

OECD *publishing*

Decarbonisation and inter-governmental fiscal relations: Policy challenges and reform options

**Luiz de Mello and
Teresa Ter-Minassian**

**OECD WORKING PAPERS
ON FISCAL FEDERALISM**

June 2023 No. 43

OECD NETWORK ON FISCAL RELATIONS ACROSS LEVELS OF GOVERNMENT (THE “FISCAL NETWORK”)

OECD Working Papers on Fiscal Federalism

This series is designed to make available to a wider readership selected studies drawing on the work of the OECD’s Network on Fiscal Relations across Levels of Government. Authorship is usually collective, but principal writers are named. The papers are generally available only in their original language (English or French) with a short summary available in the other.

OECD Working Papers should not be reported as representing the official views of the OECD or of its member countries. The opinions expressed and arguments employed are those of the author(s).

Working Papers describe preliminary results or research in progress by the author(s) and are published to stimulate discussion on a broad range of issues on which the OECD works. This working paper has been authorised for release by Manal Corwin, Director of the OECD Centre for Tax Policy and Administration.

Comments on Working Papers are welcome, and should be sent to either fiscalnetwork@oecd.org or the OECD Network on Fiscal Relations, 2 rue André Pascal, 75775 Paris Cedex 16, France.

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

You can copy, download or print OECD content for your own use, and you can include excerpts from OECD publications, databases and multimedia products in your own documents, presentations, blogs, websites and teaching materials, provided that suitable acknowledgement of OECD as source and copyright owner is given. All requests for public or commercial use and translation rights should be submitted to rights@oecd.org.

Copyright © OECD 2023.

Abstract

Decarbonisation and intergovernmental fiscal relations: Policy challenges and reform options

This paper explores the nexus between decarbonisation and intergovernmental fiscal relations, focusing on related challenges and reform options. It highlights the significant role of subnational governments in tackling climate change. Subnational and national governments share responsibilities in areas such as taxation, spending and regulation pertaining to environmental protection, as well as climate change mitigation and adaptation, which calls for effective intergovernmental co-operation to align policy objectives and implementation strategies. The paper outlines decarbonisation requirements across sectors and discusses subnational government involvement in service delivery, investment, revenue generation and regulatory frameworks. Policy options to strengthen subnational contributions to national decarbonisation goals are presented. While focusing primarily on OECD countries, the paper acknowledges the need for improved information on subnational decarbonisation efforts in both advanced and developing countries.

Keywords: climate change, decarbonisation, green tagging, environmental goals, fiscal federalism institutions

JEL classification: H23; H70; Q57

Résumé

Décarbonisation et relations fiscales intergouvernementales : Défis politiques et options de réforme

Ce document explore le lien entre la décarbonisation et les relations fiscales intergouvernementales, en se concentrant sur les défis connexes et les options de réforme. Il met l'accent sur le rôle des gouvernements infranationaux dans la lutte contre le changement climatique. Les gouvernements infranationaux et nationaux partagent des responsabilités dans des domaines tels que la fiscalité, les dépenses et la réglementation relatives à la protection de l'environnement, ainsi qu'à l'atténuation du changement climatique et à l'adaptation à celui-ci, ce qui nécessite une coopération intergouvernementale efficace pour aligner les objectifs politiques et les stratégies de mise en œuvre. Le document décrit les exigences de décarbonisation dans les différents secteurs et examine le rôle des gouvernements infranationaux dans la prestation de services, l'investissement, la génération de recettes et la réglementation. Des options de réforme visant à renforcer les contributions infranationales aux objectifs nationaux de décarbonisation sont présentées. Tout en se concentrant principalement sur les pays de l'OCDE, le document reconnaît la nécessité d'améliorer les informations sur les efforts de décarbonisation infranationaux dans les pays avancés comme dans les pays en développement.

Mots-clés : changement climatique, décarbonisation, étiquetage vert, objectifs environnementaux, institutions de fédéralisme fiscal

Classification JEL : H23; H70; Q57

Decarbonisation and intergovernmental fiscal relations: Policy challenges and reform options

By Luiz de Mello and Teresa Ter-Minassian¹

I. Introduction

1. Concerns about climate change and environmental degradation are rising worldwide, raising awareness about the role of subnational governments (henceforth SNGs) in safeguarding the environment, mitigating climate change, and adapting to its consequences. There are at least three broad reasons why SNGs are important in these areas: *i*) the consequences of environmental problems, including climate change, vary not only across but also within countries, and therefore require differentiated policy responses; *ii*) such responses may have socio-economic costs and benefits that also vary among regions and localities; and, most importantly, *iii*) SNGs share with the national government spending, taxation and regulatory responsibilities in many of the policy areas that are relevant for environmental protection, the reduction of greenhouse gas (GHG) emissions and adaptation to climate change. As a result, there is growing attention in the literature on the links between environmental and climate objectives and the design and practice of intergovernmental fiscal relations.²

2. A companion paper for the OECD Network on Fiscal Relations (Dougherty and Montes, 2023a) explores a range of issues in relation to environmental protection and decentralisation, and provides preliminary quantitative evidence on some of its aspects. This paper focuses on the links between SNGs' spending and revenue-raising activities and a specific aspect of environmental protection – namely the reduction of CO₂ emissions (decarbonisation) – and discusses policy options for both SNGs and national governments to strengthen subnational contributions to national objectives in this area.

3. This paper begins in Section II by briefly outlining the decarbonisation needs in various sectors, as estimated by the International Energy Agency, to meet the internationally agreed objective of carbon neutrality by the middle of this century. It then discusses the main reasons for place-based decarbonisation efforts and the roles that SNGs play in decarbonisation-relevant areas, including service delivery, investments, revenue mobilisation, and regulation; as well as the main policy reform options in each of these areas.

¹ This document was discussed at the 2023 Meeting of the Network on Fiscal Relations across Levels of Government in Paris on 20-21 April 2023. We thank Sean Dougherty, Assia Elgouacem, Andrés Fuentes Hutfilter, Mauro Pisu, Kurt Van Dender and Network delegates for useful comments and suggestions but remain solely responsible for any remaining errors or omissions.

² See, for example, OECD (2019 and 2023); Martinez-Vazquez (2021); and de Mello and Martinez-Vazquez (2022).

4. In Section III, the paper focuses on how to promote the alignment of national and subnational decarbonisation agendas. It discusses the reasons for and potential forms of involvement of the national government in subnational decarbonisation policies; and highlights the need and possible actions to strengthen intergovernmental co-operation in this area. Section IV presents summary conclusions.

5. The paper focuses primarily on the experiences of OECD countries. The discussion is mostly qualitative, because, as highlighted by Dougherty and Montes (2023a, 2023b), further progress is needed in the generation of reliable quantitative fiscal information on subnational decarbonisation, and more generally, environment-relevant activities.³ The development of common international standards for green-tagging of budgetary flows – and their consistent use by national and subnational authorities – will be essential steps towards meeting this objective.

II. How subnational governments' activities can affect decarbonisation

1. Decarbonisation needs to meet the net-zero objective

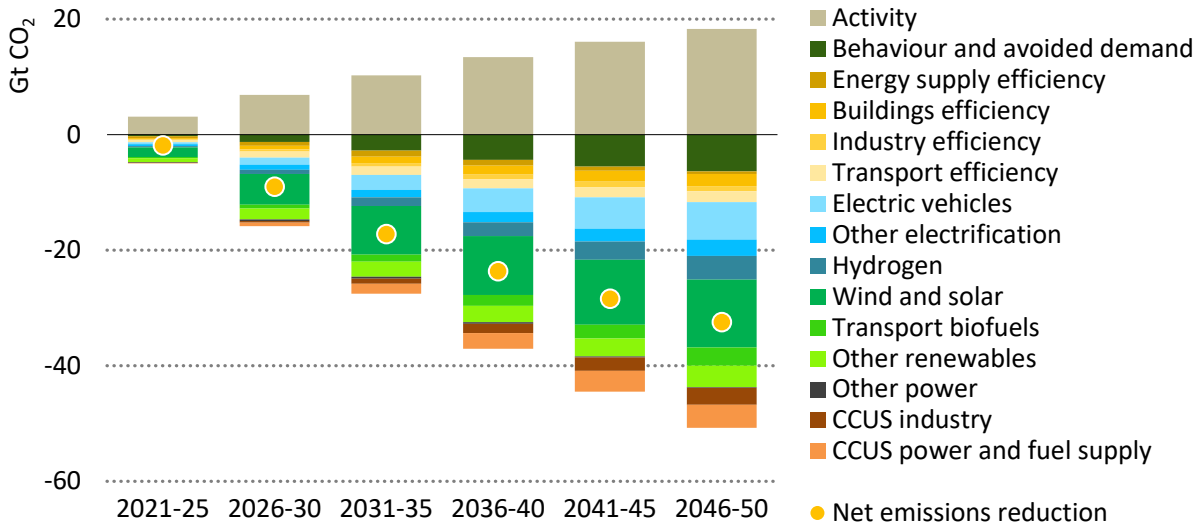
6. More than 180 countries around the world have committed to ambitious GHG emission reduction targets to meet the 2015 Paris Agreement goal of limiting global warming relative to pre-industrial times to well below 2°C, and preferably 1.5°C. Many of these countries have committed to achieving GHG emission neutrality by mid-century. However, policy actions have so far been insufficient to put emissions on track to reach medium-term (2030) and mid-century targets.

7. The net-zero emissions (NZE) scenario prepared by the International Energy Agency (IEA) provides useful insights into the magnitude of the needed reduction of emissions, as well as the policy options available to achieve agreed targets by mid-century. The scenario emphasises the importance of increasing reliance on renewables and electrification (Figure 1), and draws attention to the substantial investments needed to reach emission neutrality by mid-century (Figure 2). Infrastructure, buildings and transport account for sizable shares of the required investment. Efforts are also needed to improve efficiency in the use of energy in the economy, and to influence households' and firms' behaviour to achieve significant reductions in energy demand.

³ An important first step in this area has been the compilation by the OECD staff of a database (the Climate Actions and Policies Measurement Framework (CAPMF) of mitigation policies implemented by the 52 countries comprising the International Program for Action on Climate (IPAC) over the period 2000-2020 (Nachtigall et al., 2022). The database lists the policy actions and rates their stringency but does not quantify their fiscal costs; also, it does not separate national and subnational policies. More quantitative information is available on environmental taxation and subsidies and on effective carbon prices (OECD, 2020 and 2021) at the national level.

Figure 1. Reductions in emissions associated with decarbonisation

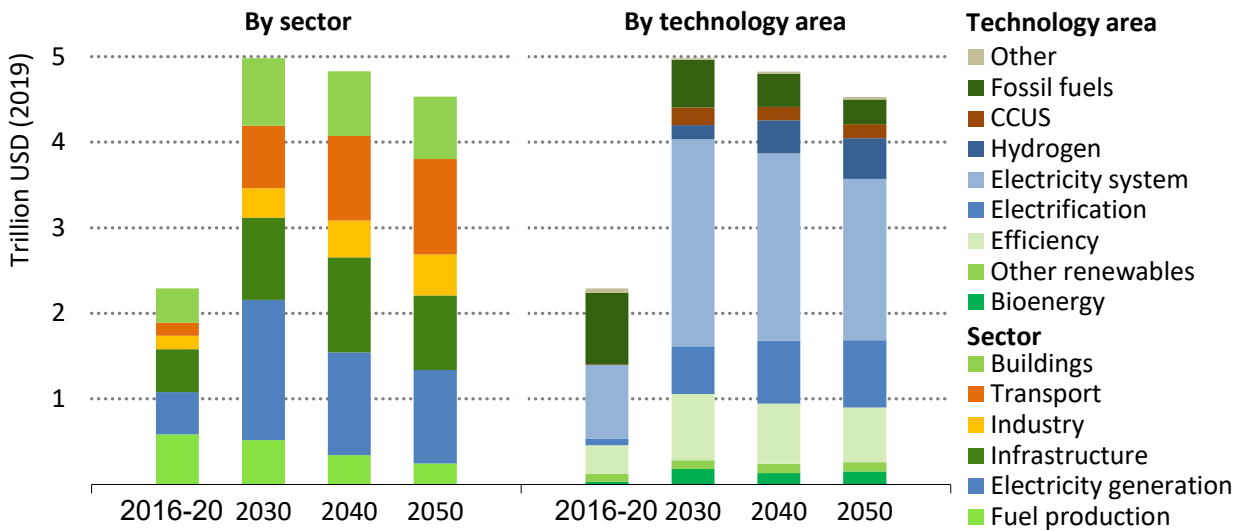
Average annual CO₂ reductions from 2020 in the net-zero energy scenario



Source: International Energy Agency (2021).

Figure 2. Investment needed for decarbonisation

Annual capital investment in the net-zero energy scenario



Source: International Energy Agency (2021).

2. The case for place-based decarbonisation efforts

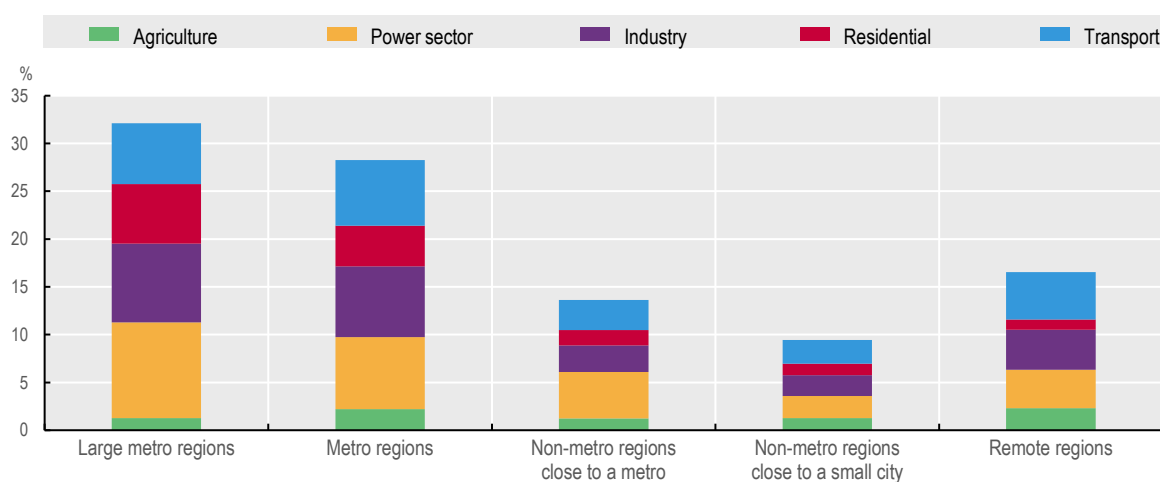
8. The current level and projected increase in CO₂, and more generally GHG, emissions vary widely not only across, but also within, countries. OECD estimates, based on the Emissions Database for Global Atmospheric Research (EDGAR) of the European Commission’s Joint Research Centre (JRC, 2020), indicate that in 2018 metropolitan areas accounted for about 60% of GHG emissions, with the bulk stemming from the power, transport and residential sectors (Figure 3). In per capita terms, however, GHG

emissions in rural regions far exceeded those in urban areas (OECD, 2021b). Moreover, the intensity of emissions in each region reflects its productive structure, resulting in a wider variation within than across countries (Figure 4). For instance, regions that are rich in fossil fuels or rely on industries heavily dependent on such fuels tend to have levels of per-capita emissions that are several times higher than their respective national averages.

9. Differences in emission levels and in their sources in turn entail differences in the intensity and nature of required decarbonisation efforts. Moreover, these efforts can have significantly different economic, fiscal and social costs across the national territory. Such differences need to be taken into account in the design of national decarbonisation agendas, evidencing the importance of place-based policies in such agendas. These considerations also evidence the importance of a meaningful involvement of SNGs in the formulation and implementation of the agendas, given their knowledge of local economic and social conditions.

Figure 3: Regional GHG emissions

Contribution by type of region, 2018

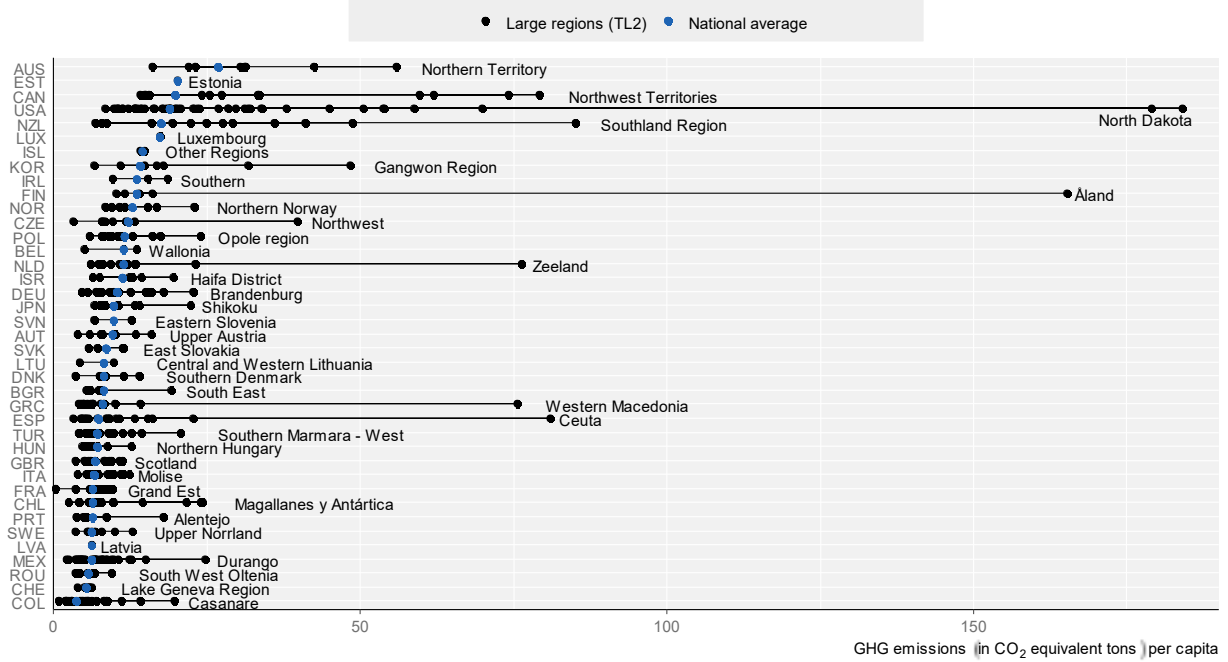


Note: OECD countries, Romania and Bulgaria. GHG emissions exclude those from land use and land use change.

Source: OECD calculations based on EDGAR, JRC (2020).

Figure 4: Within-countries variation in GHG emissions is larger than across countries

GHG emissions per capita from all sectors, large regions (TL2), 2018



Source: OECD calculations based on JRC (2020), EDGAR – Emissions Database for Global Atmospheric Research, EC Joint Research Centre.

10. Decarbonisation policies can also have important benefits. They include: a) improvement in air quality, with related positive effects on public health and productivity; b) reduction in traffic congestion and related gains in work and leisure time; and c) increases in energy efficiency of building and related reduction of energy poverty, to name just a few (OECD, 2021b). SNGs, by virtue of their knowledge of local conditions, are best placed to ensure that such potential co-benefits are taken into account in the design of decarbonisation policies.

3. Subnational spending responsibilities and decarbonisation

a) Delivery of public services and direct energy use

11. SNGs are important players in most of the sectors involved in the decarbonisation scenario mentioned above. They also have a substantial stake in the success of decarbonisation, as they are responsible for large shares of spending on adaptation to climate change and tend to be first responders to climate-related natural disasters.⁴

12. As highlighted by the IEA scenario, the electricity sector is key to meeting net-zero emission targets. The global demand for electricity is expected to be boosted by economic growth and by decarbonisation policies in industry, transport and housing, as discussed below. This requires actions to shift the production of electricity away from fossil fuels and towards cleaner sources, such as hydropower, solar and wind, as well as to increase efficiency in its use. In many countries, regional and local governments are involved in the generation and distribution of electricity,⁵ most often through enterprises

⁴ For a discussion of complementarities and possible trade-offs between mitigation and adaptation policies, see OECD (2021c).

⁵ In contrast, electricity transmission is generally a national responsibility.

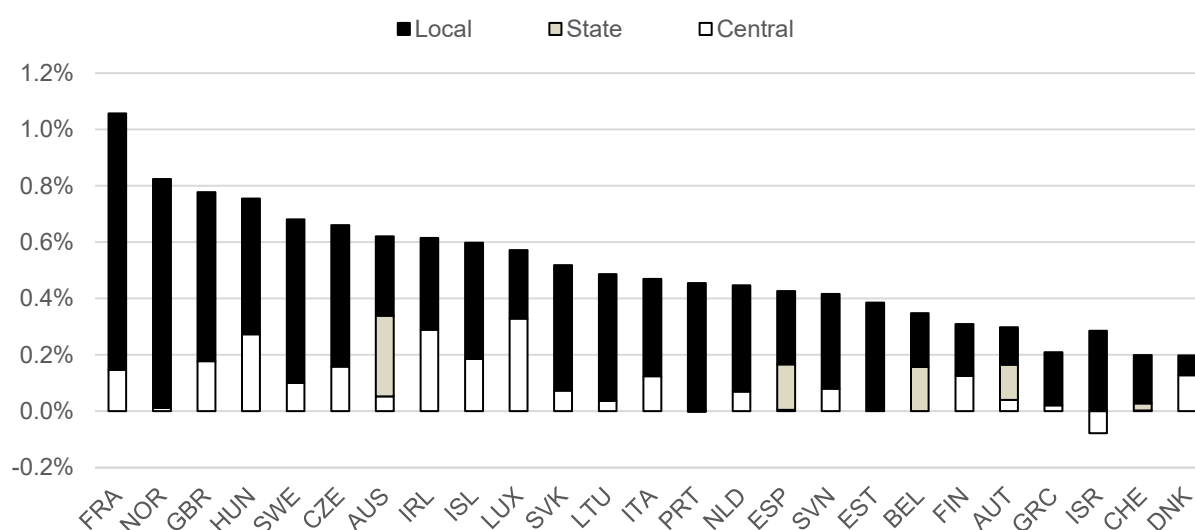
in which they have ownership or controlling interest. Thus, they can influence production, pricing and investment decisions of their SOEs operating in the energy sector. Moreover, they are generally responsible for street lighting and in some case district heating, as well as efficiency in the use of energy for the provision of these services.

10. In the transport sector, despite a projected continued strong rise in passenger and freight travel, major cuts in emissions are targeted to be achieved over the next decades through a combination of: a) shifts in transport modes (e.g. increased use of urban and regional public transport, and of railways for long-haul transport); b) electrification of transport systems and light vehicles, and increased use of biofuels and hydrogen in heavy vehicles and aviation; and c) behavioural changes that could lead to sustained reductions in demand (e.g. reduced commuting, greater recourse to carpooling, increased use of low- or non-emitting vehicles, such as bicycles).

11. SNGs can play an important role in many of these changes through pricing mechanisms (e.g. carbon taxes and emissions trading schemes); policies regarding taxation and non-tax measures (discussed in section II-3 below); regulation and behavioural nudges (discussed in section II-4 below); and investments in relevant low-emission infrastructure, including public transportation facilities, charging stations for electric vehicles, and mass urban transport systems.

12. The decarbonisation of residential and commercial buildings is expected to make a growing contribution to the targeted reduction in emissions over the next decades (Figure 1 above). SNGs account for the lion's share of public spending in the housing sector in OECD countries (Figure 5). They are often active in the subsidised market segment, by investing in the construction of new properties to be leased on favourable terms to vulnerable social groups; by financing the upkeep of existing properties; or by subsidising rents in the private housing market. They also often participate in the not-for-profit segment in joint ventures with private-sector developers and managers. Thus, they can directly influence carbon emissions from such buildings by adhering to appropriate standards for the sourcing and efficiency of energy in new buildings, and by retrofitting old ones. Moreover, they can promote the decarbonisation of private housing through their taxation, subsidization, and regulatory policies, as discussed in subsequent sections below.

Figure 5. Spending on housing by level of government, % of GDP, 2019



Source: OECD Fiscal Decentralisation database.

13. SNGs can also contribute to decarbonisation through their activities relating to the use of public land under their control, in particular by limiting or banning the mining of coal and the exploration of fossil fuels in their respective jurisdictions; by safeguarding existing forests, which are important carbon sinks; by expanding urban green spaces; and by limiting urban sprawl through regulation.

14. Finally, SNGs can promote decarbonisation through actions affecting their own use of energy. They can do so by retrofitting their own buildings, especially schools and equipment, to make them more energy-efficient; by incentivising the use of public transport by their employees, and by reducing their commuting frequency by allowing work from home, when appropriate; and by computerising remote access by the population to many public services.

b) Investments in green infrastructure and financing challenges

15. As shown in Figure 2 above, to meet the net-zero emission target, global investments in infrastructure needed for decarbonisation would have to more than double in the current decade from their 2016-20 average and remain broadly unchanged in the following two decades. SNGs will have to bear the brunt of such investment effort; they accounted on average for nearly two-thirds of climate-related public investments in OECD countries over the period 2000-2016.⁶ However, such investments were equivalent to only 0.7% of GDP for the general government and 0.4% of GDP at the subnational level (OECD, 2019). This highlights the magnitude of the effort that regional and local governments will need to make in decarbonisation-related investments in the decades ahead.

16. As discussed in the previous subsection, the increased investment effort will need to be concentrated in electricity, transport and housing. In most of these areas, decarbonisation-oriented investments are also expected to have some positive distributional effects. Reduction of emissions-generated air pollution in crowded urban areas as a result of investments in green mass transport would have beneficial effects on the health of low-income residents and lower their cost of commuting to available jobs. In addition, improvements in the energy efficiency of social housing would help reduce energy poverty, and investments in green urban spaces would increase the liveability of low-income areas of cities.

17. The magnitude of the needed subnational investment effort entails significant funding, financing, and governance challenges. On the funding side, substantial additional subnational revenue mobilisation will be needed. Options to increase subnational own revenues, in particular green revenues, are discussed in section II-3 below, while the contributions that national governments can make through increased transfers are covered in section III. This section focuses on financing, and on some governance issues.

18. SNGs often face substantial obstacles in mobilising appropriate external sources of financing for their investments. Some of these obstacles are even more pronounced for investments in decarbonisation, which tend to be affected by greater technical and policy uncertainties and lower appropriability of returns. Foremost among the obstacles is the fact that many regional and local governments have limited control over their revenues. Own tax revenues frequently account for less than half of total subnational revenues; nontax revenues are underexploited; shared revenues are generally determined by formulas set in national legislation; and discretionary transfers from national governments are volatile and often procyclical.

19. These characteristics tend to undermine financial markets' assessment of the creditworthiness of many SNGs. Access of the latter to financing is also limited in many countries by fiscal rules aimed at avoiding risks of subnational fiscal distress and crises. In particular, fiscal rules often preclude SNGs' borrowing in foreign currency, to avoid unhedged depreciation risks, since subnational revenues are typically denominated in domestic currencies. This limitation is especially constraining for SNGs in countries with less developed domestic capital markets.

⁶ The study (OECD, 2019) used a novel preliminary methodology to track climate-related components of government spending and investments in OECD countries (excluding Israel, Korea, and the United States),

20. Subnational borrowing is also frequently constrained by scale considerations (most relevant for smaller regions and municipalities), which discourages lenders. This constraint can be mitigated by the creation of public agencies charged with pooling local bonds or loans. Other significant obstacles are the more limited debt management capacities at the subnational than the national level of government; and perceptions of significant governance flaws in SNGs. Such flaws may include: a lack of adequate transparency of their finances; weaknesses in their legislation, regulations and practices for procurement; and more generally weaknesses in their processes of planning, assessing, selecting and managing the implementation of investments.

21. Diagnostics of the state of public investment management processes (such as the IMF's Public Investment Management Assessments (PIMAs), which recently have been expanded to include a new module for the assessment of climate-related investments, or C-PIMA⁷) and the associated recommendations for improvement have focused so far mainly on the national level of government, given staff resource limitations. Vertical and horizontal intergovernmental co-operation fora could be useful vehicles for a broader use of such diagnostics by SNGs, providing a solid basis for the development and implementation of appropriately tailored strategies to strengthen the subnational management of climate-related and other investments.

22. Strong public investment management (PIM) systems are also an essential precondition for successful use by SNGs of Public Private Partnerships (PPPs) to finance and implement decarbonisation investments. It is a well-known tenet in the relevant literature that the choice between PPPs and other delivery modalities, including direct public procurement, should be based on relative value-for-money, rather than just availability of financing, considerations.⁸ It is however a fact that in practice governments at all levels often see PPPs as a way of mobilising private capital for public investments, or even of circumventing restrictions imposed by fiscal rules limiting or prohibiting subnational borrowing. PPPs entered into without appropriate processes of project selection, risk sharing arrangements, and monitoring of implementation often result in costly renegotiations or even costlier early terminations.⁹ These complexities apply to all levels of government, and they are particularly challenging for the subnational jurisdictions, given the technical and human capital capacity constraints they frequently face.

23. Recent years have witnessed a rapid growth of the issuance of “green” bonds to finance investment projects with expected favourable decarbonisation (and more generally environmental) impact. These bonds aim to attract especially institutional investors seeking to fulfil environmental goals or mandates. The first such bonds were issued by the World Bank and the European Investment Bank in 2007 and their cumulative issuance has now surpassed USD 2.2 trillion, according to the Climate Bonds Initiative (CBI).¹⁰ Government-issued bonds account for a significant portion of that total. Regional and local governments, especially large cities, have become increasingly active in their issuance.

24. Green bonds are self-labelled. Only a small share of them is certified by the Climate Bonds Standards Board to meet the relevant sectoral criteria for “greenness” developed by the Board, meaning that there is still significant scope for “greenwashing” in the characterisation of this type of bonds. The proceeds of these bonds are earmarked for use in green projects but the stream of future revenues from the projects may or may not be ringfenced to service the bond. Some green bonds enjoy various forms of

⁷ IMF (2021) provides an overview of the C-PIMA diagnostic tool, and of the main results of its application in 11 pilot case studies (3 of which were in OECD countries).

⁸ de Mello and Sutherland (2015) review the main modalities for the delivery and financing of subnational infrastructure investment.

⁹ World Bank, 2023 provides empirical evidence of significant fiscal risks from inappropriate PPPs in a range of emerging economies.

¹⁰ [Climate Bonds Initiative | Mobilising debt capital markets for climate change solutions.](#)

tax advantages. Empirical evidence on whether green bonds carry a pricing premium compared with plain vanilla ones is limited, but there are initial indications that certified sustainability-linked bonds do so. If confirmed by further evidence, this could incentivise issuers, including SNGs, to seek such certification.

25. In addition to investments in decarbonisation-oriented infrastructure, some SNGs are also involved in supporting the development of new technologies for the production of clean energy. According to the IEA, while most of the targeted global emission reductions in the current decade will utilise existing technologies, successful innovations will need to play a major role in the subsequent decades. Increased public funding of the R&D needed to develop new technologies would help accelerate their design, testing of prototypes, and eventual deployment to scale. This will require reversing the trend decline in global government spending on R&D in energy, which is estimated to have fallen from 0.1% of GDP in 1980 to only 0.03 % of GDP in 2019. While national governments can be expected to carry out most of this effort, given resource availability, economies of scale, and externalities of such activities, some SNGs, especially at the regional level, are also devoting resources to R&D on decarbonisation either through direct programs or by supporting universities, corporations and start-ups active in this area (OECD, 2021b).

3. Subnational revenues and decarbonisation

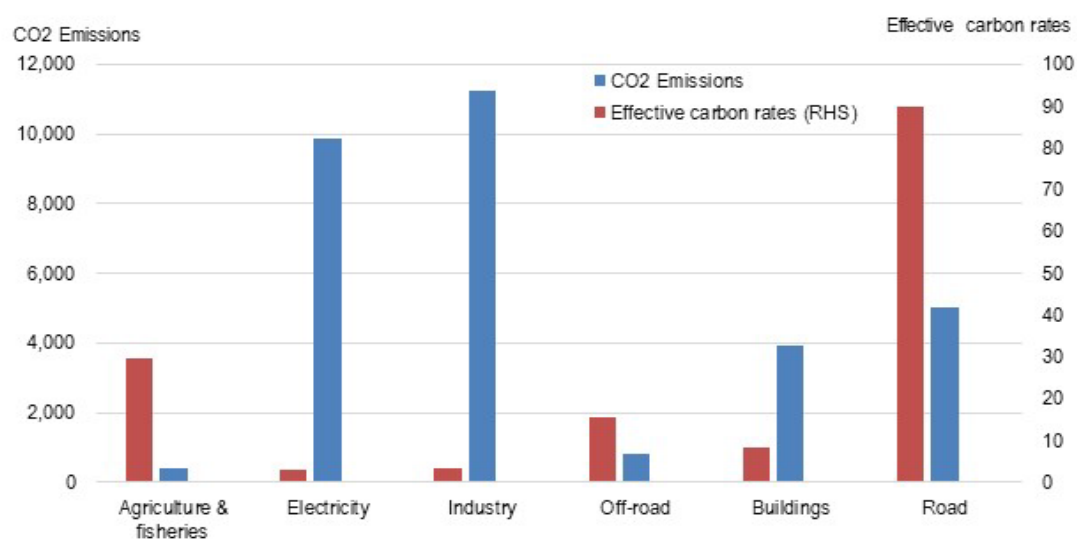
26. Decarbonisation policies based on pricing signals are potentially effective instruments to lower emissions, but carbon prices, broadly defined, are currently low and uneven across sectors and fuels, affecting their emission-reduction potential (Figure 6, Panel A). In particular, effective carbon rates – the sum of fuel excise taxes, carbon taxes and tradeable emissions permit prices – are much higher for road transport than for buildings. They also vary widely across countries (Figure 6, Panel B).

27. Taxes are an important component of pricing-based decarbonisation policies (Figure 7). Taxes on emissions (carbon taxes and emissions trading schemes) represent the most direct contribution to such efforts. If uniformly applied, carbon taxes minimise abatement costs by allowing economic agents to choose the most cost-effective approach to reducing emissions in their individual circumstances (e.g. through increased use of energy-saving technologies; by redirecting resources towards less polluting activities; or by reducing consumption of high-carbon goods and services) (IMF, 2019; D’Arcangelo et al., 2022).

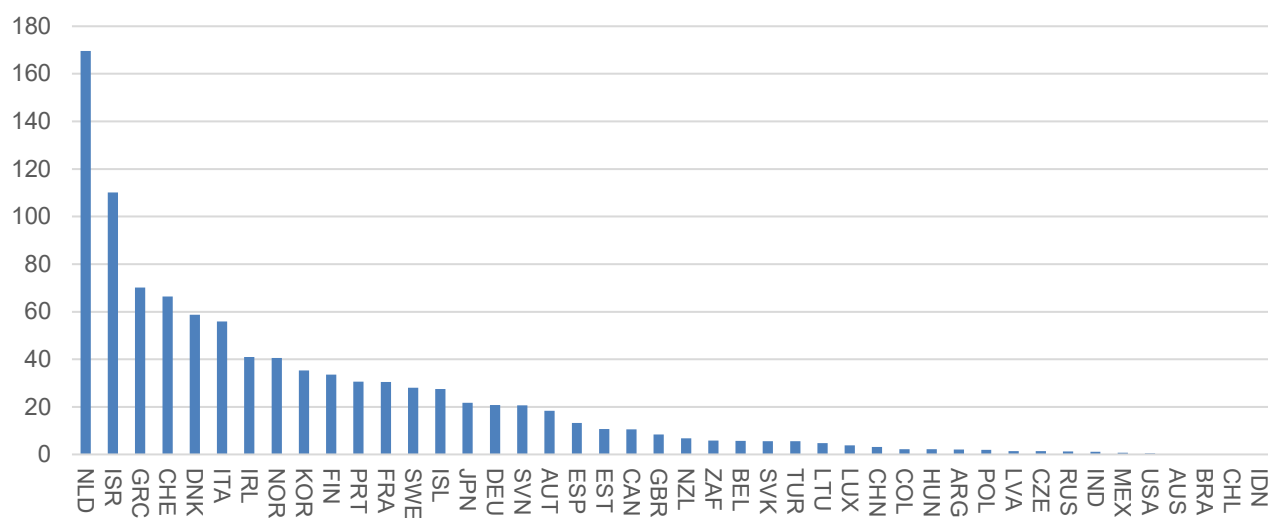
28. Since most countries currently significantly under-price their emissions, the adoption or increase of existing carbon taxes would have in principle a significant revenue mobilisation potential. However, these taxes require the capacity to assess levels of emissions accurately and, because of their relatively high visibility, tend to generate significant political resistance, especially if levied at rates that reduce the international competitiveness of domestic firms. Also, they can have adverse distributional effects, if higher-carbon goods and services have a larger weight in the consumption baskets of lower-income groups. Moreover, carbon taxes can only provide a temporary boost to revenue, since receipts are set to decline in tandem with emissions.

Figure 6. Emissions and effective carbon prices, 2018

Panel A. By sector



Panel B. By country

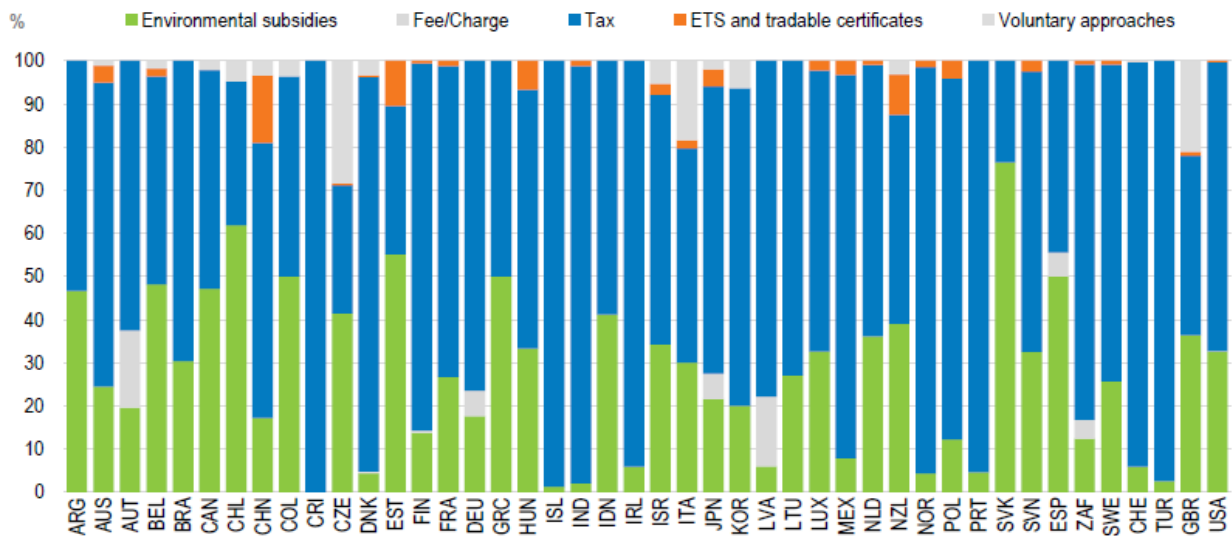


Note: Effective carbon rates are as of 1 July 2018. CO₂ emissions are calculated based on energy use data for 2016.

Source: OECD (2022a).

Figure 7. Shares of different policy instruments in decarbonisation

Share of climate-related policy instruments by category, 2019



Note: The figures do not include standards and regulatory instruments. See source below for additional information.

Source: D'Arcangelo et al. (2022).

29. An alternative price-based instrument to foster decarbonisation is emissions trading, such as cap-and-trade systems. Emission trading systems (ETS) share most of the pros and cons of carbon taxes but their revenue-raising potential depends on the share of permits that are auctioned, as opposed to granted free of charge (Marten and Van Dender, 2019; Flues and Van Dender, 2020). On the other hand, because their impact on the cost of emissions is less explicit, they generally face lower political resistance than carbon taxes.

30. The above-mentioned characteristics of carbon taxes and ETS --in particular their administration difficulties, and the fact that the distribution of their costs for firms and individuals is likely to vary significantly within national territories-- make them less appropriate for most subnational than for national governments. Nevertheless, a number of SNGs around the world have introduced their own carbon taxes or ETS, in some cases ahead of the central governments themselves. According to the World Bank's Carbon Pricing Dashboard, such mechanisms are in place or scheduled for implementation at the subnational level in several Canadian provinces, U.S. and Mexican states, as well as Japan.

31. Other, easier to administer, taxes and non-tax revenues can yield a "double dividend" in terms of providing a price incentive to reduce emission-generating activities and generating revenues for SNGs. Among them are subnational taxes on fuel products, or subnational surcharges on national taxes on such products. By being limited to one source of emissions, these taxes are less effective than all-encompassing carbon taxes in reducing emissions. However, since the price elasticity of demand for fuel products tends to be relatively low in the short run, these taxes can raise significant revenues for SNGs. Also, if levied at the consumption stage (e.g. at fuelling stations), these taxes have less adverse effects on enterprises' competitiveness, although they can still have differential impacts across products (depending on the share of transport costs in their cost structure) and individuals (depending on various factors, such as their access to, and cost of, public transportation; the energy efficiency of the vehicles they use, etc.).

32. Many SNGs also levy taxes or surcharges on the consumption of electricity. These taxes incentivise households and enterprises to increase their energy efficiency, but they may also have the unintended consequence of encouraging the use of more polluting sources of energy, unless these alternatives are also taxed at similar or preferably higher rates. Moreover, these taxes tend to have undesirable distributional effects, since lower-income households tend to consume a higher share of their

income on electricity and are less well equipped to manage consumption than their more affluent counterparts. To minimise adverse distributional effects, electricity taxes generally exempt household consumption below relatively low thresholds.

33. Another potentially green subnational tax source are taxes on motor vehicles, levied at the time of sale and/or on annual basis. These taxes may encourage the use of public transport, but their main purpose is revenue mobilisation, rather than decarbonisation. Where the tax is levied on an *ad-valorem* basis, they may discourage the purchase of newer, more fuel-efficient and more expensive, vehicles. In other cases, polluting vehicles may be taxed more heavily (OECD, 2022b). Differentiating the rates in favour of electric or lower fuel-consuming vehicles would make these taxes “greener”, to the extent that electricity generation is “green”, but probably also regressive.

34. Moreover, subnational governments can use taxes and fees that capture the value created by installing green infrastructure, by using tax increment financing and other land value capture measures,¹¹ although these are more frequently used in connection with adaptation than decarbonisation activities.

35. Other subnational taxes can, of course, contribute to SNGs’ decarbonisation objectives, even if they do not provide a price signal to carbon emitters. This is because they mobilise revenues that enable higher decarbonisation-oriented direct subnational spending, investments or subsidies, as discussed in the preceding subsections. In this respect, efforts to enhance subnational revenue mobilisation, including by greater recourse to underutilised taxes, such as property taxation in many countries, can contribute to meeting broader decarbonisation objectives.

36. SNGs can, and frequently do, also use their tax systems to incentivise energy efficiency and/or shifts to lower-carbon energy sources through credits against their individual or corporate taxes (or surcharges on national taxes). In theory, explicit budgetary subsidies for abatement activities or investments should be preferred to tax expenditures because their cost and distributional impact are more transparent, and thus their cost-effectiveness is more open to scrutiny and evaluation. But, in practice at both the subnational and national levels, political economy considerations often weigh in favour of the use of tax incentives.

37. Various types of subnational nontax revenues can also be useful instruments for decarbonisation. Some municipalities in large metropolitan areas (e.g., London, Milan, Singapore and Stockholm) levy congestion charges on vehicles entering the city centre during peak traffic hours. Other regional or local governments in various countries use fees or fines on selected carbon-intensive activities (Martinez-Vazquez, 2021). In some cases, betterment fees can also be levied to finance the energy retrofit of urban infrastructure and amenities, in pursuit of broader decarbonisation objectives.

38. An important consideration regarding the use of price instruments to meet decarbonisation objectives concerns the political economy, especially where the overall tax take is already high. As noted above, public opinion support for explicit pricing instruments, such as carbon taxes, tends to be low because of their direct effect on the cost of emissions and hence consumption. Evidence nevertheless shows that support tends to rise to the extent that the revenue associated with these instruments is used to finance the provision of services and infrastructure related to climate change mitigation (OECD, 2022c).

¹¹ See Ingram and Hong (2012) for a comprehensive discussion of value capture policies.

4. Subnational regulatory activities for decarbonisation

39. Decarbonisation instruments based on market signals, such as carbon taxes, ETS, and feebates¹² or other subsidies, are typically more effective in influencing the behaviour of firms than of households, reflecting information failures, coordination problems and status quo biases, which are more prevalent in the latter than in the former. Moreover, the use of price-based instruments is often constrained by the administrative cost, distributional, and political economy considerations mentioned above. Therefore, governments at all levels complement these instruments with regulations in their respective areas of responsibility, which also have an effect on emissions without nevertheless imposing an explicit price on them. The cost for economic agents to comply with regulatory standards and mandates can be seen as an implicit (typically less visible) carbon price, in contrast to emission pricing schemes that set an explicit one.

40. SNGs exercise regulatory powers for decarbonisation purposes mainly in the areas of transport, land use and buildings. As main providers of transport services in metropolitan areas, SNGs have prerogatives to design public transport networks, including the choice of technologies that reduce the associated emissions (e.g. replacing oil-fuelled buses with electric or gas-powered ones). They can also incentivise the use of public or low-carbon means of transport through dedicated lanes and pedestrian zones. Some middle-tier governments in federal countries set emission standards for vehicles registered in their respective jurisdictions. They also regulate the availability of charging stations for electric vehicles.

41. SNGs, especially local jurisdictions, are also involved in the issuance and enforcement of land-use regulations. These regulations have implications for emissions and for the overall environmental characteristics of regions and localities. They affect the amount of land available for different uses, such as agricultural, industrial, commercial and residential, which have different emission-reduction potential. Zoning regulations also influence the scope for densification or sprawl in urban areas, which have different implications for emissions. The latter tend to be higher in less densely populated areas, due to the greater use of private transport, even though performance varies considerably among localities, depending on the availability and use of public transport and the energy used in it, as well as on the extent of carbon capture exercised by green areas.

42. Subnational regulatory activities play an important role in the decarbonisation of buildings. Electrification helps to reduce emissions in this sector by discouraging use of polluting fuels for heating/cooling and the use of appliances. There is also a need to ensure high standards of energy efficiency in new buildings and to retrofit those properties that do not meet acceptable standards based on current regulations (Hoeller et al., 2023). While policies to electrify energy generation fall most often under the purview of national governments, those related to energy efficiency in buildings tend to be joint or exclusive responsibilities of SNGs. A survey of European regional and local authorities, conducted by the OECD and the Committee of the Regions in 2021, shows that most such jurisdictions have developed their own plans and policies for decarbonising buildings, but also face capacity constraints and funding gaps to ramp up efforts in those areas (OECD, 2022c).

43. A key regulatory instrument in this sector is the inclusion in regional or local building codes of appropriate and regularly updated standards for the thermal and insulation characteristics of new commercial and residential properties. Such codes are now commonplace and generally appropriately enforced by the relevant jurisdictions in advanced economies, but unfortunately are not always available or properly enforced in emerging-market and developing countries, where construction activity is expected to be strongest due to more rapid population growth (OECD, 2021a).

¹² Feebates are programs that combine fees on high-carbon activities (e.g. the ownership of fuel-inefficient vehicles) with rebates for low-carbon ones (e.g. the purchase of fuel-efficient ones). By design, feebate programs are revenue neutral.

44. As for older buildings, which account for the bulk of the housing stock, investment in energy retrofitting is discouraged by high costs, a shortage of finance, and split incentives between landlords and renters. Regulations on landlord-tenant relations, which include rules for adjustments in rents, are often issued by local governments, and can help address the split incentive problem that discourages energy retrofitting in rental markets by allowing the associated costs to be passed on to rents.¹³ SNGs can also regulate the minimum percentage of owners of common properties (condominiums) required to approve measures to energy retrofit such properties. Furthermore, the subnational governments also play a part in the issuance of energy performance certification and the enforcement of regulations in this area. Certification is an important tool to raise awareness about the energy performance of properties, which is a pre-condition for homeowners/landlords to invest in home improvements. Studies indeed show that most people do not know the energy performance of where they live, cannot manage their energy use at home, and do not understand well how electricity bills are calculated (de Mello, 2022). In addition, certification may facilitate the reflection in rental and housing prices of the benefit of improved energy performance through investment in energy retrofitting (although empirical analysis has yielded mixed results, so far).

III. How to promote the alignment of national and subnational decarbonisation policies

45. The previous section discussed the reasons for involvement of SNGs in decarbonisation. This section will discuss: a) why national governments need to be involved in subnational activities that impact decarbonisation; b) the various ways in which national governments can prevent subnational actions that have adverse effects on carbon emissions and support subnational decarbonisation efforts; and c) how strengthening intergovernmental co-operation arrangements can facilitate an effective alignment of national and subnational decarbonisation policies.

46. There are several reasons for national governments' involvement in subnational actions that could impact adversely or favourably emissions. First of all, national governments are responsible for defining and delivering on any international commitment to reduce emissions, such as those undertaken in the context of the Paris agreement (the nationally determined contributions, NDCs). There is therefore a case in principle for utilising any scope afforded to them by prevailing legislation, including in their relations with their SNGs, to implement those commitments.

47. The main economic case for the national governments' involvement rests in the fact that subnational activities that affect emissions have potentially significant spillovers beyond the borders of the jurisdiction undertaking them. Therefore, national governments may wish to avoid or at least limit such spillovers, if adverse, and support them, if favourable.

48. Moreover, SNGs may use their regulatory powers to lower emission and energy efficiency standards in efforts to attract investment, which would result in a sort of "race to the bottom" that would be undesirable from the point of view of reducing emissions at the national scale. Such policies may reflect political ideologies and pressures, as well as economic and fiscal considerations. A case can therefore be made for national governments to limit the scope for such predatory competition if it generates significant externalities and/or conflicts with national decarbonisation goals.

49. Another reason for national governments' involvement is the fact that decarbonisation-oriented policies are likely to have different distributional effects across the national territory. For example, closing a coal mine, or phasing out other especially polluting industries, may impact some communities (regions or localities) especially strongly. The national government is better placed than the affected SNGs to support those sectors of the economy and social groups most adversely affected by these transition costs.

¹³ The incentive mismatch between homeowners and renters is borne out by the empirical evidence, as surveyed by Solà et al. (2021) and Gerarden et al. (2017), among others.

Support can be provided in the form of targeted assistance to businesses and households, active labour market policies to facilitate matching and job search, as well as training and re-training programs for displaced workers. Tailoring these initiatives to the needs and preferences of the regions in need is part of a broader strategy to reconcile nation-wide decarbonisation ambitions with regional asymmetries in the incidence of transition costs (OECD, 2021b).

50. Finally, national governments have greater financial resources (in terms of revenues and access to financing sources) to support subnational investments in decarbonisation. They also have greater technical expertise in measuring emissions from various activities and in assessing the impact of mitigating policies on them. National governments' technical and financial support is also important in relation to climate change adaptation, given that needs are shaped most notably by climate and geography, which often vary considerably within the national territory and affect different regions and localities asymmetrically.

51. In practice, national governments' involvement in subnational activities relevant for decarbonisation varies significantly across countries, reflecting constitutional and other legal constraints, various characteristics of the intergovernmental fiscal relations system, and the priority attached by the national government to decarbonisation objectives. *Caeteris paribus*, it tends to be higher in unitary than in federal countries.

52. The involvement can take a number of forms. First, the national government can set nationwide minimum standards for public and private activities that have significant impact on emissions, leaving SNGs to go beyond such standards, if they so wish. For example, in the transport area, the national government could mandate minimum energy efficiency standards or even a timetable for a shift to electric power use for new vehicles, and a maximum speed limit on interstate highways or on national roads. In the real estate area, it could set minimum energy efficiency standards for subnational building codes and specify a timetable for the achievement of minimum energy efficiency standards in public buildings, such as schools and health care facilities, through energy retrofiting. The national government also has an important role to play to set national energy performance certification and labelling systems for existing buildings, which account for the lion's share of the stock of buildings and structures, so that incentives can be strengthened for investment in energy retrofiting. The experience of the European Union is instructive in this regard, since new supra-national directives are being introduced to ramp up national efforts that will need to be implemented at the subnational level as well (de Mello, 2023).

53. Such national mandates may be subject to legal challenges in federations, highlighting the need for intergovernmental dialogue and consultation prior to their imposition. Intergovernmental dialogue is anyway desirable also in unitary states to ensure that some relevant local specificities are given due consideration in the formulation of the mandates, and that SNGs are compensated for any significant financial burdens imposed by such mandates on them.

54. National governments can play an important role in supporting subnational revenue mobilisation efforts for decarbonisation. First, at a minimum they can remove any legal obstacles to the levying by SNGs of green taxes of the types discussed in Section II-3 above. For example, they could allow SNGs to levy surcharges on national carbon taxes, where available, or taxes on the consumption of fossil fuels. They could even set floors on the rates of such taxes¹⁴. Alternatively, they could levy their own carbon or fuel taxes at higher rates and share them with SNGs on a derivation basis. More generally, national governments can ensure that SNGs are assigned adequate revenue sources to carry out their spending responsibilities, including for emission-reducing activities and investments. And, by avoiding the emergence of subnational soft budget constraints, national governments can incentivise their SNGs to adequately exploit their assigned revenue bases (Ter-Minassian, 2015).

¹⁴ An example in this respect is the Canadian federal backstop for carbon pricing.

55. National governments can also support subnational decarbonisation efforts, including in dealing with transition costs, through intergovernmental transfers. These can be used to help fund subnational decarbonisation-oriented activities and investments, and to mitigate asymmetries in the impact of decarbonisation policies across the national territory. Given the specific policy objective being pursued with such transfers, special-purpose grants are preferable to untargeted ones. They may be also accompanied by conditionalities, policy or outcome based¹⁵. A blend of matching and non-matching grants may help balance the objective of ensuring additionality of resources devoted by individual SNGs to decarbonisation with the also important objective of enabling poorer jurisdictions that could not meet matching requirements to benefit from the national support.

56. In addition to the provision of matching or non-matching capital grants, national governments can support subnational investments aligned with national decarbonisation goals by facilitating sustainable financing for them. This may involve reforms of fiscal rules to replace—still fairly common in non-advanced economies—blanket prohibitions for SNGs to borrow or issue bonds for investments with rules limiting their access to such types of financing on the basis of appropriate indicators of their fiscal sustainability and liquidity. National governments can also support the creation of nationwide financial institutions specialised in the financing of creditworthy subnational investments (as is, e.g., the case in Finland and New Zealand). Moreover, national governments can promote decarbonisation by setting appropriate transparency standards for carbon emissions-sensitive subnational activities and investments, and by sharing with SNGs through technical assistance the relevant knowledge on estimating the effects of such activities.

57. More generally, it is clear from the considerations above that an effective alignment of national and subnational decarbonisation policies requires open and constructive intergovernmental dialogue in which different perspectives can be discussed and brought to bear on the decision-making process of governments at all levels in areas of joint responsibility. International experience shows that the institutionalization of such dialogue through the creation of intergovernmental co-operation fora is important to its effectiveness.¹⁶

58. High-level vertical co-operation fora are the appropriate venues for discussion of broader reforms of intergovernmental systems that may be needed to ensure clarity of responsibilities of the different levels of government, avoid unfunded mandates, promote adequate fiscal autonomy of SNGs, and align investment priorities in the decarbonisation agenda. More focused sectoral co-operation fora in the relevant spending areas can help ensure that agreed decarbonisation objectives are translated into specific sectoral agendas, and that their implementation is transparent and monitored by all parties concerned.

59. Effective horizontal co-operation in decarbonisation efforts is especially important among the constituent municipalities of metropolitan areas. The socio-economic flows within these areas, in particular those related to commercial activities and mobility patterns, which need to be decarbonised, do not necessarily match administrative municipal boundaries. Institutions (metropolitan governance structures, or at least well-functioning co-operation fora) that facilitate the achievement of intermunicipal consensus on relevant spending, revenue, and regulatory policies can be instrumental in the success of decarbonisation within the area.

60. Both vertical and horizontal co-operation fora can also be very useful vehicles for the sharing of knowledge, good practices and successful experiences, and also of lessons from unsuccessful ones. Co-operation fora can also promote positive demonstration effects.

¹⁵ See OECD (2021b) for a discussion of the possible types of conditionality attached to decarbonisation-oriented intergovernmental grants and of country examples in this area (e.g. the Climate Lens in Canada).

¹⁶ Ter-Minassian and de Mello (2016) discuss in some detail the benefits of vertical (among different levels of government) and horizontal (among governments at the same level) cooperation and provide a range of examples of such fora in advanced and selected emerging countries.

IV. Conclusions

61. This paper has reviewed the main channels through which activities of SNGs can influence the outcomes of countries' decarbonisation efforts. In most countries, SNGs have sole or concurrent responsibility in a number of areas that will need to make major contributions to national decarbonisation agendas towards meeting agreed decarbonisation targets by mid-century. Key among them are electricity distribution, transport, commercial and residential buildings, as well as land use. SNGs can affect decarbonisation outcomes in these areas through their public consumption, subsidies and transfers, and investments; through their revenue policies and other price-based mechanisms, such as ETS; and through their use of regulatory powers.

62. The mix of subnational policies in these areas varies widely both across and within countries, reflecting a host of factors: geographic ones, such as the size (in land mass and population) and urban or rural nature of the jurisdictions, and their climate and endowment of fossil fuels; economic ones, such as their level of development, economic structure and the state of their public finances; institutional ones, in particular the federal or unitary nature of the country, the main characteristics of the intergovernmental fiscal relations system, and the level of capacity of the jurisdiction in question; and socio-political ones, such as prevailing ideology and political orientation of the relevant administration.

63. The paper has discussed qualitatively and conceptually some of these interrelations. A more quantitative empirical analysis is hampered by the current lack of comparable and adequately detailed data on decarbonisation-relevant subnational spending and revenues and on non-pricing and regulatory measures, including at the subnational level. The development of such a database, based on a standardised methodology, should rank high in the international decarbonisation agenda. It could begin by focusing on regional and large local governments in for example the largest carbon emitting countries. Efforts by the OECD in this area, not least through the establishment of the Inclusive Forum for Carbon Mitigation Approaches, constitute a laudable step in this direction.

64. The variety of decarbonisation-relevant subnational policies and activities points to the importance of their mutual consistency. SNGs, especially regional and medium-to-large local governments, should develop their own decarbonisation agendas tailored to specific circumstances, and in fact many of them already do so. However, it is also essential that such agendas be well aligned with national ones – supporting each country's international commitments and their implementation in practice – which is unfortunately an area where progress currently lags.

65. National governments have various instruments to promote and support subnational decarbonisation efforts, by avoiding unfunded spending mandates; by reviewing, and expanding as needed, the assignment of own-revenue sources (including green taxes) to SNGs, and by helping strengthen the capacity of subnational tax administrations; through decarbonisation-targeted special purpose grants and capital transfers; and by facilitating the access of credit-worthy SNGs to fiscally sustainable financing for green investments.

66. Well-functioning general and sectoral intergovernmental co-operation fora can be effective venues for the dialogue between a national government and its SNGs, and among the latter, which are necessary to promote the above-mentioned alignment of decarbonisation agendas and the policies and reforms to implement these agendas.

References

- D’Arcangelo, F., M. Pisu, A. Raj and K. Van Dender (2022a), “Estimating the CO₂ emission and revenue effects of carbon pricing: New evidence from a large cross-country dataset”, *OECD Economics Department Working Papers*, No. 1732, OECD Publishing, Paris.
<https://doi.org/10.1787/39aa16d4-en>
- D’Arcangelo, F., I. Levin, A. Pagani, M. Pisu, Å. Johansson (2022b), “A Framework to Decarbonise the Economy”, *OECD Economic Policy Papers*, No. 31, OECD Publishing, Paris.
<https://doi.org/10.1787/4e4d973d-en>
- de Mello, L. (2023), “Real Estate in a Post-Pandemic World: How Can Policies Make Housing More Environmentally Sustainable and Affordable?”, *Hacienda Pública Española/Review of Public Economics*, forthcoming.
- de Mello, L. and D. Sutherland (2015), “Financing Infrastructure”, in J. Frank and J. Martinez-Vazquez (Eds.), *Decentralisation and Infrastructure in the Global Economy: From Gaps to Solutions* (Routledge), pp. 146-70.
- de Mello, L. and J. Martinez-Vazquez (2022), “Climate Change Implications for the Public Finances and Fiscal Policy: An Agenda for Future Research and Filling the Gaps in Scholarly Work”, *Economics*, Vol. 16, pp. 194-198.
- de Mello, L. and T. Ter-Minassian (2022), “Improving subnational governments’ resilience in the wake of the COVID-19 pandemic”, *OECD Working Papers on Fiscal Federalism*, No. 37, OECD Publishing, Paris. <https://doi.org/10.1787/6b1304c8-en>
- Dougherty, S. and A. Montes Nebreda (2023a), “The multilevel fiscal governance of ecological transition”, *OECD Working Papers on Fiscal Federalism*, No. 44, forthcoming, OECD, Paris.
<http://oe.cd/il/FFwps>
- Dougherty, S. and A. Montes Nebreda (2023b), “Consolidated Expenditure by Government Function: an Extension of the Fiscal Decentralisation Database”, Background document for the Network on Fiscal relations across Levels of Government, OECD, Paris. <http://oe.cd/SbF>
- Flues, F. and K. Van Dender (2020), “Carbon pricing design: Effectiveness, efficiency and feasibility: An investment perspective”, *OECD Taxation Working Papers*, No. 48, OECD Publishing, Paris.
<https://doi.org/10.1787/91ad6a1e-en>
- Gerarden, T.D., R.G. Newell and R.N. Stavins (2017), “Assessing the Energy-Efficiency Gap”, *Journal of Economic Literature*, Vol. 55, pp. 1486-1525.
- Hoeller, P, V. Ziemann, B. Cournède and M. Béтин (2023), “Home, Green Home: Policies to Decarbonise Housing”, *OECD Economics Department Working Papers*, No. 1751, OECD Publishing, Paris.
<https://doi.org/10.1787/cbda8bad-en>
- IEA (2021), *Net Zero by 2050: A Roadmap for the Global Energy Sector*, International Energy Agency, Paris.
- IEA (2022), *World Energy Outlook 2022, An updated roadmap to Net Zero Emissions by 2050*, International Energy Agency, Paris.
- IMF (2021), “Strengthening Infrastructure Governance for Climate-Responsive Public Investment”, IMF Policy Paper, 2021.
- Ingram, Gregory K. and Yu-Hung Hong (2012). *Value Capture and Land Policies*. Lincoln Institute of Land Policy. Cambridge, MA.

- JRC (2020), *EDGAR - Emissions Database for Global Atmospheric Research*, Joint Research Centre, European Commission, Brussels.
- Marten, M. and K. Van Dender (2019), "The use of revenues from carbon pricing", *OECD Taxation Working Papers*, No. 43, OECD Publishing, Paris. <https://doi.org/10.1787/3cb265e4-en>
- Martinez-Vazquez, J. (2021), "Adapting fiscal decentralisation design to combat climate change", *International Center for Public Policy Working Paper*, No. 21-05, Georgia State University, Atlanta.
- Nachtigall, D. L. Lutz, M. Cardenas Rodriguez, I. Hascic and R. Pizarro (2022), "The Climate Actions and Policies Measurement Framework: A Structured and Harmonised Climate Policy Database to Monitor Countries' Mitigation Action", *OECD Environment Working Papers*, No. 203, OECD Publishing, Paris. <https://doi.org/10.1787/2caa60ce-en>
- OECD (2019), "Financing climate objectives in cities and regions to deliver sustainable and inclusive growth", *OECD Environment Policy Papers*, No. 17, OECD Publishing, Paris. <https://doi.org/10.1787/ee3ce00b-en>
- OECD (2021a), *Brick by Brick: Building Better Housing Policies*, OECD Publishing, Paris. <https://doi.org/10.1787/b453b043-en>
- OECD (2021b), *OECD Regional Outlook 2021: Addressing COVID-19 and Moving to Net Zero Greenhouse Gas Emissions*, OECD Publishing, Paris. <https://doi.org/10.1787/17017efe-en>
- OECD (2021c), "Strengthening adaptation-mitigation linkages for a low-carbon, climate-resilient future: Policy perspectives", *OECD Environment Policy Paper* No. 23, OECD Publishing, Paris. <https://doi.org/10.1787/6d79ff6a-en>
- OECD (2022a), *Pricing Greenhouse Gas Emissions: Turning Climate Targets into Climate Action*, OECD Series on Carbon Pricing and Energy Taxation, OECD Publishing, Paris. <https://doi.org/10.1787/e9778969-en>
- OECD (2022b), *Consumption Tax Trends 2022: VAT/GST and Excise, Core Design Features and Trends*, OECD Publishing, Paris. <https://doi.org/10.1787/6525a942-en>
- OECD (2022c), *Decarbonising Buildings in Cities and Regions*, OECD Urban Studies, OECD Publishing, Paris. <https://doi.org/10.1787/a48ce566-en>
- OECD (2023), *Environmental Tax Policy Review of Andalusia*, OECD Publishing, Paris. <https://doi.org/10.1787/fe6d8b45-en>
- Solà, M.M., A. de Ayala, I. Galarraga and M. Escapa (2021), "Promoting Energy Efficiency at Household Level: A Literature Review", *Energy Efficiency*, Vol. 14.
- Ter-Minassian, T. (2015), "Promoting responsible and sustainable fiscal decentralisation", in *Handbook of Multilevel Finance*, edited by E. Ahmad and G. Brosio, E. Elgar Publishing.
- Ter-Minassian, T. and L. de Mello (2016), "Intergovernmental Fiscal Co-operation: International Experiences and Possible Lessons for Brazil", *Technical Note*, No. IDB-TN-1048, Inter-American Development Bank, Washington, DC.
- World Bank (2023), *Off the Books: Understanding and Mitigating the Fiscal Risks of Infrastructure*, World Bank, Washington, DC.