literature on linking ETSs as **key aspects for countries considering a link** (Tuerk et al., 2009). The same presumably also holds for other types of linking between carbon pricing mechanisms. Over time, **cooperation between individual systems would likely lead to the emergence of one or several carbon pricing 'hubs'**. Aside from enjoying potentially larger, more efficient markets with a reduced risk of carbon leakage, the frontrunner jurisdictions forming the hub would also enjoy reputational benefits from displaying climate leadership. Finally, as first movers, they would be well placed to shape the design and priorities of the hub, as well as potential model rules for new entrants.

Figure 6 below depicts illustrative pathways for linking carbon pricing instruments. Linking up could occur around one core 'carbon pricing hub' that gradually attracts more and more parties to join in. The G7, given its economic weight and potential for global leadership, would be a natural core for such a hub. Alternatively, several hubs might form, for instance along geographical lines or 'comfort zones' for carbon price levels – which would probably need to be similar across the hub. Importantly, governments that are part of a hub would need to commit to refrain from introducing other policies that could offset the price signal of the ETS or the carbon tax.

Hubs could be homogeneous or heterogeneous in terms of instruments. An ETS-only hub is arguably the most likely to emerge as its benefits are most palpable, and such linking has already happened in practice (cf. the joint California-Québec system, and the ongoing linking negotiations between the EU and Switzerland). Over time, an ETS-only hub could start collaborating with independently operating carbon tax or regulatory systems, for instance where the economies are closely integrated. Alternatively, a hub could initially be made up of heterogeneous carbon pricing instruments. Close economic ties and competiveness concerns would again be a likely determinant for this to happen. With a view to increasing the cost-effectiveness of mitigation efforts, regulatory instruments and taxes in the hub might over time move to a trading-based system, following the example of the now-abolished Australian Carbon Pricing Mechanism that started out as a tax but was to transition into an ETS in 2015. Alternatively, the hub might move towards a common carbon tax base and rate. This would however be politically difficult to set up (consider attempts at tax policy harmonisation within the EU) and even harder to sustain as jurisdictions would in effect have to give up their right to determine tax policy, albeit in a limited area.

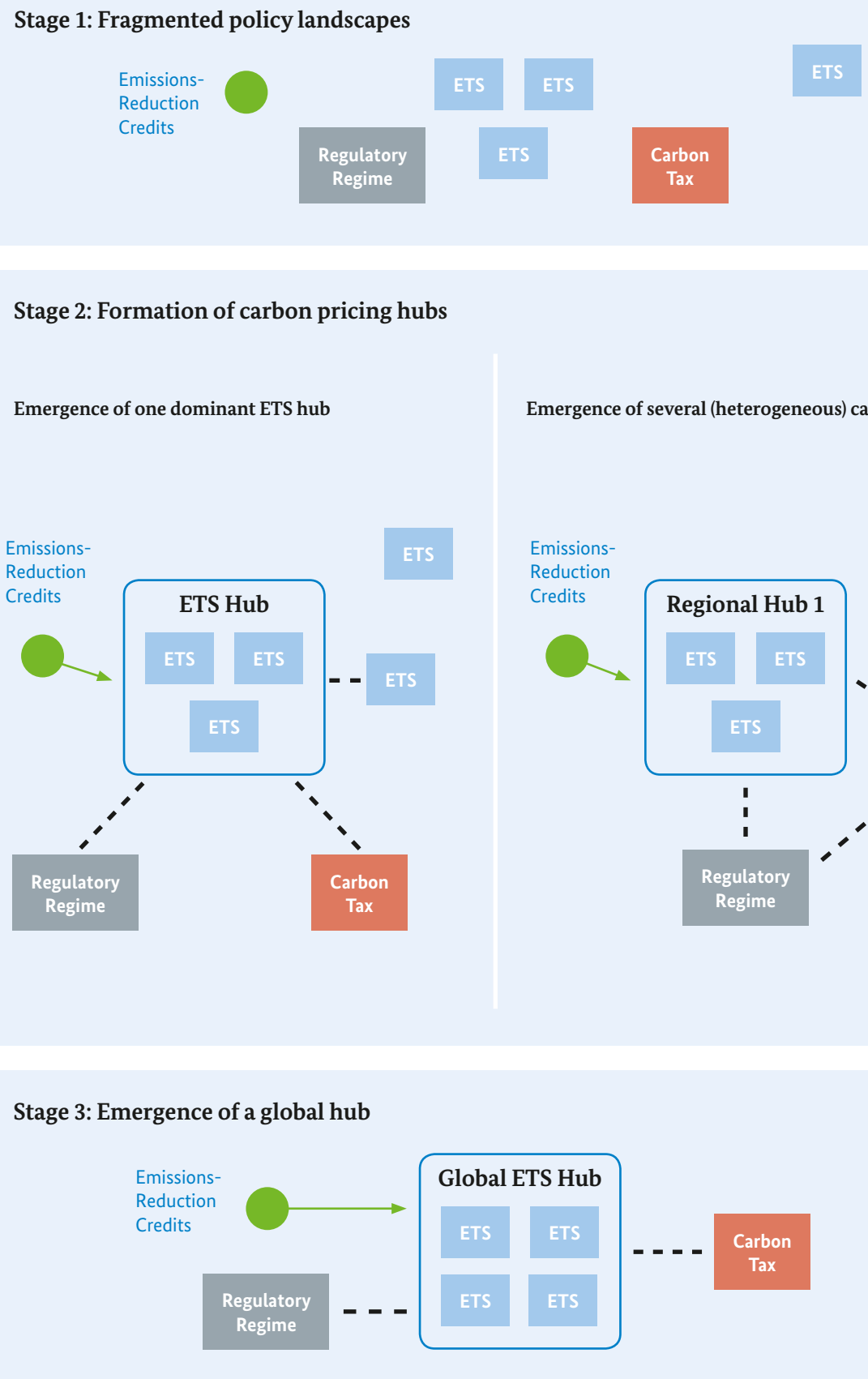

Figure 6. Pathways towards a global carbon pricing hub. For unit flows inside the hubs, see Figures 2 and 3.

Functional and institutional requirements for linking carbon pricing policies

Both the process leading up to a link and the management of a linked system have a number of functional and institutional prerequisites. Depending on the context, tasks could be assumed by different actors and entities:

- **Common accounting framework and definition of tradable units:** In any scenario involving unit flows, a common accounting framework and agreed definition of a tradable unit are key to avoid double counting when linking. Any provisions to this effect at the UNFCCC level would greatly facilitate future linking. Alternatively, such rules could be agreed on in a bilateral or multilateral setting, or be adopted from other international organisations or networks.
- **Standards for MRV, offsets and other key aspects of instrument design:** Comparably robust MRV standards are a precondition for any linking venture, trading-based or not. Again it would be useful if standards for MRV were defined by the UNFCCC. Minimum criteria or standards for other key design elements should however rather be agreed on in a dedicated intergovernmental setting, or proliferate from good practice in a dominant system. Both PMR and ICAP are conducting work in this area that may provide a useful basis for such efforts. Lastly, 'model rules' for linking that encompass these and other aspects would facilitate future linking negotiations; again, these could emanate from an intergovernmental setting like ICAP or be adapted from an international organisation like the OECD.
- **Market management and oversight:** Market management and oversight of a joint system would likely require a standing body to take over these tasks. For the linked California-Québec system, they are assumed by WCI, Inc., a private not-for-profit corporation. Alternatively, one could imagine an intergovernmental body or public entity providing such services to one or even to several carbon pricing hubs, based on their specific needs and requirements.
- **Assessment of implicit carbon prices:** This would be a precondition for linking in any ETS-tax-regulatory scenario. Comparing explicit and implicit carbon prices from regulatory measures would require the development of robust methodologies for estimating implicit prices and a trusted entity for conducting the assessments. An international organisation or body might be well placed to fulfil this task; however, a more bottom-up approach is also conceivable. Finally, regular 'ambition reviews' of the parties involved would likely take place in negotiations involving all participating governments.

Conclusions

The above discussion and analysis leads to the following conclusions:

Carbon pricing enables ambitious climate policy. Keeping the world on a trajectory that allows for limiting global warming to 2°C by 2100 requires a significant scale-up of global climate policy efforts. The size of the climate challenge does not leave room for inefficient policies. Market-based instruments like emissions trading and carbon taxes, which send a strong and sustainable price signal to emitters, have been shown to be most cost-effective by a wide margin. They provide flexibility to emitters, incentivise innovation and can generate substantial amounts of climate financing.

Carbon pricing is spreading. By 2015, 40 countries and over 20 subnational jurisdictions across five continents have already put an explicit price on carbon. National and subnational governments in the G7 have pioneered carbon pricing approaches, and other parts of the world, including emerging economies, are following suit. When a national Chinese ETS is established in 2016, it will surpass the EU as the world's largest carbon market. Big emerging emitters like the Republic of Korea and Mexico have also adopted carbon pricing instruments.

Linking systems increases the benefits of carbon pricing. In a world that is trending towards a bottom-up climate regime, linking carbon pricing instruments is key to connecting fragmented policy efforts. Linking further increases the flexibility and cost-effectiveness of market-based mitigation and levels the playing field for business. Linking is politically complex and requires a careful weighing of benefits and costs. Yet, ultimately it creates room for more climate ambition, enables leadership and enhances the political stability of the joint system.

Linking is also possible between heterogeneous climate policy instruments. Linking, when understood as the effort to harmonise carbon prices across different pricing systems, is theoretically possible not just between different ETSs, but also between ETSs and carbon tax regimes and even regulatory measures for emissions abatement. This report investigated three scenarios for converging carbon prices among major emitters in the medium to long term: An ETS-only scenario, an ETS-tax scenario, and a scenario where ETSs and taxes co-exist and collaborate with regulatory systems and where linking efforts are based on the estimated implicit carbon price of the latter. Different linking variants are conceivable under each of them, involving direct flows of units between systems or price harmonisation through political coordination.

An ETS-only linking scenario delivers the greatest benefits and is the only plausible scenario to enable a single price on carbon. Across the three scenarios, ETS-only linking yields the largest gains in cost-effectiveness as it allows for the unrestricted exploitation of abatement opportunities across the linked system. Unrestricted linking between ETSs also gives rise to a single price on carbon for all covered entities, which is most effective in reducing carbon leakage concerns. Given the difficulties of comparing explicit and implicit carbon prices and the differing political preferences for regulation, linking between market-based instruments (ETSs or carbon taxes) is more feasible than with regulatory regimes.

Linking can involve different processes and institutions. The institutional and functional requirements for a link to emerge depend on its type. A common MRV and accounting framework, joint definition of tradable units, standards for key design elements of carbon pricing instruments, 'model rules' for linking, oversight and management of the joint market and – for the ETS-tax-regulatory scenario – methodology and process for estimating implicit carbon prices are key aspects in this regard. While some functions are best fulfilled at the UNFCCC level, others can be assumed either by international organisations or networks or in smaller bilateral or multilateral settings.

Linking requires trust and political leadership. Linking processes may move through different stages (Burtraw et al., 2013), from political coordination to restricted and finally more comprehensive unit exchanges between systems. As carbon pricing systems start collaborating on a broader basis, this may lead to the formation of one or more carbon pricing hubs, which could be homogenous or heterogeneous in terms of instruments. To reap the full benefits of linking, a transition to emissions trading as the dominant instrument is desirable in the long term. Key to the success of linking is mutual trust among the parties involved, which requires an ongoing process of political dialogue and cooperation preceding and accompanying any actual link.

Recommendations for the G7

The G7 group of countries should consider the following actions to support the development of a sustained and robust global carbon market:

The G7 group of countries should take a leadership role on carbon pricing. In the medium to long term, G7 members and other major emitting economies should implement and further refine carbon pricing approaches. If appropriate, carbon pricing policies should be scaled up to the national level, potentially leading to a G7 carbon pricing hub. In the near term, G7 countries should strive to instil momentum on carbon pricing to the G20 process, which covers additional large emitting economies that already have a price on carbon or are considering it.

The G7 should campaign for a market-friendly and ambitious Paris outcome. In the long-term, ambitious climate action requires cost-effective joint mitigation efforts through linking of carbon pricing policies. To facilitate linking, the G7 should champion a Paris outcome that creates a basic infrastructure for effective future coupling of carbon markets and that avoids any language that would impede or preclude such efforts (Bodansky et al., 2014). In particular, G7 members should support an international climate agreement that entails the following elements:

- Parties should be allowed to meet INDCs by collaborating with other parties and by financing emissions-reduction activities in those countries.
- Mitigation contributions and actions should build on robust commonly agreed standards for MRV.
- The outcome should provide minimum standards for the definition of tradable units.
- Parties should develop a common accounting framework that enables transparent tracking of units and avoids double counting.

The G7 should raise momentum for carbon pricing through a strategic political dialogue. A voluntary political platform involving G7 members and other interested major emitting economies would be an appropriate venue for this. The platform would enable a high-level discussion on pathway towards a global carbon market and highlight members' commitment to ambitious long-term mitigation through carbon pricing, encouraging others to follow suit. The platform should collaborate with and build upon the work of other relevant actors where appropriate and initiate outreach activities with groups of interested countries.

The G7 should lend political support to the ongoing dialogue between existing ETSs and other carbon pricing instruments through forums like ICAP and PMR. As carbon pricing is spreading around the world, many governments are already cooperating at a technical level through organisations such as ICAP and PMR. The G7 should lend high-level political support to their efforts to exchange experiences and lessons learned on ETS and other carbon pricing instruments, and encourage them to develop standards for their design and as well as model rules for facilitating future linking. G7 members should also encourage ICAP and PMR to seek early dialogue with ETS/carbon pricing aspirants to ensure compatibility with a prospective global carbon market at an early stage.

The G7 should encourage international organisations like the OECD to initiate an assessment on existing and required carbon prices along the global pathway for decarbonisation. Insights into adequate carbon prices and pricing pathways that allow for the achievement of mitigation objectives would greatly facilitate the linking of different carbon pricing instruments. As an interim step to initiate such discussions, G7 members should support the development of methodologies for comparing implicit and explicit carbon prices, embedded into a larger dialogue on mitigation ambition.[6]

[6] For instance, building on early work by the OECD (OECD, 2013).

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Acronyms

CDM	Clean Development Mechanism
CO2	Carbon Dioxide
EPA	Environment Protection Agency
ETS	Emissions Trading System
EU ETS	European Emissions Trading System
EU	European Union
EUR	Euro
G7	Group of 7
G20	Group of 20
GHG	Greenhouse Gas
ICAP	International Carbon Action Partnership
INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
JCM	Joint Crediting Mechanism
JI	Joint Implementation
JVETS	Japan Voluntary Emissions Trading Scheme
MRV	Monitoring, Reporting and Verification
MSR	Market Stability Reserve
MW	Megawatts
NDRC	National Development and Reform Commission

OECD	Organisation for Economic Co-Operation and Development
PMR	Partnership for Market Readiness
RGGI	Regional Greenhouse Gas Initiative
tCO2	Tons of Carbon Dioxide
tCO2e	Tons of Carbon Dioxide Equivalent
U.S.	United States
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
WCI	Western Climate Initiative