Chapter 5

Policies for scaling up low-emission and resilient investment

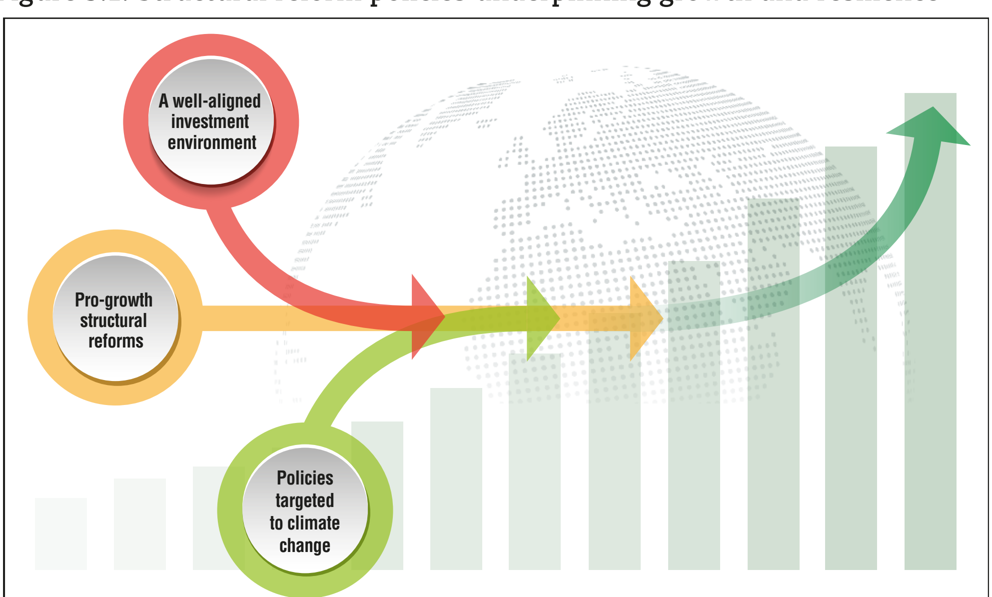
Triggering the investment needed for low-emission and resilient economic growth requires a co-ordinated constellation of policies, spanning structural pro-growth reforms, climate policies and the broader investment environment. This chapter first considers how structural reforms can kick-start growth while also supporting the low-carbon transition. It then focuses on climate-change policies, including carbon pricing. Next, the chapter examines how policies making up the broader investment environment may be misaligned with climate objectives. If investment conditions are not conducive to low-carbon investments, even the best-designed climate policy is unlikely to be effective. Finally, the chapter considers how policy can be used to better orient public infrastructure planning and implementation towards low-carbon options, both at national and sub-national levels.

Quality investment, whether from the public or private sector or a combination of the two, is a key driver of low-emission and resilient growth. A successful transition requires policies that influence investment decisions across the entire fixed capital stock – long-lived infrastructure and buildings, and shorter-term production capital and machinery – as well as individual and business consumption decisions. This chapter shows how triggering the right investment while stimulating economic growth requires a co-ordinated constellation of policies, spanning both core climate policy and structural pro-growth reforms.[1]

The chapter starts by considering how structural reforms can kick-start growth while also supporting the low-carbon transition. It then focuses on policies targeted specifically at climate change objectives, including carbon pricing. Next, the chapter examines how policies making up the broader investment environment may be misaligned with the objectives of climate policies, building on *Aligning Policies for a Low-carbon Economy* (OECD/IEA/NEA/ITF, 2015) and the OECD *Policy Framework for Investment* (OECD, 2015a). If investment conditions are not conducive to low-carbon investments – or if policy conditions favour carbon-intensive investments – even the best-designed climate policy is unlikely to be effective. Figure 5.1 shows the interaction of structural, climate and investment policies. Finally, the last section of the chapter considers how policy can better orient public infrastructure planning and implementation towards low-carbon options. Public sector decision-making has a key role in infrastructure investment at both the national and sub-national levels. In some countries, the government remains the key actor and investor in infrastructure, whether through traditional public procurement or through state-owned enterprises.

Several policy themes run throughout the chapter: the need for country specificities to be taken into account, the need for policies to be inclusive and progressive (see also Chapter 6) and the role of innovation. Innovation is a crucial component of low-carbon growth and is influenced by policy in many ways, beyond core public funding of research and development. In addition, in this chapter policies are considered in particular for how they influence investment decisions for infrastructure. Different or additional incentives may be required to influence infrastructure investment decisions, as opposed to consumption or operational choices, for example due to the longer-term nature of infrastructure projects or their contribution to the public good.

Figure 5.1. Structural reform policies underpinning growth and resilience



Each country's economic structure, starting point and broader policy conditions will influence the policies required for attracting investment for the transition, their interaction with one another and with existing policies, and the best form of implementation. Chapter 2 indicated how greatly country contexts differ, within the G20 and more widely. Factors with an important bearing on policy options include:

- The nature of the existing infrastructure and other capital stock, and the sectoral investment needs required by low-emission pathways. Infrastructure will need to be expanded in emerging economies, and replaced and maintained in advanced economies (see Chapter 3).
- The structural factors that affect the agility and responsiveness of an economy to a growth stimulus, such as labour market flexibility, access to education and social protection (see Chapter 4).
- The openness of infrastructure sectors to private investment. The public and private sectors have different roles depending on a country's level of development (mobilisation of private finance is discussed in Chapter 7).
- Countries' social, economic and political landscapes, and governments' political will to act on climate, which are heavily influenced by factors such as poverty, access to energy and dependence on fossil fuels (see Chapters 2 and 6).
- The availability of resources, both financial and human, the strength of institutions, and capacity of the government and regulatory and business institutions (including state-owned enterprises, SOEs) to implement the needed reforms and uphold the rule of law.

Structural reform policies with benefits for both growth and the low-carbon transition

To create the conditions for low-emission growth, governments need first to ensure that the economy as a whole is conducive to growth and open to competitive investment. Structural reform policies that promote growth include product and labour market reforms, reforms that improve access to education and training, and those that increase knowledge-based capital. Such pro-growth reforms can also support the low-carbon transition by making economies more flexible, adaptable and resilient, including to climate impacts.

Reforms leading to well-functioning product and labour markets, as well as policies that do not trap resources in inefficient firms, can facilitate the reallocation of resources to their most productive use. Such structural policies play a key role in boosting productivity, the main determinant of long-term economic growth (OECD, 2015b). They can also help ensure that resources are allocated in a way that is consistent with moving to low-carbon economic activities, and minimise adjustment costs of getting there. Policies that help diffuse technology can also boost productivity, allowing more firms to approach the technological frontier.

Knowledge-based capital has become a key determinant of long-term productivity growth. It is particularly important in the context of the low-emission transition, as it accelerates the adoption of new technologies (OECD, 2015c; Andrews and Criscuolo, 2013). Among the different forms of intangible knowledge capital, R&D is vital. As a key driver of innovation, it reduces the costs of the transition to low-emission pathways. Taking advantage of knowledge-based capital to accelerate low-emission development depends on market reforms that allow reallocation of labour and capital to their most productive uses, as modelled in Chapter 4. This is because the initial cost incurred in deploying knowledge-based capital and R&D typically does not increase when it is combined with increasing amounts of other inputs (labour, capital) in the production of goods or services.

Provisions in employment protection legislation need to ensure that labour markets are flexible enough while ensuring a "just transition" for workers. As discussed in Chapter 6, the modest aggregate effect on jobs of the transition hides substantial job losses and geographical dislocation in some sectors, in addition to significant creation of new jobs, some of which require new skills. While employment protection legislation is instrumental in guaranteeing a just transition, it should not impose heavy or unpredictable costs on hiring and firing (Andrews and Cingano, 2014). In some emerging economies, employment legislation discourages hiring on formal contracts and keeps workers in low-productivity activities in the informal sector, thus excluding them from social safety nets and hampering worker mobility. Simpler and more flexible labour laws and broader safety nets can help workers move from the informal to the formal sector. In Turkey, for example, employment protection rules nurture a large informal sector (OECD, 2017a), and the social safety net for displaced workers could be improved by making public support for retraining and job search more reliable.

Identifying and addressing skills bottlenecks can help create a pipeline of low-carbon, growth-enhancing investment projects. When low-emission technologies create demand for skills, new vocational training programmes can be developed and top-up training offered to the existing workforce. The recent increase in environmental patenting underlies the importance of preparing the workforce for a period of rapid eco-innovation, including by raising science, technology and engineering skills (OECD, 2012a). There may be a significant role for local labour market institutions in identifying and satisfying specific training needs, for example, with respect to transport, urban development and waste management (OECD, 2014a).

Policies facilitating mobility of workers can boost growth and smooth impacts of the transition. Improving access to low-cost housing and assisting workers to relocate can help them to benefit from economic opportunities where they arise. Speeding up administrative procedures for building permits can boost responsiveness of housing supply, which can benefit the transition if it is combined with efforts to accelerate energy efficiency investment in housing. Transaction costs affecting the buying and selling of dwellings – such as stamp duties, acquisition taxes or other fees – lower mobility. On the other hand, policies that improve access to low-cost quality housing – for example, by introducing housing benefits or boosting the supply of low-rent social housing – improve well-being of low-income households, especially if the housing is made available in areas well-connected to jobs. Regulation that balances landlords' and tenants' interests can encourage the take-up of rented housing, encouraging mobility. Flexibility in the regulation of rents can also improve incentives for energy-efficiency investment, helping to overcome landlords' reluctance to make such investment (Andrews et al., 2011; Ameli and Brandt, 2015).

Policies that improve access to education make the most of the potential of youth from disadvantaged socio-economic backgrounds and improve intergenerational mobility across countries, boosting the inclusiveness of economic growth. They are also important to boost low-emission growth and to meet demand for new skills. Higher enrolment rates in early childhood care and education, and higher spending on childcare and early education, for example, tend to lower the influence of socio-economic background on students' secondary education achievement (Causa and Johansson, 2009). In emerging economies, access to education is also important to strengthen growth and ensure more equitable spread of benefits, including adult education to make it easier for workers to move to new jobs (OECD, 2017a). Cash transfers to low-income families, conditional on school attendance, have proven effective to improve education access and outcomes in some countries, such as Brazil (OECD, 2013a).

Some aspects of financial policy and regulation can also be considered as structural reforms important for the transition. Bankruptcy regimes that do not sanction small-business failure too severely can foster experimentation with new, riskier technologies, including low-carbon technologies. This increases the ability of economies to learn from new innovations, making it more likely that entrepreneurial ventures are brought to the market. Reducing the cost of winding down a business also makes it less likely that (inefficient) firms with low growth potential and outdated technologies, including high-carbon business models, are prevented from "exiting" the market and instead can release resources and valuable skills to more innovative business ventures.

Legal systems need to support efficient resource allocation and raise the returns to innovation, in part by limiting the duration of legal procedures such as bankruptcy (Andrews et al.; OECD, 2015c). In Mexico, improvements in the legal system could enhance the efficacy of contracts and the security of property rights, allowing the entry of firms with high potential to grow.

Reforms to improve the efficiency of lending and capital markets are also important for the efficient reallocation of resources, notably policies to avoid bailing out banks, including too-big-to-fail banks (Chapter 7). Reluctance to pursue such policies may retain capital in high-income countries, where bail-out expectations are likely to be more credible, while investment needs to achieve decarbonisation and sustainable development are biggest in emerging economies.

The rapid economic, technological and structural changes needed to meet the Paris Agreement objectives require responsive and inclusive economic and social systems. Pro-growth structural reforms may appear secondary to policy interventions focused on GHG mitigation or climate resilience. Yet they are critical for a more effective growth-oriented transition.

Strong and coherent climate policy as the basis for the transition

Core climate policies are the basic building block to shift investment and decision-making towards low-emission and climate-resilient options. They include carbon pricing, the removal of fossil fuel subsidies, and policies that complement carbon pricing. Such complementary policies include targeted investment incentives (e.g. feed-in tariffs or tenders for renewables), standards and direct regulation (e.g. to overcome barriers to energy efficiency, such as landlord-tenant situations) and information provision (e.g. energy efficiency labelling). Core climate policies also include measures to enhance adaptation to climate change impacts.

Carbon pricing: an essential emissions mitigation policy

Carbon pricing currently delivers weak investment signals.

Putting a price on GHG emissions is an essential climate mitigation policy. Pricing emissions, through taxes or tradable permits, encourages emitters to seek cost-effective abatement options (Box 5.1). The introduction and strengthening of carbon prices can also signal strong policy commitment, which may have knock-on effects on behaviours and activities not directly subject to the price.

Box 5.1. **Carbon pricing instruments in practice**

Carbon pricing includes taxes on energy use, carbon taxes and carbon emission permit prices, all of which increase the price of carbon emissions relative to other products. Carbon taxes and carbon emission permit prices (from emissions trading systems) are sometimes called "explicit" carbon prices as they are directly aimed at influencing decisions based on carbon content. Taxes on energy use are sometimes referred to as "implicit" carbon prices as they implicitly price the carbon contents of fuels, even if their primary (and political) purpose is not related to climate change.

Carbon pricing encourages energy users to reduce energy consumption from carbon-intensive sources and switch to cleaner alternatives. These prices can be set to reflect marginal external costs of carbon emissions or to attain abatement targets, or they can be the result of other policy objectives while still having the same behavioural effects as prices implemented for climate reasons.

Taxes and emissions trading are cost-effective policy tools to reduce emissions for three reasons. First, emitters have an incentive to cut emissions as long as this is cheaper than paying the price, and this equalises marginal abatement costs across emitters, ensuring overall cost-effectiveness. Second, carbon prices decentralise abatement decisions, thus overcoming the asymmetry of information between the government and polluters: the regulator does not need to stipulate which emissions should be reduced using which technologies. Third, they provide an ongoing incentive to cut emissions, thus stimulating innovation (OECD, 2016a).

Emissions trading and taxes offer different levels of certainty about total emissions and price levels. Emissions trading systems generally cap total emissions but the price of permits fluctuates following market dynamics. Such volatility can be reduced by setting a minimum and a maximum price. Goulder and Schein (2013) argue that the policy objective for emissions trading is cost-effectiveness, i.e. achieving a predefined cap and minimum costs. Taxes can send a stable price signal, but give no guarantee on the level of emissions. Net benefits are maximised under a tax when marginal abatement costs increase faster than environmental damages (Weitzman, 1974). The evidence suggests that abatement costs generally increase faster than environmental damages as long as economies are sufficiently far from irreversible tipping points.

From a public administration perspective, taxes are easy to implement if they can be grafted onto existing excise tax systems. Emissions trading systems generally require a whole new set of instruments. Monitoring and enforcing emission caps is crucial.

The Paris Agreement allows parties to co-operate to meet their targets (Article 6) and 95 (I) NDCs state intentions to use international carbon pricing in some form. International co-operation on carbon pricing can take different forms, from agreeing on a minimum carbon price to linking emissions trading systems, and may provide numerous benefits. These include a more consistent price signal, a lower abatement cost for a given level of emissions (cost-effectiveness), lower price volatility and higher market liquidity. In addition, international co-operation can reduce concerns about carbon leakage – which occurs when companies move their production to countries with less ambitious climate measures, leading to a rise in emissions – due to different carbon prices between countries. New research emphasises the importance of establishing trust and reciprocity for international co-operation on climate policy (Cramton et al., 2017), and argues that minimum carbon prices are a natural focal point (Cramton, Ockenfels and Stoft, 2017). Monitoring countries' use of carbon pricing can encourage participation through transparency.

Box 5.1. **Carbon pricing instruments in practice** *(cont.)*

Making international links through carbon pricing does present some challenges. Under emissions trading, countries may be concerned about surrendering control of the domestic carbon price to an international market – and the possible impact on inflation – or the potential scale of international transfers generated. It is easier to link emissions trading systems when markets are characterised by a similar size, share comparable levels of ambition, and show other common features, such as the types of price controls and allocation methods leveraged. The linked emission trading systems in California and Québec show that these technical challenges can be overcome. There is no experience to date of jurisdictions agreeing to a common carbon price level using taxes, but the European Union has adopted a set of minimum taxes for mineral oil products.

The potential of carbon pricing is far from being realised. At the same time, lower oil prices in recent years have reduced the impact of carbon taxation policies. Within the G20, most CO_2 emissions are not priced at all, and less than 10% are priced at EUR 30 or more per tonne of CO_2 (a conservative estimate of the lowest social costs that would result from a tonne of CO_2 emissions), measured on a basis of “Effective Carbon Rates” (ECRs)[2].

Calculating ECRs is a means to combine the carbon prices resulting from emissions trading, carbon taxes and the carbon price equivalent of specific taxes on energy use (OECD, 2016a).[3] These three components all increase the price of CO_2 emissions compared with other spending items, so they capture the economically relevant contribution of tax and emissions trading policies to the cost of emitting CO_2.

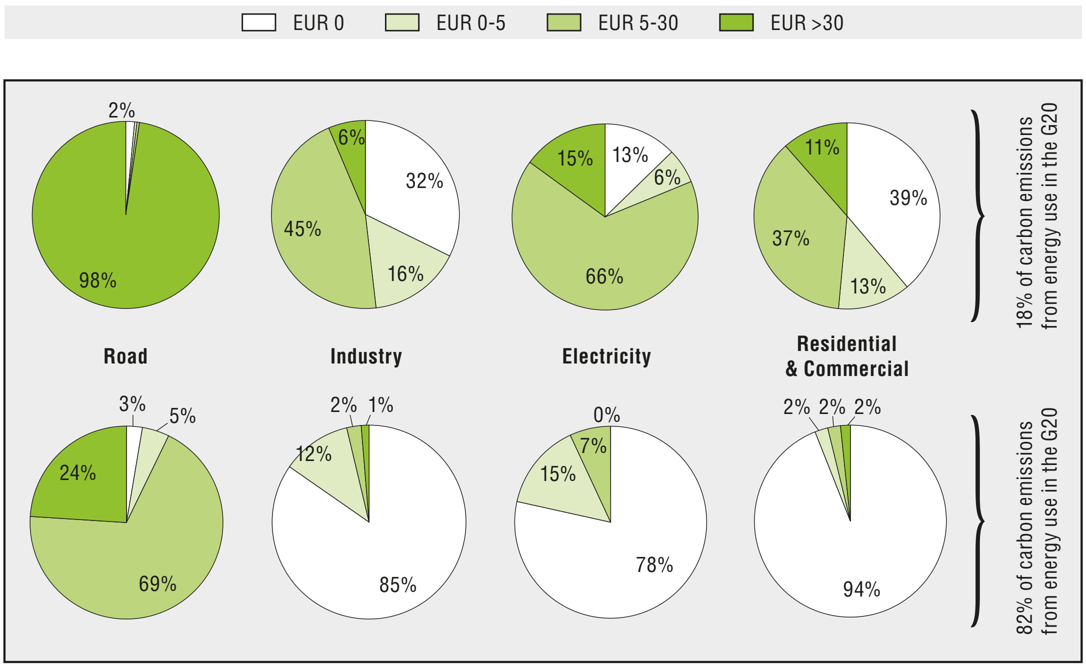
Currently, high effective carbon rates occur mostly in road transport, due to excise taxes on motor fuels. Such taxes are generally implemented as revenue raising instruments rather than to price carbon or change behaviour, but they do provide an incentive to reduce CO_2 emissions, as well as helping to curb air pollution, congestion and other external costs related to car use. Therefore, high rates in transport may well be justified. They have not been enough to decarbonise road transport, however, indicating that even where prices work, they cannot by themselves drive a structural shift away from low-occupancy, car-oriented mobility patterns.

In G20 countries, 84% of energy-related CO_2 emissions occur outside road transport, where they face very low or zero effective carbon rates, with only 2% facing a price of EUR 30 or more. ECRs consist mostly of excise taxes, although carbon taxes and emissions trading systems play a significant role in some sectors and countries. There is large variation in the levels and coverage of ECRs across the main economic sectors in different G20 members (Figure 5.2). The ten G20 members with the highest average ECRs (Argentina, Australia, France, Germany, Italy, Japan, Korea, Turkey, United Kingdom and the European Union) account for 18.1% of G20 emissions, whereas the nine countries with the lowest rates (Brazil, Canada, China, India, Indonesia, Mexico, Russia, South Africa and the United States) account for 81.8% of these emissions. The Netherlands is the only country surveyed that prices more than 50% of emissions from non-road sectors at EUR 30 per tonne of CO_2 or more (OECD, 2016a).[4]

Table 5.1. **Proportion of emissions subject to a positive effective carbon rate**
by price instrument across all G20 countries (biomass emissions included)

		Taxes			Effective carbon rate
	ETS	Carbon tax	Specific taxes	Combined tax	
Industry	10%	6%	21%	21%	26%
Residential and commercial	3%	6%	21%	21%	19%
Electricity	15%	4%	27%	27%	36%

Figure 5.2. **Proportion of CO_2 emissions from energy use priced at different levels**
in the ten G20 members with the highest average effective carbon rates (upper row)
and the nine G20 members with the lowest (lower row)



Note: Biomass emissions included.
Source: Adapted from OECD (2016a).
StatLink http://dx.doi.org/10.1787/888933484338

Carbon pricing needs careful design to send strong low-carbon investment signals

Certain design features of carbon pricing are necessary to reduce emissions and ease implementation. First, prices need to be sufficiently high and apply to the broadest possible range of emissions.

The larger the share of emissions covered by pricing, the stronger the incentive for cost-effective abatement. Coverage of energy and carbon taxes can be broadened by taxing fuels that have previously been untaxed (e.g., coal is untaxed in many countries and natural gas for heating often benefits from preferential or zero rates). Sector coverage can be broadened too. Some trading systems, such as New Zealand's, cover fuels directly at the stage of production and import, achieving broad coverage.

Second, any transitional support given to firms or households should avoid weakening abatement incentives in general, and low-emission investment signals in particular. For carbon pricing to influence investment decisions effectively, it is important to avoid preferential rates and free allocation of permits. Preferential tax treatment weakens all mitigation incentives, including for low-carbon investment. Granting permits to firms for free can create windfall profits and can also affect firms' technology choices, especially in sectors with limited competition.[5]

Full auctioning of permits sends a stronger signal to invest in low-emission technologies and to develop new ones, as it avoids the creation of rents that can favour carbon-intensive investment choices. Full auctioning can be phased-in to accommodate the transition of the existing emission-intensive capital stock. A commitment to full auctioning should also reassure firms that competing activities have to decarbonise, strengthening low-carbon innovation incentives. It also sends a strong positive signal to existing low-carbon firms.

To influence investment strongly, commitment to carbon prices needs to be long-term, and prices need to be predictable and subject to limited volatility. A stable price guarantees firms a minimum return on investment and innovation in clean technologies, and predictability facilitates risk management. Price fluctuations in trading systems create uncertainty; without a price floor, a minimum return on clean investment is not guaranteed (Goulder and Schein, 2013). The minimum auction price in California, which rises by 5% plus inflation each year, signals to firms that they will need to innovate in order to produce with low-carbon technologies. Taxes tend to generate more predictable carbon prices than emissions trading systems, although they too can change.

Productive use of revenue from carbon pricing is essential

How public revenues are used is also a crucial aspect of carbon pricing policy design. Revenue raised through carbon pricing can be large and can add to the direct benefits of pricing, but poor revenue-use can weaken these benefits. Pricing all emissions at EUR 30 per tonne would generate revenue of around 1% of GDP, on average across G20 countries, at current emissions levels.

Decisions on how to best use revenue from carbon pricing should strike a balance between social benefits and ensuring widespread support for carbon pricing. Depending on circumstances, the revenue can be deployed to stimulate growth (e.g., via higher spending or the reduction of more growth-inhibiting taxes), to increase inclusiveness (e.g., by increasing transfers), to compensate for potential loss of competitiveness, or to support low-carbon R&D. These options affect economic efficiency, welfare and social support for carbon pricing differently. A thorough examination of revenue use from carbon pricing should be part of an assessment of its payoffs. Distributing permits for free, awarding concessionary rates or setting tax-free thresholds should be considered as implicit forms of spending potential revenue (Bowen, 2015; ICMM, 2013).

Carbon tax revenues have so far more often returned to taxpayers through tax cuts whereas auction revenues from ETS permits are more often spent on green investment (OECD, 2017b forthcoming). Among G20 countries, carbon-pricing revenues are recycled in a variety of ways, including support for the transition, other green spending and broader tax cuts (Box 5.2) but clear assessment underlying these choices is not usually available.

Box 5.2. **How G20 countries use revenue from carbon-pricing policies**

In the **European Union,** at least half of EU ETS auction revenues for each participating country should be used for "climate and energy-related purposes" (European Commission, 2016).

Various provinces in Canada have implemented carbon-pricing policies. In **British Columbia,** the carbon tax is offset by tax cuts and credits for households and businesses, to obtain revenue neutrality. In **Alberta,** revenues from a carbon levy provide rebates to low- and middle-income households; since 1 January 2017, they have also funded a reduction of the small business income tax to 2%. Revenues are also reinvested in renewable energy projects, green technologies and infrastructure, and support energy efficiency through a new provincial agency (Alberta, 2016). In **Quebec**, all revenues from the GHG emissions cap-and-trade system are paid into a Green Fund to boost green spending and investment. In **Ontario,** auction proceeds will fund projects to promote pollution abatement, such as housing retrofits and incentives to promote electric-vehicle usage, as well finance the Green Investment Fund (Ontario, 2017).

Box 5.2. **How G20 countries use revenue from carbon-pricing policies** *(cont.)*

In **China,** auction revenue from ETS in Beijing, Shanghai, Shenzhen, Tianjin, Chongqing and Hubei may be used to compensate firms faced with competitiveness and leakage concerns. The government also has signalled an intention to set aside revenues to support "corporate carbon reduction, carbon market regulation and the carbon trading market" (Carl and Fedor, 2016).

In **France**, revenues from carbon taxation (implemented in addition to the EU ETS) finance a tax credit to boost business competitiveness (MEEDM, 2017). As of 2017, over half of revenues are allocated to an Energy Transition account to promote renewable energies.

In **India**, a tax on coal production (not strictly a carbon price) is used to fund the National Clean Energy Fund to promote low-carbon innovation and green activities and technologies, as well other ministerial budgets (Bowen, 2015).

In **Japan**, revenues from **Tokyo's** cap-and-trade emissions system are largely targeted at offsetting additional costs and price surges affecting small businesses and households, through tax reductions, credits and low-interest loans to encourage green spending (Bureau of the Environment, Tokyo Metropolitan Government, 2010.)

In **Mexico**, revenues from the carbon tax flow into the general government budget (OECD, forthcoming).

In the **United Kingdom**, revenues from a carbon price floor (implemented in addition to the EU ETS) contribute to the general budget.

In the **United States**, several states have implemented carbon-pricing policies. Revenues from the north-eastern **Regional Greenhouse Gas Initiative (RGGI)** promote energy efficiency, clean and renewable energy, green technologies and research. Households also receive rebates on their energy bills (RGGI, 2016). In **California**, ETS auction proceeds fund projects and programmes including low-carbon transportation and energy- and resource-efficient housing (CARB, 2017). Additionally, California requires electrical utilities to fully auction their emission allowances and to return all proceeds to households and businesses, to offset higher electricity bills (CARB, 2013).

South Africa is scheduled to implement a carbon tax in 2017. It has been indicated that revenues should return to households through tax shifting, tax incentives and financial assistance. Additionally, revenues would be earmarked to programmes that promote a low-carbon economy as well as specific mitigation measures for low-income households (The Davis Tax Committee, 2015).

Carbon taxation in **Australia** was repealed in 2014 after two years of implementation. Half of revenues were directed towards households through tax cuts, pension and allowance increases and other financial assistance, with a particular focus on low-income households. Revenues were also used to invest in green spending and technologies, and assist and provide funding to small businesses (Commonwealth of Australia, 2012).

With careful policy design, carbon-pricing revenue use can sometimes generate a double dividend: an emission dividend and a growth dividend through the reduction of other distortionary taxes, such as on labour or corporate income. Opportunities for a double dividend can also arise because of the low administration costs of upstream carbon taxes and their potential to cover emitting activities in the informal part of an economy. Revenues are frequently earmarked (Box 5.2). Strong earmarking – assigning all of the revenue to a stated purpose – is often deemed inefficient as it does not allow policymakers the flexibility to redirect spending when needed. Soft earmarking, or statements of policy intent, can help garner social support for implementation without the disadvantages of strong earmarking.

Higher energy prices strengthen some firms' ability to compete, creating carbon-neutral growth potential

Higher carbon prices may adversely affect the ability of some firms to compete, although the available empirical evidence reveals little to no effects to date. There is growing econometric evidence that the immediate competitiveness impacts of existing carbon-pricing mechanisms have been negligible (Arlinghaus, 2015; Partnership for Market Readiness, 2015). While this can partly be explained by the low prices and free allocation prevailing in most mechanisms, these same prices have reduced emissions, and windfall profits have occurred, so it is not the case that prices have always been ineffective environmentally or trivial economically. Rather than impinging upon strong firms' capacity to realise productivity growth, enhanced environmental policy stringency tends to be followed by an increase in short-run productivity growth of the most productive industries and firms (Albrizio et al., 2014). In the longer run, substitution possibilities are larger and stronger firms will be able to exploit them, potentially resulting in improved competitiveness.

Where measures to alleviate competitiveness concerns are used, support to industry is often not well targeted to address the risk that companies will move production to countries with less stringent carbon policies (i.e. carbon leakage). For example, over the current trading period of the EU ETS, 43% of allowances are freely allocated to firms deemed at risk of carbon leakage, but the criteria used to distribute allowances to firms are not always closely related to real risks of relocation or downsizing (Martin et al., 2014). In particular, the trade intensity metric, which implies a free allocation to 75% of the subsectors in the EU ETS, ignores that most of the firms exposed to trade have a low carbon footprint and are therefore immune to a carbon price.

International co-ordination on carbon pricing – such as agreeing on a minimum carbon price or linking emissions trading systems – would alleviate the risk of carbon leakage (Box 5.1). The benefits of co-ordination are recognised in the private sector, leading to several recent calls from industry for the G20 to co-ordinate on carbon prices (*e.g.* BDI, 2016; Investors on Climate Change, 2016, or the Carbon Pricing Leadership Coalition).

Carbon prices can help countries to reduce the size of the informal sector

Higher carbon prices can reduce the incentive for economic activity in the informal sector, complementing the structural reforms described above. Carbon and energy taxes can be collected upstream from the few firms that are importing or extracting fuels, ensuring low-cost compliance. Likewise, an emissions trading system can require importers and extractors of fossil fuels to acquire permits for the entire carbon content of the fuels they sell. In a competitive market,[6] importers and extractors will pass the carbon price through to fuel users. Thereby all sectors of the economy will pay the tax, both the formal as well as the informal. In addition, if revenues from energy taxes are recycled to reduce personal income or corporate profit taxes, it becomes less profitable to work in the informal sector.

Recent simulation studies for the United States and Spain suggest that the economic gains from reducing the informal sector through higher energy taxation are substantial (Bento et al., 2014, and Markandya et al. 2013). A countervailing effect could be increased attempts to evade energy taxation. While simulations for India and China show this may happen, the gains from reducing the informal sector through higher energy taxation dominate (Bento et al., 2014).

Strategies for reforming subsidies for fossil fuels

Subsidies to fossil fuels are incompatible with policies that attempt to internalise the costs of carbon emissions through pricing. Although no complete global accounting of subsidies has been compiled, subsidies that artificially maintain low prices for electricity and fuels — particularly petroleum products used in transport, kerosene, natural gas, fuel-inputs to electric power plants — are the most common (Table 5.2 and Figure 5.3). While subsidies have recently declined, this is partly due to falling oil and fossil fuel prices. Many of the policies that maintain these low prices have been around for decades. Investments in energy-consuming capital — vehicles, home appliances, factories — have in turn been made on the basis of these artificially low prices, locking in inefficient patterns of consumption.

Table 5.2. Government support to fossil fuels in G20 countries

USD billions

	2012	2013	2014
Production	28	21	18
Consumption	398	380	354
Of which, market transfers to consumers	*247*	*236*	*213*
Of which, other transfers (direct payments and tax preferences)	151	144	141
General Services	4	6	4

Note: 1. Including subsidies related to the under-pricing of electricity.
Sources: IEA (2015) and OECD (2015d).

Some governments also favour domestic production of fossil fuels, and their processing into products or electricity, through policies including concessional credit, loan guarantees, infrastructure and special tax features, such as accelerated depreciation. Some multilateral development banks have also financed fossil-fuel-related projects in developing and emerging countries, justifying these projects by the additional export earnings they will bring for the country, or investment in new industries they will attract. The effect for the climate, however, may be to encourage a development model that diverges from a low-emission track or that risks stranding a lot of fossil-related assets, like oil pipelines and coal-fired power plants (see also Chapter 7).

The fiscal impact of fossil-fuel subsidies, particularly those that keep fuels at low prices, can be large. Before Mexico embarked on its reform of gasoline and diesel price subsidies in 2014, the fiscal burden of those subsidies reached as high as 1.4% of GDP. Morocco's energy subsidies reached 5.5% of its GDP in 2011, before reforms were implemented (World Bank, 2012). And in 2012, before Indonesia embarked on its recent reforms, its fossil-fuel consumption subsidies were 4.1% of GDP – four times total government expenditure on health (AsDB, 2015).

Developing more complete and accurate information on subsidies can not only help make the public case for reforms, but also provide the basis for improving the targeting of subsidies (see also Chapter 6). In Germany, an official biannual Subsidy Report is released, including a "sustainability check" of all subsidies, and the Federal Environment Agency also carries out ongoing analysis of environmentally harmful subsidies, including in the energy sector.[7] Italy releases an official annual "Catalogue of environmentally friendly and harmful subsidies" aimed at helping the Parliament and the Council of Ministers define environmental policies that take into consideration international and European recommendations (Ministero dell'ambiente, 2016).

When subsidies are provided through interventions that force state-owned companies to sell energy below cost, investment often suffers, and the quality of the service declines over time (Fattouh and El-Katiri, 2013). Rationing may be another result. In Argentina, for example, electricity tariffs were set below production costs for over a decade, leading to significant underinvestment in the sector and frequent blackouts (Di Bella et al., 2015). To address this issue, the current government has embarked on an ambitious utility subsidy reform (Box 5.3).

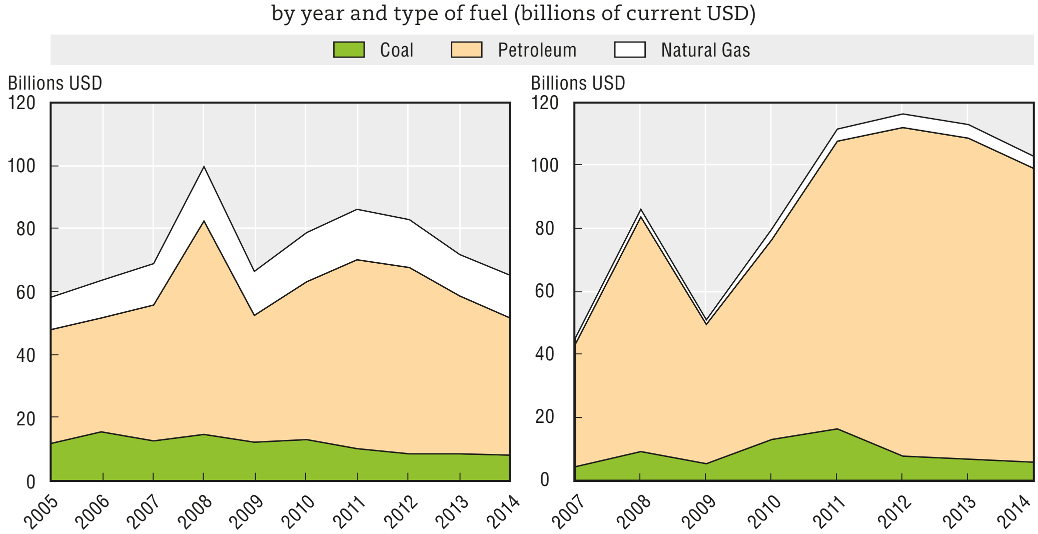
Box 5.3. **Electricity subsidy reform in Argentina**

For over a decade after its 2001 economic crisis, Argentina froze prices for public services, including electricity, to support poorer households (Lakner et al., 2016). The years of accumulated price distortion led to residential consumers only paying 10% of average electricity generation costs (Bidegaray, 2015). The total cost of energy subsidies in Argentina amounted to an average of 3.9% of GDP (2.1% on fuel, in addition to 1.8% on electricity) between 2011 and 2013, among the highest in the region (Di Bella et al., 2015). Besides the fiscal burden, the subsidy was not evenly distributed, with the majority being assumed by wealthier households (Lakner et al., 2016).

In 2015, an extensive energy- subsidy reform was launched, covering oil and gas as well as electricity, seeking to tackle the fiscal deficit and rebalance the economy. The reform has led to rapidly increasing electricity tariffs, for example between 61% and 148% in Buenos Aires, depending on consumption level. Despite the sharp increases, the tariff still only recovers 47% of generation costs (Buenos Aires Herald, 2017). A "social tariff" on electricity is available to protect the 2 million poorest consumers. The wider energy reforms face significant public resistance due to fears about job losses and increasing poverty. In August 2016, the Supreme Court reversed increases in gas prices for residential consumers until public hearings on tariff increases are held (Financial Times, 2016). The government faces the challenge of implementing the reform while minimising the social costs and smoothing the transition.

Figure 5.3. **Support to fossil fuels in OECD and key partner* countries**

Total support for fossil fuels in OECD countries (left) and selected partner economies (right) by year and type of fuel (billions of current USD)



Notes: *Brazil, the People's Republic of China, India, Indonesia, the Russian Federation and South Africa.The charts are based on an arithmetic sum of the individual support measures identified in the Inventory. Along with direct budgetary support, it includes the value of tax relief measured under each jurisdiction's benchmark tax treatment. The estimates do not take into account interactions that may occur if multiple measures were to be removed at the same time. Because they focus on budgetary costs and revenue foregone, the estimates for partner economies do not reflect the totality of support provided by means of artificially lower domestic prices. Particular caution should therefore be exercised when comparing these estimates with those reported by the IEA (2014a) for these countries.

Source: OECD (2015d).

StatLink http://dx.doi.org/10.1787/888933484346

Several countries could benefit from the unilateral reform of their fossil-fuel subsidies. Substantial energy subsidies to consumers are in place in emerging and developing countries, while OECD countries use a combination of tax expenditures and direct budgetary support to fossil-fuel producers and consumers (Coady et al., 2015; OECD, 2015d; IEA, OPEC, OECD and World Bank, 2010 and 2011). Reforms of fossil-fuel subsidies can bring many benefits. They can alleviate economic inefficiencies and trade distortions, tackle distributional inequity, and boost energy security, resource conservation and environmental protection (Burniaux and Château, 2011; Burniaux et al. 2011; OECD, 2014b). They can also support economic diversification, such as reforms now underway in Saudi Arabia (Box 5.4). At the global level, revenue gains from fossil-fuel subisdy reforms could amount to 4% of global GDP and CO_2 reductions could be more than 20% (Coady et al., 2015).

Box 5.4. **Energy and water price reform in the Kingdom of Saudi Arabia**

The government of Saudi Arabia, recognising the risks posed by an economy over-reliant on oil exports and with rapidly growing domestic energy consumption, has recently launched an ambitious whole-of-government reform programme called Vision 2030. One pillar of Vision 2030 is the Fiscal Balance programme, a significant energy and water price reform with the joint objective of improving fiscal stability and initiating a low-emission transition, by progressively increasing domestic fuel prices.

During the first phase of price reform, implemented in 2016, tariffs have increased on average by 35% for households and 46% for industry (Table 5.3). In the proposed second phase, scheduled to start in 2017, domestic energy prices are expected to be linked to a reference export price. While the methodology for calculating the reference price and the mechanism for varying domestic prices have not yet been announced, the stated objective is to adopt a domestic pricing mechanism based on international market prices, rather than on domestic production costs.

Table 5.3. **Energy and water prices in Saudi Arabia, 2016 and March 2017**

Product	Sector	2016 prices	Current prices (March 2017)
Gasoline (USD/l)	*- for households*	0.12 - 0.16	0.2 - 0.24
Electricity (USD/kWh)	*- for households*	0.013 - 0.069	0.13 - 0.08
	- industry	0.03	0.04
	- Commercial	0.03 - 0.07	0.04 - 0.08
	- government	0.07	0.09
Water (USD/m³)	*- for households*	0.026 - 1.6	0.04 - 2.4
	- others	0.026 - 1.6	0.04 - 2.4
Diesel (USD/barrel)	*- for transport*	10.6	19.1
	- for industry	9.12	14

Taking 2015 international energy prices and domestic energy consumption as a reference, the current reform is expected to reduce the cost of energy benefits to consumers from SAR 300 billion per year in 2015 to SAR 91 billion by 2020, according to estimations by KAPSARC.

Source: KAPSARC (2017).

Given that subsidies encourage the over-consumption of fossil fuels and increase GHG emissions, each country has an interest in other countries reforming their subsidies as well. For this reason, several groups of countries have recently made joint commitments to phase out inefficient fossil-fuel subsidies. The G20 did so first in September 2009, followed the Asia-Pacific Economic Co-operation (APEC) forum. Another grouping, the nine-nation Friends of Fossil Fuel Subsidy Reform, has made similar commitments. Belonging to such a group provides additional legitimacy for domestic reform efforts, and can facilitate information and experience sharing.

The G20 and APEC have followed similar paths in their common objectives to "rationalise and phase out over the medium term inefficient fossil fuel subsidies that encourage wasteful consumption", while recognising "the importance of providing those in need with essential energy services, including through the use of targeted cash transfers and other appropriate mechanisms". Both started with voluntary reporting of fossil fuel subsidies (all subsidies for some, for others just those that in their view would qualify as inefficient). From 2013, both groups agreed to conduct voluntary peer reviews of countries' reform efforts. Only a minority of G20 and APEC countries have completed peer reviews, however, or are in the process of completing them, and the process is time-consuming.

The resulting published reviews have expanded the public information available on fossil fuel subsidies, as well as improving understanding within the government. China, for example, prepared for its reciprocal G20 peer review with the United States by investing more than a year in identifying and understanding the aspects of its energy policy that favoured fossil-fuel production or consumption – consulting with academics, internal and foreign experts, and its energy industry – before submitting its report. By participating in the review teams, country experts have also come to better understand the diversity of support mechanisms, and the challenges other countries faced in designing and implementing reforms that will be politically acceptable and endure. One of the defining characteristics of peer reviews is that they are conducted on a non-adversarial basis, and are dependent on the existence of mutual trust among the parties involved in the review (Pagani, 2002).

Experiences from past attempts to reform agricultural subsidies suggest that, in order to maintain momentum for reform, there is a need for regular, up-to-date, publicly available and comparable information on progress in all the participant countries. This approach is institutionalised through the regular notification of domestic support to agriculture by the members of the World Trade Organization (WTO) and, among the OECD countries and their key partners, by the maintenance of a database on government support and the publication annually of an *Agricultural Policy Monitoring and Evaluation report* (OECD, 2016b). The WTO's Agreement on Agriculture committed all its members to the cessation of export subsidies and phased reductions of certain other forms of support. In contrast, the OECD policy monitoring and evaluation process is, formally, voluntary.

A similar regular and concurrent process could be considered as a mechanism to underpin international efforts to reform inefficient fossil-fuel subsidies. Comprehensive data on support have already been gathered for most of the G20 and APEC countries (OECD, 2015d), and several years' worth of estimates of the level of consumption subsidies, by fuel, have been compiled on an individual country basis for most of the rest of the world (IEA, 2015; Coady et al., 2015; IDB and World Bank, 2017 forthcoming). What remains to be done is to develop a common understanding of the effects of different types of fossil-fuel subsidies, which types (and in what combinations) are the most inefficient, and what approaches to reform work best in each country.

Critical in most fossil-fuel subsidy reform is the design of accompanying measures to compensate the rise in prices of basic commodities. Chapter 6 describes how countries have managed this transition, including minimising the possible regressive impacts of reform.

Beyond carbon pricing: interactions with other incentives and regulations

Well-designed and targeted economic instruments to promote reduction in GHG emissions can usefully complement carbon-pricing measures by addressing additional market failures and barriers, such as split incentives, information asymmetries, path dependency in innovation, policy uncertainty and country risks. Measures include specific investment incentives (in both infrastructure and land-use sectors), standards and mandates (e.g. efficiency standards) and information instruments (e.g. energy labelling) (Table 5.3). Where multiple measures are used, managing policy interactions is important.

Table 5.4. **A wide range of policy instruments can complement carbon pricing**

Policy type	Examples	Most commonly employed for: Renewable energy	Energy efficiency	Low-carbon transport
Targeted investment incentives (or technology support policies)	• Feed-in tariffs (premium or "fixed") and other renewables incentives (e.g. net-metering for households) • Tradable permits (e.g. UK renewable obligation certificates) • Capital grants • Tax incentives (e.g. tax rebates, depreciation rules)	Yes	Yes	Yes
Standards and mandates	• Technology standards (e.g. biofuel blend mandate) • Performance standards (e.g. fleet average CO_2 emissions, energy performance standards) • Renewable portfolio standards	Yes	Yes	Yes
Information approaches	• Rating and labelling programmes • Public information campaigns		Yes	Yes

Sources: OECD/IEA/NEA/ITF (2015); Hood (2011); de Serres, Murtin and Nicoletti (2010).

Investment incentives need to be stable and predictable, with clear, non-discretionary criteria for policy exit.[8] For example, many governments have introduced mechanisms providing fixed tariff contracts (power purchase agreements). While these provide revenue certainty for investors, setting appropriate tariff levels is challenging. If financial incentives do not adapt to the decreasing costs of maturing technologies, scarce government resources might end up funding unnecessary rents. For this reason, several governments are adopting new policy design features, such as declining feed-in tariffs, or turning to auctions to control the cost of support incentives (Box 5.5). Other countries have opted for market-based mechanisms, such as renewable portfolio obligations (RPOs) coupled with tradeable renewable energy certificates; monitoring and enforcement of obligations is critical for such systems to work (Haas et al. 2011; Shrimali and Tirumalachetty, 2013).

Environmentally motivated tax incentives – tax reductions or subsidies aiming to encourage environmental behaviour – are another form of investment incentive but should be used sparingly. They are poor substitutes for policies that directly discourage pollution in a cost-effective manner, such as carbon pricing. This is partly because it is difficult to target incentives correctly. There is a risk of subsidising non-intended choices that may be more carbon-intensive; for example, subsidising public transport while not increasing the costs of car use may encourage some households to locate further away from work and increase commuting distances. Tax incentives can also support investment that would have been made even in the absence of the tax incentive (poor additionality).[9] In addition, tax incentives are often costly and regressive (Appelt et al, 2016; Greene and Braathen, 2014).[10]

Box 5.5. **Evolving technology incentives for renewable electricity**

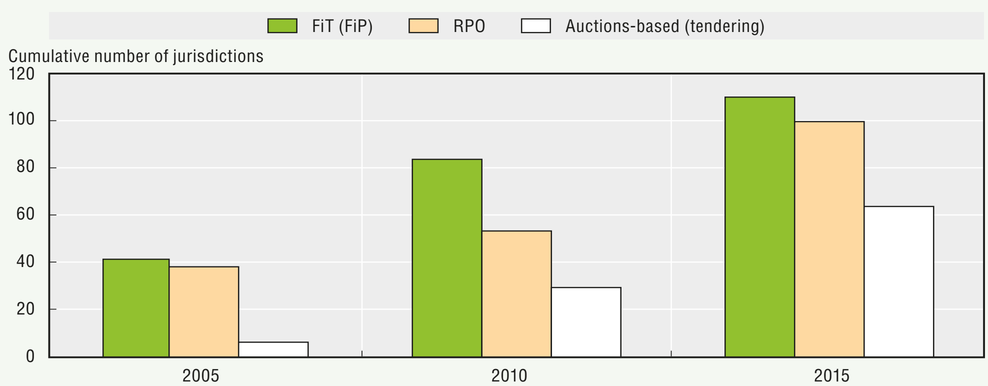
Fixed tariffs for renewable electricity off-take have stimulated deployment effectively but it has proven difficult for governments to control the total cost of these subsidies. Feed-in tariffs (FIT) support the deployment of renewable energy by offering long-term purchase agreements. They have played a major role in promoting investment in renewable energy projects. However, governments have found it difficult to control FIT programme costs as market uptake and technology cost reductions have been underestimated (Couture, T. et al., 2010). Some countries have introduced automatic mechanisms to control FiT programme costs, with the incentives declining based on the level of deployment.

Countries are moving away from pre-defined feed-in tariffs and adopting tendering processes to set tariffs for renewables. In theory, tenders provide numerous benefits, including competitive determination of tariff levels, control over budget allocated to renewables financial support and installed capacity. At least 67 countries had adopted

Box 5.5. **Evolving technology incentives for renewable electricity** *(cont.)*

renewable energy auctions by November 2016, up from 6 in 2005 (IRENA and CEM, 2015) (Figure 5.4). For instance, South Africa abandoned its renewable energy feed-in tariff in 2011, without a single contract being signed or negotiated in the two years of its existence, in favour of a competitive tender process, which is considered largely successful in channelling private sector finance into the renewable energy sector (Eberhard et al., 2014). The four rounds completed to date have cumulatively generated ZAR 192.6 billion in private sector investment, with foreign investment accounting for 28% (DOE South Africa, 2015). Mexico held its first auction open to private bidders in 2016 (Bloomberg, 2016a). The United Kingdom's renewable obligation certificate trading scheme is being replaced by a contract for difference mechanism,[11] where the variable top-up on the market price is determined through tendering. Some G20 countries are also experimenting with competitive tendering frameworks to support energy efficiency, as in the case of the German "STEP up!" scheme (STEP up, 2017).

Figure 5.4. **Number of countries/states/provinces with renewable energy policy, by type**



Source: REN21 (2016).

The cost-effectiveness of renewable-energy auctions depends on design and the level of competition. In technology-neutral auctions, different technologies compete to be the least-cost option (in Brazil, for example, renewables were competing with natural gas). In contrast, technology-specific auctions support the development of targeted technologies, as in India. The segmentation can also target generation profiles (baseload electricity, peaking electricity and non-peaking intermittent) as in California. In the United Kingdom renewables are clustered into technology "pots" reflecting their level of maturity. The volumes and frequency of auctions can also affect competition: if demand outstrips supply, then competition is severely reduced, as was reportedly the case in the 2011 South African tender (IRENA and CEM, 2015).

The introduction of technology- or experience-specific qualification requirements (financial guarantees), while important to determine the adequacy of bidders, may restrict market entry and hamper competition, for example by posing significant barriers to the participation of SMEs. The division of public procurement contracts in smaller lots can help but has to be balanced with the economies of scale expected from auctioning large lots. The overall tendering process should be designed to avoid price manipulation and collusive behaviour.

The bankability of the off-taker has a key influence on the attractiveness of auctions (IRENA and CEM, 2015). For instance, the creditworthiness of Indian government-owned utilities (Discom) varies widely from state to state; this has been cited as an important factor behind the significant difference in the auctions' ability to attract investors. Useful mechanisms in these circumstances are the creation of specific funds to ensure compliance with PPAs (e.g. Argentina) or policy risk insurance (e.g. USA OPIC) (IRENA, 2016, IASS, 2016).

Sources: OECD (2015e) and as cited.

Standards and mandates, such as technology and performance standards, have also been widely used as part of climate policy, in particular to promote energy efficiency. By failing to put a price or opportunity cost on the negative externality, however, standards and mandates generally do not ensure that environmental objectives are achieved at the least economic cost. Their use may be appropriate when barriers or information asymmetries stifle price elasticity. Performance standards can be successful in overcoming split incentives: energy efficiency standards for buildings can ensure that landlords invest in energy efficiency, which they otherwise would not do as tenants pay the energy bill.

Performance standards allow firms to search for the cheapest options to meet requirements. Technology standards are more prescriptive but may be the best option in specific circumstances, notably when the administrative costs of performance standards are too high or when abatement costs are relatively homogeneous across agents (de Serres, Murtin and Nicoletti, 2010). The effectiveness of technology standards can also rival that of prices when regulators and emitters have access to similar information. Performance standards for power plants may be one example.

Some standards might have the perverse impact of imposing higher costs on new (and more environmental friendly) firms. An example is vintage differentiated environmental regulations (VDR), which impose tighter regulation on new entrants than on existing firms; in 2015, for example, Canada introduced rules requiring investment in carbon capture and storage for all new coal plants, while existing plants can continue to operate unabated through to 2030. While VDRs may be justified on economic grounds – they smooth adjustment costs in the face of changing policy conditions, for example – they can result in higher costs for new firms, leading to slower penetration of less emissions-intensive technology (Coysh et al., 2017).

The third set of instruments available to policy makers includes approaches aiming at removing information gaps, for example through the labelling of energy performance of appliances and cars. Information-based instruments alone cannot reflect all environmental costs of product use, but they can transform markets by encouraging manufacturers to compete on this newly visible attribute (de Serres et al., 2010). Information approaches have also proven effective where actors may be unaware of either risks or available incentives related to climate change, such as in agriculture.

Climate policy instruments are usually not used in isolation, and managing interactions is important. Overlapping policies can be appropriate when several failures and market barriers need to be addressed. For example, several energy efficiency policies (e.g. labelling, standards, tax credits) may be introduced because there are several barriers (e.g. lack of information, split incentives) that prevent energy savings investment from being made. Targeted investment incentives, which in some cases overlap with carbon pricing, can be justified if they stimulate and lower the cost of low-carbon technologies, contributing to lowering the future cost of climate mitigation (de Serres et al., 2010; Acemoglu et al. 2012). Even where there is a rationale for overlapping policies, however, their interaction with quantity-based carbon pricing instruments such as emissions trading needs to be carefully evaluated (Hood, 2013).

Balancing climate and economic policy for agriculture and land use

Policy makers also need to take into account the synergies and trade-offs between productivity, mitigation and adaptation in agriculture and other land-use sectors, given the importance of land sectors for GHG emissions. Agriculture GHG emissions are increasingly decoupled from agricultural production in OECD countries (OECD, 2014c). This can be largely attributed to improved technologies and farm management practices, combined with incentives to lower emissions. Some policy incentives have reduced on-farm energy consumption (OECD, 2016c, 2016d, 2015b, 2015f, 2015g). Several other measures could reduce farm GHG emissions cost-effectively, such as increasing efficiency of fertiliser use and improving cattle breeding. These could be encouraged by information or incentive-based measures. Some market instruments like manure rights can be used and expanded to encourage a shift towards more profitable, emission-efficient sectors. Incentives that encourage emissions abatement and natural asset sustainability could facilitate the transition if governments help communities address their capacity gaps.

Policies to reduce agricultural GHG emissions can have significant impacts on water management and on water quality (though, absent mitigation, the impact of agriculture on water is likely to be more important with climate change; OECD, 2014d). Mitigation practices can affect water quality through their impacts on soil erosion rates, fertiliser and pesticide input uses, and the amount and nutrient content of animal manure. In addition, the development of bioenergy feedstocks may cause additional water use and, in some places, expand the use of water for irrigation. The synergies and trade-offs between mitigation and agricultural management practices are site-specific, however, and in many cases not yet known. It is nevertheless important to recognise these linkages in the design of mitigation policies to reduce the risk of conflict between mitigation and water policy objectives and to maximise potential synergies.

Combining sustainable agriculture and land-use policies with free trade principles is also important, as removing barriers to trade in agriculture products can optimise land use and reduce the overall demand for land in countries that have a comparative advantage in producing agricultural goods. In turn, it can alleviate pressures on forests. To avoid additional deforestation pressure from agricultural free trade agreements in resource-abundant countries, parallel policy instruments are needed to promote conservation efforts in accessible forest areas, as well as stronger institutions (Robalino and Herrera, 2010). Providing incentives to reduce emissions in other land-use sectors is equally important. In an attempt to halt deforestation and reduce emissions from land-use change, Brazil has introduced a number of policy instruments, including tradable forest quotas and low-interest loans for sustainable agriculture practices (Box 5.6).

Box 5.6. **Land-use policies to combat emissions from deforestation in Brazil**

Over the past decade, emissions from land-use change in Brazil have fallen more than five-fold from a peak in 2005, while emissions from other sources (including energy, agriculture, waste and industrial processes) have been increasing. As a result, emissions from land-use change as a share of total emissions have fallen from 68% in 2005 to 31% in 2015 (Government of Brazil, 2016; La Rovere et al., 2017). There has also been over 70% reduction in the deforestation rate in the Amazon between 2004 and 2016 (INPE, 2017).

Central to the efforts to reduce deforestation have been measures to address the underlying factors, such as the lack of clear land rights – which was resulting in rural conflicts and forest clearing as a way to define ownership – and enforceability of legal instruments to protect forests. The new Forest Code, adopted in 2012, introduces several changes to address these issues. These include the use of high-resolution satellite imaging to monitor forest cover and mandatory registration of all rural properties, with detailed geo-referenced information (OECD, 2015h). The code requires landowners to preserve a certain share of native vegetation of their land, with some flexibility allowed through trading.

Box 5.6. **Land-use policies to combat emissions from deforestation in Brazil** *(cont.)*

To address emissions from the agriculture sector, in 2010 Brazil adopted the National Plan for Low Carbon Emissions in Agriculture (ABC Plan), which provides low-interest loans to encourage farmers to adopt sustainable agriculture practices. The ABC Plan has set ambitious 2020 targets, which include reducing annual GHG emissions from agriculture by 160 million tonnes of CO_2 equivalent, and rehabilitating 15 million hectares of degraded pasture land (Angelo, 2012). While the uptake of the programme was initially slow, and slowed again in 2015-16, 28 500 loans have been issued since its inception, totalling more than BRL 13.2 billion (Newton et al., 2016).

Policies to improve climate change adaptation in agriculture and resilience of infrastructure

Climate change policy discussions often focus on reducing GHG emissions, but policies to adapt to climate change and improve resilience are also vital, as Chapter 2 highlighted. The majority of G20 countries have now developed national adaptation plans to co-ordinate their policy response to climate change. These can strengthen countries' capacity to manage climate risks (OECD, 2015i; OECD, 2015j). Key areas for achieving this are raising awareness and filling knowledge gaps on adaptation; mainstreaming climate risk management into decision-making; identifying necessary adaptation actions for key sectors and monitoring progress in building resilience.

Adaptation in agriculture: a key sector, vulnerable to climate impacts

Governments have an important role to play in encouraging adaptation in the agricultural sector, all the more so as sustainable, productive and climate-friendly agricultural systems will be needed to reach food security objectives for a growing world population (Chapter 2). As the benefits of most adaptation measures are local and directly captured by farmers, policy interventions may be needed to align privately profitable actions with socially desirable outcomes (Ignaciuk, 2015; OECD, 2015k). Smallholder farmers are less likely than better educated and better capitalised medium- and large-scale farmers to have access to the knowledge of sustainable agriculture pathways, meaning that adaptation efforts may fall short of what is best for society. Especially in less-developed countries, smallholder farmers face limited access to markets, credit, extension advice, weather information, risk management tools and social protection (FAO, 2016).

Agricultural policies are becoming more climate-aware.[12] Many OECD countries are promoting adaptation in agriculture and making national plans for climate change adaptation, especially in water policy, climate risk management, and extension services (OECD, 2016c, 2016d, 2015b, 2015f, 2015g). However, there is room for further improvement, in particular to better align strategic policy objectives and remove disincentives for farmers' adaptive actions.

Policy misalignment may send contradictory signals and dilute the impact of adaptation initiatives. For instance, although well-devised insurance programmes are a relevant policy instrument to help agriculture become more resilient to weather-related disasters, subsidised crop insurance premiums may induce more risky farming practices. Countries that support their agriculture through farm payments based on current production, land acreage or animal numbers may be creating incentives to continue producing subsidised commodities that are not well adapted to gradually changing weather conditions or extreme weather variability. Overall, a general lack of capacity to access and make use of relevant climate data can prevent farmers from integrating climate risk into their daily practices. Budgets for adaptation to climate change remain small at this stage.

Further, adaptation efforts in the agriculture sector need to be aligned with water policies, and consider both climatic uncertainty and regional specificity. Effects of climate change on agriculture occur through crop water requirements, availability and quality of water, varying across a range of scales from local to regional to continental (OECD, 2014d). Furthermore, the frequency and severity of extreme events such as floods and droughts may increase as a result of climate change and cause substantial damage to agricultural production (OECD, 2016e).

As a result, risk management instruments such as prevention and insurance can play a major role in managing the increased risk of floods and droughts. At the watershed level, well-designed, flexible and robust water-sharing rules and economic instruments, such as water pricing and water trading, can foster adaptation of water systems. Short-run incentives like public buyback of water rights on spot markets allow farm systems to cope with intra-seasonal volatility of water supply and reallocate water to its most efficient uses within the growing season. Long-run incentives like individual or group water rights and administered water pricing will allow agriculture to adapt to continuously changing conditions of water supply and other factors like growing population, increasing demand from urban areas, and the need to reserve some water for the needs of natural ecosystems. Policies aimed at improving water management can also orient agriculture towards increased productivity gains, which will make agriculture more input-efficient, and thus help mitigate the impact of the sector on climate (OECD, 2014d, 2016e).

To strengthen the agricultural sector's resilience to climate change, there are a number of entry points available for government intervention (Ignaciuk, 2015; OECD, 2015k, 2016h, 2016i). First, there is a need to scale up investment in public and semi-public agricultural research and innovation programmes. Improved access to research results through training and education then helps farmers and other stakeholders make rational decisions and scale up these innovations. Second, providing accurate and detailed information along with technical assistance on the risks and consequences of climate change, as well as opportunities for adaptation, allows stakeholders to make timely and informed adaptation decisions. Third, by encouraging adaptation planning and offering temporary financial assistance in clearly defined circumstances, public policy can help smooth the costs of switching to climate-adaptive practices (e.g., building the carbon storage capacity of agricultural soils through no-till cropping coupled with the permanent use of a land cover plant species and crop rotation). Finally, creating a well-functioning free trade system for agricultural and food products may support adaptation by compensating regional changes in productivity induced by climate change and enhance the four pillars of food security: accessibility, availability, utilisation and stability. Reducing tariffs and subsidies on agricultural products would help decrease agricultural prices.

Promoting resilient infrastructure

To achieve the overall goals of national climate change adaptation plans, it is crucial to ensure the resilience of all new and existing infrastructure, rather than simply to construct new infrastructure specifically intended to address climate risks. The vulnerability of new infrastructure investments to climate impacts will depend on their design, location and operation over time.

Climate resilience measures need to be tailored to specific contexts, and range from rerouting transport links out of flood plains to operating regimes for hydropower facilities. In general, owners and operators of infrastructure are best placed to decide on the appropriate measures. There is an incentive for them to do so, as they will reap the benefits of increased reliability, increased lifetime and reduced maintenance costs. However, in practice, there are several constraints on adaptation that can lead to a sub-optimal level of resilience.

Infrastructure owners and operators may be unaware of the potential impacts of climate change, lack the data or tools to make decisions or face distorted incentives, meaning they may not be in a position to measure and value relevant risks. Sources of distortion include misaligned policies, including regulatory frameworks, and unpriced externalities. Governments can use four tools to help overcome these barriers and facilitate the climate resilience of infrastructure networks (Vallejo and Mullan, 2017):

- **Improving risk information and assessment to support decision making:** Governments can support this process by ensuring that suitable data are available on climate-related hazards, including historical weather and flood losses, and encourage the provision of high-quality climate projections.
- **Screening and factoring climate risks into public investments:** Governments can influence resilience measures by considering climate resilience in their procurement and lending criteria. Multilateral development banks are playing a pioneering role in implementing risk screening of their lending decisions. For infrastructure implemented through public-private partnerships (PPPs), the allocation of risks should be examined to ensure that it is conducive to adaptation. Well-designed insurance requirements for PPPs can help to manage governments' potential liabilities while providing an incentive for risk reduction.
- **Enabling infrastructure resilience through policy and regulation:** Decisions relating to resilience will be shaped by the broader regulatory environment (including spatial planning, economic regulation and technical standards). Governments can address misalignments and support sub-national entities' capacity to implement relevant policies.
- **Encouraging climate risk disclosure:** There are a growing number of voluntary initiatives in support of climate risk disclosure. Governments can encourage the disclosure of climate risks where there are gaps in existing initiatives. If such mechanisms are appropriate, they should avoid duplication, provide incentives for reporting and be enforced.

Climate policies can boost innovation for the low-carbon transition

Many of the core climate policies presented above will play a role in driving innovation that generates low-emission and climate-resilient solutions. Policies that stimulate innovation and orient it in this way are vital. Markets do not provide sufficient incentives, even with carbon pricing. Low-carbon innovation is hindered by market failures that are related to the lack of carbon pricing and that affect innovation more broadly. The different types of climate policies considered above unlock the market for low-emission products and business practices –by internalising CO_2 costs, for example, or by providing incentives for environmental friendly behaviour – while defining the returns from follow-up innovations (GGGI, 2014). Recent evidence suggests that carbon pricing stimulates innovation rapidly and significantly (Dechezleprêtre, Martin and Bassi, 2016). However, not all environmental policies provide the same dynamic incentives, so governments should evaluate the innovation potential of climate policies according to several criteria, including (Johnstone et al., 2010):

- Dynamic efficiency: Does the policy create incentives to continuously search for cheaper abatement options?
- Predictability: What effect does the policy have on investor uncertainty?
- Flexibility: Are potential innovators free to identify the best way to meet the objective?
- Incidence: Does the policy target the environmental objective as closely as possible?

Tax incentives are often used to promote private R&D and can be targeted towards low-carbon technologies. Current market conditions and path-dependence concentrate innovation in high-carbon technologies. Preferential treatment of low-carbon innovation is justified to overcome this drawback and push economies to a low-carbon growth path. Further, the knowledge spillovers from patents for low-carbon technology are among the highest, as these patents are frequently cited (Dechezleprêtre, Martin and Mohnen, 2014). Large spillovers suggest that focusing on low-carbon innovation enhances economic growth.

However, the mere existence of large spillovers does not imply that targeted tax incentives are justified in every circumstance. Tax incentives may work best for bringing near-to-market solutions closer to broader market dispersion, whereas direct support for R&D or technology demonstration or deployment is likely to give a greater boost to innovation upstream in the supply chain. Upstream support has larger pay-offs, so it may be better to use instruments other than tax incentives (Dechezleprêtre et al., 2016). However, direct support requires expertise to ensure research projects are well selected and executed. If targeted tax incentives for green R&D, or direct support, are implemented, they need to be carefully designed so as not to create new path dependency. Additionality also needs to be considered: the tax incentive should create additional environmental benefits that would not have occurred otherwise.

Tuning broader investment conditions for low-emission and resilient infrastructure

Climate policies are introduced in the framework of existing policies and regulations sometimes geared towards carbon-intensive activities. These existing policies might inadvertently weaken the incentives provided by core climate instruments – and as a result weaken the business cases for investment and innovation in low-emission and climate-resilient infrastructure. For example, Box 5.7 points to recent evidence suggesting that policy interactions between climate and other policies have affected investment (and innovation) in renewable power. To align broader investment conditions with climate goals, policy makers need to assess whether both the general investment environment and specific policies in areas such as competition, land-use planning, trade and tax provide an unwarranted advantage to carbon-intensive technologies.

Addressing misalignments: Applying the OECD Policy Framework for Investment to low-emission infrastructure

The OECD Policy Framework for Investment (PFI) provides a systematic checklist of key policy issues for governments to create better conditions for attracting private investment (Table 5.4).[13] This section focuses on selected policy areas most relevant to supporting investment in low-emission infrastructure. Many of these policies also feature in the OECD Product Market Regulation index, used in Chapter 4 to model the effects of policy on private investment (see Annex 4.A3 in Chapter 4), so the policy suggestions in this section are supportive of the "decisive transition" in Chapter 4.

Table 5.5. **Relevant policy areas for low-emission infrastructure from the OECD Policy Framework for Investment**

Policy Domains	Selected policy areas	Relevance for low-emission infrastructure investment		More pressing for
		Energy sector	*Public transport*	*Advanced or emerging*
Investment policy	Restriction on foreign direct investment.		High barriers constrain flows of low-carbon capital and access to "best in class" technologies.	Emerging economies
	Contract enforcement and policy stability.	Retroactive policy changes and contract enforcement issues with off-taker in case of tendering (i.e. bankability issues, limited creditworthiness) undermine investment attractiveness.	Long-term contracts with a public authority require specific mechanisms for contract renegotiation and enforcement.	Both
	Land rights acquisition.	As opposed to fossil generation, renewable power plants need to be located close to the exploited renewable energy source.	Construction works require dealing with several owners both in urban and extra-urban projects.	Emerging economies
	International investment agreements.	Their impact is uncertain. They might help to attract foreign funds but might constrain the relocation of capital.		Both
Investment promotion and facilitation	Complex and uncertain permitting procedures.	Lower the investment risk-return profile for both on- and off-grid generation projects.		Both
	Investment promotion agencies.	Opportunity to increase the capital flows and to target investors (i.e. long-term investment funds).		Both
	Special economic zones.	Can become the testbeds for new policies and help resource rich countries to diversify.		Emerging economies
	Rule of law.	Corruption risk undermines efforts to secure an attractive investment environment for capital-intensive projects.		Both
Competition policy and design of regulated markets	Governance and competition with SOEs.	May crowd out private investment or increase the cost of capital due to a perceived higher risk.		Emerging economies
	Independent competition authority.	Limited competition and market rigidities can favour fossil-fuel incumbency. In addition, regulators need to be skilled in new low-carbon technologies to manage cases where environmental regulations and competition may not be aligned.		Both
	Electricity market design.	The increasing penetration of renewable generation challenges the current design of wholesale power market, given its low marginal cost.		Advanced economies
Land planning	Integrating land-use with transport planning and resource assessment.	Areas rich in renewable energy sources might require adjustment to their land-use destination.	Higher densities make the deployment of large-scale public transport systems more feasible.	Both
Trade policy	Tariffs and non-tariff measures on imports of low-carbon equipment.	Increase the (domestic) cost of low-carbon technologies, thereby slowing investment in cleaner energy.		Both
	Barriers to trade in environmental related services.	Limit access to the expertise associated with installing and operating low carbon equipment, thereby increasing costs and investment risk.		Both
Tax policy	Tax incentives.	Can have unintended environmental effects (e.g. provision of company cars for private use and the deductibility of commuting costs from personal income taxes).		Both
	Corporate income tax and technology bias.	Restrictions on loss carryovers tend to disadvantage technologies with a high share of upfront investment costs, including renewables.		
	Accounting rules for energy efficiency contracts.	Accounting rules may not capture the economic nature of energy performance contracts.		Both
Policies influencing responsible business conduct	Governments schemes on climate-related information disclosure.	Government-sponsored schemes are limited in the scope of required disclosure and their methodologies are insufficiently comparable across countries.		Both

Box 5.7. **Investment conditions and core climate policies combine to boost investment and innovation in renewable electricity generation**

New research by the OECD analyses data on more than 70 explanatory variables across OECD and G20 countries – climate mitigation policies, investment environment variables and control variables – to investigate determinants of investment flows and innovation in renewable power from 2000 until 2014.

The results support the hypothesis that beyond the need to set stronger, coherent climate mitigation policies, policy makers also need to align the broader investment environment in order to effectively mobilise investment in renewable power. Across OECD and G20 countries, renewables investment was primarily driven by targeted investment incentives, i.e. feed-in tariffs (FiTs), renewable certificates (RECs) and public tenders. FiTs and RECs have been effective in advanced OECD and G20 countries, while tenders have been effective in emerging G20 and OECD countries, and for wind-power investments across OECD and G20 countries. Support measures for fossil fuels used in power generation appear to deter renewable investment for emerging economies. Results also suggest that climate mitigation policies are enhanced when they are combined in certain ways. In emerging economies, for example, public RD&D spending in the renewable sector enhances the impact of explicit carbon prices or RECs.

Results suggest that investment flows in renewable power also depend on the attractiveness of the broader investment environment, particularly in emerging economies, as well as in wind and solar energy. Significant factors include the overall ease of doing business; perceived levels of corruption; investment policy (e.g. policies on registering property; and regulatory quality for solar energy); investment facilitation (e.g. licenses and permit systems for wind energy); competition policy (e.g. direct control of the state over enterprises) and trade policy (ease of trading across borders in the EU and for solar power). Financial market policy is also a key factor, for example access to domestic credit for the private sector, sovereign credit ratings, and implementation of Basel III leverage ratio requirements. Separately, results also confirm the important role played by core climate policies in promoting innovation, in particular that feed-in tariffs and public RD&D spending have stimulated patenting activity in renewable power technologies across OECD and G20 countries.

Source: Ang, Röttgers and Burli (2017).

Investment policy

Core investment principles such as not discriminating against foreign investors and ensuring the transparency and predictability of regulations are important to stimulate investment in low-emission infrastructure. Beyond the impact on total available capital, any restriction on foreign investment is also likely to limit access to best-in-class technologies (OECD, 2015m), thus slowing down the uptake of less carbon-intensive technologies and practices. Restrictions on foreign direct investment (FDI) in infrastructure sectors have fallen recently, as measured by the OECD FDI index.[14] China has lifted several restrictions on FDI, including for renewable power projects (NDRC, 2015). Such restrictions are above average in the transport sector across G20 countries, however.

Land acquisition is a pressing issue for renewable generation projects as they need to be located where natural resources such as wind and geothermal are best. Conflicts may emerge if sites are already occupied or are protected for nature, biodiversity or tourism reasons. In cities, complexity and uncertainties in acquiring land rights can delay the development of mass public transportation systems. When formal property rights for land are lacking, particularly in remote rural areas in some developing countries, these issues are likely to be exacerbated.

Tools that can reduce barriers in property regularisation include increased co-ordination between the different institutions involved in the property registration process and introduction of a land lease process (OECD, 2016f). For renewable energy, mapping natural renewable resources has proved instrumental, in part by reducing due diligence costs. To mobilise support from local communities, Denmark introduced an obligation for developers to offer a certain percentage of project shares to local residents (ENS, 2015).

Investment promotion and facilitation policies

Investment promotion and facilitation policies include laws, policies and regulations that promote a country or region as an investment destination for international investors, such as targeted investment incentive schemes, or that ease the burden for investors to establish or expand their existing investments, for example by streamlining administrative processes.

Low-emission infrastructure projects typically face high transaction costs due to cumbersome approval procedures. Streamlining licensing and permitting procedures facilitates investment in low-carbon infrastructure projects, especially for renewable power generation, and could be beneficial both in OECD countries (e.g. several European countries) and in other economies (e.g. China, India and Indonesia). Intricate administrative procedures can delay utility-scale renewable projects up to several years, while smaller projects might simply not go ahead because of the administrative uncertainties and costs (OECD, 2015l). One-stop-shops (OSSs)– offices in charge of issuing all required permits for project approval – can ease the regulatory burden. In Denmark, the three licences required to establish an offshore wind farm are all granted by the Danish Energy Agency. In Indonesia, authority for licensing geothermal power generation is now held by the central government while it was previously held by either central or local government depending on location (IASS, 2016; AsDB/World Bank, 2015). However, OSS effectiveness can be hindered if their role is limited to collecting permits issued by other offices (OECD, 2015l). Standardisation of contracts can also help reduce due diligence costs and favour aggregation of projects for refinancing by larger investors (CEFF, 2016).

Permitting issues also hinder the development of off-grid electrification. For instance, environmental authorities may subject mini-grid projects to the same process as power stations, requiring prohibitively expensive environmental impact assessments that may not be commensurate with the scale of potential project risks (Reiche, Tenenbaum and Torres de Mästle, 2006). Some countries are experimenting with a permanent exemption from obtaining a licence or permit for small mini-grids, as in Tanzania (up to 100 kW) and Mali (up to 20 kW), or developing an integrated licence for all activities connected to mini-grid operations (REN21, 2014).

The overall regulatory burden for large-scale infrastructural projects can also be reduced by tendering pre-approved sites, a common practice for transport projects that is now being adopted for low-emission infrastructure projects. In the Netherlands, the power grid operator obtains the necessary permits for future off-shore wind sites and performs a general environmental impact assessment for the sites, leaving bidders to submit only a project-specific environmental impact assessment. A similar approach has recently been introduced in the United States, where the Department of the Interior is encouraging developers to build solar farms on public land by completing preliminary (non-project specific) environmental impact statements before opening the competitive leasing procedure (Bloomberg, 2016b; Solar PEIS, 2017). Other mechanisms to lower administrative burdens include establishing a legal time limit for permit approval (Kozluk, 2014).

Investment promotion agencies (IPAs) can play an important role in attracting foreign capital by emphasising low-carbon options and carefully targeting and packaging projects. This requires a focus on specific subsectors whose selection should be based on criteria such as production costs, supplier-client proximity and availability of technologies and skills (UNCTAD, 2013). Focusing on projects that are bankable – politically supported, regulatory prepared and packaged in suitable sizes for relevant target groups – can be an effective strategy. For example, the Danish IPA (invest-in Denmark) has taken steps in this direction by focusing on specific clean technologies, including wind and bioenergy.

Other concerns regarding a country's investment environment, such as political instability, sovereign credit rating and corruption, may increase financing costs and deter foreign capital. Corruption particularly undermines efforts to secure an attractive investment environment for low-carbon projects given their capital intensity and reliance on public procurement. It is vital that governments follow best practice in fighting illegal business conduct, including due diligence and presence of appropriate reporting channels (OECD, 2016g; OECD, 2011; OECD, 2009; OECD, 2006).

Competition policy and design of regulated markets

Effective competition is essential to develop a business environment that can attract private investment in infrastructure sectors traditionally dominated by governments and state-owned enterprises. As elements of natural monopoly are present in sectors crucial for the low-carbon transition, such as energy and transport, good regulation is especially important, including through an independent competition authority with well-delineated responsibilities whenever several public agencies are present (energy authority, transport authority).

When formerly integrated activities are liberalised, good market design is crucial to ensure alignment with low-carbon objectives (OECD/IEA/NEA/ITF, 2015). G20 countries differ in the degree of competition in infrastructure sectors. Many developed countries have adopted market approaches in the electricity sector, unbundling generation, transmission and distribution and creating wholesale electricity markets open to competition. Other countries, including in the G20, retain a more integrated electricity sector. In the transport sector, competition is generally even more limited. In rail transport, other operators have entered the market in only a few countries, even though competition is technically possible in others (Casullo, 2015).

In markets where state-owned (or formerly state-owned) incumbents retain a dominant position, governments should ensure a level playing field. If SOEs receive undue preferences or advantages – in addition to direct compensation for their public service objectives – this may crowd out private investment and increase the cost of capital for new entrants. In Brazil, for instance, equal access by all firms to funding by the state-owned development bank could improve competition and resource allocation. In South Africa, exemptions for state-owned enterprises from competition laws has allegedly hindered competition. In China, removing implicit guarantees to SOEs could improve the allocation of capital, and potentially reduce emissions by slimming excess energy-intensive manufacturing capacity.

The OECD guidelines on SOE governance lay out the importance of effective corporate governance for SOEs as well as ensuring that SOEs are not exempted from general laws and regulations, including stringent financial reporting and disclosure requirements (OECD, 2015n). In the case of renewables, SOEs or incumbent utility firms may receive faster or cheaper access to the electricity grid due to close relationships with system operators. They may also be less likely to face curtailment when supply exceeds demand, and could be preferred bidders in tenders for new capacity. In many G20 countries, incumbent energy utilities, which are often publicly owned and carbon-intensive for historical reasons, can have a significant influence on energy policy. In some circumstances they have blocked energy efficiency programmes(Amon and Holms, 2015). However, other evidence suggests SOEs have been prominent investors in renewable electricity (Prag et al., 2017 forthcoming).

Where markets have been liberalised, investment decisions are meant to be driven by the price signals delivered by the wholesale power market, but market arrangements need to be improved in order to sustain competition and provide effective investment incentives. The progressive decarbonisation of electricity generation is challenging the current design of energy-only markets. Many liberalised electricity markets are no longer delivering accurate price signals because they were not designed to mix conventional power generation with high proportions of zero-marginal-cost renewable electricity. In addition, the variable and non-dispatchable nature of some renewable technologies can make it more difficult to balance demand and supply. Addressing this challenge requires equipping power markets with features such as high-resolution prices, pricing system reliability, better demand response, improved allocation of transmission and distribution networks costs, and the integration of storage (IEA, 2016a). More inter-connected grid systems can also significantly reduce duplication of resources, thus freeing investment for more efficient use elsewhere.

Another challenge for liberalised electricity markets is the need to maintain electricity generation capacity margins for security purposes at times of scarcity. Countries are developing different options to guarantee security of supply, including capacity mechanisms that ensure that plants will be available to run in times of scarcity. Some have criticised capacity mechanisms recently for prolonging the life of fossil-fuel plants that would otherwise be retired, therefore slowing down the process of decarbonisation. Others argue that capacity mechanisms are necessary to ensure adequate supply and flexibility as the share of variable renewable energy increases significantly.[15] Governments need to carefully monitor the effects of these measures as they look for an economical approach to decarbonising electricity while ensuring a reliable electricity system (IEA, 2016a).

In emerging markets with fast-growing electricity demand, the majority of electricity systems remain vertically integrated or without wholesale electricity markets. In China, market prices are regulated but transmission has been separated from generation. While some provinces have recently launched "market pilots" as part of the power sector reform efforts started in 2015 (RAP, 2016b),[16] revenues of power generators are essentially still based on administratively determined power prices. Similarly, in India about two thirds of the generation capacity is government-owned (OECD/IEA/NEA/ITF, 2015) and power traded on the wholesale market constituted only about 10 per cent of the total electricity generation in 2015-16 (CERCIND, 2016; Chattopadhyay, 2014). Such integrated and highly regulated electricity systems pose different alignment challenges. For instance, the administratively determined power prices paid to Chinese power generators are generally set to cover average cost. In turn, this requires generators to produce the yearly quantity of electricity planned by the public authorities in order to equalise revenues and average costs. This has reportedly led to heavy curtailment of wind power generation in order to maintain running hours of fossil fuel plants.[17] Furthermore, regulated prices make it difficult for utilities in some countries, such as China and India, to pass on the higher prices they pay for renewable PPAs, meaning integrated utilities face a disincentive to accepting more variable renewable energy supply on the system. Tariff issues, along with factors like non-technical losses (theft), have eroded the creditworthiness of several Indian distribution companies, potentially weakening the attractiveness of tendered PPAs. Recent measures to reform the Indian energy sector are likely to improve the overall business environment.

In general, rigid provisions on generation, transmission and distribution may hinder off-grid renewable-based electrification. For many low-income households in developing countries, off-grid solar has become an economically attractive alternative to kerosene for lighting purposes. Several companies are entering this market, either selling (or increasingly leasing) solar household-level systems or building community-level mini-grids powered by renewable or diesel generators. Even if a vertically integrated structure is maintained, the legal framework should accommodate distributed generation, or off-grid solutions will remain informal, foreclosing access to financing and limiting their growth (REN21, 2014).

Land-use planning

Land-use planning policies are important levers to reduce GHG emissions over the longer term because they can prevent the locking-in of energy- and carbon-intensive behaviour, particularly in urban areas. Cities in developing and developed countries are facing similar challenges from congestion and urban growth. However, these concerns are more pressing in developing countries, where urban growth is far more rapid due to urbanisation and motorisation processes that have not yet peaked (Srinivasan, 2001). Further, evidence suggests that as cities become richer, they tend to experience urban sprawl and declining density. This has been particularly the case in Asia (Box 5.8).

Sprawl tends to be associated with increasing road traffic and cost of infrastructure development. Integrating land-use and transport planning to address urban sprawl and create more compact cities can thus make the deployment of large-scale public transport systems more feasible, increase the share of public transport and encourage non-motorised travel. By combining pricing and regulatory policies to slow down the ownership and use of personal vehicles with strict land use control, governments could decrease cars' share of transport from 50% to 25%, depending on the region (OECD/ITF, 2017).

With numerous stakeholders and authorities involved in transport and urban planning, alignment is challenging. Consolidating planning agencies' responsibilities to include all transport modes as well as urban planning would facilitate such alignment. There are several successful examples of multimodal transport agencies, such as Singapore's land transport authority, which co-ordinates metro lines, buses and road projects. The institutions responsible for urban and transport planning are usually separate, however, and sometimes operate at different administrative scales. A possible solution is to promote fully integrated agencies operating at the metropolitan level rather than the jurisdiction of urban authorities.

Transit Oriented Development (TOD) aims to create dense neighbourhoods around transit stations, and has been successful in some places, notably in the United States (Cervero et al., 2004). Relying on a partnership between private property developers and public authorities, TOD can be seen as a more local and project-specific approach to integrating land and transport planning. If such projects are not accompanied by appropriate policies to preserve affordable housing in areas close to transit stations, however, the ensuing real estate premiums can lead to a "gentrification" process. In turn, this may lead to lower than expected ridership since wealthier households are more likely to prefer private vehicles to public transport, especially in developing countries (Siemiatycki, 2006).

While the existing built environment limits the options available to existing cities, new cities can be built with a low-carbon approach at their heart. Flagship eco-city projects are being built across the globe, including Masdar in Abu Dhabi, Tianjin Eco-City in China, and

Songdo eco-city in Korea. These are developed according to such principles as sustainable mixed-use development and integration of transport and land use. For instance, the Tianjin masterplan aims at providing public transit options for 80% of the population within 800m of their homes (GIZ and ICLEI, 2014). However, such projects are not exempt from criticism, including the risk of being "enclaves of the rich" (Caprotti, 2014), and still exposed to pollution generated by neighbouring sources.

Box 5.8. Urban planning: alarming trends in city density

Planning tools and strategic documents for urban planning exist in most countries, but they have proven to be insufficient to control urban sprawl. Despite land control policies, most developed countries have witnessed urban expansion since the 1950s when many people moved from city centres to suburbs. This resulted in urban sprawl with lower population density. This trend continues: between 1990 and 2000, the urbanised area in Europe increased by 18.4%, while population density fell by 9% (Oueslati et al., 2014). The two main determinants of urban extent are population and GDP per capita (OECD/ITF, 2017). Urban extent increases at a slower pace than population, thus bigger cities tend to be denser. However, richer cities tend to be more sprawling, meaning the average density of cities decreases (Table 5.6). This is true for all regions of the world, although to different degrees. The density decrease is particularly sharp in Asia, where rising GDP per capita will drive urban expansion.

Moreover, the combined effects of urban extension, population and income growth will result in a surge in road traffic, and require significant road investments. The situation is particularly dramatic for Asian cities, where the drop in density is sharp, 19% between 2010 and 2050, while road traffic rises by 532%. Maintaining an efficient transport system would require an increase of 295% of the trunk road network. Strict land use rules would drastically reduce the need for road infrastructure building, thus allowing the funding of large transit systems. By avoiding excessive sprawl, the costs of new road construction could globally be decreased by at least USD 10 trillion between 2015 and 2050.

Table 5.6. Projected variation in density, traffic and trunk road needs in cities

(% of variation between 2015 and 2050 for different world regions in business as usual scenario)

	Density	Traffic	Trunk road needs
Africa	-8%	325%	158%
Asia	-19%	532%	295%
Europe	-7%	40%	39%
Latin America	-8%	152%	92%
Middle East	-2%	228%	98%
North America	-1%	68%	36%
OECD Pacific	-8%	12%	24%

Source: Chen and Kauppila, 2017. and as cited.

Land-use planning when combined with land value capture tools can also help cities fund large-scale transport systems. A municipality can increase the value of land either through legal actions (e.g. providing permits for building facilities that will increase the value of existing buildings, such as a mall) or through improved access (e.g. new metropolitan lines). Through land value capture, the local authorities and the private actors agree beforehand how to share the capital gain, thus helping cities to mobilise financing for the initial construction and long-term operation and maintenance. Examples of land value capture tools include tax increment financing, development charges, development rights and joint development. Land value capture is not new, but its application for large investments in metropolises is growing. New York, Washington, London and Paris have all recently used some form of land value capture scheme and this example could be followed in other large G20 cities (see Box 7.3 in Chapter 7). A major difficulty of these schemes is the ex-ante evaluation of the value created by public investment and to calibrate the tax accordingly. Areas with weak property rights, such as slums, are also less amenable to land value capture.

Table 5.7. **Funds raised or to be raised by land value capture for selected large projects**

City	Project	Fund raised or projected	Percent of project cost
London	Crossrail	4.1 billion GBP	32%
Washington, D.C.	New York Avenue Metro Station	25 million USD	28%
Washington, D.C.	Dulles Metro-rail Silver Line Expansion	730 million USD	14%
New York	Subway 7 Line Extension	2.1 billion USD	88%

Source: Adapted from Salon (2014).

Implications of international trade and trade policy

When countries are linked through international trade, their climate policies affect and are affected by other countries' climate policies. The resulting fear of loss in competitiveness and "carbon leakage" can be an important political consideration where the stringency of climate policies differs across countries. Trade is also a source of GHG emissions in its own right, partly due to the energy consumption of international shipping and aviation – which are difficult to regulate due to the international nature of bunker fuels – as well as road transport. However, trade is also a mechanism for diffusion of low-emission technologies and services can and help countries to adapt to changing production conditions, including due to climate impacts. This section focuses on the role of trade in supporting investment in low-emission infrastructure and technologies.

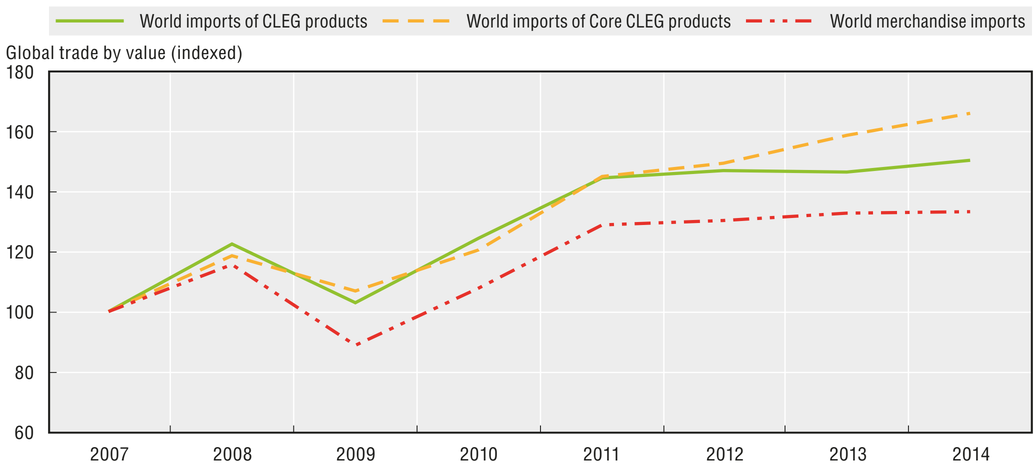
An open, rules-based trade regime is one means of achieving the investment necessary to achieve the low-carbon transition. A clear recent investment pattern has been the growing fragmentation of production across borders, underscoring the necessity for countries to maintain an open, predictable and transparent regime for both trade and investment, as the two have become increasingly interlinked.[18] More and more, companies rely on networks of goods and services suppliers to source the inputs they need at lower cost (OECD, 2017c). Trade and investment remain the primary channels for technology diffusion (Keller, 2004; Alvarez et al., 2013), including for low-emission technologies.

In the past decade, global trade in environmental goods has outpaced overall merchandise trade (Figure 5.5), driven in large part by demand from the renewable-energy sector and for solar photovoltaic (PV) panels in particular. This reflects the growing urgency of climate change and the increasingly stringent policies that many governments have put in place to mitigate their countries' emissions of GHGs and other pollutants.

Policy obstacles still hinder trade in low-carbon goods and associated services. Many countries levy tariffs on imports of low-emission equipment. These make low-emission technologies more expensive than they need to be, thereby slowing investment. Several OECD countries and emerging economies are negotiating a plurilateral agreement liberalising trade in environmental goods (known as the Environmental Goods Agreement, or EGA). Once final, this agreement would bind at zero[19] import tariffs on several products deemed environmental, many of which help prevent or reduce GHG emissions.

Figure 5.5. **The past decade has seen growth in global trade in environmental goods outpace overall merchandise trade**

(2007 = 100)



Note: Environmental products are here taken to refer to the OECD's Combined List of Environmental Goods (CLEG), which contains about 250 six-digit HS lines. See Annex 1 in Sauvage (2014) for more information on the CLEG.

Source: OECD calculations based on UN Comtrade and WTO data.

StatLink http://dx.doi.org/10.1787/888933486424

Other trade obstacles can also hamper the diffusion of low-carbon technologies, for example non-tariff measures like local-content obligations attached to feed-in tariffs. Such measures tie the award of public support to the use by solar- or wind-energy investors of locally made inputs, which can increase the costs of renewable-energy projects and slow technological diffusion when foreign-made inputs exist that are cheaper, of better quality, and more technologically advanced (OECD, 2015o; Bahar et al., 2013). Where governments want to create jobs in low-carbon sectors, it is probably more effective to foster the deployment of renewable-energy capacity than to require the use of locally made equipment. This is because the majority of jobs along the renewable-energy value chain are in installation, construction (e.g. erecting wind turbines) and maintenance services, as opposed to upstream and midstream segments (e.g. the manufacturing of solar PVs), which tend to be capital-intensive and automated (OECD, 2017c).

The mutually supportive relationship between trade and investment in low-carbon infrastructure is most apparent in the area of environmental and related services. From the design and construction of a geothermal power plant to the repair and maintenance of a wind turbine, numerous services are essential to the uptake of cleaner technologies, such as customising, installing and maintaining equipment (OECD, 2017d). This underscores the need for governments to accelerate their efforts to liberalise trade in environmentally related services, for instance by shortening work permit processing time for people providing such services, given the environmental and economic gains that would result. These efforts would not only complement ongoing negotiations to liberalise trade in environmental goods, but also reinforce current initiatives for mitigating pollution in all its forms.

Tax incentives, corporate income tax and accounting rules

Aside from taxes on GHG emissions or other externalities, policies related to tax and financial accounting may favour or disadvantage investment in low-carbon technologies. These include tax incentives not motivated by environmental concerns; provisions of the corporate income tax system that may inadvertently skew investment incentives; and accounting rules that may hinder energy efficiency investments.

Tax incentives within the tax code

Tax incentives should be designed with care and used only in particular circumstances. Those aimed specifically at encouraging low-emission investment were covered above under core climate policies. Tax incentives that are not motivated on environmental grounds may hinder the low-carbon transition. For example, providing company cars for private use for tax reasons and enabling commuting costs to be deducted from personal income taxes have unintended environmental effects. Employee compensation is effectively taxed more lightly than cash wages when the compensation comes in form of personal company car use (Harding, 2014). Such tax incentives encourage the use of cars over other modes of transport, increasing air pollution, GHG emissions and noise. Deductibility of car commuting costs encourages consumers to live further from work, increasing environmental impacts. Deductibility of public transport commuting costs can have similar effects but it also may reduce the proportion of commuters using cars, and hence related impacts.

Corporate income tax and technology bias for or against low-emission technologies

Features of the corporate income tax code may favour or disadvantage low-carbon technologies for producing electricity. Unintended technology bias from corporate income tax provisions can arise when the cost profiles of substitute technologies differ. Electricity generation technologies using renewable sources of electricity tend to feature upfront investment costs (including financing costs) that are higher than the variable and fixed costs during production. Technologies relying on conventional sources of energy, such as coal or gas, exhibit a more evenly spread cost profile, with operating costs reflecting the market price of the fuel. When capital cost profiles of technologies differ, at least three features of corporate tax systems may favour or disadvantage low carbon technologies: immediate expensing of variable costs but not investment costs, accelerated depreciation, and restrictions to loss carryovers.

Immediate expensing of variable costs favours investment in carbon-intensive electricity generation technologies. Corporate income tax is levied on profits that are calculated as the difference between revenues from goods sold and expenses. Variable costs are expenses and therefore fully deductible in the period in which they occur, thereby decreasing taxable profit. Investment costs, on the other hand, are depreciated over the asset's lifetime and not immediately deducted from taxable profits. Technologies with a high share of variable costs will benefit more from immediate expensing of variable costs than technologies having a high proportion of costs upfront during investment, such as most renewable electricity technologies.

Fiscal depreciation can favour investment in renewable electricity projects to the extent that the applicable tax depreciation rate does not reflect the actual economic depreciation rate of the capital asset. The majority of G20 countries provide accelerated depreciation to both carbon-neutral and carbon-intensive technologies, with often higher levels of acceleration for carbon-neutral technologies, suggesting there is no inadvertent misalignment with the low-carbon transition on average.[20]

Restrictions to loss carryovers limit the ability of businesses to carry over losses to subsequent (or preceding) fiscal years in order to offset profits. Such provisions therefore disfavour technologies that require a higher share of costs in the investment stage, such as renewables. This effect may be particularly relevant in the case of young, innovative firms, which often have limited access to external finance and are more likely to incur losses during the start-up phase. Loss carryovers are restricted in all but four G20 countries, which suggests there is misalignment.[21]

Accounting rules and energy efficiency investments

Accounting rules can deter investments in energy efficiency, especially in the public sector, in the context of energy performance contracts (EPCs). EPCs can take different forms but usually involve a service provider who is paid from the energy savings made possible on the client's premises. EPCs accounted for about 70% of energy service companies' (ESCOs) revenue in the United States, and are also considered the main business model of Chinese ESCOs (IEA, 2016b). Nevertheless, the accounting treatment of the costs and expected benefits arising from EPCs poses specific challenges, especially if the contract involves governments and local authorities.

Local authorities are often required to record future payments to the service provider as future liabilities on their accounting books. Consequently, as public accounting rules record the cost but not the economic benefit of investments in terms of lower future energy bills, local authorities who face particular constraints on their debt levels are discouraged from engaging in energy savings through EPCs. This is the case in Europe, where EUROSTAT rules (guidance note of 07/08/15) state that investments in energy saving measures have to be attributed to public building owners (EPC client), even if financed through an EPC (unless certain specific requirements are met). This can be problematic as public debt levels are constrained by the Maastricht Treaty. Private firms with limited ability to raise debt may face similar hurdles as, even if their debt levels are not regulated, they are exposed to market discipline and the energy efficiency investment may worsen their debt to equity ratio (IPEEC, 2016; EFFIG, 2015). The need to review accounting rules to identify possible barriers to investment in energy efficiency was recognised by G20 Energy Ministers in the Voluntary Energy Efficiency Investment Principles for G20 participating countries. Progress in implementing these principles and relevant best practice was reviewed in the 2017 G20 Energy Efficiency Investment Toolkit (EEFTG, 2017).

Policies influencing business conduct

Policies that shape business conduct can encourage companies, investors and consumers to make less carbon-intensive choices. The absence of such policies can be considered a misalignment, given that business engagement is crucial to the successful design, financing and implementation of measures to address climate change and is an integral part of responsible business conduct.[22] Policies to influence business conduct include the information policies discussed under climate policies above, such as labelling schemes requiring information on the energy consumption or carbon footprint of products. Others are specific to influencing business behaviour, including voluntary and mandatory disclosure and reporting, mandatory energy audits and consumer protection policies to limit company "greenwashing" (OECD, 2010; Klintman, 2016).

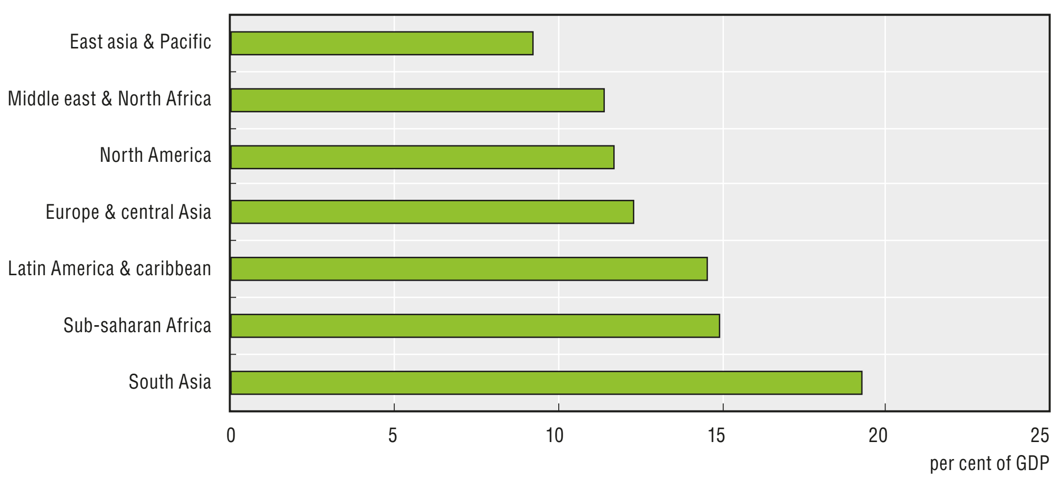
Governments can influence company behaviour, as well as investor and consumer choices, by requiring that financial and non-financial businesses disclose accurate, high quality, and comparable information on how companies are exposed to climate change and how they are addressing related risks and opportunities. Currently, 16 G20 governments require companies to disclose some type of climate-related information. Disclosure requirements vary from country to country, however – for example, in their scope and measurement methodology – thus providing insufficient and non-comparable information (OECD/CDSB, 2015). Often the scope of required disclosure does not extend beyond GHG emissions, so it does not cover the company's exposure to climate-related risks, or wider strategies to limit emissions or address risks.

The need for private sector investment to drive the low-carbon transition has prompted policymakers, including finance ministries, to encourage greater alignment between market behaviour and the Paris Agreement and the Sustainable Development Goals. This in turn has exposed limitations of corporate reporting schemes on climate issues, and in the use of information by investors and others as a basis for decision-making. The way in which companies manage climate change risks has rarely been integrated into reporting on risks, opportunities, strategy and governance practice. Corporate climate risk management targets have been developed by individual companies internally rather than by reference to sectoral, national or global goals, thus making it difficult to assess corporate contributions to wider policy goals. Reporting tends to focus only on historical information (such as GHG emissions) rather than future-oriented assessments of climate risk (OECD/CDSB, 2017, forthcoming). Disclosure of climate risks by financial institutions and institutional investors is a fast-moving area, however (see Chapter 7).

Public infrastructure choices and procurement for low-carbon and resilient pathways

All G20 governments are important economic actors in their respective territories, in particular through procurement of basic infrastructure – such as roads, bridges, harbours, sanitation systems, electricity networks – and the public purchase of good and services. Although varying between countries, public procurement expenditures[23] amount to 13% of GDP on average in OECD countries, and an often higher share of developing economies' GDP (Figure 5.6).

Figure 5.6. **Public procurement as a share of GDP**



Source: blog/World Bank (2016).

In all countries, it is crucial to integrate climate factors into the methods and policies that governments use to plan for and procure infrastructure – even where significant private sector investment has already been made in infrastructure, whether through public-private partnerships (PPPs; Box 5.9) or other means. At the planning and project selection level, the infrastructure selection process in the next decade may lock in carbon-intensive and climate-change-vulnerable infrastructure (Chapter 3), or conversely create momentum towards sustainable and climate-resilient solutions. Public procurement can also support low-carbon and climate-resilient innovation through the creation of lead markets, ultimately lowering the risk for suppliers of these innovations.

Box 5.9. **PPPs and low-emission infrastructure investment**

A growing proportion of infrastructure services has been delivered through public-private partnerships (PPPs), though with significant differences across countries. In 2013, the PPP capital stock represented around 1% of GDP in advanced economies and around 5% of GDP – with peaks of up to 9% – in emerging and low-income countries. Evidence of whether they provide infrastructure more efficiently than traditional public procurement is mixed (IMF, 2015). Numerous low-carbon infrastructure projects have been developed through PPP frameworks. Examples include mass rapid transit systems in India, bike-sharing schemes in European cities, building-energy-efficiency projects in Berlin, and a forest and watershed restoration programme in São Paulo. Public-private partnerships have also proven to be efficient instruments for food-waste reduction and prevention, thus helping to reduce unnecessary GHG emissions from agriculture (OECD, 2016h).

A practical question is whether PPPs are particularly suited for the procurement of low-carbon infrastructure. If governments decide to leverage the framework of PPPs, then government PPP units may be the appropriate administrative unit for managing the delivery of low-carbon performance as an integral part of infrastructure projects (OECD, 2012b). While subnational governments – jointly with publicly owned companies – are the major contributors to public investment in advanced and large emerging economies (IMF, 2015), they often lack the adequate capacity for managing PPPs (OECD, 2013b). For this reason, mandating dedicated government PPP units to work with local authorities and creating guidelines for their staff can help to spread best practices in designing PPPs (OECD, 2014e).

Sources: OECD (2008); Kennedy and Corfee-Morlot (2012); and as cited.

Reflecting climate factors in public infrastructure decisions

Integrating climate change considerations into government infrastructure decisions is crucial to ensure that investment plans and project selection are consistent with climate change mitigation and adaptation ambitions. Where cost-benefit analysis (CBA) is used to prioritise infrastructure projects,[24] climate change considerations need to be incorporated into the CBA framework – both for GHG emissions and for climate resilience (Box 5.10). To internalise the value of GHG emissions in infrastructure, some OECD countries systematically use a "shadow" carbon value in their appraisal of proposed policies and infrastructure decisions (Smith and Braathen, 2015).

Box 5.10. **Cost-benefit analysis in transport**

In most G20 countries, CBA is compulsory and standardised for large-scale transport infrastructure investments, but its scope is very limited. CBA is mainly used to detect "white elephants" – projects that are far too costly given the social benefits they provide. To ensure optimal allocation of investment from the point of view of climate objectives, CBA should remain one of the major tools for programming and prioritising projects under a given budget allocation. Although national infrastructure plans exist, they are usually assessed using some form of multi-criteria analysis, making the underlying trade-offs between costs and benefits unclear.

The scope of appraisal should include not only transport infrastructure but also all transport policies. Achieving transport decarbonisation requires complete policy packages that go beyond infrastructure investments. Even simple transport policies can involve complex trade-offs, and significant money streams and economic costs. For instance, many national low-carbon strategies support and subsidise electric cars. In Norway, as a result of generous policies to increase the use of electric vehicles, sales are rapidly increasing, reaching a market share of 20% in 2015 (IEA, 2016c). Yet this policy has side effects: thanks to the subsidies, driving an electric vehicle implies very low costs, potentially leading to more driving at the expense of public transport and cycling. It is also costly: the electric vehicle subsidy package costs up to 13 500 USD/tCO_2 (Holtsmark and Skonhoft, 2014).

National methodologies usually include a single carbon value that is applied to every project, thus guaranteeing comparability in the decision-making process and ensuring that investments are aligned toward climate targets. This allows decision-makers to weigh trade-offs between climate change mitigation and other policy objectives such as travel time savings, economic competitiveness and air quality. As long as carbon values follow pathways that are consistent with the mitigation efforts required globally, they ensure that carbon-intensive investments are avoided – except if such investments provide very significant benefit to the transport system and no credible alternative is available.

Incorporating climate-resilience factors into CBA is, however, more challenging due to uncertainty of climate-change impacts that have clear implications for the way networks should be designed (see section “Promoting resilient infrastructure”). First, ensuring continued infrastructure and services performance may decrease the present value of networks or increase maintenance and refurbishment costs. Second, authorities or private operators must design and build new infrastructure in the context of these same changing climate variables. Uncertainty regarding these variables presents the risk of over- or under-specification of infrastructure design standards. Over-specification of design standards results in stranded investments whereas under-specification may lead to network service degradation (OECD/ITF, 2016).

Fostering low-carbon innovation in infrastructure: the role of public procurement

For public procurement to drive low-carbon innovation in the construction value chain, most countries need to change practices. Criteria for appraising public procurement bids can evolve to improve economic efficiency and facilitate the low-carbon transition. An important barrier to the penetration of innovation through public procurement is continued reliance on a single lowest-price criterion for the appraisal of bids, even though this does not guarantee the best value for money for clients, or indeed the lowest cost. Countries should be encouraged to use the Most Economically Advantageous Tender methodology (Box 5.11), which relies on attributes beyond the price.

For instance, governments have been using the total cost of ownership of the procured goods or services, which takes into account the cost of operation and maintenance. Some jurisdictions have introduced life-cycle analysis and the monetisation of externalities, including CO_2, in the evaluation of bids, with measurable effects on life-cycle CO_2 emissions (Box 5.11). This has been backed with a transparent framework, helping both bidders and procuring teams. Generally, robust methods are required to ensure that non-financial metrics do not introduce more subjectivity than price-only auctions.

Several changes can be made to improve the low-carbon performance of public procurement, in infrastructure and beyond:

- Public procurement teams must be adequately resourced to be able to introduce this dimension in their procedures. In particular, the procurement of functionality (e.g. mobility needs vs. number of cars) should be favoured, to avoid the over-specification of bids that might hinder innovation.
- Procurement teams must be also provided with methodologies that allow objective evaluation of bids that include non-price attributes, such as GHG performance. Several standards exist for measuring the GHG performance of products, plants or companies. Relying on well-established methodologies helps avoid risk of bid appraisals not being conducted properly.
- Budget and accounting rules should accommodate the choice of projects whose economic superiority is measured over several years, to facilitate the use of public procurement criteria beyond the lowest price.

- Market dialogues can be established before procurement processes to allow the private-sector suppliers and public clients to exchange information about available innovations and the future direction of demand. This can be done in a transparent way, without harming the competitive nature of procurement.

Identifying activities where public procurement can mitigate carbon lock-in and trigger climate-friendly innovation should be made a priority. Upgrading public-procurement practices in these activities will take time and resources (including professionalisation of the work force and development of new procurement methods) and should be considered an important soft investment for the transition. It is an opportunity to create lead markets and to introduce a competitiveness and innovation agenda into the process.

Public-procurement authorities from different jurisdictions should be encouraged to co-operate. In some instances, jurisdictions have joined forces internationally to tip the supply side of the market towards sustainable solutions. For example, 11 European cities recently launched joint procurement of compressed natural gas garbage trucks (Baron, 2016). There is a significant community of practice in the area of sustainable public procurement that could be used to share best practice. These changes ought to be envisioned in the broader context of public procurement challenges, as presented in the OECD Council Recommendation on Public Procurement (OECD, 2015p). The Recommendation promotes transparency, integrity, open competition, stakeholder participation, risk management, appropriate integration in overall public finance management, and specific measures to ensure accountability throughout the procurement cycle.

Box 5.11. **Encouraging low-carbon performance through infrastructure procurement**

The Department of Public Works of the Dutch Ministry of Infrastructure and the Environment (Rijkswaterstaat, or RWS) has developed an approach to encourage the minimisation of environmental impacts related to infrastructure building. The policy direction was given by the House of Commons, asking that public procurement be 100% sustainable by 2015, with green criteria included in all tenders.

RWS uses the Most Economically Advantageous Tender (MEAT) methodology, which includes both price and quality attributes. In RWS tenders, however, quality attributes are fully monetised and translate into discounts on the bid price; the contract is awarded to the bidder with the lowest adjusted price. RWS tenders combine two sustainability criteria in the quality attributes of the tender:[25]

- The CO_2 Performance Ladder rates a company on a scale from one to five on the basis of energy savings, resource efficiency and renewable energy use. Companies must monitor their performance, formulate ambition and evaluate effects. More ambitious contractors, as rated by the ladder, benefit from a discount applied to their tendering price of 1% to 5%. The ladder is backed by an auditing system.
- A Sustainable Building Calculator (DuboCalc), provided to tenderers, assesses the environmental impacts of material use in the proposed project. DuboCalc provides a transparent assessment of environmental impacts, and helps contractors "optimise" on the basis of environmental costs, rather than mandating specific levels of performance.[26]

DuboCalc has led to significant reductions in projects' CO_2 footprint whenever bids included the design as well as the construction of the infrastructure. This gives more opportunities to innovate and to reduce the use of materials. It does not necessarily entail higher financial costs – even before the positive impacts of innovation are taken into account.

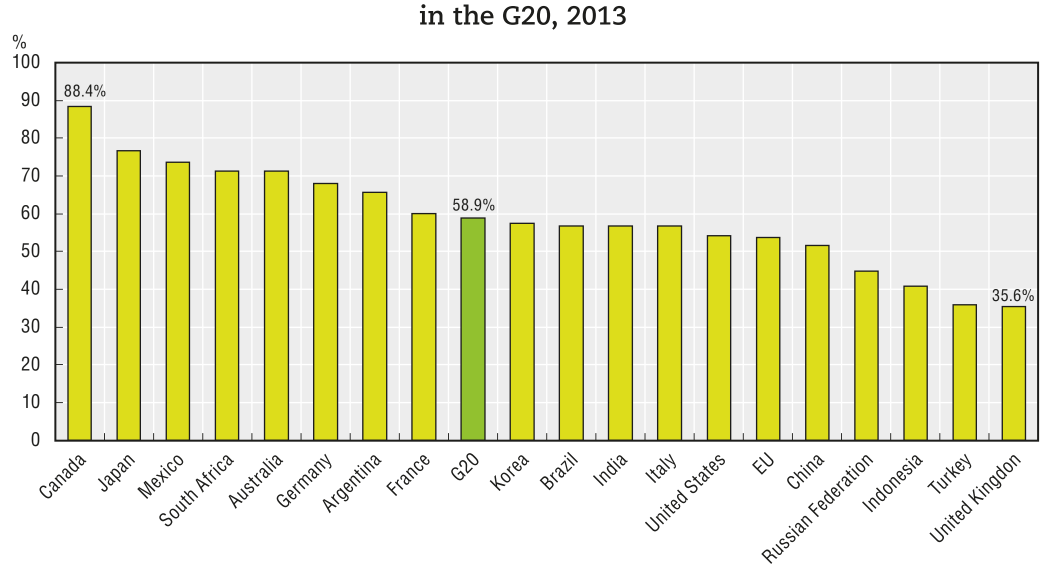
Box 5.11. **Encouraging low-carbon performance through infrastructure procurement** *(cont.)*

As an example, a recent tender for the reconstruction of a motorway was won by a company operating at the highest rung of the performance ladder, for a bid price of less than EUR 200 million, with a EUR 10 million discount to account for high performance on the environmental cost indicator. This high performance was triggered by the use of recycled and innovative materials and lower use of asphalt with certified life-cycle analysis. This illustrates the role of this. The winning project offered a 50% saving in CO_2 emissions compared with the last tender in this bid, showing how procurement procedure can create lead markets for new low-carbon products.

Multi-level governance of climate investment

Subnational governments are among the major contributors to public investment in G20 countries, accounting for 59% of public investment on average in the G20, but with a wide range across countries (Figure 5.7). In addition, they often have authority across several policy domains crucial to the transition, including spatial planning, housing, local roads and city public transport.

Figure 5.7. **Subnational government investment as a share of public investment in the G20, 2013**



Source: OECD elaboration based on OECD/UCLG (2016), *Subnational around the world: structure and finance*. Note: no data for Saudi Arabia. G20 average is unweighted.

StatLink http://dx.doi.org/10.1787/888933486432

For these reasons, effective multi-level governance is critical to implement the Paris Agreement, as national and subnational governments are also mutually dependent for their climate investment policy. Cities and regions are well situated to identify complementary local infrastructure or services tailored to local contexts, and to co-ordinate investment needs and priorities (OECD, 2014f). For example, to address a 'mega-city malaise' China has adopted a strategy for co-ordinated development of its Jing-Jin-Ji region, consisting of Beijing and Tianjin municipalities and Hebei province. The guideline for the region's integrated development adopted in 2015 envisages transfer of some administrative functions away from Beijing, and prioritises environmental protection, energy security, traffic management and industrial upgrading (China Daily, 2017a and 2017b).

The OECD Council Recommendation on Effective Public Investment Across Levels of Government (Box 5.12) can help governments assess the strengths and weaknesses of their public investment capacity from a multi-level governance perspective. It provides practical guidance on the use of various policy instruments (Allain-Dupré et al., 2017 forthcoming), and a set of indicators to support their implementation.

Box 5.12. **Council Recommendation on Effective Public Investment Across Levels of Government (2014)**

The OECD adopted in 2014 a Recommendation on Effective Public Investment Across Levels of Government. A Recommendation is an OECD instrument adopted by the Council. Recommendations are not legally binding, but practice accords them great moral force as representing the political will of member states.

The OECD Recommendation underline how member countries should take steps to ensure that national and sub-national levels of government effectively utilise resources dedicated to public investment for territorial development in accordance with 12 key principles, including adoption of effective instruments for co-ordinating across national and sub-national levels of government, reinforcement of the expertise of public officials and institutions involved in public investment, and ensuring proper framework conditions for public investment at all levels of government.

Source: www.oecd.org/effective-public-investment-toolkit/.

Notes

1. This chapter benefited also from the helpful comments and insights provided by the participants of three OECD-led workshops (OECD workshop on financing green infrastructure, Paris, November 2016; OECD-ORF workshop Growth, Investment and the Low-Carbon Transition in India, Delhi, March 2017, hosted by the Observer Research Foundation; and OECD-DRC workshop Growth, Investment and the Low-Carbon Transition in China and the World', Beijing, April 2017, hosted by the Development Research Center of the State Council).
2. Adopting a lower-bound of EUR 30 can be seen as a weak test, in the sense that carbon prices should be *at least* at this level to reflect damages.
3. VAT is not included in the ECR as it applies to all products, at least approximately, and generally leaves the relative prices of energy products unaffected (cf. Chapter 3 in OECD, 2016a)
4. These numbers include emissions from biomass in the emission base. OECD (2016h) discusses the rationale for and the impacts of including or not including emissions from biomass in the emissions base.
5. Where there is perfect competition, permit allocation rules do not affect marginal mitigation incentives as permits carry opportunity costs (Goulder and Schein, 2013). However, when rents occur, incentives for mutually exclusive investments are affected by them (Devereux and Griffith, 1998a; Devereux and Griffith, 1998b). Free allocation of permits is a source of economic rents.
6. In a monopolistic environment such a tax would act a tax on importers and producers allowing the government to capture parts of their monopoly rent.
7. www.umweltbundesamt.de/publikationen/umweltschaedliche-subventionen-in-deutschland-2016; www.bundesfinanzministerium.de/Content/DE/Standardartikel/Themen/Oeffentliche_Finanzen/Subventionspolitik/2015-08-26-subventionsbericht-25.html.
8. Phase-out clauses are necessary not only for financial support measures but also for those aiming at increasing "utility of ownership", commonly applied in the case of electric vehicles. Additional policies like waivers on access restrictions, possibility to drive on bus lanes and free parking should be only temporary: as the number of electric vehicles grows, increased congestion of bus lanes or city centres will lead to decreased benefits for EV owners and to negative impact on public transportation.
9. See, for example, IMF, OECD, UN and World Bank (2015).
10. Further, Borenstein and Davis (2015) find that higher income households receive a disproportionate share of tax credits under various tax incentives in the United States.
11. The difference mechanism provide a variable top-up on the market price up to a pre-agreed strike price determined through tendering. Interestingly, at times when the market price exceeds the strike price, the generator is required to pay back the difference, thus protecting consumers from over-payment.
12. This realisation of the importance of climate change's importance for the sector is broader than just OECD countries; in January 2017, G20 agriculture ministers recognised "the need for agriculture and forestry to adapt to mitigation and emphasised their role in its mitigation" (G20, 2017).
13. Other relevant OECD tools and reports are also used here, including OECD, (2015l) and OECD/IEA/NEA/ITF (2015).
14. The FDI Regulatory Restrictiveness Index (FDI Index) measures statutory restrictions on foreign direct investment. It gauges the restrictiveness of a country's FDI rules by looking at the four main types of restrictions on FDI: 1) Foreign equity limitations; 2) Discriminatory screening or approval mechanisms; 3) Restrictions on the employment of foreigners as key personnel and 4) Other operational restrictions,
15. The production of wind- and solar-based electricity increases 15-fold between 2015 and 2050 in the IEA 66% 2°C scenario (IEA, 2017).
16. To date, the market pilots have focused almost entirely on implementation of direct trading. Within the pilot market, generators that are approved to participate in these programs can sign contracts directly with eligible industrial customers, with contracted output no longer counted in the operating-hour planning process (RAP, 2016a).
17. The regulated rigid pricing and production mechanism may also prevent some of the efficiency gains expected from the Chinese Emission Trading Scheme (Baron et al., 2012; OECD/IEA/NEA/ITF, 2015).
18. Reflecting the growing linkages that exist between trade and investment, the Chinese Presidency of the G20 established in 2016 a working group dedicated to that question (i.e. the Trade and Investment Working Group, or TIWG).

19. That is, the agreement would impose a legal obligation on all Parties to maintain zero import tariffs on the selected environmental goods.
20. Data sources: Hanappi, T. (2017a, forthcoming) and International Bureau of Fiscal Documentation (IBFD).
21. In 2015, companies are allowed to claim unlimited loss carryovers only in four G20 countries: Australia, Germany, South Africa and the United Kingdom. Data sources: Hanappi, T. (2017b, forthcoming) and International Bureau of Fiscal Documentation (IBFD).
22. The OECD Guidelines for Multinational Enterprises are one of the leading international standards on responsible business conduct. Many of their recommendations (including on the chapters on environment, consumer protection, disclosure, etc.) promote business practices relevant to addressing climate related impacts and risks. http://mneguidelines.oecd.org/guidelines.
23. Public procurement is defined as the process of purchasing goods, services or works by the public sector from the private sector, following the definition used in World Bank, 2016.
24. Trends in the use of CBA are worrying, however. A The use of CBAs dropped considerably in small-scale infrastructure projects in recent decades (World Bank, 2010). In addition, decisions on large EU transport infrastructure projects are often made without support from CBA results (Proost et al., 2011). Other evidence suggests CBA results hardly affect actual decision-making (Nellthorp and Mackie, 2000; Odeck, 2010).
25. Other quality attributes include: public-oriented approach, project management, design, and risk management.
26. The costs are derived from an authoritative life-cycle analysis of materials (from extraction to demolition and recycling), including CO_2 emissions and ten other externalities. Penalties are applied if performance is less than promised, for both the CO_2 performance ladder and the environmental cost evaluated with DuboCalc (OECD, 2015f).

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