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The FASTER Principles for Successful Carbon Pricing:

An approach based on initial experience

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This is a joint report written by the Organisation for Economic Cooperation and Development (OECD) and the World Bank Group (WBG). Comments from the International Monetary Fund (IMF) and research and drafting support provided by Ecofys are gratefully acknowledged. The findings, interpretations, and conclusions expressed in this work do not necessarily reflect the views of these organizations, their Boards of Executive Directors, or the governments they represent.

Contents

Acronyms

AVR	Accreditation and verification
BAT	Best-available technology or technique
BCA	Border carbon adjustment
CARB	California Air Resources Board
CDM	Clean Development Mechanism
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
EC	European Commission
EDF	Environmental Defense Fund
ETS	Emission trading system
EU	European Union
EU ETS	European Union Emission Trading System
EUTL	European Union Transaction Log
GDP	Gross domestic product
GHG	Greenhouse gas
IETA	International Emissions Trading Association
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
LPG	Liquified Petroleum Gas
MRR	Monitoring and reporting
MRV	Monitoring, reporting and verification
MSR	Market stability reserve
NDRC	National Development and Reform Commission
NOx	Oxides of nitrogen

OECD	Organisation for Economic Cooperation and Development
PMR	Partnership for Market Readiness
RBF	Results-Based Financing
R&D	Research and development
RD&D	Research, development and demonstration
RGGI	Regional Greenhouse Gas Initiative
SO_2	Sulphur dioxide
UK	United Kingdom
VAT	Value-added Tax
WBG	World Bank Group
WCI	Western Climate Initiative
WHO	World Health Organization
WTO	World Trade Organization

Preface

As global leaders prepare for the next round of climate change negotiations in Paris, it is encouraging that many governments around the world have already begun to put a price on carbon dioxide and other greenhouse gas (GHG) emissions, and that companies—including from the oil and gas industry—are calling for widespread carbon pricing.

By 2015, 39 national and 23 sub-national jurisdictions, representing about 12 percent of global greenhouse emissions and an aggregate market value of almost USD$50 billion, were putting a price on carbon. But the ambition and coverage of pricing instruments needs to accelerate significantly for the world to meet international climate goals.

We know from experience that well-designed carbon pricing schemes are a powerful and flexible tool that cut emissions that cause climate change. Properly designed and implemented, they can play a key role in enhancing innovation and smoothing the transition to a prosperous, low-carbon global economy.

Economists and investors have long argued that an economy-wide price on carbon is the best way to reduce GHG emissions, since it requires all market actors to properly account for their contribution to climate change. While there are many other powerful tools in the low-carbon toolkit—such as energy efficiency standards and incentives for clean energy—an economy-wide price on carbon is critical in shifting entire economies onto a low-carbon pathway.

It is increasingly clear that nothing short of an economic transformation is required. That transition cannot happen overnight. This report outlines principles for successful carbon pricing, based on economic principles and experience of what is already working around the world. It is intended to provide a foundation for designing efficient, and cost-effective carbon-pricing instruments—primarily explicit carbon taxes and emissions trading systems—at the national and sub-national level.

The Paris climate talks are a unique opportunity to put the global economy on a low-carbon pathway that will deliver more efficient economies, better health and a safer planet. Carbon pricing is necessary to bring down greenhouse gas emissions and lower climate risks. It is the foundation for the necessary transition to a zero-carbon future by the end of this century.

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Director
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The FASTER Principles for Successful Carbon Pricing

Fairness

Successful carbon pricing policies reflect the "polluter pays" principle and contribute to distributing costs and benefits equitably, avoiding disproportionate burdens on vulnerable groups.

- Carbon pricing policies capture the costs of damage caused by emissions and so level the playing field between emission-intensive and low-carbon economic activities. Over time, they are expected to shift the structure of the economy towards low-carbon activities.
- Potential risk of adverse competitiveness impacts and carbon leakage is usually limited to relatively few exposed sectors and can be managed through the design of pricing policies or complementary measures; it will be reduced as carbon pricing becomes more geographically extensive.
- National systems that support innovation and well-functioning labor markets can ease the transition of jobs and assets from carbon-intensive to low-emissions firms as the economic structure adjusts consistently with carbon-pricing policies.
- If carbon pricing disproportionally burdens poor households in some circumstances, targeted complementary measures (e.g., fiscal transfers) can provide protection without undermining incentives to reduce emission-intensive activities.

Alignment of Policies and Objectives

Successful carbon pricing policies are part of a suite of measures that facilitate competition and openness, ensure equal opportunities for low-carbon alternatives, and interact with a broader set of climate and non-climate policies.

- Successful carbon pricing policies are supplemented by measures that support deeper emissions reductions over time. These include innovation policies, the removal of institutional barriers, behavioural incentives, public spending reallocations and policies that encourage investment in low carbon infrastructure and seek to avoid lock-in of polluting investments.
- Providing consistent signals to consumers, producers and investors require reforms to address counterproductive policies (e.g., fossil fuel subsidies).
- Carbon pricing policies coexist with a range of non-climate policies that can either support or undermine the transition to a low-carbon economy. Policy coherence across a range of policy areas is therefore important.

Stability and Predictability

Successful carbon prices are part of a stable policy framework that gives a consistent, credible, and strong investment signal, the intensity of which should increase over time.

- A predictable and rising carbon price promotes orderly transition to a low-carbon economy over time, opening up new business opportunities and stimulating innovative business models. It can also contribute to stability of government revenues. A lower but gradually rising carbon price creates the right incentives, but produces greater short-term emissions than an initially higher carbon price would.

- While predictability is essential to support long-term investment decisions, incorporating flexibility—by adjusting the carbon tax or rules-based interventions in an Emissions Trading System (ETS)—can help economies adapt to unpredictable economic and technological developments and advances in scientific understanding of climate change. National carbon budgets can at the same time reduce long-term uncertainties on how much abatement is targeted.

Transparency

Successful carbon pricing policies are clear in design and implementation.

- Early and regular communication with affected stakeholders about the rationale, desired outcome, and shared benefits helps to generate support for carbon pricing and to manage the associated change in the structure of the economy.
- Systems that effectively monitor and verify emissions and mitigation efforts are critical for public trust and support.

Efficiency and Cost-Effectiveness

Successful carbon pricing improves economic efficiency and reduces the costs of emission reduction.

- Carbon pricing encourages emissions reductions at least cost, giving affected entities flexibility to choose how and when to reduce emissions based on their own assessments of costs and benefits.
- Carbon pricing improves resource allocation in the economy by ensuring the damaging costs of GHG emissions are taken into account in production, consumption and investment decisions by the public and private sectors, households and individuals.
- Administration can be simplified and therefore costs minimized by building on existing policies and institutions.
- Judicious use of revenues from carbon taxes or emission allowance auctions can produce additional economic benefits, including fiscal dividends.

Reliability and Environmental Integrity

Successful carbon pricing schemes result in a measurable reduction in environmentally harmful behavior.

- Comprehensive coverage of fuels, sectors and gases enhances environmental impact, but transaction and monitoring costs for some sources need to be managed.
- Carbon pricing policies consistent with environmental objectives are more effective when substitutes for emission-intensive activities or products are easily available at low cost.
- Carbon pricing policies can deliver multiple benefits, including local environmental and health benefits.
- The choice and design of pricing instrument matter for environmental outcomes.

Introduction

The case for climate action has never been stronger. Current weather extremes, including storms, floods and drought, affect millions of people across the world. Climate change is putting water security at risk; threatening agricultural and other supply chains[1] as well as many coastal cities. The likelihood of severe pervasive and irreversible impacts (IPCC, 2014a) will grow without action to limit and reverse the growth of GHG emissions globally. Last year's Intergovernmental Panel on Climate Change (IPCC) report makes clear the overwhelming need to take action now on climate change and that the costs of inaction will only rise. The challenge is to decarbonize our economies by 2100 with action in the next decades being critical.[2]

The choices made by government, the private sector, and civil society as part of the transition to a decarbonized economy will determine the extent of future climate impacts but also provide an opportunity to unlock investment and build an innovative, dynamic low-carbon economy. This transition to a low-carbon development path will radically transform the way we produce and consume energy in particular.[3] It will require policies that efficiently promote opportunities for emissions mitigation and clean-technology developments, while imposing the least overall burden on the economy (Stern, 2006).

This report focuses primarily on domestic carbon-pricing mechanisms that put an explicit price on GHG emissions—whether through taxes on the carbon content of fuels or emissions, or similar emissions trading systems (ETS).[4] Carbon pricing as an instrument of international cooperation is not discussed, except under efficiency and cost-effectiveness, as it is addressed in depth in other reports.[5]

It recognizes that while carbon prices are critical, policymakers have a wide array of potential policy tools at their disposal, such as energy efficiency standards for vehicles, buildings, lighting, appliances, and other energy-using equipment. Others include: taxes on electricity, and fuel-inefficient vehicles; emission rate standards for power generators; and subsidies for the development and deployment of low-carbon technologies (e.g., electric vehicles, biofuels, wind and solar power, home insulation).

Economic policies such as excise taxes on energy use are strongly similar to carbon taxes because they

[1] Turn Down the Heat: Why a 4°C Warmer World Must be Avoided, launched by the World Bank in November 2012; Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience, launched by the World Bank in June 2013; and Turn Down the Heat: Confronting the New Climate Normal, launched by the World Bank in November 2014 constitute three reports. Summary for Policymakers (SPM) of IPCC Working Group III, 2014a: scenarios consistent with limiting warming to 2 degrees are characterized by emission levels 40–70 percent lower in 2050 than in 2010, and emissions levels near zero $GtCO_{2eq}$ or below in 2100.

[2] Summary for Policymakers (SPM) of IPCC Working Group III, 2014 (IPCC, 2014d): scenarios consistent with limiting warming to 2 degrees are characterized by emission levels 40–70 percent lower in 2050 than in 2010, and emissions levels near zero $GtCO_{2eq}$ or below in 2100.

[3] This paper mostly focuses on energy-related CO_2 emissions, as they represent a significant amount of global greenhouse gas emissions, and they are generally more straightforward to monitor than emissions from changes in land use and non-CO_2 sources (e.g., methane and nitrous oxides from agricultural practices).

[4] Other documents, such as the OECD's *Taxing Energy Use*, address the important role of indirect carbon pricing mechanisms and how they can be harnessed more effectively for the transition.

[5] See, e.g., World Bank Group, *State and Trends of Carbon Pricing 2015*, which provides updates and analysis on international carbon markets and climate finance, offset mechanisms, and corporate internal carbon prices.

influence market signals and greenhouse gas emissions. They are already used in most countries, but the rates are uneven, and often very low, particularly for coal use. Aligning such taxes with the carbon content of energy, while taking account of other policy objectives, is another way to introduce systematic carbon prices (OECD, 2015). Other policies, such as tax provisions on property or company cars or electricity market regulation, can either support a carbon-pricing signal or work against it. These issues of policy coherence are beyond the scope of this report and are addressed in detail elsewhere (OECD, 2013).

This report draws on a growing base of global experience in implementing carbon pricing mechanisms, as well as economic literature,[6] to identify a set of principles for successfully steering an economy towards the long-term goal of decarbonization. It focuses on how to achieve this in a fair, and transparent way that harnesses emission-reduction opportunities at least cost, provides flexibility, and is aligned with other policies.

By introducing carbon-pricing policies, governments, and businesses can trigger investment decisions and behavioral changes in firms and households to support the long-term goal of de-carbonization and deliver environmental protection at the lowest overall economic cost. Such policies provide firms, and households with the flexibility to choose where, when, and how to reduce emissions in an equitable way. By reducing the use of carbon-intensive fuels, carbon-pricing policies can help alleviate local environmental problems like premature deaths from exposure to local air pollution. They can also provide a valuable source of government revenue, enabling a reduction in other taxes (e.g., on labor, and capital income) that can distort economic activity, and harm growth. Carbon tax revenues also provide government with additional means to protect the poor, and avoid concentrating losses (either spatially or within a particular group).

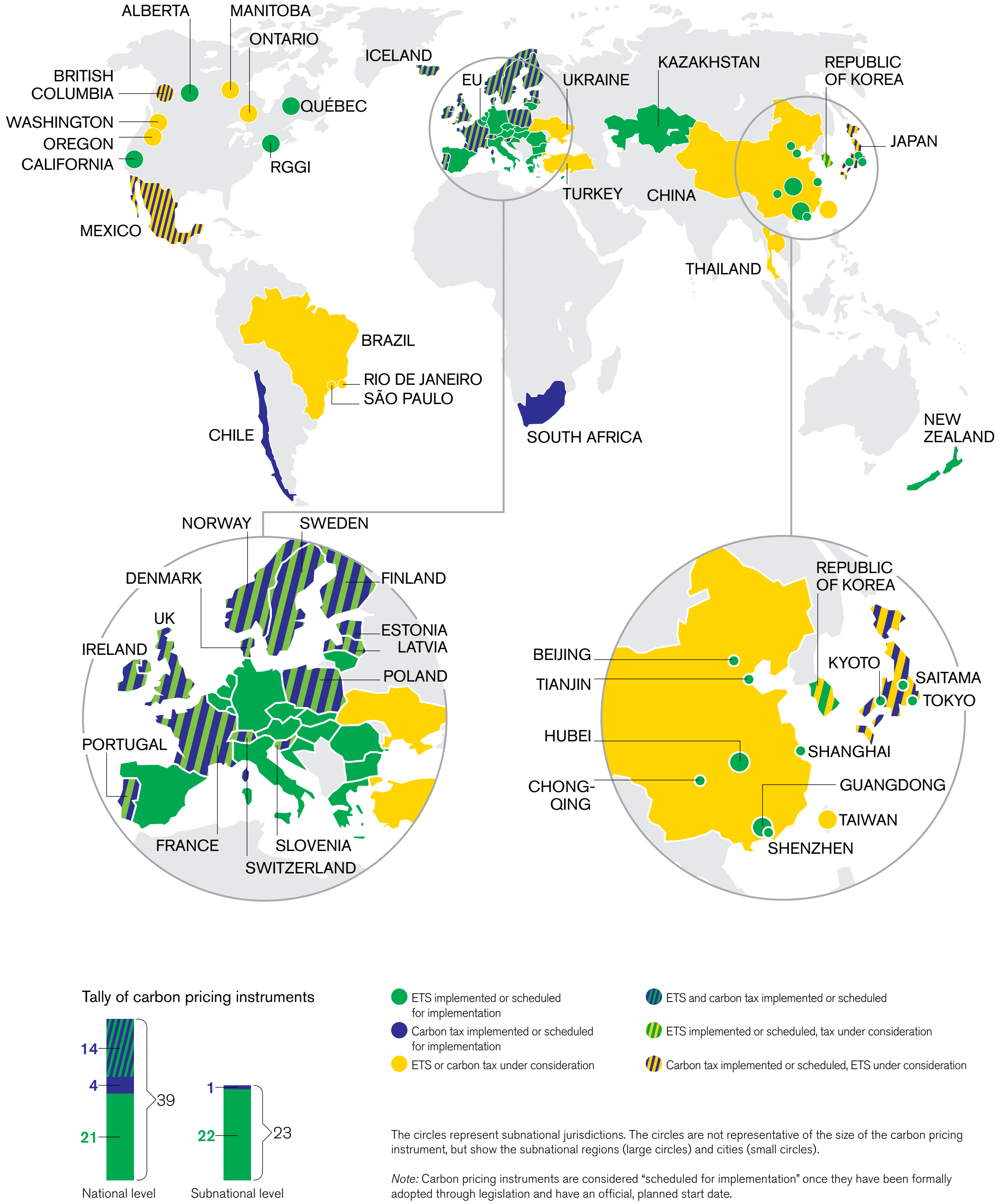
For these reasons, carbon pricing mechanisms are increasingly being adopted. As of June 2015, 39 national governments and 23 sub-national governments have implemented or are scheduled to implement carbon pricing instruments (Figure 1). Together, these instruments now cover about 7 Gt CO_{2e}, or about 12 percent of annual global GHG emissions. Combined, the value of the carbon-pricing mechanisms globally in 2015 is estimated to be just under US$50 billion (World Bank, 2015). Emission-trading schemes are valued at about US$34 billion, and existing carbon tax schemes at around US$14 billion.

The "FASTER" principles presented in this report lay out an approach that focuses on the emerging design features for successful and cost-effective carbon pricing policies drawn from initial and growing experience around the world. By maintaining a focus on fairness, alignment with existing policies, stability, transparency, efficiency, and reliability, the FASTER principles show that a well-designed carbon pricing instrument can provide the flexibility, and certainty for a thriving business, and investment climate, while effectively reducing emissions. Case studies provide concrete examples of how the principles are being implemented in practice.

The hope is that the FASTER principles will guide, and inspire countries, regions, states and businesses considering future carbon pricing systems to accelerate progress and will evolve to capture new experience with design and implementation going forward. This continual process of learning will help us collectively accelerate the shift from carbon-intensive assets to cleaner, more efficient solutions.

[6] See, for example, OECD (2013a), *Effective Carbon Prices*; Mooij de et al, *Fiscal Policy to Mitigate Climate Change: A Guide for Policymakers;* IMF, Parry et al (2014), "Getting Energy Prices Right: From Principle to Practice," IMF.

FIGURE 1: Overview of existing emerging and potential regional, national and sub-national carbon pricing instruments (ETS and tax).



Source: World Bank Group (2015).
Alexandre Kossoy, Grzegorz Peszko, Klaus Oppermann, Nicolai Prytz, Noemie Klein, Kornelis Blok, Long Lam, Lindee Wong, Bram Borkent. 2015. "State and Trends of Carbon Pricing 2015" (October), World Bank, Washington, DC. Doi: 10.1596/978-1-4648-0725-1 License: Creative Commons Attribution CC BY 3.0 IGO.

Fairness

Successful carbon pricing policies reflect the "polluter pays" principle and contribute to distributing costs and benefits equitably, avoiding disproportionate burdens on vulnerable groups.

Carbon pricing helps level the playing field between activities that impose climate change damages and low- or zero-emissions activities that do not. Carbon prices can gradually lead to structural transformations by enhancing the competitiveness of low-carbon firms and increasing the costs of emissions-intensive activities. Ensuring that carbon pricing schemes are fair requires policies and temporary protection measures that support a smooth transition for affected people. This section focuses on: (i) competitive fairness between firms; (ii) employment fairness during structural transformations; and (iii) social fairness for vulnerable low-income consumers.

Carbon pricing policies capture the costs of damage caused by emissions, and so level the playing field between emission-intensive and low-carbon economic activities. Over time, they are expected to shift the structure of the economy towards low-carbon activities.

Successful carbon pricing changes the relative competitive position of firms by increasing the financial costs of emissions-intensive activities, which inflict climate change damages on society, and favor low-emission activities that do not contribute to climate change (Bowen, 2011). This results in economically efficient and socially fair impact on the relative competitiveness of firms, where they face the truer economic cost of production. It levels the playing field between emissions-intensive and relatively 'clean' firms. The expected macroeconomic result is a shift in the structure of the economy toward low carbon activities.

Companies do not compete only on costs, but on overall efficiency of converting complex inputs (energy, material, labor, land, knowledge) into high value products, and services. However for sectors producing relatively homogenous products, such as commodities, steel, cement and electricity, cost competition is critical.

Explicit carbon prices (emissions taxes, and emissions trading systems) are not the only instruments that make firms internalize their emissions costs. When comparing carbon prices across firms and jurisdictions, successful systems also take into account the impact of implicit, and indirect carbon prices embedded in other policy instruments, such as energy taxes, emission standards or support systems for renewable energy and energy efficiency (Vivid Economics, 2010), (OECD, 2013a).

Properly designed environmental policies can even enhance competitiveness and business performance by inducing technology innovation and increasing productivity, which can partly offset additional costs of compliance with the policy (Porter, 1991), (Jaffe and Palmer, 1997). More evidence of this hypothesis has been found in high-income countries that have used price-based policy instruments to address pollution from more technologically advanced sectors, which faced prior barriers to innovation (Brannlund and Lundgren, 2009), (Levinson, 2009), (Lanoie et al, 2011), (Copeland, 2012), (Calel and Dechezleprêtre, 2012), (Ambec et al, 2013), (Albrizio et al, 2014), (Zhu and Ruth, 2015).

Potential risk of adverse competitiveness impacts and carbon leakage is usually limited *to relatively few exposed sectors and can be managed through the design of pricing policies or complementary measures; it will be reduced as carbon pricing becomes more geographically extensive.*

Significant differences in climate policy costs experienced by firms in different jurisdictions can lead to potential "carbon leakage." Carbon leakage occurs when a domestic carbon price causes economic activities (and related emissions) to move to jurisdictions without equivalent policies.[7] Emissions leakage may occur through two main channels—short-term changes of production volumes in existing facilities, and long-term shifts in new investment decisions.

So far research suggests that carbon prices have not led to carbon emissions leakage on a significant scale (Partnership for Market Readiness, 2015), (Arlinghaus, 2015), (Martin et al, 2014), (Flues and Lutz, 2015), (Abrell et al, 2011), (Barker et al, 2007), (Chan et al, 2012), (Cummins, 2012), (Ellerman et al, 2010), (Graichen et al, 2008), (Lacombe, 2008), (Martin et al, 2012), (Sartor, 2012), (Sartor et al, 2013). There are a few possible reasons for this result. First, the risk of leakage may be negligible because emissions costs have not had a significant impact on production and investment decisions compared to other factors such as the quality of institutions, availability of capital, skills of workers, proximity to markets, governance and tax regimes. Second, existing carbon price levels may be too low and the systems too new to have an impact. Third, governments have successfully used leakage reduction measures—for example free allowances—to limit leakage risk (Lanzi, 2013).

The risk of future carbon leakage is real as long as carbon price signals are strong and differ significantly between jurisdictions. This risk, however, is likely to be limited to a few exposed sectors—those that are emissions-intensive and heavily traded. Trade intensity makes sectors particularly vulnerable as it limits their ability to pass on the increased carbon costs to consumers without losing significant market share. Providing assistance to address leakage to sectors that are not exposed or vulnerable may lead to unwanted consequences.

[7] The Intergovernmental Panel on Climate Change defines emission leakage as "the increase in CO_2 emissions outside the countries taking domestic mitigation action divided by the reduction in the emissions of these countries" (IPCC, 2007), (Allwood J. M. et al, 2014).

BOX 1: Carbon Prices and Competitiveness—Selected Evidence

Data from the **United Kingdom** production census suggests that the introduction of the Climate Change Levy (an energy tax) had a significant impact on energy intensity, but no detectable effects on economic performance or plant exit (Martin, 2014).

A study of **British Columbia's** carbon tax found limited impacts on industrial competitiveness, with the exception of two companies in the cement sector that lost market share. At the same time, British Columbia is also home to a growing clean technology sector, with more than 150 firms in operation in 2012—accounting for 22 percent of Canada's clean technology presence in a province with 12 percent of Canada's GDP. Several experts have attributed the growth in the clean-tech sector to the carbon tax (Demerse et al, 2015).

The risk of carbon leakage can be effectively managed. Some risk mitigation measures are integrated into a design of carbon-pricing systems, while others are complementary to them. Different assistance measures have their relative merits and weaknesses and sometimes are combined in one legislative package, where different forms of assistance are applied to different sectors.

Integrated measures have been generally preferred to date, as more transparent and directly linked to leakage concerns. Broadly speaking, six distinct types of integrated measures can be observed, three of which involve free allowance allocations:

(i) Free allowance allocations, based on:

- ***Grandfathering:*** firms receive free allowances directly related to their historical emissions (e.g. EU ETS phases I and II, Korea ETS in all but three sectors, Kazakhstan Phases I and II, Beijing, Chongqing, Guangdong, Hubei, Tianjin). Often used in the introductory stages as it is easy to implement for administration and politically palatable, but provides weak leakage protection and may lead to contentious political negotiations with affected industries or even an increase in emissions unless it is a transition to a benchmark-based assistance.

- ***Fixed sector benchmarking*** (FSB): firms receive free allowances related to their historical production and a product-specific benchmark of emission intensity of the whole sector (EU ETS Phase III).
- ***Output-based allocation*** (OBA): firms receive free allowances related to their actual production and a product-specific benchmark of emission intensity of the whole sector (e.g. California, New Zealand, Korea in three sectors and Shenzhen). Benchmarking assistance (either output-based allocations or fixed-sector benchmarking) can protect against leakage and convey the right incentives to improve productivity and reduce emissions. It favors most efficient firms in a sector. Makes negotiations with industry more transparent. Additional administrative costs are manageable. There is a trade-off between the two benchmarking approaches. OBA is more administratively complex than FSB and may be more effective at preventing leakage but can compromise the environmental integrity of the policy unless designed with additional environmental safeguards.

(ii) **Administrative exemptions:** exempting some emissions or sectors/firms from the carbon pricing scheme, or setting reduced rates for them (e.g. a number of carbon taxes in EU countries and proposed South Africa carbon tax). They are easy to apply and may be appropriate to secure political support in the early stages, but may undermine the environmental objectives of the scheme especially if applied to high-emission sectors.

(iii) **Rebates:** providing subsidies to industry (direct rebates) or reducing other taxes paid by the exposed industry (indirect), often by an equivalent amount (e.g. UK climate change levy, Swedish NOx charge).

(iv) **Border carbon adjustments** (BCAs): imposing emission costs at the border on importers of carbon-intensive goods and/or providing a rebate to firms exporting to third countries, unless those countries have an equivalent carbon pricing regime (Cosbey et al, 2012). BCAs effectively extend the carbon pricing regime to entities outside the implementing jurisdiction. Arguably BCA perform most strongly on grounds of environmental integrity and leakage protection, but face political, administrative (Davie, 1995), and possibly legal challenges (Laborde, 2011). The application of BCAs to carbon regulation remains untested and risky, but may be more feasible when introduced by a coalition of partners with significant market power (Condon et al, 2013), (Nordahus, 2015) and coupled with financial transfers to support a low-carbon transition (World Bank, 2015).

Complementary measures usually take the form of fiscal or financial transfers to support adjustment of affected sectors to higher carbon prices. For instance, European Union funds support green technology innovation and member states can compensate firms for indirect carbon costs arising from the ETS through national state aid schemes. New Zealand also provides support for research and development into emissions-reduction opportunities in agriculture.

Concerns over potential competitiveness impacts and carbon leakage will ultimately decrease as carbon pricing becomes more widespread and harmonized across jurisdictions. Such international or inter-regional harmonization can be achieved by harmonization of at least minimum rates of carbon taxes, direct linking of domestic or regional emissions trading systems (see Box 3), or through indirect "networking" (World Bank, 2014). Harmonization of carbon prices globally will be fair and more efficient if supported by cross-border resource and technology transfers to low-income countries to address equity concerns (Gillingam,

BOX 2: Examples of Measures to Alleviate Competitiveness Concerns and Support Efficient Firms

In the **EU ETS** free allocation of allowances is being gradually replaced by auctioning, with implementation at a faster pace for the sectors that are not trade exposed (such as power). Sectors exposed to leakage will continue receiving a larger portion of their cap through free allocation. The arrangements for addressing carbon leakage have been designed to provide an ongoing incentive for firms to outperform others in their sector in terms of emission efficiency. The benchmark for free allowances is based on industry emission performance so that only the top 10 percent of performers receive free allowances to cover 100 percent of their emissions. Other firms receive the same volume of free allowances as best performers, but those firms that do not meet the benchmark have to purchase additional allowances at the market price to cover their actual emissions.

Sweden refunds the revenues of the nitrogen oxides (NOx) charge on large boilers, stationary combustion engines and gas turbines to participating entities in proportion to their energy output. Although not a carbon pricing instrument, this redistribution scheme penalizes emissions and rewards efficiency at the same time, while not affecting firms' production levels. In this way cash stays within the sector, while companies have incentives to reduce emissions and increase production efficiency (Sterner and Höglund (2000), Gersbach (2004), Fisher C. (2011)).

Since 1993 **Denmark** has rebated a portion of the carbon tax to various businesses, but not in proportion to their emissions. The Danish government provided a 97 percent reduction in carbon tax payments for some energy intensive firms of which 22 percent was conditioned on signing agreements to reduce their energy use—the rebate that was later abolished. From 2010 firms under EU ETS are exempted from the CO_2 tax and the rest pay the full tax. At the time of writing this report the Danish CO_2 tax was around 23 EUR/tonne, an increase from 12 EUR/tonne in 2010. (Jens Holger Helbo Hansen, Ministry of Taxation, Denmark—personal communication.)

BOX 3: Linking the California and Québec Emissions Trading Systems

California and Québec, which together with British Columbia, Manitoba and Ontario, form part of the Western Climate Initiative (WCI), linked their emissions trading systems from January 1, 2014. Together, they form the largest carbon market in North America. Compliance units are fully fungible across both jurisdictions. Four auctions have been held to date (November 2014 and February, May and August 2015). The systems were designed to be linked, and assessed to ensure equal stringency prior to linkage, to ensure the environmental integrity of the scheme. In April 2015 Ontario announced its intention to join the regional program. Linkages would increase the total emissions covered by the caps, further enhance efficiencies and reduce competitiveness concerns. (Environmental Defense Fund/ International Emissions Trading Association, 2015).

2012). Results-Based Finance (RBF) can be a "transition" vehicle to phase-in carbon pricing through international support.

National systems that support innovation and well-functioning labor markets can ease the transition of jobs and assets from carbon-intensive to low-emissions firms as the economic structure adjusts consistently with carbon-pricing policies.[8]

[8] See extensive discussion on this issue in Deichmann Uwe and Fang Zhang (2013), *Growing Green: The Benefits of Climate Action,* World Bank Group.

BOX 4: South Africa's Carbon Tax Proposal

South Africa's proposed carbon tax covers CO_2e emissions from fuel combustion, coal gasification, and non-energy industrial processes, as determined by the carbon content of the fuel consumed. The tax is scheduled to start in 2016 at a rate of 120 South African rand/tonne CO_2e (US$10/t CO_2e) and increase by 10 percent per year until 2019. It is expected to cover approximately 75 percent of total national emissions.

To ameliorate potentially damaging economic impacts to South African companies, the government agreed to introduce tax-free thresholds under which business will not have to pay. The tax-free threshold will be fixed at 60 percent of tax payments due, meaning that companies are responsible for paying the tax on 40 percent of their total emissions. Trade-intensive and other sectors with limited potential to reduce emissions (such as the cement, iron, steel, aluminum and glass sectors) will have higher tax-free thresholds, reaching up to 90 percent. Tax-free thresholds are planned to be phased down after 2025 or replaced with thresholds based on firm-specific carbon budgets. A combination of the tax-free thresholds and an annual increase of the carbon tax rate is expected to provide a clear carbon price signal (Morden et al, 2015).

Sometimes governments choose to offer assistance to scale-down less-efficient facilities in carbon-intensive sectors. The employment implications of carbon pricing are part of an overall economic transition, similar to other structural transformations, which ultimately leads to the more productive and sustainable use of resources. Immediate employment impacts in affected sectors can be different from the economy-wide impact, as employment, and job-skill requirements change in other sectors as they adopt cleaner technologies and increase output.

Jurisdictions where many people rely on emissions-intensive industries for jobs, like many rapidly industrializing developing countries, will be more vulnerable to carbon price increases than those where these industries play a smaller role. Countries differ not only by vulnerability but also in their ability to adapt to labor market impacts. Wealthier countries typically have more resources and stronger institutions to smooth the structural transformation that may be caused by carbon prices.

Governments can reduce vulnerability to the employment impacts of carbon prices by supporting technology improvements of firms in affected sectors (e.g. through providing access to information, markets and finance, in particular for small and medium enterprises). These approaches can also help to reduce the impact on those less-efficient firms that are exiting the market. Decisions on which approach to take need to be balanced with other factors for sectors that are otherwise competitive or of strategic importance.

Increasing adaptability involves strengthening the overall business environment and increasing labor market flexibility so workers in affected industries have incentives, and are able to find jobs in more efficient firms and in growing sustainable low-carbon sectors. Active labor-market policies—such as training, employment services, public works or hiring, and wage subsidies—can increase business adaptability to new opportunities. Carbon pricing policy can contribute to generating additional revenue, which can be channelled, for example to facilitating strategic transformational skills development through national education systems. For example, Chile introduced its carbon tax as a part of a much larger tax reform package with the explicit aim of providing additional resources for education and other social needs.[9] Well-designed and implemented social protection programs targeted to displaced workers can provide effective safety nets for those who will find it more difficult to move to new jobs.

If carbon pricing disproportionally burdens poor households in some circumstances, targeted complementary measures (e.g. fiscal transfers) can provide protection without undermining incentives to reduce emission-intensive activities.

[9] The Chilean Tax Reform was approved in Congress in September 2014. Within a comprehensive package of tax reform the carbon tax in particular will be applied to emitters from energy generators of 50 MW and larger. The tax is set to be US$5 per ton of CO_2. The tax becomes effective in 2017. Source: Chile's Market Readiness Proposal at http://www.thepmr.org/country/chile-0.

Carbon pricing policies have the potential to benefit vulnerable low-income segments of society. The distribution of damages from climate change seems to fall more heavily on poor countries, which often are more exposed, less able to adapt and where more people live in areas affected by local pollution from burning fossil fuels (Akbar et al, 2014).

However, in the transition period, where fossil fuels dominate energy and transport systems and clean technologies are more expensive, increasing carbon prices may translate into increased energy costs. These increased energy costs may fall disproportionately either on low-, or high-income households, depending on what share of their disposable budgets are spent on different energy services. New evidence based on experience in 21 OECD countries shows that distributional effects of pricing policies vary by fuel: Taxes on transport fuels are not regressive on average in OECD countries, while taxes on electricity and heating fuels tend to be regressive, meaning that low-income households are responsible for proportionally larger tax burdens compared to wealthier households (Flues and Thomas, 2015). The impact needs to be better understood particularly in developing countries that depend on fossil fuels or non-renewable biomass. The final impact will depend on how the tariff structure is set and adjustments can be made to benefit the poorest segments of the population.

In developing countries impacts on households may differ because of the different patterns of consumption of fuels and electricity. For example, increasing consumer prices of kerosene, used for lighting and heating in low-income households without access to electricity, usually pose a higher burden on the poorest people. Carbon taxes may even slow down the switch to modern cooking fuels, such as electricity or LPG (Pachauri et al, 2013). Gasoline usually shows a progressive pattern, with the richer quintile losing a higher portion of their income than poor people. Electricity price increases are in most cases slightly regressive, although there are some exemptions, such as India and other countries where many low income households are not connected to the power grid (Vagliasindi, 2012).

Negative effects can be mitigated through effective policy design, primarily smart revenue recycling. A portion of additional revenues generated by carbon prices is usually sufficient to compensate the income loss of the poorest and most vulnerable energy consumers (OECD, 2014). This compensation can be provided as monetary support through, for example, social welfare cash transfers or targeted income tax adjustments (Bento et al, 2009; Callan et al, 2009; Cohen et al, 2013). This type of support can enhance affordability and improve equity, while maintaining incentives for low-income households to improve energy efficiency and reduce their emissions. In contrast, consumption subsidies for electricity tend to be regressive (benefitting primarily high-income households) in the majority of countries (Komives, 2007), (Vagliasindi, 2012). Implementation of targeted transfers can be challenging, depending on the targeting method and

BOX 5: Examples of Mitigating the Social Impact of Carbon Pricing

The Regional Greenhouse Gas Initiative (RGGI) in the Northeastern United States illustrates a constructive approach to deliver relief from high energy bills and make investments that capture efficiency opportunities and power its economies with clean and renewable power. Collectively, RGGI has invested over US$1 billion from the proceeds of its ETS in the energy future of participating states in New England and the Mid-Atlantic region. RGGI's investments in energy-efficiency programs are expected to return more than US$2.3 billion in lifetime energy bill savings to 1.2 million participating households. In addition, RGGI provides direct bill assistance for energy and electricity customers in need. From 2008 to 2012 RGGI invested more than US$130 million in low-income rate relief and efficiency.

British Columbia's carbon tax design includes a tax credit for low-income households to offset the financial burden of more expensive fuel. The credit was last increased in 2011, when it rose to Can$115.50 per adult and Can$34.50 per child. A study found that low-income households were better off after 2010 because the Low Income Climate Action tax credit was more than the amount paid in carbon tax (Lee and Sanger, 2008).

administrative capacity, including the capacity of the existing social safety nets. The challenge increases for countries with large informal sectors.

The welfare of low-income groups can also be improved by improving the energy performance of buildings, appliances and transport services. With such assistance, increasing the cost of energy does not need to lead to higher energy bills. It also increases the comfort in buildings that are more efficiently heated and insulated or improves public transport for those who cannot afford a car. Special efforts may need to be made, however, to target the poorest households.

Environmental objectives are usually not the main reason for energy tariff increases. Incremental tariff increases due to carbon taxes are usually minor compared to the tariff increases implemented in developing countries to improve the commercial sustainability of energy and transport utilities and thus reliability of, and access to, energy and transport services.

Alignment of Policies

Successful carbon pricing policies are part of a suite of measures that facilitate competition and openness, ensure equal opportunities for low-carbon alternatives, and interact with a broader set of climate and non-climate policies.

In reality carbon pricing policies will always coexist with a suite of other measures designed to reach multiple social objectives. Some of these policies will be **complementary**, supporting deeper emissions reductions over time. Others will be **counter-productive**, weakening the carbon-price signal. Coherence across a range of policy areas is important. Overlapping policies may have merits of their own, but also interfere with carbon-price incentives.

Successful carbon pricing policies are supplemented by measures that support deeper emissions reductions over time. These include innovation policies, the removal of institutional barriers, behavioral incentives, public spending reallocations, and policies that encourage investment in low carbon infrastructure and seek to avoid lock-in of polluting investments.

Carbon pricing is the cornerstone of a package of policy measures designed to achieve emissions reductions at lowest cost (Nordhaus, 2002); (Newell, 2015); (Parry et al, 2014). Complementary policies are often needed to advance reform in areas that are not sufficiently responsive to price signals, or where markets do not provide price signals to individuals or organizations. Direct regulations can also help support market-based instruments in case of market failures, presence of institutional barriers such as a lack of incentives for research and development; behavioral challenges, inherited infrastructure that locks in higher-emitting activities; or simply a lack of finance (Popp, 2015). For example, in the absence of public transport infrastructure commuters find it difficult to change commuting habits when they face higher prices of fuels. Compliance with such standards and regulations results in consumers and producers indirectly paying a price for reducing emissions.

Complementary policies are particularly important for energy efficiency, as market failures such as imperfect information and split incentives create hidden costs and risks that hinder otherwise efficient projects. The removal of these barriers makes households or small firms more responsive to the carbon price signal (Alcott, 2014); (Alcott et al, 2012); (Busse et al, 2013); (Helfand et al, 2011); (Sallee, 2014); (Sallee et al, 2009). Examples include providing information on energy saving opportunities and benefits, aligning incentives between landlords and tenants, and facilitating their ability and willingness to pay higher up-front costs (IPCC, 2014). Sometimes households or small firms are willing to invest in low-carbon alternatives but cannot afford it, or do not have sufficient access to finance. Often governments themselves create additional barriers through counterproductive policies, such as energy price subsidies or fiscal rules that deprive the entities that undertook investments of the benefits of energy savings.

Aligned carbon pricing policies improve the implementation of other policies. Many countries have introduced regulations with energy and emission performance standards—such as those commonly used for cars and buildings in China, the European Union, and North America. Their implementation on the ground is often weak, because of the insufficient economic incentives for compliance. Carbon price can make high-performance buildings and cars less expensive than business as usual alternatives, thereby aligning economic incentives with direct regulations.

Properly aligned taxes on the carbon content of energy are another mechanism for pricing GHG emissions. Explicit carbon pricing mechanisms (taxes or cap-and-trade schemes) are gaining traction but remain much less widespread than specific taxes on energy use. Excise taxes are typically levied on quantity or energy units (e.g. a liter or gallon of fuel). Since carbon emissions are proportional to the volume of fuel burned, a fuel tax is equivalent to a carbon tax. Given differences in tax rates and in the carbon content among fuels, the implicit carbon taxes resulting from excise taxes can differ strongly among fuels (Box 6).

For certain economic activities, price signals are not the main driver of decision-making. For example, some land-use decisions are primarily based on cultural or social considerations. Another example is the choice of transport by commuters, which is influenced not only by price, but also by convenience, safety and time spent—all of which depend on the availability of transport infrastructure and quality of its services.

Carbon pricing is not likely to induce adequate investment in research, development and demonstration (RDR&D) of low-emission technologies.[10] The case for complementary intervention may be strongest for basic research, which lays the groundwork for future technological advances (Newell, 2015). Given the large funding needs for this type of research, carbon pricing revenues represent only a small fraction (Box 7). Obstacles also arise at the technology demonstration and deployment stage. For example, firms are often reluctant to pioneer the adoption of a new technology because it

[10] Supplementary innovation incentives can yield significant economic benefits, though typically on a smaller scale to those from carbon pricing (e.g., Nordhaus, 2002; Parry et al, 2014).

BOX 6: Carbon Taxes and Specific Taxes on Energy Use

Taxing Energy Use (OECD, 2015) shows the differences in implicit carbon tax rates among fuels and uses. This OECD analysis considers explicit carbon taxes and implicit carbon tax rates from specific energy taxes, as these are economically similar, to calculate the total effective tax rate on CO_2. On average, the effective tax rate per tonne of CO_2 in an OECD country in 2012 equals €164 per tonne of CO_2 on average for oil products used in road transport, €24 on average for oil products used for heating and process use, and €5 on average per tonne of CO_2 for coal and peat used in heating and process use. The differences in effective tax rates are very large, with the lowest rates benefiting the most emission intensive fuels. What does this imply for the practice of carbon pricing?

One approach would be to assume that some prevailing taxes include an implicit carbon component, as well as components to address other policy goals (e.g. raise revenue, combat pollution, reduce congestion, improve the political feasibility, slow adaptation to changing circumstance, etc.). Taxes could be reformed to ensure that the carbon component is made equal across fuels and user types, as would be the case with a carbon tax. The exercise may be worth pursuing when a major overhaul of excise taxes to optimize their effectiveness in curbing a range of external costs is envisaged, but may provide little guidance for the introduction of carbon pricing.

A second approach would be to require that the tax on all sources and uses of energy is at least equal to the aspired level of carbon prices. Alternatively, the carbon price could be added to all excise taxes on energy use except where there are explicit carbon taxes or cap-and-trade schemes. The difference between these two alternatives reflects a view on whether current taxes contain some degree of implicit carbon taxation. The choice between both may mainly be a matter of political expedience. The importance of the reform in both cases is that all forms of energy use would be subject to at least the intended carbon price. Given the currently low carbon prices for large portions of energy use, especially carbon-rich coal, large gains are to be had from such reforms.

BOX 7: Carbon Pricing and Complementary Technology Policies: The EU and US Cases

The EU ETS does not prescribe how member states should use the revenues from allowance auctions. However, in Phase III 300 million emission allowances from the New Entrants' Reserve (NER) were set aside to be sold at the EU level to support one of the world's largest funding programs for innovative low-carbon energy demonstration projects. The program was conceived as a catalyst for the demonstration of environmentally safe carbon capture and storage (CCS) and innovative renewable energy technologies on a commercial scale within the European Union. In the context of the upcoming ETS review, the European Commission considers continuing to sell allowances to establish an "innovation fund" that would also promote industrial breakthrough technologies. In addition the "modernization fund" is proposed by dedicating a portion of total revenues from allowance sales to improve energy efficiency and energy systems in the poorer EU countries. In addition, the EU has agreed that at least 20% of its budget for 2014–2020—as much as €180 billion—should be spent on climate change-related action. For example, the research and innovation program (Horizon, 2020) with an envelope of €63bn has the objective of 35% climate mainstreaming (over €22bn) over the period. The focus will be on research and innovation activities on energy, climate and clean technologies.

While the United States does not have a national carbon price, it has advanced a comprehensive suite of low-carbon energy technology policies and measures. For example, the U.S. government funds about half of the basic research into energy technologies, or about US$6 billion a year. A number of experts (e.g. Newell, 2015) have recommended a significant expansion of this funding (US$3 billion or more, or about 1.5 percent of revenue from an expected U.S. carbon tax) targeted strategically (e.g., for electricity storage, safer technologies for nuclear power, direct conversion of solar energy into electricity), though spending should be ramped up gradually to allow time for training of additional engineers and scientists. The U.S. tax code also provides tax credits for private R&D expenditures into energy and other technologies, with resulting budgetary costs approaching US$10 billion a year (Newell, 2015).

could end up benefiting other firms; in other cases, demand for the technology is insufficient to achieve commercial viability. These sorts of problems apply to a number of different low-carbon technologies,[11] but may be most pronounced for solutions like carbon capture and storage, which have high up-front costs and long-range emissions savings.

The most effective approaches use a portfolio of measures targeting different stages of the technology innovation process. Instruments for promoting applied RD&D and technology deployment by private firms include subsidies, prizes, and intellectual property protection. Each of these measures have pros and cons, and the appropriate mix of instruments needs to be carefully considered. For example, direct R&D subsidies may have the drawback of failing to distinguish between more promising and less promising opportunities. Competitive prizes for new technologies avoid these problems, but require measurable objectives that can be defined in advance. Intellectual property rights reward the commercial viability of new technologies, though they limit diffusion nationally and may do little to reward innovators for technologies that are easily transferred to other countries. Technology support measures need to be flexibly designed to accommodate uncertainty over future technology costs (e.g., to avoid locking in technologies with higher than expected costs) and then phased out as technologies mature and penetrate the market. Box 7 discusses these issues in the context of the U.S. and EU energy technology policy.

If regulatory instruments target the same sources and emissions as carbon pricing, care needs to be taken to ensure alignment. For example, applying both emissions standards and carbon pricing to emissions from energy or industrial installations can constrain the carbon price signal and limit the choice of emission-reduction opportunities. The overall policy cost would increase, without

[11] Numerous studies suggest that the efficient level of R&D for new technologies in general is several times the level actually performed by industry (e.g., Griliches 1992, Mansfield 1985).

necessarily improving environmental outcomes. On the other hand, sometimes direct regulations such as emissions performance standards and "best-available" technology or technique[12] (BAT) standards may be a preferred option, and carbon pricing is not needed. For example, installations covered by the EU ETS are exempt from CO_2 emissions performance standards under the EU Industrial Emissions Directive, while local emissions from the same sources are regulated by BAT and emission standards and not carbon pricing.[13]

Carbon pricing instruments interact with the underlying market designs and structures. When considering carbon price design, the existence of competitive markets and the ability to pass through costs matters. If there is no electricity market, carbon pricing may have no effect, and direct regulation of emitting activities may have stronger impact on emissions. An ETS may be challenging to implement in markets that are small and/or inflexible (e.g. with price controls, regulated trading and non-competitive structures). In such distorted markets, existing companies or facilities may use an ETS to further strengthen a dominant market position. Countries can mitigate this risk by facilitating competition in emissions trading markets, using new entrants' reserves, regulatory rules, and oversight by antitrust agencies. Successful systems address this issue by using the emissions trading to improve underlying power market design and enhance competition.

Providing consistent price signals to consumers, producers and investors requires reforms to misaligned and counterproductive policies (e.g. fossil fuel subsidies).

Policy consistency requires managing interactions between policy instruments, and aligning policies across policy domains. The misalignment of larger policy frameworks—including investment, taxation, innovation and international trade, as well as sectoral policies governing distinct areas such as electricity markets, water infrastructure, urban mobility and rural land-use—can distort the effectiveness of carbon pricing policies. Taking policies relating to international trade as an example, misalignments exist across three policy areas: trade liberalisation; "green industrial policy" and its impact on global value chains for renewable energy; and the machinery of trade itself—international maritime and aviation transport. As one example, this can create difficulties for governments in taking unilateral action to price emissions from trade, as shipping and aviation are mainly international industries that are covered by international conventions (OECD, 2015).

Counterproductive policies undermine the environmental benefits of carbon pricing and should be scaled back. One example is fossil fuel subsidies, or more general mispricing of energy, whose predominant effect is to lower energy prices, thereby increasing energy demand and GHG emissions. A common example is when domestic retail fuel prices are held down below international prices (mainly for petroleum products and natural gas) or when domestic prices are below cost-recovery prices (for electricity). Energy-price reforms and carbon prices are mutually reinforcing policy tools that lead to better energy access, improved quality of energy services and environmental sustainability. Raising energy prices to reflect both supply and environmental costs would also help to reduce emissions (Box 8). Other examples of climate-harmful subsidies include those for company cars, parking, livestock production and crop production using fertilizers that release nitrogen oxides. These counterproductive policies are still common in many countries. They often disproportionately benefit wealthier groups and are costly to the budget and the economy.

Carbon pricing policies coexist with a range of non-climate policies that can either support or undermine the transition to a low-carbon economy. Policy coherence across a range of policy areas is therefore important.

[12] EU environmental legislation uses the broader concept of "technique," which includes technologies as well as the ways in which the installations are designed, built, maintained, operated and decommissioned.

[13] For more details on these policies, see http://ec.europa.eu/environment/industry/stationary/ied/legislation.htm.

BOX 8: Government Support for Fossil Fuels

Taxpayers continue to bear substantial costs as governments support the exploration, extraction and consumption of fossil fuels, in contradiction with climate-change mitigation objectives. The International Energy Agency estimates that price-driven subsidies for the consumption of fossil fuels in a selection of emerging and developing countries amounted to US$548 billion in 2013 (IEA, 2014). The OECD estimates that support for the production and consumption of fossil fuels in advanced economies amounts to about US$55–90 billion per year (OECD, 2013b).

The IMF finds that pre-tax subsidies for petroleum products, electricity, natural gas, and coal reached US$ 490 billion worldwide in 2013, or 0.7 percent of global GDP (IMF, 2015). The IMF then adds a measure for "non-internalized externalities," which are meant to account for the failure of governments to fully internalize environmental damages and other consumption-related externalities (e.g. road accidents, traffic congestion, carbon emissions, air pollution) through higher taxes on energy products. Using this approach, it finds that government support for fossil fuels could be construed as dramatically higher, even up to $5.3 trillion (IMF, 2015). Setting energy prices to levels that are commensurate with supply costs in developing and emerging countries would help reduce global CO_2 emissions in the order of 2–6 percent points (IMF, 2015); (IEA, 2014).

Carbon pricing policies frequently operate in parallel with other similarly motivated fiscal and regulatory incentives affecting the same emissions sources. Examples include: energy-efficiency standards for vehicles, buildings, lighting, appliances, and other energy-using equipment; incentives for bio-fuels, wind, and solar power; emission standards for power generators; and subsidies for clean technology deployment. Some of these policies are designed to address other market failures or to achieve other policy objectives. Without proper management of policy interactions, they may interfere with the effectiveness of the carbon price in reducing emissions (see Box 9). These policies may also become redundant as comprehensive and appropriately scaled carbon pricing is introduced, although they may still be needed to strengthen investor confidence or to foster other, non-climate-related, policy objectives (Hood, 2013).

Under an emissions trading system, other climate policies can lead to low allowance prices (Braathen, 2014) reducing incentives to invest in cleaner technologies and lowering government auction revenues. The downward pressure on emissions prices from other policies can be mitigated by a number of measures (see Box 9), including floor prices or market stability mechanisms discussed under the 'Stability and Predictability' principle. Under a carbon tax, overlapping policies can reduce emissions without affecting the emissions price, though raising the tax may achieve the same emission reduction at lower costs.

Policy interventions to promote deployment of new low-carbon technologies can be compatible with carbon prices if they are phased out as technologies penetrate the market. Successful policies create a level playing field across competing technologies and avoid locking in a particular technology. Once market barriers have been overcome, incentives can be removed to avoid favoring one technology over others.

BOX 9: Managing Interactions between Carbon Pricing and Other Policies

The European Union

The EU climate-energy package includes a number of policies to support a triple target by 2030: reducing greenhouse gas emissions by 40 percent below 1990 levels; increasing the share of renewables in the EU's energy mix to 27 percent; and achieving a 27 percent increase in energy efficiency above 2005 levels. This has led to national-level policies implemented in parallel to the EU ETS, e.g., feed-in tariffs and other incentives to promote new renewable power, energy efficiency obligations and subsidy programs. These policies have increased renewable energy penetration, reduced electricity demand and thus contributed to additional surplus of allowances that were not accounted for at the time ETS was designed. This has further reduced already low carbon prices, making carbon-intensive, coal-based generation more competitive in electricity markets when compared to gas-fired electricity (Böhringer et al, 2010). Renewable support systems, however, achieved their objectives as industrial and energy policies—renewable energy costs decreased, penetration rates increased and European companies became global leaders.

Recognizing these tensions, the European Commission (EC) in 2013 recommended that member states limit financial support for renewables to only the amount that is necessary to make renewables competitive in the market. The EC advised that as technologies mature, renewable support schemes should be gradually removed, while incentivizing producers to respond to market developments (EC, 2013). This was followed up by new state aid guidelines that promote a gradual move to market-based support for renewable energy. To increase cost effectiveness and limit distortions, the new guidelines foresee the gradual introduction of competitive bidding processes for allocating public support and also foresee the gradual replacement of feed-in tariffs by feed-in premiums (EC, 2014). At the same time, the Market Stability Reserve was introduced to reduce price fluctuations by changing the surplus if it becomes too large or too small. Some member states (e.g. UK) went further and introduced carbon price floor and CO_2 emission standards for new coal generators that are comparable with gas-fired power generation.

California

California's emission trading system is a key element in implementing its 2006 Global Warming Solutions Act. California Governor Jerry Brown further pledged that by 2030 the state will cut petroleum use by up to 50 percent, expand renewable energy supply to half of the state's electricity use, double energy savings in existing building by 2030 (relative to current levels), address short-lived climate pollutants, and manage natural and working lands to store carbon. In April 2015, the governor's Executive Order established a target of greenhouse gas emission levels 40 percent below 1990 levels by 2030. California also has complementary policies affecting sectors that are covered by the ETS as part of an overall strategy for emission reductions. Policies in capped sectors address market failures, drive technology and systems innovation and investment, and have multiple benefits that are not adequately captured by ETS itself.

BOX 10: China's Alignment of Policies

China has considerable experience aligning carbon pricing programs along with other climate policies. In November 2014, the announcement of the joint statement regarding action plans on climate change beyond 2020 between the United States and China highlights two of China's policy alignment priorities: (1) to peak CO_2 emissions by 2030 and try to reach this peak as early as possible; and (2) raise the share of non-fossil fuels in primary energy consumption to 20 percent by 2030.

China has large and growing experience with the Clean Development Mechanism voluntary emissions trading platforms, and a large-scale pilot emissions trading system. Since 2011, China has been experimenting with seven regional carbon market pilots. Each pilot covers a large city—Beijing, Tianjin, Shanghai, Chongqing and Shenzhen—or a province—Guangdong, and Hubei. Together the pilot systems account for over 1 billion allowances per year, according to the National Development and Reform Commission, making China the world's second largest carbon trading market following the European Union's EU ETS. Building from these pilots, China has announced the creation of a national ETS, scheduled to begin in 2017, with the start-up phase followed by a roll-out phase in 2020.

Complementary to carbon pricing, China has established a number of complementary climate policies, including low-carbon city-development programs, which include pilot demonstration projects in clean transport and green industrial parks, and local air quality improvement initiatives. Furthermore, there are several subsidy programs for renewable energy. In 2014 the government announced plans to cut fossil fuel dependency, reduce carbon emissions, and increase renewable energy generation (NDRC, 2014). It also set 2020 targets for primary energy consumption, coal use and the share of non-fossil fuel energy production in the national energy mix (China State Council, 2014).

Stability and Predictability

Successful carbon prices are part of a stable policy framework that gives a consistent, credible and strong investment signal, the intensity of which should increase over time.

Carbon pricing policies offer stability if they are part of a long-term strategy that **gradually phases in** a cost for emissions and explains how the government will ensure that **unexpected events can be addressed** while maintaining the overall goal of reducing greenhouse gas emissions at low cost. This sort of predictability of policy and market framework will drive greater business support and allow firms and consumers to **plan their investments** in the necessary low-carbon infrastructure and solutions.

A predictable and rising carbon price promotes orderly transition to a low-carbon economy over time, opening up new business opportunities and stimulating innovative business models. It can also contribute to the stability of government revenues. A lower but gradually rising carbon price creates the right incentives, but produces greater short-term emissions than an initially higher carbon price would.

A predictable and consistent climate policy and market framework promotes more orderly transition to a sustainable low-carbon economy at lower cost. Achieving zero net GHG emissions globally by 2100 (IPCC, 2014b) requires a clear and credible signal that the cost of emitting greenhouse gases will increase over time. This promotes cost-effective investments in clean technologies and new business opportunities and models that can be aligned with expected business cycles (OECD, 2011). Climate policy consistency improves market confidence, and enhances incentives for innovation that encourage expansion of markets for low-carbon businesses and discovery of new ways to mitigate climate change (e.g., Sauvage, 2014).

Policy stability can manifest differently under a carbon tax or an emissions trading system.

- **With a carbon tax, the predictable increase of the tax rate promotes fiscal stability and allows optimization of low-carbon investments over time.** A predictable price allows governments to plan for the use of prospective carbon-pricing revenues, for example, in reducing the rates of other taxes in the fiscal system. Investment decisions depend not just on the carbon price in the short-term but over the life of an investment. Therefore investors' certainty about the level of a carbon price in the future enables more efficient near-term investment decisions and avoids lock-in of carbon-intensive assets. This, in turn, reduces the overall cost of achieving the desired emission-reduction outcome.
- **Under an emissions trading system, the stability of the market framework follows from setting a clearly defined limit to the quantity of allowances.** Cost-effective optimization of low-carbon investment may be influenced in the long term by setting and maintaining long-term targets for emissions reductions and ensuring technology neutrality across a sufficiently broad set of sectors, activities and countries; not necessarily by managing the carbon price directly. Under an ETS, stakeholders may consider direct price controls (e.g. through administratively set price floors or triggers for market interventions) to represent a form of intervention contributing

BOX 11. Academic Literature Provides a Useful Reference for the Long Term Carbon Price Trajectory That Is Consistent with Global Climate Stabilization Targets

Academic studies suggest that socially efficient carbon prices should increase at the social discount rate, typically by around 2–5 percent a year in real terms, starting from the levels that are significantly higher than most existing carbon market prices (IAWG, 2013) (Stern, 2006). It is not evident from the literature and empirical experience that limiting carbon price development to a narrow bandwidth is a necessary condition for successful carbon pricing or that this optimal path needs to be strictly followed in all circumstances. In reality the phasing of financial carbon price trajectories will be shaped by political economy considerations, business cycles as well as economic and social realities in different countries. Nonetheless, incentives would be aligned and investment planning optimized if producers and consumers expected a broad-based and long-term convergence of the average international carbon price signals with what scientists suggest would be socially optimal for the global economy.

to regulatory uncertainty for market participants, as demonstrated during the debate on the post 2020 revisions of the EU ETS. Expectations about the development of the carbon price over a longer, multi-year period depend on the expected scarcity of emission allowances. Genuine price discovery is a unique advantage of carbon markets, as this provides society with valuable information about the opportunities and costs of reducing emissions.

Introducing carbon taxes at a low level, then expanding coverage and price level progressively can help ease transitions to carbon pricing, while providing continuing signals for clean technology investments. Experience in jurisdictions such as British Columbia (Box 12) or Sweden (Figure 2) suggests that progressive introduction of carbon taxes may increase political and social support by enabling households and firms to adapt gradually to higher energy prices (OECD, 2013b). Staged expansion to different sectors is also an option. For example, Finland's carbon tax initially covered only heat and power generation but was subsequently extended to cover transportation and heating fuels. This sort of phased implementation may sacrifice abatement opportunities in the short term. However, if investors have confidence that price levels and coverage commitments will be maintained in the future, phased taxes can lead to increased investment in long-lived, low-carbon infrastructure. Phasing in emission reductions also allows time for technology development to help reduce abatement costs and align adjustment with normal capital replacement cycles. Under an ETS, this is often achieved by more a progressively higher cap on the annual number of allowances at the outset, predictable tightening of the cap and transparent rules for how allowances will be withdrawn from the market. A rising trajectory of emissions prices or a declining trajectory for the limit to the total number of allowances under an ETS usually implies that the easiest abatement opportunities are seized first, with progressively more challenging emission reduction opportunities implemented over time.[14]

While predictability is essential to support long-term investment decisions, incorporating flexibility—by adjusting the carbon tax or rules-based interventions in an Emissions Trading System—can help economies adapt to unpredictable economic and technological developments and advances in scientific understanding of climate change. National carbon budgets can at the same time reduce long-term uncertainties on how much abatement is triggered.

The ability to cope effectively with scientific and economic uncertainties is fundamental for efficient carbon pricing policies (OECD, 2009). The challenge for governments is to ensure that pricing mechanisms are designed in such a way that they can respond to unpredicted events, while remaining sufficiently predictable to preserve

[14] It also means that sometimes complementary policies, such as land use planning and infrastructure investments (discussed under the Alignment principle) may be needed to facilitate measures that are more costly in the short term, but strategically important in the long run (Fay et al, 2015).

BOX 12: British Columbia's Carbon Tax: A Phased Approach

The Canadian Province of British Columbia launched its carbon tax in 2008, at a rate of Can$10 per tonne of CO_2. The government introduced a schedule with four annual increases of Can$5/tonne, allowing the tax to reach a pre-determined rate of Can$30/tonne in July 2012. The tax applies to the carbon content of all fossil fuels purchased or used in the province, as well as methane and nitrous oxide.

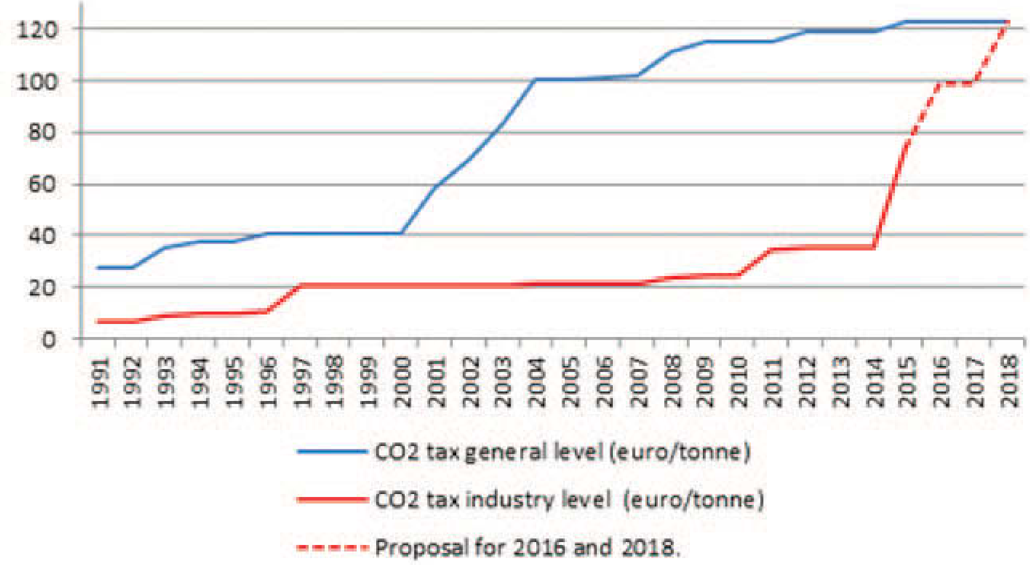
Carbon tax revenue has risen from Can$306 million in the first year of the tax to Can$1,120 million in fiscal year 2012/2013, or about 5 percent of total provincial tax revenue for that fiscal year. When introduced, the carbon tax led to an increase in the price of gasoline of around Can$0.0234 per liter, a modest increase in the context of normal price fluctuations. The fact that there was little evidence of any negative impacts from the tax helped to dampen opposition and played a major role in getting the principle of the tax accepted.

While the initial price of British Columbia's carbon tax was relatively low, the legislated annual tax increases meant that the government was able to raise the tax in subsequent years with minimal political controversy, because the increases were clear and anticipated. The province was able to move from a low to a more stringent price with less opposition than might have been the case if a Can$30 rate per tonne was implemented upfront. At the same time, expectations of progressively rising prices to 2012 provided incentives for clean technology investments.

By July 2012, British Columbia's carbon price contributed Can$0.067 to the average Can$1.38 price per liter of gasoline in Vancouver, compared to approximately Can$0.40 contributed by other local, provincial and federal taxes. Changes in the political landscape in the province and growing business concerns regarding potential competitiveness impacts prompted the government to freeze the carbon tax at Can$30 per tonne for five years in 2013.

Sources: Clean Energy Canada (2015), Pedersen and Elgie (2014), Harrison (2013) and Metcalf (2015).

FIGURE 2: Development of Swedish carbon tax rate over time



Source: Swedish Ministry of Finance (NOTE: from 2008 industry outside EU Emissions Trading Scheme (EU ETS)).

incentives for innovation and long-term investments in low-carbon technologies.

Carbon taxes and emissions trading systems respond differently to uncertainties. Over the short term, taxes provide certainty over incremental abatement costs—as these are pinned down by the tax rate—while emissions will vary with changes in energy demand, relative fuel prices, costs of renewable technologies. In emissions-trading systems, the level of emissions is fixed by the cap, giving more certainty about overall environmental outcomes. Changes in economic conditions or rapid progress with abatement will affect emission prices through changes in the demand for allowances. This price uncertainty is an intended feature of a system, because by design allowance prices should be established through the decisions of participating entities. However, if unconstrained, this variability may have detrimental effects on long-term clean technology investments by making returns more risky to investors. Price volatility in trading systems can be reduced as discussed in Boxes 13 and 14.

BOX 13: Reinforcing Stability and Predictability in the EU Emissions Trading System (EC, 2015)

Phase I of the EU Emissions Trading System (2005–2007) relied on EU member states to issue allowances in accordance with national allocation plans because the European Union lacked sufficient information about member state emissions levels to establish a harmonized cap. The majority of member states over-allocated allowances in an effort to safeguard economic competitiveness, leading to a rapid reduction in the price of allowances in 2007. Phase I allowances could not be carried over to Phase II in order to shield future trading from the risk of potential excess allowances and to guarantee that the ETS delivers the emission reductions necessary for compliance with the EU commitment undertaken in the Kyoto Protocol. The number of allowances was reduced in Phase II (2008–2012) by 6.5 percent to stay below 2005 emissions levels.

Phase III of the EU Emissions Trading System (2013–2020) includes an EU-wide emissions cap, in place of national caps, and uniform allocation rules to avoid potential market distortions and reduce the potential for member states to over-allocate allowances. The cap is reduced by 1.74 percent each year. When the economic crisis of 2008 eroded the carbon price level by reducing the economic output of industry, many stakeholders urged the European regulator to step in and protect the price level. Pros and cons of market flexibility versus policy predictability were extensively discussed.

A wide ranging policy debate was held in Europe considering structural reforms to the EU ETS, to address the surplus of allowances on the market. A widely held view emerged that volume based measures, such as the recently adopted Market Stability Reserve (MSR), would be more suitable than discretionary price measures such as a minimum carbon price floor. An extensive discussion of the merits of the options considered can be found in the Impact Assessment that accompanies the legal proposal on the Market Stability Reserve (*Source:* http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014SC0017).

Several options were considered as part of the discussion on structural reform of the EU ETS including increased targets, retiring allowances, an extended scope and discretionary price measures, some of which were dismissed because they would only address the issue in the long term.

Discretionary price-based mechanisms, with an explicit carbon price objective, would alter the very nature of the current EU ETS from a quantity-based market instrument. Because they require a process to decide on the level of the price floor, the carbon price could become primarily a product of administrative and political decisions (or expectations about them), rather than a result of the interplay of market supply and demand. Setting the minimum price too high would just fix the carbon price, reduce the flexibility and result in higher abatement costs, while setting it too low would not be effective in addressing the surplus and create more certainty about the price. Stakeholders also indicated that a minimum price would also complicate linking the EU ETS to other emissions trading systems and would not result in an additional environmental benefit without cancellation of allowances. More certainty for investors through a minimum price could come at the risk of imposing excessive costs on ETS participants and society if technological breakthroughs substantially lower abatement costs (European Commission, 2014).

BOX 14: Reinforcing Stability and Predictability in the Emissions Trading Systems of California and Québec

In the linked California and Québec ETS, market intervention is triggered by the price of allowances. In this system, an auction reserve price or floor price is set. If the market price falls below the auction floor price, then some allowances may not be sold at auction. The California Air Resources Board and the Québec government may only sell unsold allowances if the closing price of the auction exceeds the floor price for two consecutive joint auctions. The floor price was initially set by Québec and California at US$10 in both American and Canadian currencies for 2012, the year the two programs took effect and a year before their first compliance periods began. This price has since increased annually by 5 percent plus the rate of inflation, calculated by the Consumer Price Index in each jurisdiction. Accordingly, in 2015, the Auction Reserve Price was set at US$12.10 and at Can$12.08. For each joint auction, the harmonized regulations stipulate that the floor price is the higher of the California or Québec floor price according to the exchange rate published by the Bank of Canada on the day prior to the auction. For example, for the May 2015 joint auction, the floor price was set at US$12.10 or Can$14.78 per allowance (i.e., per ton of CO_2e.) and some vintage 2013 allowances that had not been sold were put back on sale after the closing price of the two prior joint auctions exceeded the floor price.

Mechanisms can strike a balance between flexible policy that adapts to new information and the need for policy consistency and predictability. For carbon taxes, pre-specified rules for periodically updating tax levels in response to new information can help to strike this balance, although there is little experience with such rules being implemented.

For emissions trading systems, policy and market stability options include:

1. **A predictable policy framework,** including setting the cap several years in advance with clear rules and processes for how it will be set into the future. Governments can also provide advance notice of changes that are likely to influence price, such as extending the scope of the ETS to more sectors or sources, and changing rules of access to international credits. This will allow the market time to factor those changes into future prices and adjust their decisions accordingly.
2. **Linking/networking with other ETS**, since a larger market usually smooths volatility, while joint market rules agreed on by several jurisdictions also reduce political risk of erratic changes influenced by political or economically vested interest groups.
3. **Market stability reserves**, discussed in Boxes 13 and 14.
4. **Safety valves**, where the government sells additional permits at a fixed price to prevent allowance prices from rising above a set ceiling price.
5. **Price collars** that combine a price ceiling with a price floor. This approach turns effectively to a tax when allowance prices are low and into a price ceiling (safety valve) when allowance prices are too high.
6. **Banking and borrowing provisions**, with constrained borrowing from future trading periods to avoid a negative impact on environmental integrity.
7. **Offsets—**the transparent and predictable use of carbon credits generated outside of the ETS can be used to offset the obligation to surrender ETS allowances. The ability to use offsets prevents allowance price spikes, but loose offsets criteria may lead to unexpected price drops.
8. **Timely release of price-relevant information** helps firms to make efficient price discovery and improves investment decisions. The price can become unstable if price sensitive information is not released to the full market or is poorly timed.
9. **Clearly defined property rights (carbon assets)—**when property rights associated

with carbon assets are clearly defined, market actors have confidence that they will receive the benefits from their investments.

10. **Wide market participation and development of secondary markets** supports price discovery and reduces overall transaction costs.

11. **Market oversight and regulation** ensures that the market is competitive and free from manipulation.

12. **Extending** the scope of the ETS to more sectors or sources.

National carbon budgets can also play a role in reducing long-term uncertainties, by clarifying the total amount of emissions that will be permitted for a country over a specified multi-year period and allowing for regular review of progress toward the budget. For example, the United Kingdom legislated for binding carbon budgets in its *Climate Change Act 2008* and has budgets in place to 2027, when the country is legally committed to achieving a 50 percent reduction in emissions relative to 1990 levels.[15]

[15] More information on this policy is available at www.gov.uk/government/policies/reducing-the-uk-s-greenhouse-gas-emissions-by-80-by-2050/supporting-pages/carbon-budgets.

Transparency

Successful carbon pricing policies are clear in design and implementation.

Successful carbon pricing policies involve public **dialogues with affected stakeholders** about the rationale for the policy and incorporate their feedback into the policy design and implementation. Establishing **independent and public reviews**, along with a robust **monitoring and verification system and reporting** on performance, builds public trust in carbon pricing efforts.

Given the structural changes expected in the economy as a result of a successful carbon price, transparency is a prerequisite for a social mandate to price carbon emissions. This includes: communicating with relevant stakeholders about the proposed policy design early in the process and soliciting their feedback; creating clear and easy-to-understand rules, including monitoring, reporting, and verification (MRV) procedures; and establishing well-defined lines of regulatory responsibility and market oversight, which are subject to public scrutiny. Carbon prices need to be supported by laws and regulations that clearly define liable entities and what they must do to comply; systems also must be enforceable.

Early and regular communication with affected stakeholders about the rationale, desired outcome, and shared benefits helps to generate support for carbon pricing and to manage the associated change in the structure of the economy.

Carbon pricing systems require a systematic communications and stakeholder engagement program to explain the government's aims and proposed design of the system, and to receive input from affected groups. For example, as part of the development of its carbon tax, Ireland conducted extensive consultations with community, environmental and business interest groups to improve the public's support (see Box 15). Similarly, California's stakeholder engagement process involved hundreds of public and private meetings and workshops with affected stakeholders, including capped entities and other groups. A comprehensive and inclusive engagement process is mandated through law to enable broad public participation in its rulemaking proceedings.[16]

Once the carbon pricing system is in place, successful programs conduct regular independent and public reviews of policy performance by checking progress towards achieving stated objectives, identifying any possible unwanted effects and evaluating whether performance is aligned with policy goals.

Systems that monitor and verify emissions and mitigation effort are critical for public trust and support.

Monitoring, reporting and verification (MRV) programs provide the backbone for successful carbon pricing systems. Processes to collect and organize emissions data in a manner that is complete, consistent, comparable, accurate and transparent are key to gaining public trust. Additionally, MRV programs are the basis for understanding the reliability of the carbon pricing policy to meet environmental objectives, and to provide emissions data to verify compliance and assess cost effectiveness. A number of jurisdictions—including

[16] See www.arb.ca.gov/html/decisions.htm for more information on California's stakeholder engagement process.

BOX 15: Ireland's Carbon Tax and Public Acceptance During the Fiscal Crisis

The adoption of Ireland's carbon tax provides insight into the value of effective stakeholder engagement to implement a carbon tax, as well as Ireland's effort to align implementation of the carbon tax as part of a broader fiscal reform.

In 2010, in the middle of a financial crisis, the government of Ireland introduced a carbon tax that covered CO_2 emissions from non EU ETS sectors, and in particular natural gas and mineral oil used in transport, space heating in buildings, and by all businesses not covered by the EU ETS. Fuel use in agriculture is also included. Therefore, the tax targeted emissions associated with the general public's day-to-day activities, e.g., driving and home heating. The carbon tax rate on natural gas and mineral oil was increased to €20 per tonne CO_2 emitted on combustion in 2012.

A carbon tax on solid fuels was introduced in 2013, at a rate of €10 per tonne of carbon emitted on combustion. The rate was increased to €20 per tonne of CO_2 emitted on combustion in 2014. There was some opposition to the introduction of the solid fuel carbon tax on grounds of the impact on lower income households who rely more on solid fuels. To reduce the impact of the carbon tax on homes, the Government has offered generous grants for retrofitting homes to improve energy efficiency together with free upgrades for the elderly and vulnerable. Businesses dealing in solid fuels complain that they are suffering a loss of business from cross-border sales as their customers are sourcing solid fuel from Northern Ireland where it is not subject to a carbon tax. (*Source:* Emma Clutterbuck, Office of the Revenue Commissioners, personal communication.)

One study, conducted by the University College Dublin, notes that the tax rate—set at €15 per tonne of CO_2, which is high relative to the EU ETS allowance price—has been socially accepted. Along with other supporting factors, effective engagement and good planning are credited with creating circumstances that resulted in a carbon tax being proposed and subsequently introduced in Ireland. Specifically, the study states that lengthy and detailed stakeholder consultation processes carried out during the program design stage resulted in a rule that was more politically acceptable and nuanced than it would have been without this process. A key lesson from Ireland's experience includes understanding main priorities across a wide spectrum of interest groups. In this case, the farming lobby was important. Furthermore, the carbon tax aligned with interest to put the climate and energy agenda at the center of Ireland's economic revival, moving to a low-carbon economy and radically enhancing energy efficiency. An important rationale for the carbon tax was that it would stimulate new enterprises in renewables and energy efficiency and encourage innovation (Convery et al, 2013).

Another important lesson (supported also by the experiences of Sweden and Chile) is that carbon taxes are easier to introduce as part of a broad fiscal reform.

Alberta, California, New Zealand, Quebec, RGGI and Switzerland—report emissions and compliance results annually, per covered entity, as a strategy to ensure transparency of their system.

With a carbon price on wholesale suppliers of fossil fuels, a well-designed MRV program will include reporting fossil fuel production and import data by fuel type, along with provisions for converting fuel reports into emissions values. A robust MRV program for systems that apply a price at the point of emissions will account for and report emissions and activity data associated with the emitting facility. Different approaches to verification are possible—from independent third party verification to self-certification with strong penalties. Additionally, many countries, such as the United States and Australia, have also instituted mandatory GHG MRV programs in the absence of a carbon-pricing program. This has been done for government information purposes only, or for compliance with direct, non-price regulations. Table 1 provides a snapshot of verification approaches used in several jurisdictions (WRI and WBG, 2015).

The MRV rules in the EU ETS ensure the quality of annually reported emissions and the credibility of the underlying data, and are essential for effective program operation. MRV factors have been cited as

TABLE 1: Emission verification approaches used in different jurisdictions

Jurisdiction	Self-Certification	Review by Program Administrators[a]	3rd-Party Certification
California	X	X[b]	X
Canada	X	X	
European Union	X		X
Japan	X		X
Mexico	X		X
Turkey	X		X
United Kingdom	X		X
United States	X	X	

Notes:
a. Depending on the program, this could include random checks or systematic/periodic verification.
b. California audits a random sample of GHG reports in addition to a full review by the third-party verifiers.

BOX 16: MRV Standards Under the Clean Development Mechanism (CDM)

Under the Kyoto protocol, the Clean Development Mechanism (CDM) developed into the world's biggest market-based offsetting instrument, involving the largest number of developed and developing countries. The emissions accounting and reporting methodologies provide the foundation for preserving the environmental integrity of the CDM. Based on early experience, a number of reforms were enacted that led to standardized baselines, consolidated MRV rules and procedures, and enhanced communications that have significantly improved accountability issues and the transparency of the program.

contributing to public confidence in the effectiveness of the system include:

- The requirement that all installations and aircraft operators must have an approved monitoring plan, according to which they monitor and report their emissions during the year;
- The availability of the two primary regulations underpinning the program and confidence in their technical merits, which describe the rules and procedures for emissions monitoring and reporting and accreditation and verification;
- The required use of accredited verifiers to check and validate the data and information included in program participant's annual emissions reports.[17]

Emissions-trading programs also benefit from market monitoring that reviews and evaluates the activities of market participants to ensure that fair trading practices occur and that the market is free of manipulation (See Box 17).

[17] To access additional information on EU ETS MRV rules, see ec.europa.eu/clima/policies/ets/monitoring/index_en.htm.

BOX 17: Building Trust in Market Practices

EU ETS

One of the lessons learned from the initial phases of the EU ETS is that the absence of a single, transparent trading registry contributed to a higher risk of potential market misconduct and abuse. Therefore, the EU created a system-wide registry to replace individual national registries for all ETS account holders as well as the European Union Transaction Log (EUTL), which automatically checks, records and authorizes all transactions that take place between accounts in the Union registry. This was supplemented by fixing the VAT rules and improved market oversight. These verification steps helped to ensure that any transfer of allowances from one account to another is consistent with EU ETS rules. (*Source:* http://ec.europa.eu/clima/policies/ets/registry/index_en.htm)

California's ETS

The California Air Resources Board—the agency responsible for designing and implementing the state's ETS—utilizes another option to maintain a well-functioning market that is free of abuse. It conducts market surveillance and analysis and uses an independent market monitor to examine ETS auctions and all holding and trading of compliance instruments for the trading program. Activities in related markets are also tracked and analyzed. These actions have contributed to a widespread acceptance of a carbon price.

Efficiency and Cost-Effectiveness

Successful carbon pricing improves economic efficiency and reduces the economic costs of emission reduction.

Carbon pricing **minimizes the cost** of achieving environmental objectives. Due to built-in flexibility, carbon pricing instruments also **improve efficiency** in the allocation of resources in the economy by making market prices reflect the true social cost of emissions-intensive activities. Well-designed policies can also have relatively low administrative and compliance costs. **Productive use of revenues** additionally contains overall policy costs. One of the most productive uses of revenue is using it to lower the burden of other more distortionary taxes.

Carbon pricing encourages emissions reductions at least cost, giving affected entities flexibility to choose how and when to reduce emissions based on their own assessments of costs and benefits.

Ability to achieve environmental protection at lower overall cost to the economy is a key advantage of carbon pricing. Carbon pricing offers firms, people and institutions maximum flexibility as to how, when and even whether to reduce emissions, taking into account their own calculations of cost and benefits and their own preferences. It indiscriminately promotes a full range of opportunities for mitigating emissions across the economy, such as shifting to clean technologies, fuels or products, or just changing behavior by driving less and economizing on the use of heating and air conditioning (Bowen, 2011); (Krupnick et al, 2010). Carbon pricing also encourages the cost-effective composition of these opportunities, by providing the same reward for any additional tonne of emissions abatement across different sectors, firms, and households. Carbon pricing creates a continuous incentive to exploit all abatement opportunities below a certain level of cost per tonne reduced, often discovering previously unknown, innovative, and inexpensive means to reduce emissions (OECD, 2009); (OECD, 2013a); (Popp, 2015).

The cost saving potential of carbon pricing depends on two main factors.

- ***Coverage of the carbon pricing mechanism:*** The more comprehensive the coverage in terms of fuels and or sectors, the greater the scope for optimizing across the range of available low-cost options (OECD, 2009).

- ***Heterogeneity of the sources covered:*** The greater the disparity between abatement costs across firms and sectors, the greater the benefits of the flexibility offered by carbon pricing policies over regulations that, for example, might require all firms, or all sectors, to reduce emissions in the same proportion or with the same technology.

International cooperation can further improve cost-effectiveness. Due to the unequal distribution of wealth and abatement opportunities around the world, the countries that can afford to reduce GHG emissions often have to pursue expensive abatement options to meet their mitigation targets. On the other hand, developing countries often have abundant low-cost emission reduction or prevention opportunities because their industrial and infrastructure assets are often older and less efficient. Under international cooperation facilitated by carbon pricing, high-income countries can be relieved from more expensive emission reductions at home and convert cost savings into financial transfers that reduce emissions in low-income countries while accelerating their development. This pragmatic approach allows the climate to be stabilized at a lower overall cost, while also improving political acceptance for challenging climate targets.

In reality, people and governments focus not only on efficiency but also on political and equity considerations as they explore mitigation solutions. International cooperation mechanisms can foster equity and fairness through explicit agreement and make use of bottom-up carbon-pricing mechanisms to increase flexibility, cost-savings and resource transfers.

Mechanisms to facilitate international cooperation through carbon pricing may involve commonly agreed (minimum) tax rates or linking emissions trading systems (see Box 18). The former would also require an agreement on rules for transferring tax revenues to developing countries. International coordination can also occur through offset markets, which transfer finance to low-cost mitigation options in developing countries while lessening the burden on countries with carbon pricing. There are practical challenges that need to be managed to ensure that projects would not have proceeded anyway in the absence of the offset payment. While different countries have different preferences and ambitions, they can move toward a harmonized carbon price through bottom-up agreements starting at a regional or subnational level.

Carbon pricing improves resource allocation in the economy by ensuring the damaging costs of GHG emissions are taken into account in production, consumption and investment decisions by the public and private sectors, households and individuals.

Efficient economies reflect environmental costs into the price of goods and services. Putting an explicit price on emissions aligns the private and social costs of fossil fuel use. It also promotes efficiency in the allocation of resources.

An economically efficient carbon price level reflects the present value of environmental damages, and is consistent with long-run climate stabilization targets at the lowest economic cost. Prices in most existing explicit carbon pricing schemes (taxes and ETSs)—which are typically around US$10 per tonne of CO_2 or less (WBG, 2014)—are below the bottom end of the range of published estimates of efficient carbon prices in the literature. Most studies indicate that a global average carbon price (explicit and implicit) between US$80 and US$120 in 2030 would be consistent with the long-term climate stabilization target. (Clarke et al, 2014), (US IAWG, 2013), (Kriegler et al, 2013), (Nordahus and Sztorc, 2013); (IPCC, 2014d), (IEA, 2014); (Mercer, 2015). In selected instances, implicit carbon prices, embedded for example in renewable support systems in some EU countries, are already in this range (OECD, 2013a). While these carbon prices, calculated by large-scale climate-economy models, do not necessarily have to be an explicit carbon tax rate or allowance price, the difference between this range and the prices currently observed gives an indication of the scale of the challenge lying ahead.

Administration can be simplified and therefore costs minimized by building on existing policies and institutions.

Carbon pricing instruments are often less burdensome to administer compared to direct regulations. Carbon pricing works with much less information needed by regulators. Governments can set the emission price and firms are then incentivized

BOX 18: Use of Offsets in Carbon Pricing Scheme in South Africa

South Africa proposes to allow affected entities to use limited offsets in lieu of paying some of the carbon tax. In addition to enabling industry to achieve carbon mitigation at a lower cost than their tax liability and incentivizing mitigation activities in sectors not directly covered by the tax, carbon offset projects are expected to also help generate additional sustainable development benefits by moving capital to rural development projects, providing jobs, regenerating landscapes, reducing land degradation and by protecting biodiversity (EDF/IETA, 2014b).

to find their own costs, benefits and strategies as they seek to comply with the carbon pricing scheme.

Successful carbon pricing systems take administrative factors into account when designing the scope and selection of a pricing mechanism. For example, several jurisdictions found that placing a carbon tax on fuel content may be administratively easier to implement than emissions trading in some sectors, such as transport, agriculture or buildings, where monitoring is a challenge because sources of pollution are small and dispersed (Parry et al, 2015). High administrative and transaction costs can lead to decisions to exclude some emitters or establish payment obligations "upstream" on the suppliers of fuels that cause emissions when consumed "downstream" (e.g., at the refinery gate, mine mouth, processing plant or wholesale import); see, for example systems put in place by France, Finland, Slovenia and Switzerland (OECD, 2015). Upstream carbon pricing can reduce administrative costs, especially if downstream sources of direct emissions are dispersed. For example, British Columbia's carbon tax applies to the carbon content in fuels and is paid by fuel distributors. It indirectly covers around 70 percent of the province's total emissions from fossil fuel combustion, including gasoline, diesel, natural gas, fuel oil, propane and coal. It affects residential, commercial, industrial and municipal fuel use.[18]

Carbon taxes applied to upstream suppliers of fossil fuels also reduce administrative costs by making use of existing institutions known to program participants. For instance, procedures developed for excise tax purposes—such as practices to ensure that fuels do not by-pass prescribed measuring points and are taxed only once, and provisions to impose levies on imports and exempt exports—would be similar to those required to run and operate a carbon tax program. Existing excise legal frameworks for taxpayer registration, returns, payments, audit, and dispute resolution can be adapted for a carbon tax without significant alteration (Metcalf and Weisbach, 2009), (Calder, 2015). Moreover, the training and skills of compliance officers managing excise taxes would be well suited to applying a similar regime to a carbon tax (Parry et al, 2015).

[18] British Columbia, Ministry of Finance. "Myths and Facts about the Carbon Tax," see http://www.fin.gov.bc.ca/tbs/tp/climate/A6.htm.

Most existing emissions trading schemes apply carbon pricing to large emitters at the point of actual emission (downstream). Although administration and monitoring costs may be higher, downstream systems have the advantage of being more targeted and visible to emitting facilities and to the public. Emissions trading systems require empowering existing environmental agencies to issue allowances, manage an emissions registry and conduct MRV. Trading can be built upon existing exchanges, financial institutions and private consulting companies. Governments may need to extend the mandate of antitrust agencies and energy-sector regulators to cover these new responsibilities. Some governments are using hybrid systems, with downstream emissions trading for large point sources and upstream carbon taxes paid by sources not covered by the ETS. For example, Sweden, Denmark, Norway, Poland, and Slovenia apply carbon taxes to some sources not covered by the ETS.

Judicious use of revenues from carbon taxes or emission allowance auctions can produce additional economic benefits, including fiscal dividends.

Carbon pricing can raise substantial revenues. In 2014 an estimated over US$15 billion in government revenue was raised through carbon taxes and ETS sales. About a third of total government revenue, was derived from the sale of emission allowances under ETSs. The total revenue in 2014 raised through carbon taxes implemented around the world is estimated at over US$10 billion (World Bank Group, 2015). Hypothetical, potential revenues can be several orders of magnitude higher according to some estimates. Although fossil fuels are a stable tax base—i.e., consumption does not decrease rapidly as the price goes up—there may be a trade-off between fiscal and environmental dividends. In some sectors (e.g. power and industry) a carbon price will accelerate the switch away from fossil fuels and offer climate benefits, while also eroding the revenues from fossil fuel taxes.

Productive use of revenues counteracts adverse effects on the economy from higher energy prices and contains overall policy costs. One of the most productive uses of revenue is to lower the burden of other taxes—particularly taxes on personal and corporate income and payroll—that distort economic activity and harm growth. Carbon pricing can ease the shift to more efficient tax systems, rather than raising overall tax burdens (like in British Columbia) and reducing strongly distorting taxes. Some models show that if the underlying tax system is distortionary, the smart use of carbon price revenues can provide a net economic gain even before counting environmental benefits (Jorgenson et al, 2015).

Carbon pricing revenues are sometimes used to pay for productive investments in health, education and infrastructure. This option can help those countries that suffer from weak tax administration and compliance and with a large informal sector. Revenues can also be used to promote the development of clean technologies. For example, California, Quebec and the EU allocate a portion of ETS auction revenues to designated green technology funds (EDF/IETA, 2015a). Generally, revenue spending possibilities should yield economic efficiency benefits at least as large as those from alternative revenue uses (e.g., cutting other taxes). Successful systems avoid diverting potentially valuable revenues from the budget (e.g., earmarking of revenues) for low-value spending, in particular through off-budgetary institutional structures.

Reliability and Environmental Integrity

Successful carbon pricing schemes result in a measurable reduction in environmentally harmful behavior.

The success of carbon pricing in reducing GHG emissions can be influenced by a number of factors, including the carbon price level and coverage of the pricing scheme. Carbon-pricing policies are more **environmentally effective** at any rate level when substitutes for emissions-intensive activities or products are easily available at low cost, reinforcing the need for flanking policies to support carbon pricing mechanisms. **Benefits beyond GHG emission reduction** can result from carbon pricing. **The choice and design** of pricing instrument also matter for environmental outcomes.

Comprehensive coverage of fuels, sectors and gases enhances environmental impact, but transaction and monitoring costs for some sources need to be managed.

Comprehensive coverage of fuels, sectors and gases enhances environmental impact. The extent to which various emissions sources, sectors and greenhouse gases are covered by a carbon-pricing mechanism will naturally affect its environmental impact, as will the price level. It will also influence a system's cost-effectiveness, given that broadly applicable mechanisms optimize a wider range of low-cost abatement options (as discussed under the Efficiency and Cost-Effectiveness Principle).

Most current schemes target specific sectors and are not comprehensive (Figure 3 below). The EU ETS covers 45 percent of the EU's GHG emissions. It focuses on large emitting sources and covers CO_2 and two other greenhouse gases. Several EU countries (e.g. Ireland, Denmark, Sweden, Slovenia or Poland) have complemented the EU ETS with carbon taxes covering additional sectors. Korea's ETS—the world's second-largest scheme—covers 66 percent of the country's emissions, with a focus on heavy emitting industry; all six GHGs are covered.[19] Starting in January 2015, California extended the coverage of its ETS to emissions from the combustion of fuels, such as gasoline, diesel, propane and natural gas. New Zealand's ETS is the only carbon market scheme in the world that includes emissions liabilities for land-use sectors: deforestation of pre-1990 forest land (as of 2008) and biological emissions from agriculture (EDF/IETA, 2013a).

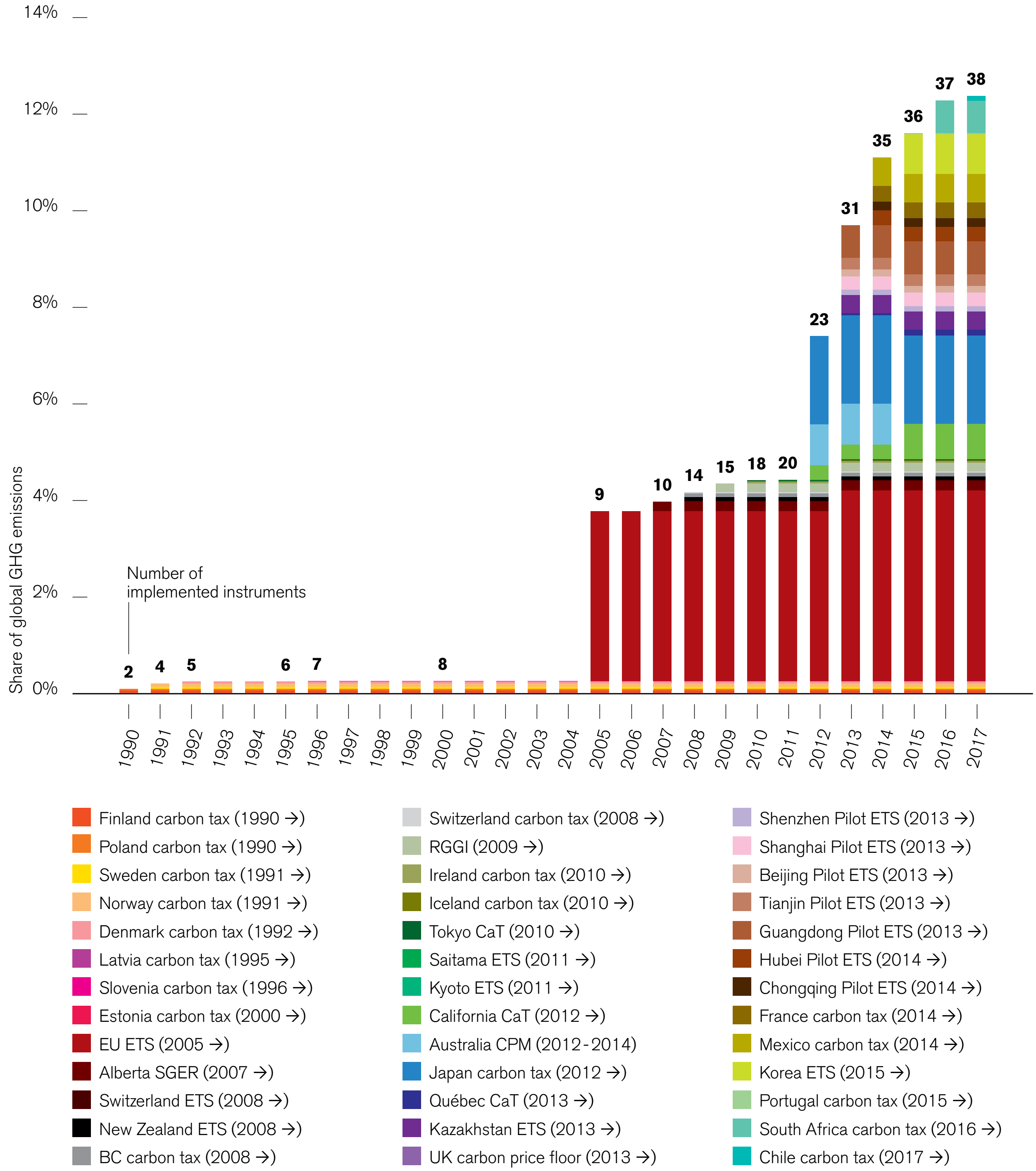
Narrowly targeted policies may be easier to implement initially than broader mechanisms in view of political challenges. There are often trade-offs between policy coverage and ambition level. Broader price mechanisms that cover many industrial sectors, for example, may need to be less stringent on introduction than more targeted mechanisms.

In general **CO_2 emissions from fossil fuel combustion are easier to price than other greenhouse gases and are the largest source of emissions.** It makes sense to price these sources first, gradually extending pricing to non-CO_2 greenhouse gases like methane and forestry emissions as the needed expertise and administrative capacity is developed.

Carbon pricing policies consistent with environmental objectives are more effective when substitutes for emission-intensive activities or products are easily available at low cost.

[19] For more information on the Korean system, see https://icapcarbonaction.com/ets-map.

FIGURE 3: Sectoral scope and percentage of emissions covered by the regional, national and sub-national emissions trading schemes.



Note: Only the introduction or removal of an ETS or carbon tax is shown. Emissions are given as a share of global GHG emissions in 2012. Annual changes in global, regional, national, and subnational GHG emissions are not shown in the graph. Data on the coverage of the city-level Kyoto ETS are not accessible; its coverage is therefore shown as zero.

Source: World Bank Group (2015) The State and Trends of Carbon Pricing.
Alexandre Kossoy, Grzegorz Peszko, Klaus Oppermann, Nicolai Prytz, Noemie Klein, Kornelis Blok, Long Lam, Lindee Wong, Bram Borkent. 2015. "State and Trends of Carbon Pricing 2015" (October), World Bank, Washington, DC. Doi: 10.1596/978-1-4648-0725-1 License: Creative Commons Attribution CC BY 3.0 IGO.

Pricing mechanisms reduce emissions through a combination of lower emitting activity, technological improvement, fuel or product substitution and other behavioral changes. The interaction between these different effects depends both on the type of activity and the cost and ease with which low-carbon technologies and products can be substituted for emissions-intensive alternatives. For example, poor households often do not replace old inefficient appliances or insulate houses after the carbon price is passed through to their energy bills. Car owners will not reduce their driving distances significantly if cities lack convenient and safe public transport and bicycle infrastructure. That "stickiness" of technologies and behaviors makes the presence of complementary, supporting policies—addressed in detail in the discussion under the Alignment Principle—particularly important to the environmental effects of carbon-pricing policies in certain sectors.

Carbon pricing policies can deliver multiple benefits, including local environmental and health benefits.

Multiple benefits result from the successful implementation of carbon pricing policies, including a reduction in premature mortality, improved air pollution and energy savings.[20] Carbon pricing can also raise road fuel charges towards levels that more fully reflect adverse side effects from vehicle use (carbon emissions, local air pollution, traffic congestion and accidents, wear and tears on roads). However, policies that tackle local problems directly (e.g., congestion charges, charges for local air pollution, or a ban of the use of solid fuels in a city) are usually more effective in solving them.

Nonetheless, it is useful to account for some domestic environmental benefits when evaluating carbon pricing proposals. The co-benefits of carbon pricing will vary considerably depending on local circumstances. For example, carbon prices will have higher local environmental benefits when local air quality can be improved most efficiently and effectively through fuel switching than when it can be best done by installation of highly efficient filters and scrubbers to remove dust and SO_2 from coal-fired combustion plants.

The choice and design of pricing instrument matter for environmental outcomes.

In principle, emissions trading systems offer more certainty about the environmental outcomes than carbon taxes because they rely on explicit emission caps (unless allocation is output-based). The environmental effectiveness of carbon taxes depends on a number of other factors that influence business decisions in emission-intensive activities. Often several years are needed to determine the impact of a tax on emissions. This is because it takes time for businesses and consumers to respond to the carbon price signal. Ex ante analyses using expected fuel price elasticities or energy technology models may provide a reasonable prediction. A tax offers more certainty about the maximum cost to the regulated entities (as discussed under the Efficiency Principle). Well-designed systems avoid over-allocation of emissions allowances or increasing the volume of free allowances, as these tactics can destroy incentives to reduce emissions and reduce the overall environmental result.

[20] Global deaths from exposure to outdoor air pollution were estimated at 3.7 million in 2010 (WHO, 2014), though some of the pollution is from other emissions sources besides fossil fuels, and a million of these deaths are jointly determined by exposure to indoor and outdoor air pollution.

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