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NON-PRICE POLICIES FOR ADDRESSING CLIMATE CHANGE: THE GLOBAL EXPERIENCE

Renu Kohli and Honey Karun*

Centre for Social and Economic Progress (CSEP) Research Foundation
New Delhi, India

Executive Summary

This note discusses the cross-country experience on non-price policy measures to lower carbon emissions. It compiles the array of non-pricing methods adopted by the G20 countries, with broad classification by sectors and objectives. The sequencing and stringency patterns of these policy levers along with the impact and implementation experiences are assessed, while specifying the information gaps. The mapping of non-price, climate policy mitigation instruments reveals wide variations in deployment across sectors and targets. The note flags the complexities in assessing the effectiveness of such policies; inter alia, the lack of rich data on which estimations of expected emission reductions could be based. Hard evidence on policies and their effects is a critical gap that needs addressing to take ahead climate policy dialogue and coordination. In the context, the note highlights the ongoing work by the OECD to develop a Climate Actions and Policies Measurement Framework (CAPMF), as a starting point for comprehensive information on climate policies.

The following insights merit deliberation and further discussion by countries in the context of search for the best way forward to involve private sector in the low-carbon transition.

One, a complex interplay of multiple and varied non-price policy levers across sectors points to challenges of causal interpretations, evaluation, and comparative assessments. Two, the motivations are often diffused.; this may be to reduce greenhouse gas emissions or another primary goal that is extremely climate relevant. Three, there is frequent complementarity with price-based policy measures, where the latter's support to incentivize behavioural changes or encourage private investments is noticeable. Four, the adoption of non-price measures is quite unique amongst countries, pointing to a need to appreciate and adapt price-based policies in accordance while recognizing the limits to their harmonization. Five, although many non-price policy levers have existed for long and increased over time everywhere, the evidence on their efficacy is inconclusive. Six, the challenges to evaluating the efficiency and impact are complex and several, inter alia, causal inferences due to multiplicity and variations in responses, quantification difficulties, etc. impede empirical assessment. Seven, and likewise, the comparative effectiveness with price-based measures in reducing emissions is complicated. Specifically, the frequent overlap of price- and non-price-based mitigation instruments makes it extremely difficult to disentangle the contribution of separate measures to emissions, risks double-counting, amongst major issues.

The note concludes with the need for better understanding about the efficiency of non-price policy instruments, exclusive and in comparison, with price-based measures. Besides illuminating possibilities of a policy-mix and associated trade-offs, this is essential to support international negotiation and coordination on climate policies, competitiveness, and carbon leakages.

I. Introduction

Climate policies have acquired fresh urgency with the changed nature of the global debate on climate change after the pandemic. A spate of net-zero emission pledges by more than 130 countries, including the world's topmost emitters, indicates accelerating actions to achieve these targets. As result, the spotlight is upon the right type and mix of policies which can reconcile the manifold complexities and trade-offs faced across countries in shifting to a low-carbon future. The search is for a suitable blend of policy instruments that can balance competing objectives, i.e., economically efficient, effective, socio-politically acceptable, and inclusive. Whether market-based or otherwise, the adopted mechanisms to reduce emissions constitute the environment for potential investment opportunities and risk appraisals. Investors also seek certainty and assurance about committing capital to sustainable projects which must also fetch decent returns. In the context, enabling policies that generate market signals and expectations about the future can facilitate investments in low-carbon alternatives if strong price incentives are created to reduce emissions in targeted activities.

Against this backdrop, the G20 members, who have almost all pledged net zero emissions over varying timespans, are keenly examining the set of policy preferences, sequencing patterns, and different models employed by countries. The clear objective here is to secure sustainable investments for the low-carbon transition, bulk of which will have to come from the private sector. The pressure to scale-up actions for implementing the net zero emission promises is high. Yet, elevated public debts and deficits after the pandemic limit the resources available for public spending on green investments. Incentivizing participation of private capital into sustainable projects and support the low-carbon transition with an eye on individual country circumstances is an important matter for the G20's deliberation. And the focus is upon the facilitating role of public policy levers in achieving these objectives.

The broad division is between pricing and non-pricing mechanisms where the former alludes to carbon pricing. Non-pricing instruments, which endeavour to check the use and efficiency of products and services causing emissions without assigning a price, are wide-ranging; these extend from sectoral policies/regulations including subsidies for green projects and finance incentives to emission disclosures, norms, standards, quotas, and such like. Evidence on their cost-effectiveness in lowering emissions is formative and unsettled; at best, it is mixed.¹ There's considerable support for complementarity² in pricing and non-pricing tools for lowering emissions (or more broadly, greenhouse gases), and to assist private enterprise and capital.

This points to a need for better understanding about their relative impacts and the possibilities of blending the two in alignment with country-specific context and requirements. Preceding

* Renu Kohli is a Senior Fellow and Honey Karun is an Associate Fellow at the Centre for Social and Economic Progress, New Delhi.

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¹ Carbon pricing through taxation and ETS is argued to be economically efficient and a cost-effective instrument for reducing emissions, incentivise shift to cleaner energies, and greater decarbonisation efforts (ADB 2021, 2022; Parry et.al. 2021, 2022; Dominioni, 2022; Mideska 2021; de Mooij et.al. 2012). Also see <https://unfccc.int/news/calls-increase-to-use-carbon-pricing-as-an-effective-climate-action-tool>. Meta-analysis of studies on carbon policies in the EU finds limited impact of carbon pricing on emissions (Green, 2021).

² A substantial literature indicates complementarity between pricing and non-pricing instruments (e.g., IPCC 2022; Stiglitz 2019; Stiglitz & Stern 2017; van der Bergh 2021; Peñasco et.al. 2021; Bertram et.al. 2015).

deliberations at the G20's *Forum on International Policy Levers for Sustainable Investment* (13 June 2022, Indonesia)³ have deliberated on these lines, specifically underlining a need for enhanced insights. Members noted the essential role of non-pricing tools in reducing emissions even as they concurred that carbon pricing mechanisms were important. The comparative effectiveness of pricing and non-pricing instruments was regarded necessary to examine in this light, as also from the standpoint of evolving methodologies to identify relevant metrics that could further serve as inputs for macro-economic models.

While the choice of tools and pathway adopted is eventually unique and country-specific, there's enormous scope to learn from cross-country experiences. Lessons learned in the design and implementation of non-pricing measures, the challenges faced in crafting policy mixes, and managing the combination with pricing tools can offer crucial insights to G20 members, both in individual capacities as also instances where joint action towards a coordinated investment drive is contemplated or may be desirable.

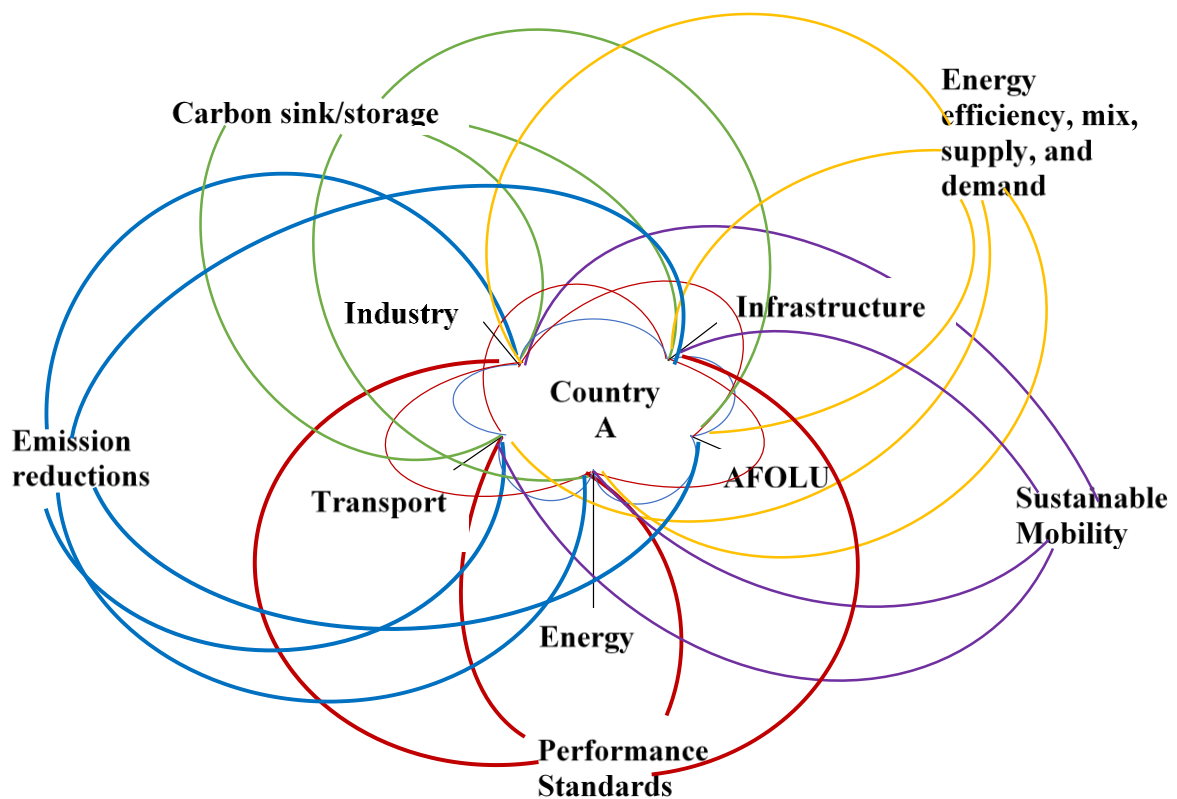
In the above setting, this note discusses the international experience on non-price policy measures adopted by countries for switching to a low-carbon economy. It is organized as follows. Section II sets out the exhaustive array of non-pricing methods adopted by the G20 countries, classified by broad sectors and objectives. Section III details sequencing and stringency patterns, implementation experiences and impact where available, specifying the information gaps. Section IV concludes.

³ Excerpts from G20 Indonesia, 2022 Presidency Summary. [www./https://g20sfwg.org/wp-content/uploads/2022/07/Presidency-Summary-%E2%80%93-Forum-on-International-Policy-Levers-for-Sustainable-Investment-%E2%80%93-13-June-2022.pdf](https://g20sfwg.org/wp-content/uploads/2022/07/Presidency-Summary-%E2%80%93-Forum-on-International-Policy-Levers-for-Sustainable-Investment-%E2%80%93-13-June-2022.pdf).

II. Climate policy in G20 countries- an overview

All the G20 members have adopted a broad and diverse set of policy instruments to mitigate climate impacts and strengthen resilience. There are a large variety of market-based pricing systems such as carbon pricing, emissions trade mechanisms (ETS), and such like, combined with numerous non-pricing instruments. Because of the multiple objectives these seek to achieve, the overlap across sectors is very high (Figure1) – a pointer to how these may interact in complex ways. To elaborate, price-based instruments such as grants and subsidies are commonly employed in various sectors as incentives to reduce emissions, promote energy-switching and efficiency, and encourage sustainable mobility in conjunction with non-price-based tools such as standards and norms relating to technology, performance, disclosures, amongst others. In general, these constitute a complementary strategy for climate mitigation in all countries.

Figure 1. Non-pricing policy levers are a complex network across sectors and purposes.



Note: AFOLU- Agriculture, Forest, and Land use obligations.

An attempt is made here to compile the many types of non-pricing measures used to check carbon or more broadly, greenhouse gas emissions (GHGs) across countries. The listing is not definitive, but sufficiently comprehensive to underscore their wide prevalence across different sectors, the typical attributes, and different reasons for which these are deployed worldwide. The exercise also demonstrates the difficulties associated with measuring or quantifying the impact of non-pricing measures upon containing emissions, and how these compare with carbon-pricing and other pricing tools. The following sub-sections classify and describe such tools across sectors, the policy mix of pricing and non-pricing mechanisms, followed by a brief country-specific profiling.

II.1 Non-pricing levers across sectors

Panel 1 depicts a distribution of the diverse range of climate-related non-price-based policies across different sectors amongst the G20 countries. This reveals dominance of overarching non-pricing levers such as setting GHG reduction targets, and support for research and development (R&D) for low-carbon activities in the hierarchy of preferences across the board (Chart 1.1). Most countries (80 percent) employ these tools across various sectors, and they feature as part of an overarching climate strategy in 15 countries. More than three-fourths of the members support R&D for low-emission or emission reduction technologies through funding, action plans, and other non-price measures. All countries have prioritized emission reductions and energy efficiency improvements across power, industry, buildings, transport, and agriculture & forestry sectors. These are not the only non-price instruments used though, as supplementary price-based and other methods are commonly observed as well.

A brief elaboration of the sector-specific non-pricing levers in existence is given below.

The Electricity and heat segment is characterized by a lead role for renewable energy targets, supplemented with fuel taxes. The sector has the most diverse set of non-price tools in use with equally expanded coverage. This is understandable as energy serves as the key input for all users, producers, or consumers in any economy. 80 percent of the countries have support mechanisms for non-renewable or low-carbon alternatives (options such as nuclear and hydrogen-based technologies), which can combine pricing and non-pricing tools; schemes to incentivize increasing the share of renewables, facilitate grid integration, as well as direct public investments; and policies for energy efficient power plant stock to prepare for the phase-out of inefficient power plants. A lesser number (14 countries) use renewable energy targets for electricity or have undertaken grid infrastructure development, instituted electricity storage policies for developing grids and storage, and allow installation of renewable electricity, such as solar PV and wind, in the system. And only three countries (Canada, European Union, and Russia) have introduced phase-out plans for coal and oil in this sector (Chart 1.2).

Industry The key mechanisms employed for industrial decarbonization are also a mix of pricing and non-pricing instruments. Other than target-setting to reduce emissions, one set of measures relates to incentives for lowering specific gases (Chart 1.3) along with technology support to develop alternate options for carbon dioxide removal (e.g., Bioenergy with Carbon Capture and Storage (BECCS), Direct Air Capture with Carbon Storage (DACCS), etc.). To better energy efficiency of industrial output, 80 percent of the countries have adopted non-pricing tools such as energy reporting, audits, and other support systems for CCS, fuel switch, reducing CH₄, N₂O and other fluorinated gases. Three-fourths of the countries have instituted performance and equipment standards, along with schemes for renewables that encourage or impose usage of renewables.

Buildings Setting of standards, codes, materials, and energy efficiency requirements to reduce carbon emissions are the major non-pricing instruments in use in the building sector. These are usually combined with price-based measures such as energy taxes. Sixteen countries have also set performance and equipment standards for bettering energy efficiency in appliances, with building codes and mandatory certification requirements to lower emissions from construction activities (Chart 1.4).

Transport Countries have mostly employed taxes to contain transport-related emissions, with 80 percent taxing fuels. Non-price levers consist of emission and efficiency norms for vehicles, and performance standards for carbon emissions: 70-75 percent of the countries have instituted emission standards for vehicles, which are combined with supportive policies such as investments in public transport, incentives for the use of electric vehicles for light-duty transportation, and use or switch to low-emission mobility modes including use of biofuels (Chart 1.5).

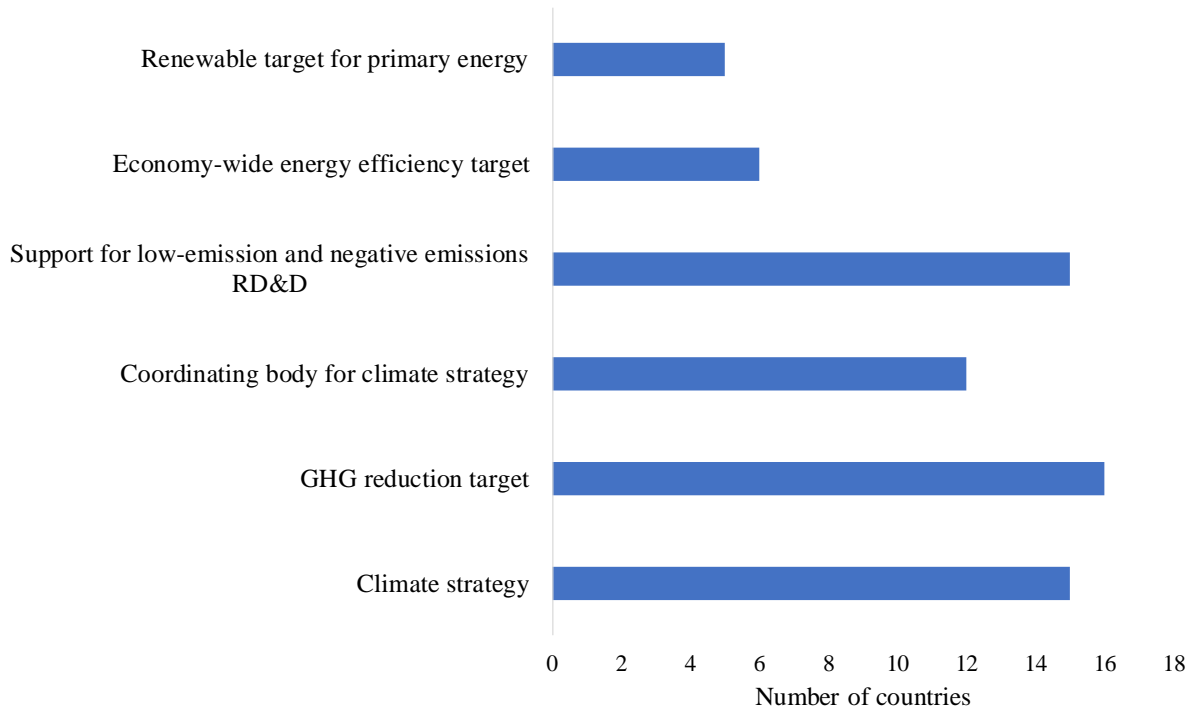
Agriculture and forestry sector Typical climate policy tools used here are laws, standards, incentives, and support for sustainable farming. The non-pricing instruments concentrate upon encouraging reduction in deforestation and enhancing efforts for reforestation and afforestation activities. The measures are distinguished by incentives in three-fourths of the countries, with few more (80 percent) setting standards for sustainable products and production (Chart 1.6).

Regulatory measures in financial sector – In addition to above, the need to incentivize larger fund flows into green and climate-friendly activities, and limit environmental risks as part of climate mitigation, financial disclosures have gained primacy. The *Financial Stability Board's Task force* on climate-related financial disclosures (2017) recommended a standardised framework aligning multiple regulatory frameworks across countries, on which the *International Sustainability Standards Board* (2022) is currently deliberating. All G20 members have introduced *Environment, Social, and Governance* (ESG) reporting and disclosure norms. For instance, *UK Financial Conduct Authority* (2020) rules; the *Companies Regulations* (2022) under the *Companies Act* (2006); and the *Limited Liability Partnerships Regulations* (2022) require climate related disclosures on comply or explain basis in line with recommendations of the task force on such disclosures. US also issued an executive order in 2021, on coverage of climate related financial risk by financial regulators, public procurement, public financial management, and budgeting processes. The EU *Sustainable Finance Disclosures Regulations* (2022) set technical standards for financial market participants for information disclosures. China also passed regulations in 2021 to standardise its processes for legal disclosure of corporate environmental information. India introduced *National Voluntary Guidelines (NVG)* (2011) on Social, Environmental and Economic responsibilities of Businesses for adoption by the listed Indian companies including banks followed by several refinements on various elements of ESG related disclosures by the Securities and Exchange Board of India (SEBI) until recently expanding the coverage and scope of climate related financial disclosures.

Panel 1. Non-pricing tools across sectors by G20 countries /1

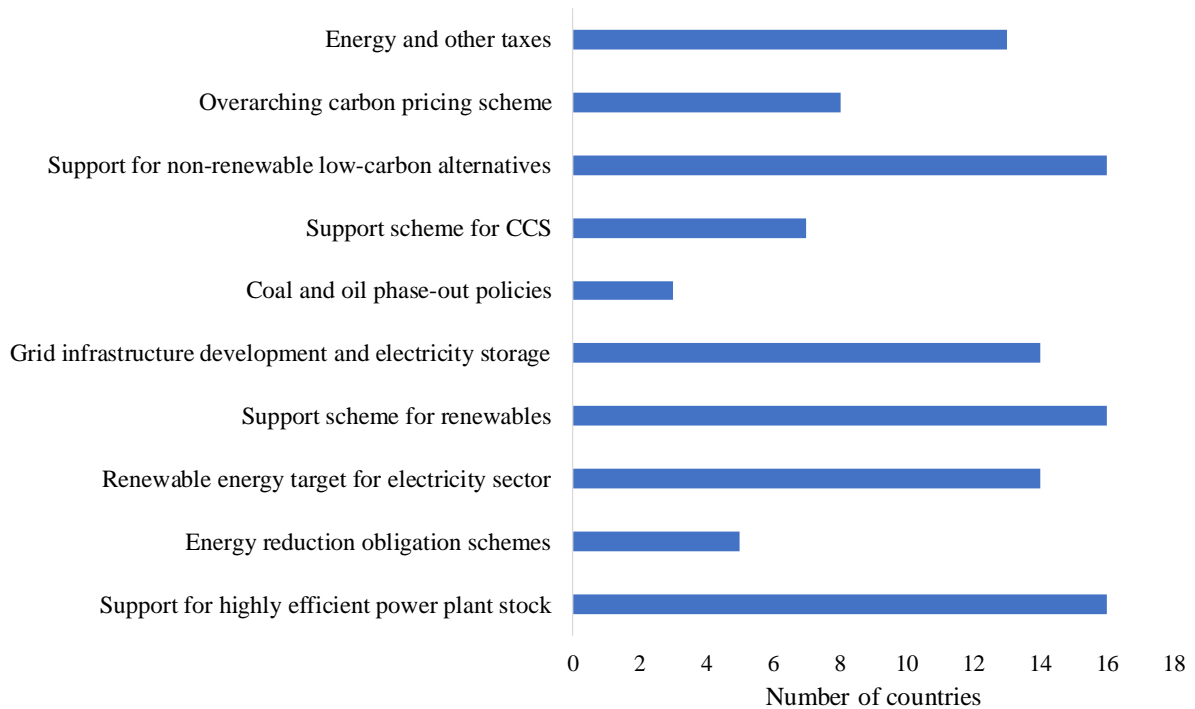
GHG reduction targets, R&D support dominate overall

Chart 1.1. General policies with multisector coverage



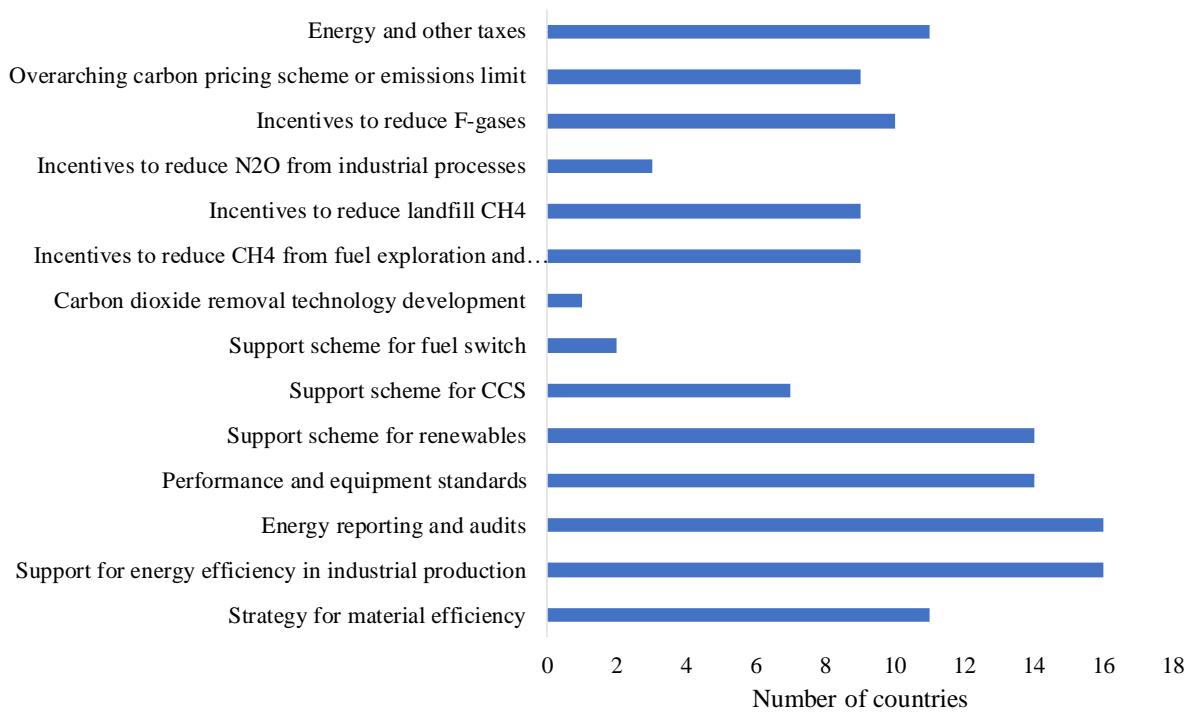
Targets, taxes, other support for green energies leads electricity sector

Chart 1.2. Policies for electricity and heat sector



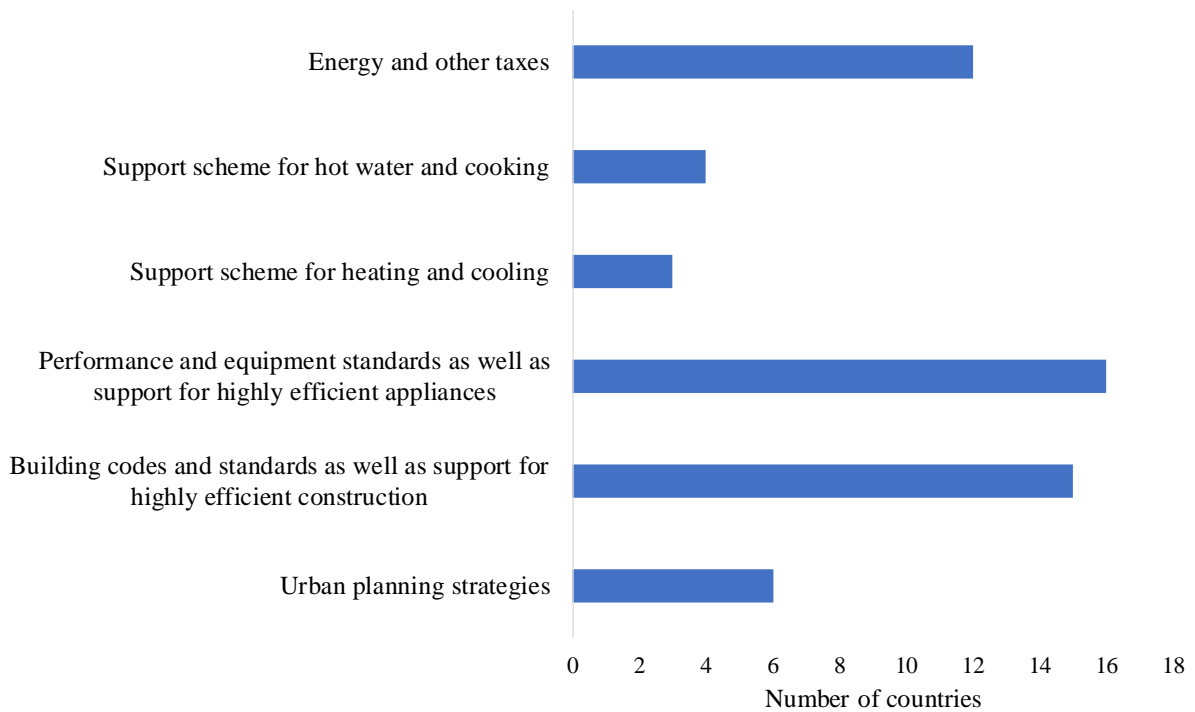
Pricing, taxes, financial incentives, technology support key mechanisms for industrial decarbonization

Chart 1.3. Policies for industry sector



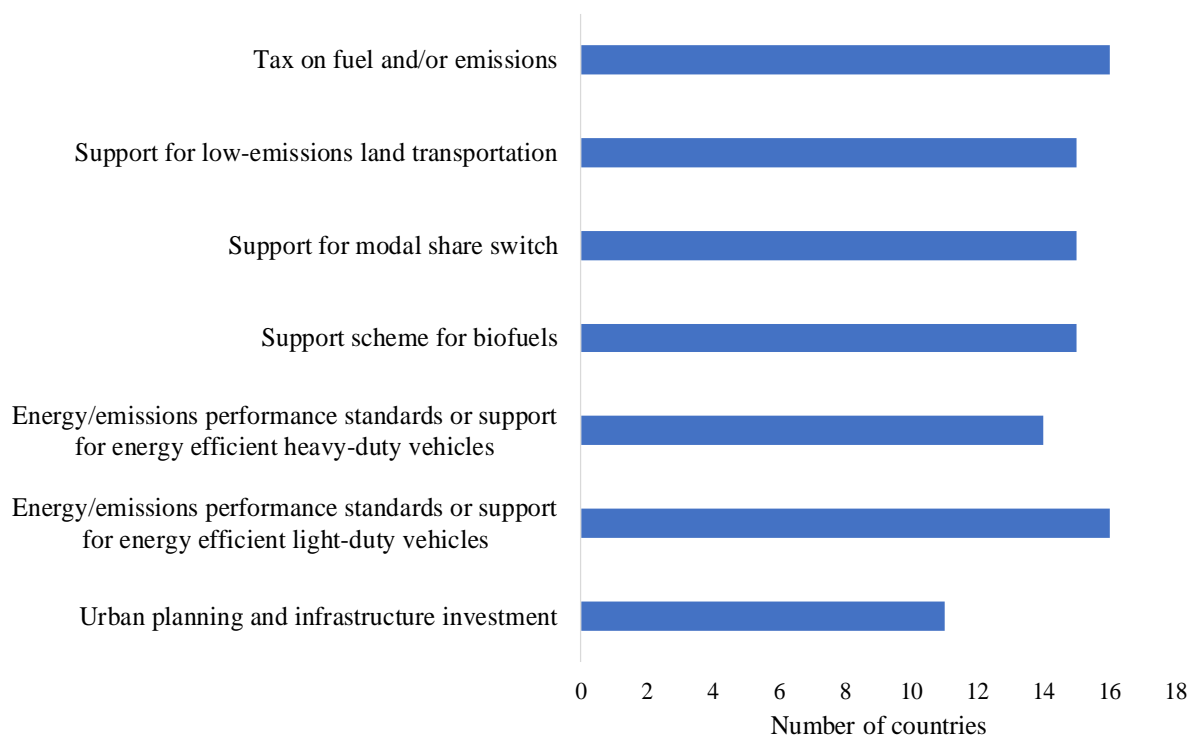
Standards, codes, materials and energy efficiency to lower building sector emissions

Chart 1.4. Policies for buildings sector



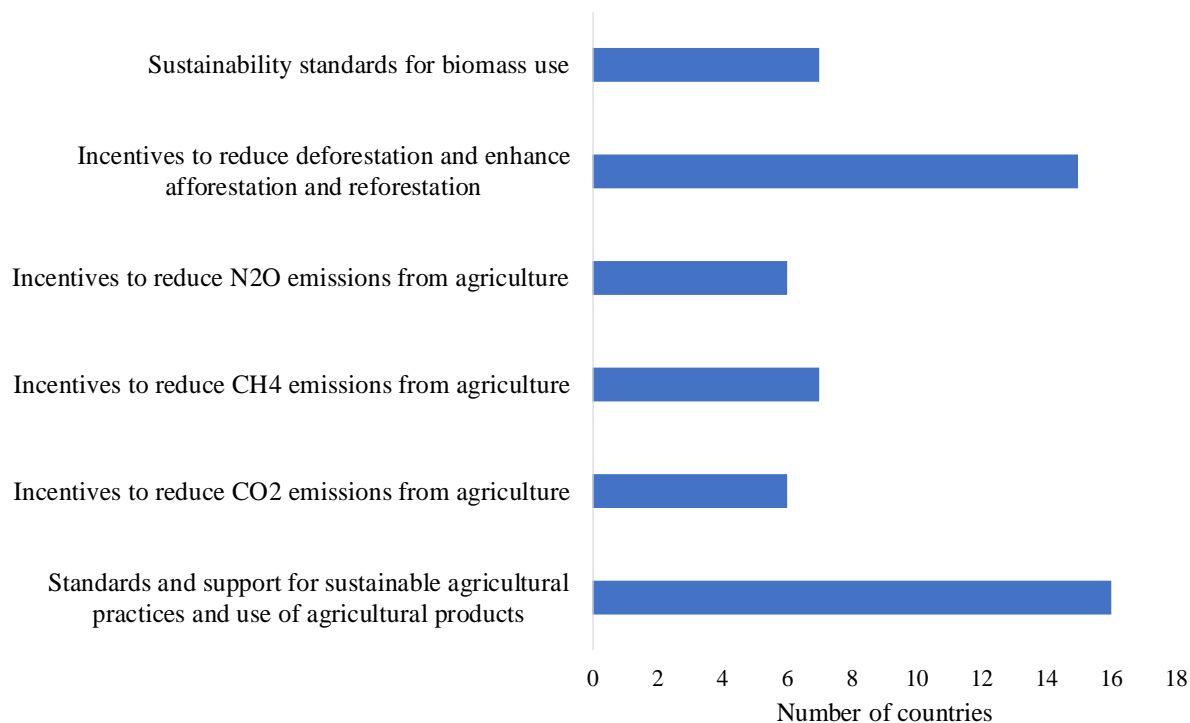
Taxes, with emission & efficiency norms, performance standards mostly cover transport emissions

Chart 1.5. Policies for land transport sector



Laws, standards, incentives with sustainable farming support in agriculture and forestry

Chart 1.6. Policies for agriculture and forestry sector



Source: Author's compilation from climate policy database

/1: See Annex for a description of the database.

II.2 How Pricing and Non-pricing measures complement each other

A pictorial mix of two sets of policy instruments, pricing and non-pricing, is given in Panel 2. This highlights the complementarity that exists across countries for checking GHG emissions. Fiscal and other financial incentives (price-based measures) are commonly deployed along with a wide range of non-pricing methods as part of the overall climate policy framework in all countries. Non-pricing interventions are of diverse nature, e.g., public information and education, regulations, research and development, rules for procurement, along with voluntary methods. Regulatory instruments, grant, subsidies, and other fiscal incentives are more evenly distributed across the various segments for reducing carbon emissions relative to voluntary approaches, and research development (Chart 2.1).

Fiscal and financial incentives abound with as many as 406 grants and subsidies across twenty countries as on date, along with 212 tax relief measures. At the opposite end of the spectrum are user charges, GHG emission allowances, GHG emission reduction crediting and offsetting mechanisms and the removal of fossil fuel subsidies where only Mexico and Saudi Arabia have introduced explicit policies⁴.

Information and education (non-pricing provisions) numbered 285 with enabling advice or aid in implementation (183) as the most popular in this genre. Some of the latter include home performance with energy stars (United States, 2002), smart metering implementation programme (United Kingdom, 2010), energy checks for private households (Germany, 2012), amongst others. In comparison, labelling, certification, and professional training and qualification provisions are less than a third of these. This possibly indicates a lower stringency of non-price methods for raising public awareness.

The **policy support measures** span numerous climate targets with 645 such as part of strategic planning. These consist of procurement of energy efficient appliances for government enterprises (India, 2013), a national energy policy (India, 2017), energy conservation and CO₂ reduction actions by government (Japan, 2007), ForestAR 2030 (Argentina, 2018), as some examples. There are 146 measures to create relevant and new institutions for sector-specific requirements such as the *Clean Energy Regulator Act* in Australia (2011), the *Offshore Oil and Gas Authorities Group* of the EU (2012), establishment of the *Non-food Biomass Feedstock Standardization Technical Committee* in China (2012), the *Amazon Fund* of Brazil (2008), *Managing Agency for the Reduction of Emissions from Deforestation and Degradation of Forest and Peat lands in Indonesia* (2013), the *National Green Tribunal Act* in India (2010), and such like as major non-pricing initiatives (Chart 2.4). Formal targets that are legally binding, e.g., energy, efficiency, emissions, etc. are fewer in contrast.

Public procurement includes instruments such as infrastructure investments (139), procurement rules (48), and funds to sub-national governments for climate resilient projects at provinces, territories, and local authorities' levels across sectors (54) (Chart 2.5). Illustratively, non-pricing policies such as procurement rules include government purchase standards (UK, 2011), Legislation to promote purchases of environmentally friendly products (Republic of Korea, 2010), Energy Efficiency in Government Operations (Australia, 2006), amongst others.

⁴ Fuel price adjustments (subsidies removal) Saudi Arabia (2017) act to increase gasoline prices (cut subsidies for full-price parity with international ones between 2018-2025; raise diesel prices (cut subsidies) to 90% international prices in same period. Mexico's new energy reform law on hydrocarbons intends eliminating gasoline subsidies and promote substitution of oil energy sources by natural gas.

In terms of their frequency of use or application for emission reductions, **regulatory instruments** are the broadest range worldwide. Such levers include monitoring (139), product standards (127), sectoral standards (135), building codes and standards (103), vehicle fuel-economy and emission standards (112), and so on (Chart 2.6). To encourage low-carbon and low-emission alternatives, **technology deployment and diffusion** measures are in wide use (111 measures), matched by technology development and demonstration projects (Chart 2.7). Funding support and related measures for research and development are fairly even at 80 such, while research grants are a distant 6 in number.

Finally, **voluntary approaches** are also an established non-pricing method to reduce emissions. The most common here are negotiated agreements between private and public sector, of which there are 126 in all (Chart 2.8). Some examples are the motor challenge programme (EU, 2003), Quebec voluntary agreement with aluminium industry (Canada, 2002), action plan to reduce greenhouse gas emissions from aviation (Canada, 2012), green & smart transportation partnership (Republic of Korea, 2012), and the 50001 ready programs (US, 2017).

Panel2. Distribution of type of non-pricing policy instruments in G20 countries /2

Chart 2.1. Instruments across sectors

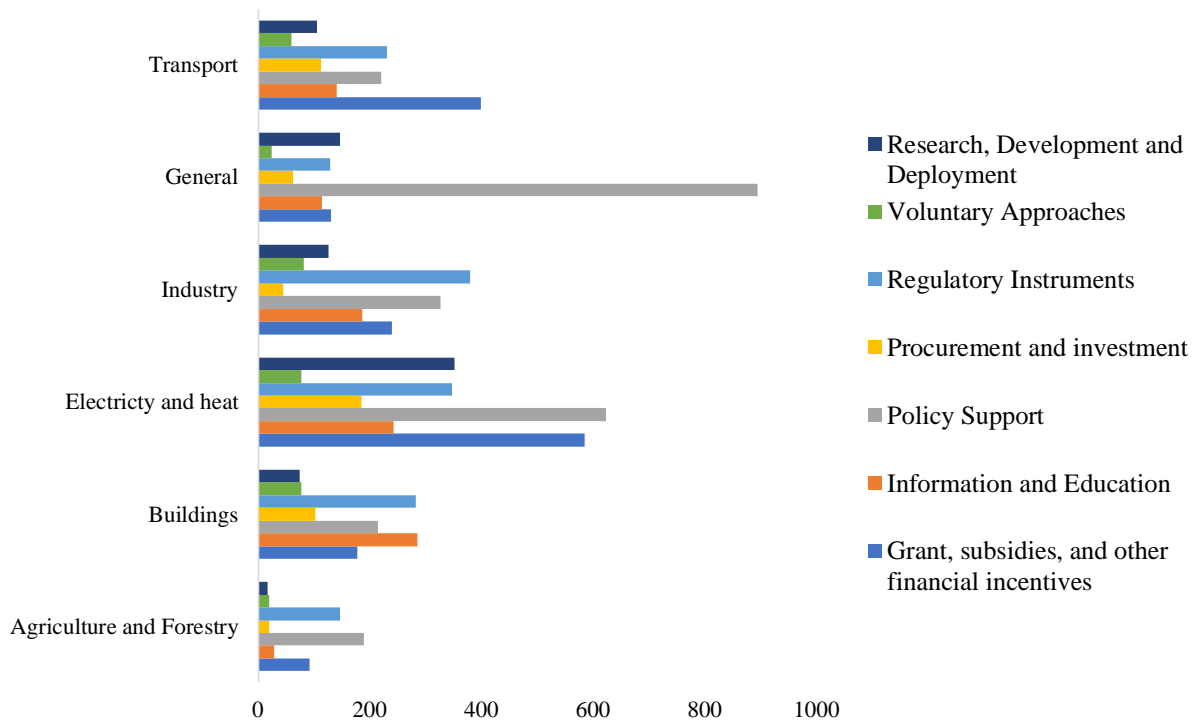


Chart 2.2. Fiscal and other financial incentives

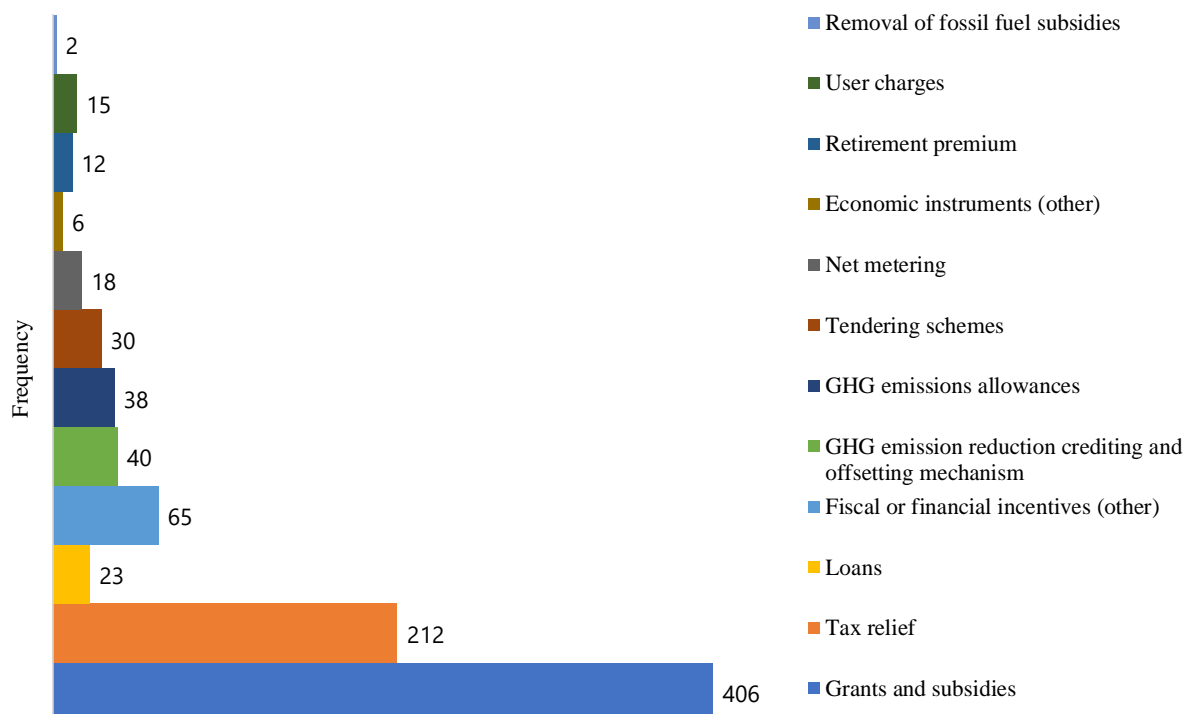


Chart 2.3. Information and education

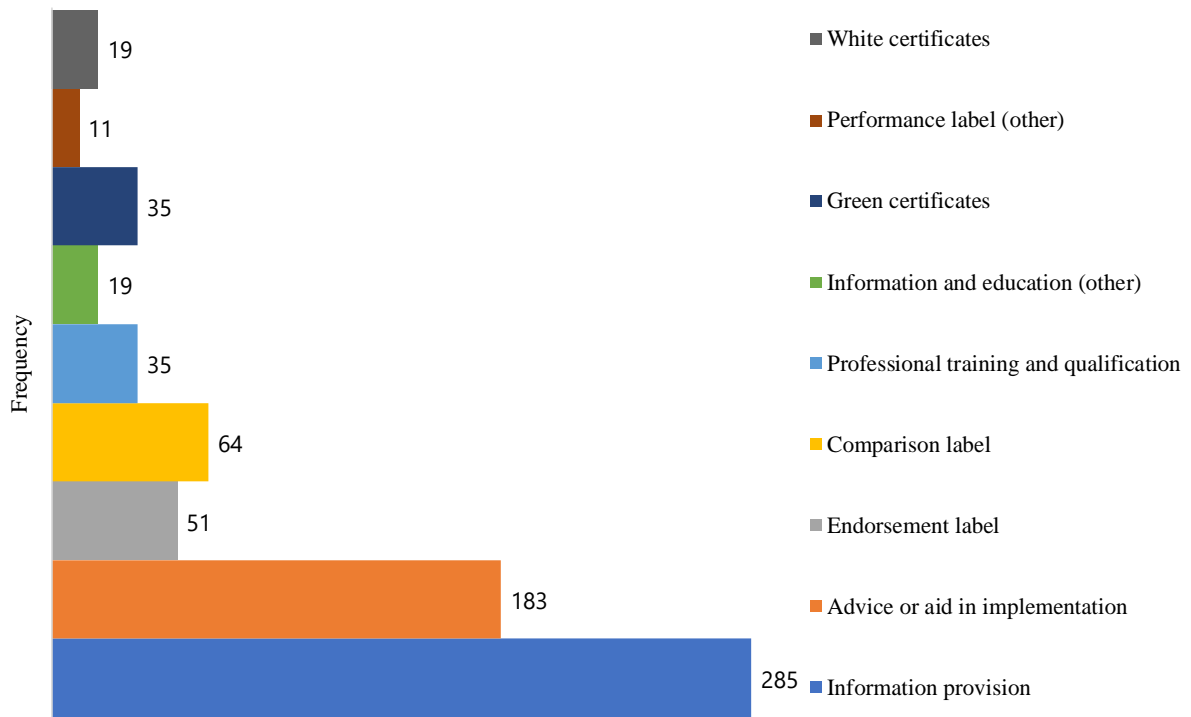


Chart 2.4. Policy support measures

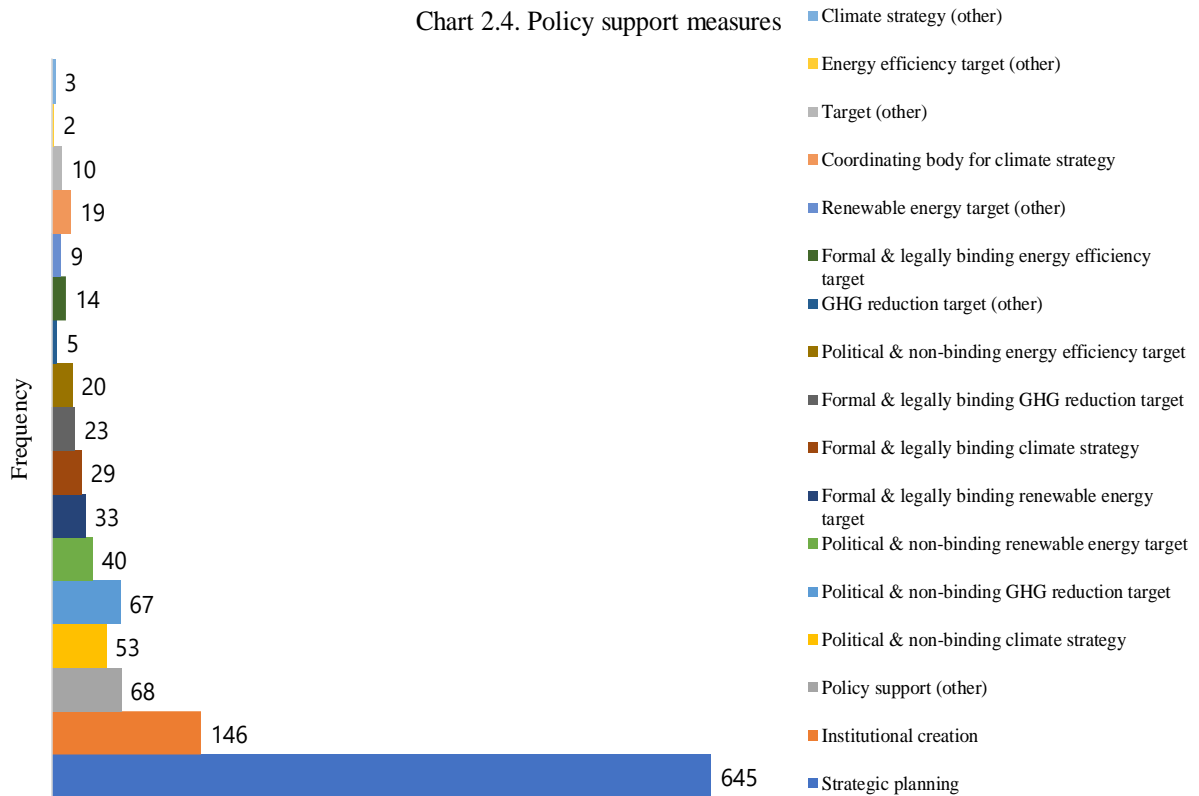


Chart 2.5. Public procurement

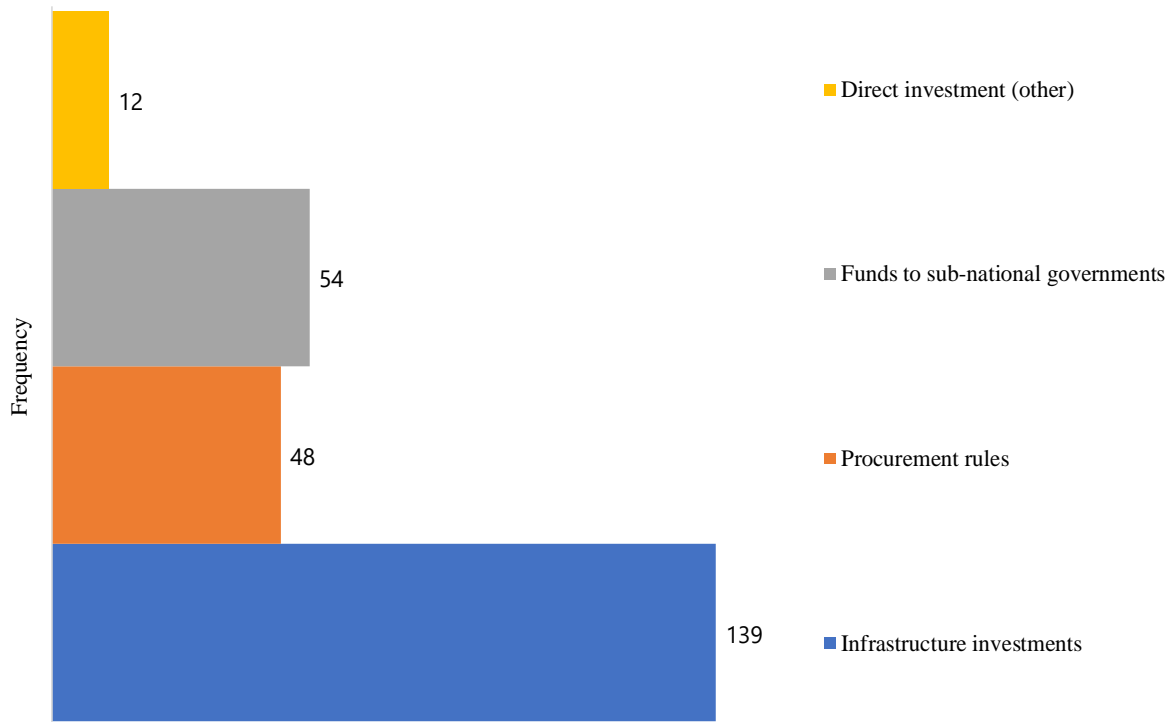


Chart 2.6. Regulatory instruments

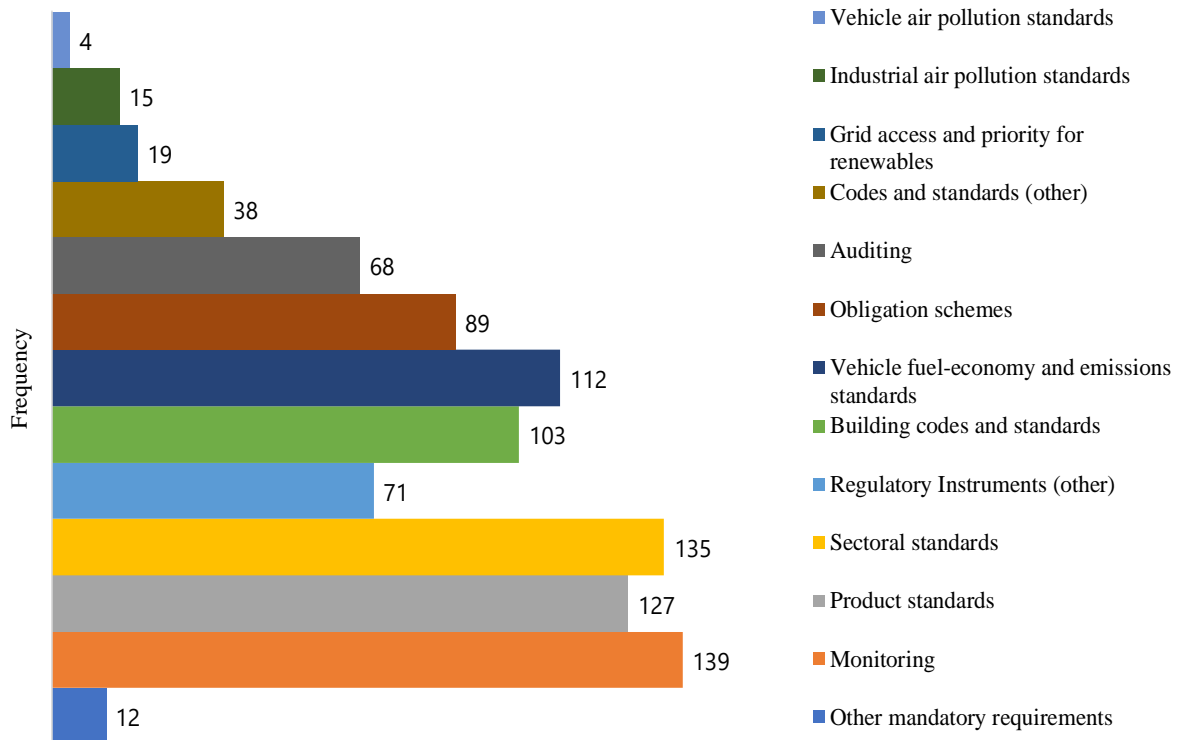


Chart 2.7. Research, Development and Deployment

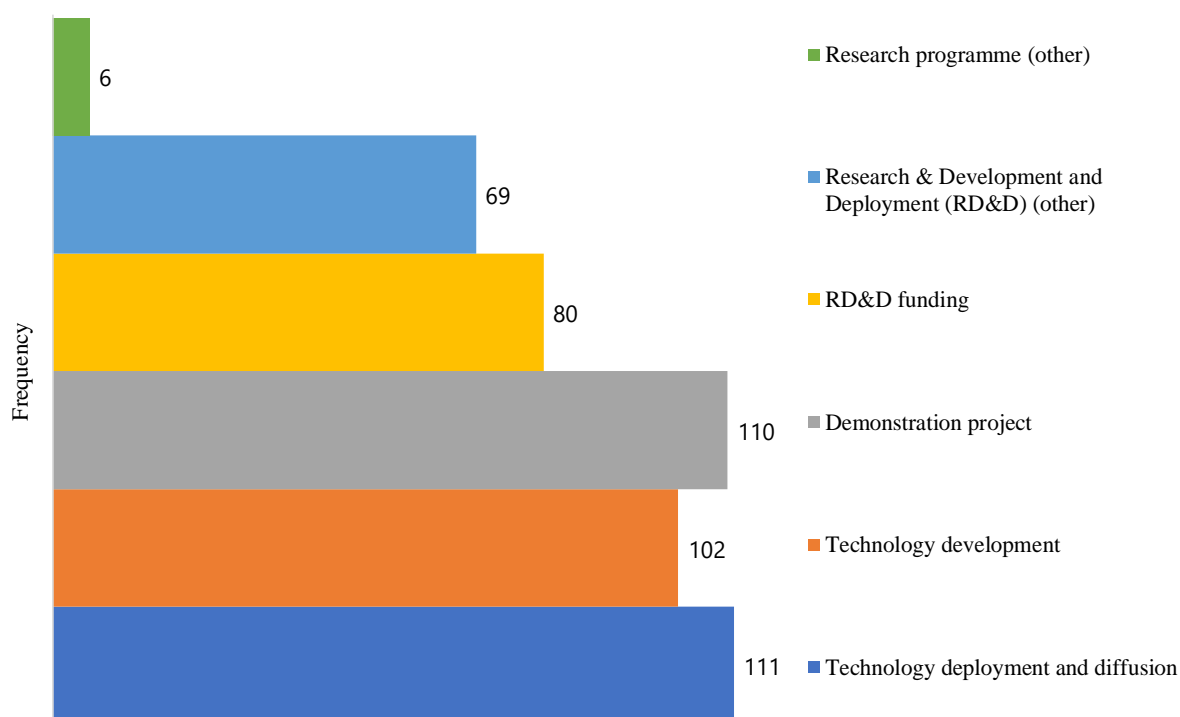
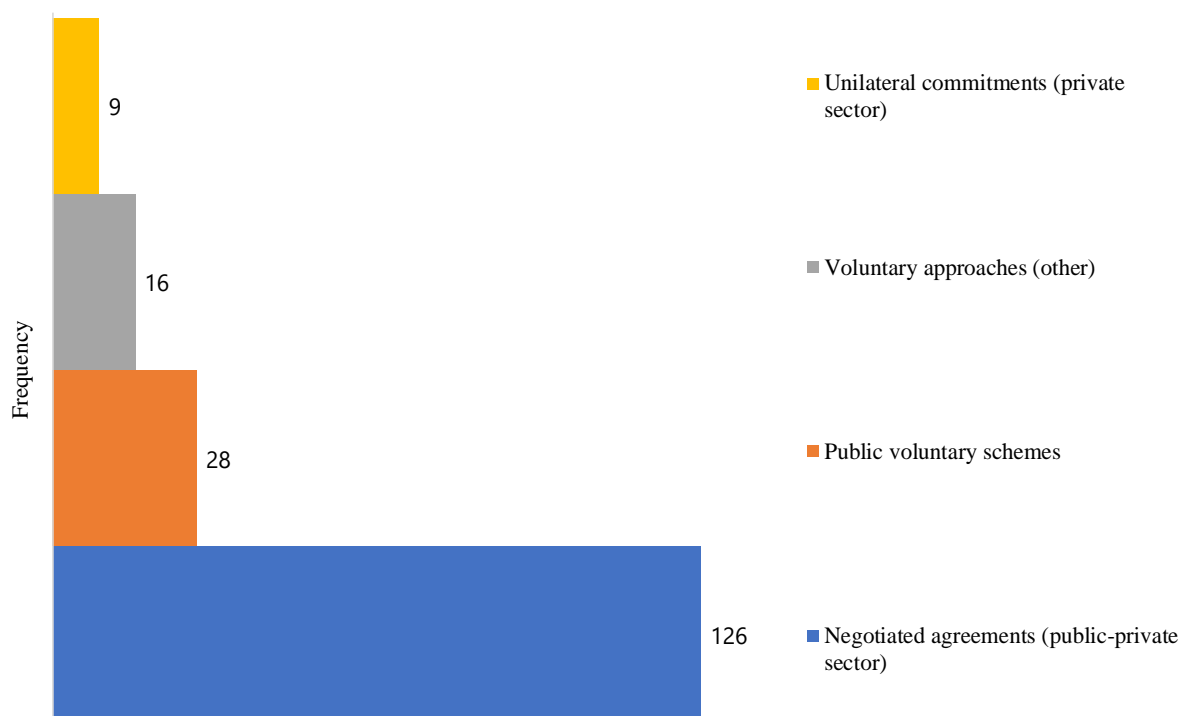


Chart 2.8. Voluntary approaches



Source: Author's compilation

12: White certificates promote energy efficiency through flexible mechanisms, including trading energy savings by energy firms. *Green certificates* require energy suppliers to have a certain share of renewable production in their supply portfolio. *Comparison labels* are often used in buildings sector to compare and improve energy efficiency ratings. *Endorsement label* indicates that a product meets specified criteria of energy efficiency

II.3 Country-wise coverage of non-pricing instruments

Targets to be achieved through non-pricing instruments are ambitious as detailed in the Annex (Table1) For instance, Australia's *Building Energy Efficiency Disclosure Act* aims to deliver more than \$50 million in energy savings, and approximately 3.5 million tonnes of emission reductions over five years. In China, the implementation plan for carbon peaking in urban and rural construction aims at new public buildings and factories in towns and cities to have 50% coverage with solar panels by 2025. The *RePower EU* plan and *Save Energy Communication* targets an increase from 9% to 13% of the binding energy efficiency target under the 'Fit for 55' package in the EU. Presidential regulation in Indonesia mandates a target of 23% new renewable energy in the national energy mix by 2025 and a 1% reduction in energy intensity per year. The UK targets 2GW of low carbon hydrogen production capacity in operation or construction by 2025, while the US has a target of zero GHG emissions from the portfolio of federal buildings, cars and trucks by 2050.

A brief country-specific profile of non-pricing instruments across the major sectors is given below. Overall, such mechanisms either reflect, and/or correspond to the respective economic structures and specific vulnerabilities to climate change, which are unique for each country. This beside, there are several common features in the use of non-pricing levers across countries: *inter alia*, the energy transition from fossil fuels to clean, renewable alternatives is structured around target-setting, carbon-emission and energy-efficiency norms, codes and performance standards cutting across users (industry, transport, buildings, etc.); there are relatively fewer measures aimed at industrial decarbonization, which are not universal and clustered around norms/standards/other regulations for energy-efficient production and lower gaseous emissions; an exclusive deployment of non-pricing methods for containment of GHG emissions, preservation of green cover, and adoption of sustainable farming in agriculture, land use and forestry sectors⁵; while codes, standards, materials efficiency, amongst other non-pricing tools are comprehensively deployed for checking emissions in buildings.

Argentina has the maximum policies in practice for the electricity and heating segment (18) where the majority provide support for renewables. Transport and agriculture and forestry are next in the hierarchy. In transport, the policy focus is directed towards setting standards for vehicles regarding energy and emissions, supplemented with support mechanisms for low emission land-transportation and biofuels. Agriculture and forestry policies set relevant standards and provide support for sustainable farming practices, incentives for reforestation, and reduction of activities leading to deforestation.

Australia has general climate policies with broad coverage of support mechanisms for research and development of low- and -negative carbon emissions technologies that help in the transition to a low carbon economy (10). It also has the most coverage with industry-focused policies (20) that are evenly distributed across material efficiency (4), energy efficiency of production (4), energy reporting and audit (3). Support measures for renewables and non-renewable, low-carbon alternatives are the main ones in electricity and heating, with nearly a dozen measures in buildings and transport sectors.

Brazil's key focus sectors are transport (23 measures) and agriculture and forestry (22). In transport, support schemes endeavour to encourage biofuels, coupled with standards for

⁵ This is explained by the fact that animal and agricultural greenhouse gases are hard to quantify, making it difficult to implement price-based measures. <https://environment.govt.nz/publications/review-of-climate-change-policies/4-policy-choices/4-3-non-price-and-supplementary-price-measures/>, Ministry for the Environment, New Zealand.

energy/emission performance and support for energy efficient vehicles. The thrust in agriculture and forestry is to combat deforestation (reduction) and enhance reforestation, for which it has 14 non-pricing instruments. Efforts in the electricity and heat sector concentrate on support schemes for renewables and non-renewable or low-carbon alternatives. The measures in the industry sector majorly focus on energy efficiency in industrial production through programmes like Alliance Program for Energy Efficiency (2019).

Canada has the maximum measures for electricity and heating, and industry at 31 each. The general measures covering all sectors number close with support mechanisms for low-emissions and negative emissions R&D, as well as GHG reduction targets. The industry sector policies also focus on schemes for renewables (6), support for energy efficiency in production (5), incentives to reduce F-gases (4), reduce CH₄ from fuel exploration and production (5). In the electricity and heat sector, the measures relate to renewable and non-renewable as well as low carbon alternatives.

China's climate policy space is dominated by electricity and heat sector with as many as 51 non-pricing measures in place; these cover support schemes on renewables and non-renewable carbon alternatives (38). To reduce industrial emission, there are 35 measures relating to performance and equipment standards, energy efficiency in production, and a strategy for material efficiency. Such measures in transport sector relate to performance standards for energy/emissions, energy efficient vehicles, and low-emission land transportation.

The European Union has broad overarching non-pricing policies (29) with near-similar industry coverage (24), followed by electricity (18). The general policies support low emissions and negative emissions R&D, set GHG reduction targets, climate strategies, amongst some. Non-pricing tools for industry are structured around performance and equipment standards, energy efficiency in production, incentives to reduce landfill CH₄, and strategy for material efficiency. Renewables and renewable energy targets, and highly efficient power plants are supported with non-pricing methods in electricity and heating.

France has the most non-pricing measures for electricity and heating sectors to support renewables (67), and non-renewable low carbon alternatives (48), and that for highly efficient power plant stock (12). There are 40 non-pricing tools in the transport segment relating to low emission land transportation (17) and support scheme for biofuels (8). Finally, there are 19 broad measures governing low emission and negative emissions R&D.

Germany has the most non-pricing mechanism for electricity and heating (48) followed by transport (27) and general policies spanning across sectors (24) to lower carbon emissions and R&D for negative emissions. 31 schemes support renewables, non-renewables and low-carbon alternatives, with 10 for highly efficient power plant stock. Transport sector measures are evenly distributed between support schemes for low-emissions land transport (8), energy/emissions performance standards and adoption of energy efficient vehicles (6), and to encourage biofuels (6).

India has the largest set of non-pricing mechanisms in the electricity and heating sector with 44 policies, focusing on supporting renewables (25). In the industrial sector, the push has been given to energy efficiency by incorporating standards in industrial production. In the building sector, India has a balanced approach with a policy focus on both building codes (3) and performance standards for appliances (10). In the transport sector emission standards for

light (6) and heavy-duty vehicles (4) exist along with policies encouraging the use of biofuels like the Biofuel Purchase policy (2006). In the agriculture and forestry sector, the focus is on forest protection and afforestation with 13 policies that regulate their use. Policies regarding strategic planning for sustainable agriculture like the National Mission on Climate resilient agriculture (2011) are also in force.

The United States has many measures in electricity and heating (74) with a focus on renewable energy through support schemes (29) including fiscal and financial incentives. Industrial decarbonization occupies next preference with focus on enhancing production energy efficiency (8), performance and equipment standards, lowering various emissions (CH₄, N₂O, and fluorinated gases). Measures in buildings sector are trained on performance and equipment standards for appliances (12) over that for building codes and standards (2). In transport sector, emission standards for light and heavy-duty vehicles exist; there are also mechanisms to promote bio-fuels usage (e.g., Biodiesel blending tax credit (2020) along with multiple other schemes. In agriculture and forestry, the focus is upon sustainable agricultural practices (6) and limiting deforestation coupled with afforestation efforts (5).

Russia has the largest set of non-price mechanisms for electricity and heating (13) focusing upon renewables' support. Industry measures relate to increasing energy efficiency, energy audits and accounting (e.g., energy passports that capture relevant information). In buildings, non-price interventions relate to ensuring efficiency via codes and standards. Emission standards for light and heavy-duty vehicles, and promotion of low-carbon transport through modal shift (3) and electric vehicles and hydrogen fuel use cover the transport sector. Finally, there are two non-price policies covering agriculture and forestry to assist protection and afforestation.

Saudi Arabia focuses most upon electricity and heating with 17 measures comprising support schemes and targets to promote renewables. Energy-efficient production and equipment standards govern measures in the industrial sector while in building, codes and equipment standards are aimed at low-carbon intensive infrastructure development. Emission checks from light duty vehicles along with emission standards and promotion of public transport cover the transport sector. In agriculture and forestry, sustainable agriculture practices, forest conservation and afforestation efforts are covered by non-pricing methods.

South Africa has the most non-pricing tools for electricity and heating (11 policies), with 7 relating to renewable energy support. In industry, 5 measures cover energy efficiency in production, coupled with energy reporting and audits, and reducing consumption and production of hydrofluorocarbons (viz. Kigali Amendment). Building codes and standards, low energy intensity in appliances through equipment standards, exist in the building sector. Transport sector emissions are sought to be contained through low carbon transport, emission standards, vehicle labelling, urban transport planning, and mandatory biofuel blending regulations. In agriculture and forestry, the policy focus of non-pricing methods has been on reducing deforestation and promoting afforestation (4).

Turkey has the most (16) measures in the form of support schemes for renewable energy and grid infrastructure development in electricity and heating sector. Non-price methods in industry are structured around increasing energy efficiency of production, equipment standards, energy reporting/audits, and controlling fluorinated gases through the Kigali Amendment. In the building sector, standards and codes are deployed while transport emissions are sought to be checked by setting energy/emission standards for light (2) and

heavy-duty vehicles (2), supported by policies to promote modal shifts (5). In the agriculture and forest sector the policy focus has been on both through support schemes for sustainable agriculture (4) and avoiding deforestation and promoting afforestation (7).

The United Kingdom has 35 policies in transport sector focusing on low emission transportation (19) through electric vehicles, charging stations, cycling, and walking; light and heavy-duty vehicle emission standards along with policies promoting biofuels complement these. Electricity and heating is covered with 18 non-pricing policies with major focus on support scheme for renewables (13). In industry, measures cover energy efficiency of production, equipment standards, energy reporting/audits, and reduction of fluorinated gases. Building standards and codes, appliance standards, and efficient materials exist for buildings sector while agriculture and forestry sector are covered by encouraging measures for sustainable farming, reducing deforestation and afforestation.

Indonesia has the largest number of non-pricing tools for agriculture and forestry (32) followed by electricity and heating in which renewables' support dominates (19). As in other countries, industrial sector non-price methods focus on energy-efficient production, equipment standards, energy reporting/audits, and reducing CH₄ in fuel exploration/production. In buildings, there's equal policy focus on building standards/codes and appliance standards. The transport sector has energy/emission standards for light (4) and heavy-duty vehicles (2), policies promoting a modal shift (5), and policies pushing for biofuels (5). As mentioned earlier agriculture and forestry are the most policy focused with 25 policies to avoid deforestation and promote afforestation along with 4 policies on sustainable agriculture. Indonesia also has policies to ensure sustainable use of biomass (3).

Italy has as many as 28 non-pricing levers in electricity and heating, with 21 support schemes for renewable energy. Industry emissions are checked by non-price-based measures for improving energy efficiency of production while building standards and codes, and appliance standards for efficiency are in use in the buildings sector. In transport, such measures are used to promote biofuels (6) and green infrastructure (3). A single measure the Fund for GHG emissions reduction and energy efficiency (Finance Law 2001) is there to discourage deforestation and increase afforestation in agriculture and forestry sector.

Japan has the largest number of policies in transport with as many as 34 policies with a focus on low emission transport complemented by vehicle standards and policies supporting biofuels. The non-pricing policies in electricity and heating have prioritised support schemes for renewable energy (7). In the industry sector the policy focus is on energy efficient production (7) along with energy reporting and equipment standards. Building standards and equipment standards for energy efficient appliances exist in the building sector. In the agriculture and forestry sector the policy focus is on sustainable agriculture (6) and reducing deforestation with afforestation efforts.

Mexico's non-pricing policies for electricity consist of renewable energy support schemes, while that in industry relate to energy efficient production coupled with incentives to reduce CH₄ from fuel exploration. The buildings sector is the weightiest with 22 measures referring to codes, norms, performance and equipment standards. Transport sector has energy/emission standards for light and heavy-duty vehicles, low emissions land transport focusing on electric mobility. In agriculture and forestry, the policy focus is on sustainable agriculture, conservation and afforestation.

Korea has an extensive coverage on electricity and heating sector with 17 support schemes for renewables and non-renewable low carbon alternatives. The policies in the industry targets energy efficiency (7) and integrating renewables (5) in the production process and reducing industrial waste. In transport policy measures focus on low-emission models for land transportation (6), support schemes for biofuels (5) and some degree of energy/emission standards for light (2) and heavy-duty vehicles (1). The general policies support RD&D for lower and negative emissions (7) and overall GHG reductions. The buildings sector policies are concentrated on setting performance and equipment standards, building codes through supporting usage of efficient appliances, and efficient construction (10).

The above mapping across the twenty countries reveals wide variations in sectors and targets in the deployment of non-price mitigation instruments. It is not surprising therefore that the effects are found to vary substantially across sectors and policies (IMF-OECD, 2022). Assessment of their effectiveness is complicated by the lack of rich data on which estimations of expected emission reductions could be based. Ongoing work by the OECD in this regard is focused on developing a *Climate Actions and Policies Measurement Framework* (CAPMF), a starting point for comprehensive information on climate policies; this would be accompanied by mapping these policies to the emission base in order to show the sectors covered by the policy instruments and how much of the emissions in the particular sector they cover. The OECD has already carried out a similar exercise covering the key price-based carbon policies (the *Effective Carbon Rates* dataset). Hard evidence on policies and their effects is a critical gap that needs addressing to take ahead climate policy dialogue and coordination. This is also crucial to alleviate concerns about competitiveness losses, increase and/or establish trust, and lower risks of implementation and breaches.

III. SEQUENCING, STRINGENCY AND EXPERIENCE

This section attempts to evaluate the experience with non-pricing policies. Because of the multitude of measures that exist to check carbon emissions, standalone or in conjunction with pricing tools, the complex interlinkages across sectors and measures make it difficult to quantify the relative impacts or compare with carbon- and other pricing interventions. As the preceding section showed, there's no country that does not fit this characterization. These are also key reasons why there are few comprehensive assessments that exist at present in this regard. Acknowledging these constraints, an attempt is nevertheless made here to enhance understanding to the extent possible.

III.1 Sequencing

In the last three decades, countries have introduced climate-related non-pricing tools in a pattern that is often unique rather than being universal. The broadest visible trend is a steady increase in the number of such measures in the last two decades relative to that in the nineties, although the peaks vary across countries. Likely, this corresponds to the steady increase in climate-related events and evidence, heightening awareness and concerns translating into agreements for urgent actions to restrict the rise in global temperatures in recent years.

A snapshot profile of their evolution across countries and mitigation spheres is presented in Panel 3 (table and charts). It can be seen the advanced economies' group (AEs) significantly scaled up the number of non-price-based measures in 1991-2010, after which further additions moderated in 2011-22; nonetheless, the increase in number of non-price tools in the past one decade is more than double that in two decades to 2010. Emerging and developing economies (EMDEs) on the other hand, display an evenly distributed rise in such policies in the same three-decade period although the numerical evolution in aggregate tracks that of the AEs. Nevertheless, AEs as a group have more policies in practice than the EMDEs amongst G20 countries (Table 3.1). This may possibly reflect lags and/or lesser urgency or stringency in emission checking measures.

There are some within-group variations. For instance, the US, France, Germany and EU introduced the most measures in 2001-2010, a three-fold increase over the previous decade; however, the UK and Japan display similar increases in the post-2000 period or two decades. Likewise, India, Indonesia, China, Argentina, Mexico, and Russia from the EMDEs had very few measures (in single-digits, or 2-7) in the nineties, but ramped these substantially in the following decade, peaking in the most recent one. Other EMDEs, e.g., South Africa and Korea, display a discrete increase in this millennium that has sustained, while Saudi Arabia appears to have continued adopting non-pricing levers to date.

The interesting aspect is the concentration of policies across G20 countries (Chart 3.1) in which there is a visible incline towards energy efficiency and a push for renewables cutting across the advanced, and emerging and developing economies alike. It is equally important to note that most countries have combined these with some form of carbon tax (Chart 3.2) apart from four countries, viz., Brazil, India, Indonesia, and Saudi Arabia.

However, indirect carbon price interventions such as fuel taxes and coal cess (as opposed to direct ones like carbon taxes and emission trading) are employed in India; according to the OECD, fuel excise taxes, an implicit form of carbon pricing, covered 54.7% of emissions in 2021 (unchanged since 2018), whereas fossil fuel subsidies covered 2.5% of emissions at the same point.⁶

Panel 3. Policy sequencing in G20 countries

Table 3.1. Number of Policies

Countries	1991-2000	2001-2010	2011-2022
Argentina	7	25	60
Australia	40	121	111
Brazil	19	51	46
Canada	37	156	113
China	6	83	116
EU	32	102	73
France	36	107	66
Germany	34	105	71
India	6	72	126
Indonesia	4	61	74
Italy	21	70	31
Japan	36	80	80
Mexico	4	33	77
Korea	13	74	60
Russia	2	24	34
Saudi Arabia	0	10	19
South Africa	1	44	41
Turkey	9	35	53
UK	16	94	88
US	82	240	91
Adv. Eco. (excl.EU)	315	1047	711
EMDEs	58	438	646
EU	32	102	73

⁶ Fuel excise taxes, an implicit form of carbon pricing, cover 54.7% of emissions in 2021, unchanged since 2018. Fossil fuel subsidies cover 2.5% of emissions in 2021, unchanged since 2018. *Pricing Greenhouse Gas Emissions*, Country Notes, India, OECD, 2022.

Chart 3.1. Policy concentration across mitigation areas

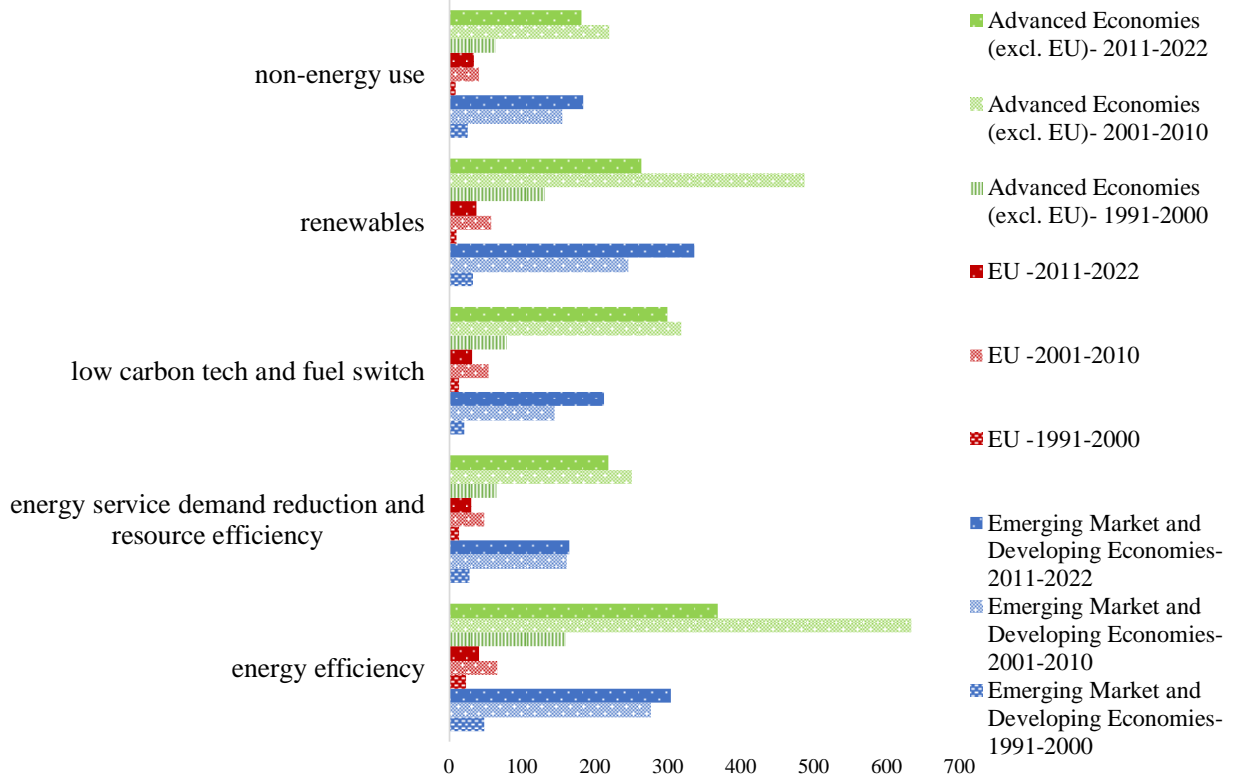
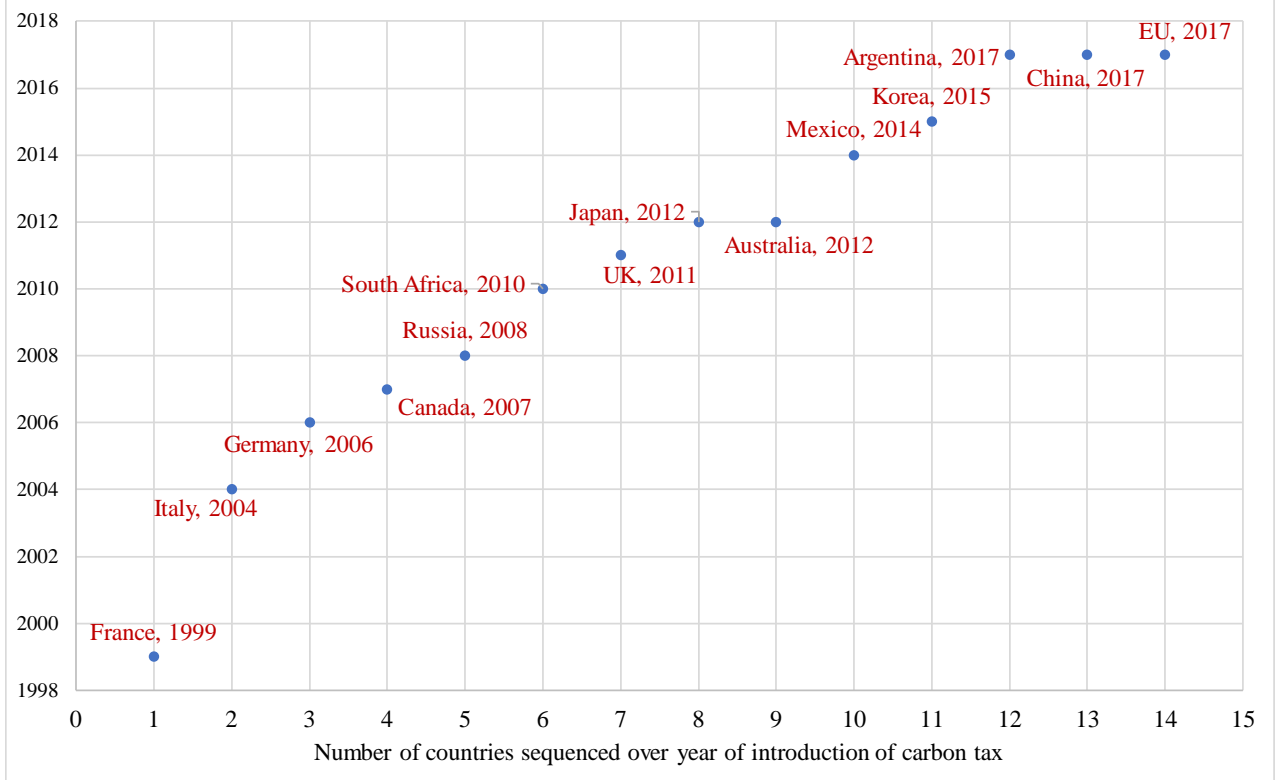


Chart 3.2. Introduction of Carbon Tax



Source: Author's compilation

III.2 Experiences with non-pricing mechanisms for greenhouse gas emissions

At first sight, there appears little correlation between country scores on different metrics of performance – GHG emission, renewable energies, and energy use – and climate policies as per the Climate change performance index tracking 63 countries (Table 1). In 2023 for example, the index ranked India 8th, followed by UK at 11 and Germany at 16th position. While it is of course, extremely superficial to interpret these correlations considering the complex combination of price- and non-price-based mechanism for controlling GHG emissions that in turn, are a function of different mix of economic activities and structures, the country-specific geographical and other climate-related vulnerabilities, respective emission levels might shed some light on the mixed outcomes on key aspects of climate policy observed here. Within the G20 for example, AEs such as the US, Japan, Australia, Canada, and Korea are some of the worst performers, and hence, at the bottom of the pyramid while considerably increasing non-price tools in three decades as documented before.

Table1. Climate Change Performance Index, 2023

Country	Overall Rank	Overall score	GHG emissions score (40%) *	Renewable energy score* (20%)	Energy use score* (20%)	Climate policy score* (20%)
India	8	67.4	29.7	7.8	16.0	13.9
UK	11	63.1	30.4	6.4	16.4	9.9
Germany	16	61.1	27.4	6.8	13.8	13.2
EU	19	60.0	24.9	7.7	13.3	14.0
Indonesia	26	54.6	21.0	11.1	13.2	9.4
France	28	53.0	26.5	5.0	13.2	8.3
Italy	29	52.9	22.8	6.9	13.9	9.3
Mexico	31	51.8	26.5	2.4	16.0	6.9
Brazil	38	48.4	20.6	11.5	14.7	1.7
South Africa	44	45.7	20.1	3.2	15.2	7.3
Turkey	47	43.3	21.9	10.3	10.7	0.5
Argentina	49	41.2	17.9	4.0	15.4	3.9
Japan	50	40.9	19.9	4.6	13.0	3.3
China	51	38.8	11.6	9.6	6.0	11.7
US	52	38.5	14.2	2.7	8.0	13.6
Australia	55	36.3	18.4	2.9	7.4	7.5
Canada	58	26.5	10.5	3.3	4.5	8.3
Russia	59	25.3	15.2	1.3	8.9	0.0
Korea	60	24.9	10.5	3.5	5.9	5.0
Saudi Arabia	62	22.4	6.4	5.8	6.0	4.2

Source: Climate change performance ranking 2023, German policy watch.

Note: * weights of each indicator in overall score

More specifically, measuring the relative impact of pricing and non-price-based methods is a well acknowledged challenge at all levels including multilateral agencies. The most recent examination by the OECD and the IMF late last year (2022) identifies the various challenges in such assessments and comparisons across policies and countries, the outstanding one being the complex interactions amongst the two sets of policies (price and non-price-based). The analysis suggests that price- and non-price-based instruments emit different signals to market participants through changes in the prices of activities or assets, and/or constraining activities or investment in assets to comply with regulatory requirements. Thus, the report establishes a need for developing an operational methodology on potential metrics to facilitate comparison and estimating the impact of non-pricing policies on overall emissions.

The OECD's existing recent work⁷ in this regard finds that pricing mechanisms, which do affect emission reduction are nonetheless insufficient to meet net-zero emissions targets at present technologies and abatement costs. At the global level, a minimum international carbon price of EUR 60 per tonne of CO₂ (2.4 times the 2018 average effective carbon rate) would lower global CO₂ emissions from fossil fuels by about 17%; more than half of this reduction would result from starting to price emissions that are currently unpriced. This points to the importance of non-price-based, complementary policies to enable acceleration of development and use of clean technologies and facilitate substitution of low-carbon energy sources for fossil fuels. Yet, to compare the relative efficacy and efficiency of the two mechanisms, the OECD-IMF report (2022) underlines that the required stocktaking and mapping into the respective emission bases of countries is needed to provide additional orientation for policy makers. This will require supplementary work, as task that the two agencies are presently undertaking.

The initial comparison of policies based on their emissions reductions and economy-wide carbon price equivalent (ECPE) are only illustrative, as there's no unique methodology to date. There's substantial variation across the G20 countries in the combined effect of chosen policies and targets.⁸ Relative to a no-carbon pricing scenario or other new mitigation measures in 2030, CO₂ reductions are around 10% or less in four countries, and range higher than 50% in other four; further, countries differ vastly in instrument choices and the relative contributions of sectoral targets; renewables' targets contribute significantly to emissions reductions in the policy mix in twelve countries; explicit carbon pricing contributes substantively in eight countries; for most, a significant contribution to realise mitigation commitments in NDCs could originate from policies not modelled therein, or not numerically specified. Finally, ECPEs for combined policies exceed \$100 per tonne of CO₂ in seven cases, are around \$30 per tonne or less in another nine. The exercise lacks sensitivity analysis at present, is dependent upon on model assumptions, the policy detail level, metrics used to compare besides the choice of benchmark setup, how national and global variables evolve, and the treatment of policies applied internationally and at sub-national levels.

There are several research attempts in related directions on climate policies. Nascimento et.al (2022) have recently studied the G20 climate policies between 2000-2019 and find significant policy adoption gaps. The study argues for widening the sectoral coverage of climate policies as a portion of global emissions remain uncovered by policies. The study, however, did not evaluate the performance of different policy instruments, leaving ambiguous the cost-effectiveness and leakages due to low stringency, lax enforcement, and so on. On the other hand, non-price policies aimed specifically at renewable energy, fuel efficiency, electrification of passenger vehicles, and forestry have been found successful to implement in China, EU, India, Japan and the United States as regards electricity generation, passenger vehicles, freight transport, forestry, industry, buildings, agriculture, and oil and gas production by Fekete et.al (2021) in their study of historical performance in terms of energy system and greenhouse gas emissions indicators

⁷ The analysis uses the OECD Effective Carbon Rates (ECR) database and covers 44 OECD and G20 countries over 2014-18 to estimate long-run responsiveness of CO₂ emissions and government carbon-pricing related revenues to carbon pricing within a unified empirical framework across countries, sectors, and fuels. The baseline estimates imply that an increase in ECRs by EUR 10 per tonne of CO₂ reduces CO₂ emissions from fossil fuel use by 3.7% on average. This responsiveness varies by sector and fossil fuel; it is stronger for road transport, agriculture & fisheries, coal, diesel and kerosene. Source: Box 2 Estimating the CO₂ emissions effects of carbon pricing, OECD-IMF report (2022).

⁸ See OECD-IMF (2022), pgs. 14-16 for more details.

Two studies, Davis and Knittel (2019) and Levinson (2019) have examined the distributive impact of the imposition of fuel economy standards (for the United States) to find no evidence in support of fuel economy standards over carbon tax, while the latter concludes energy efficiency standards were more regressive than energy taxes. Zhao and Mattauch (2022) also in a recent study on US vehicle markets and China transport sector argue an efficiency standard is found more equitable than carbon pricing when consumers prefer high-carbon technology attributes and richer households have higher consumption of high-emissions goods.

Sarker et.al (2020) analysed energy efficiency policy strategies of China, India, Indonesia, and Japan based non-price instruments such as subsidies, tax reductions, voluntary agreements, and market-based instruments such as white certificates and tendering. The study observed mixed responses wherein voluntary agreements were significant in energy efficiency in China but not others. Market-based instruments also play an important role in reducing energy intensity. Direct subsidies showed burdening government budget with limited results. Hahn and Stavins (1992) argued ease of implementation, equity, information requirements, monitoring and enforcing capabilities, political feasibility and clarity to general public are some of the important determinants other than efficiency and cost-effectiveness of a climate policy.

Many studies have also examined the impact of climate policies upon public perception and the associated challenges in public acceptance of carbon taxes. A recent survey of 40,000 respondents in G20 countries (Dechezleprêtre et.al, 2022) found that public perceptions on their effectiveness in reducing emissions (effectiveness), and distribution impacts upon others (disproportionate burden upon lower-income households), and own selves (self-interest) determine acceptance of policies to significant extent. Following the *Yellow Vests* movement in France, a survey by Douenne and Faber (2022) using a representative survey revealed possibilities of rejection of a carbon tax and dividend policy in France as people tend to overestimate their net monetary losses assuming the policy to be regressive, and do not perceive it as environmentally effective.

The response of private capital is another yardstick to evaluate the impact of non-pricing measures. For example, the impact of financial disclosures and ESG norms upon sustainable investment flows can be considered significant. These have picked up significantly in response, especially with the pandemic advent.⁹ By early 2020, sustainable investments aggregated USD 35.3 trillion in five major markets (Europe, US, Canada, Australia & New Zealand, and Japan) according to the *Global Sustainable Investment Review* (2020). At present, the cumulative green bond issuance amounts to USD 2.25 trillion globally, according to *Climate Bonds Initiative* out of which USD 65.9 billion issued in 2023¹⁰. Another estimates by Bloomberg in 2021 predicts USD 53 trillion by 2025¹¹ with Europe accounting half of the total assets followed by the US, Japan, and other Asian economies. More recently however, ESG investments have come under scrutiny with mounting concerns about ‘greenwashing’ of such investments (see Ch.3, *Global Financial Stability Report*, October

⁹ See <https://www.ft.com/partnercontent/london-stock-exchange-group/the-rise-and-rise-of-sustainable-investment.html>.

¹⁰ Data accessed on March1, 2023. Available at: <https://www.climatebonds.net/>

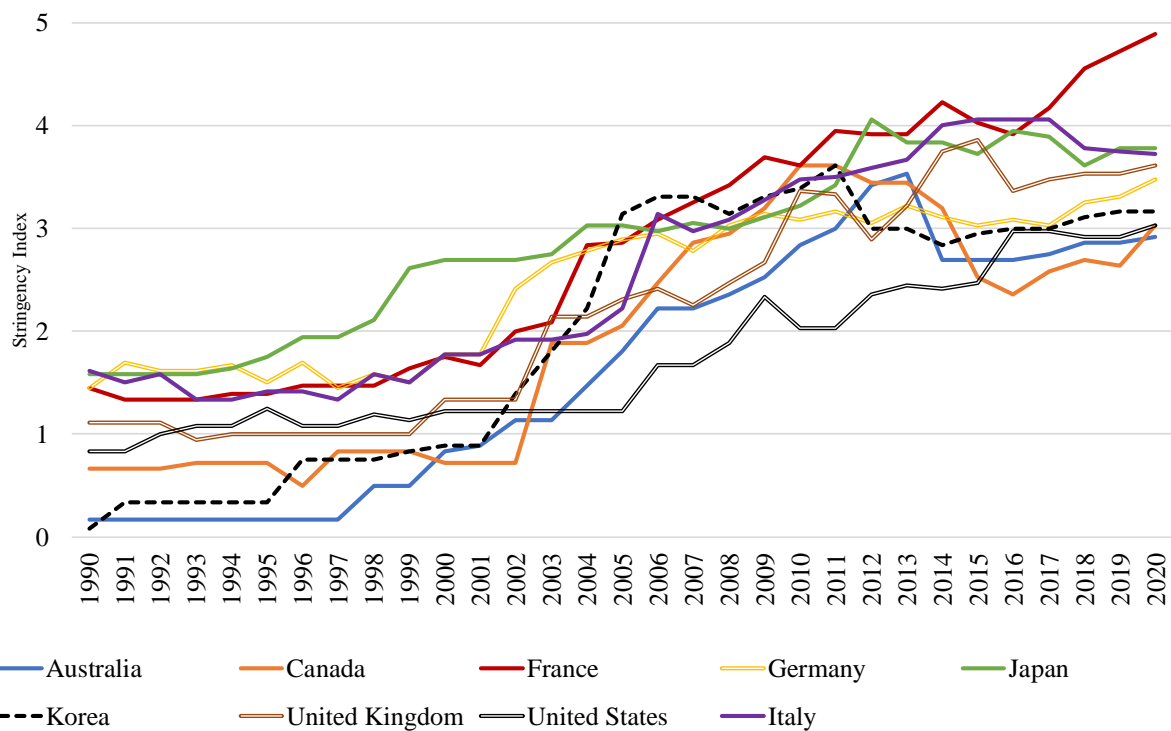
¹¹ <https://www.bloomberg.com/professional/blog/esg-assets-may-hit-53-trillion-by-2025-a-third-of-global-aum/>

2021). In this light, the G20 *Climate Sustainability Working Group* (2022) emphasised the need for developing measures to reduce greenwashing through standards for measuring, verifying and reporting (MRV) mechanisms; climate risk evaluation and management and disclosure standards; and legal standards on environmental thresholds and performance indicators.

There have been attempts to analyse experiences in introducing price and non-price-based instruments. The OECD *Environmental Policy Stringency index*¹² compares environmental policy stringency measure across countries. The index exhibits some interesting insights on the developments in G20 countries (data available for only 15 of the G20 countries) (Panel4).

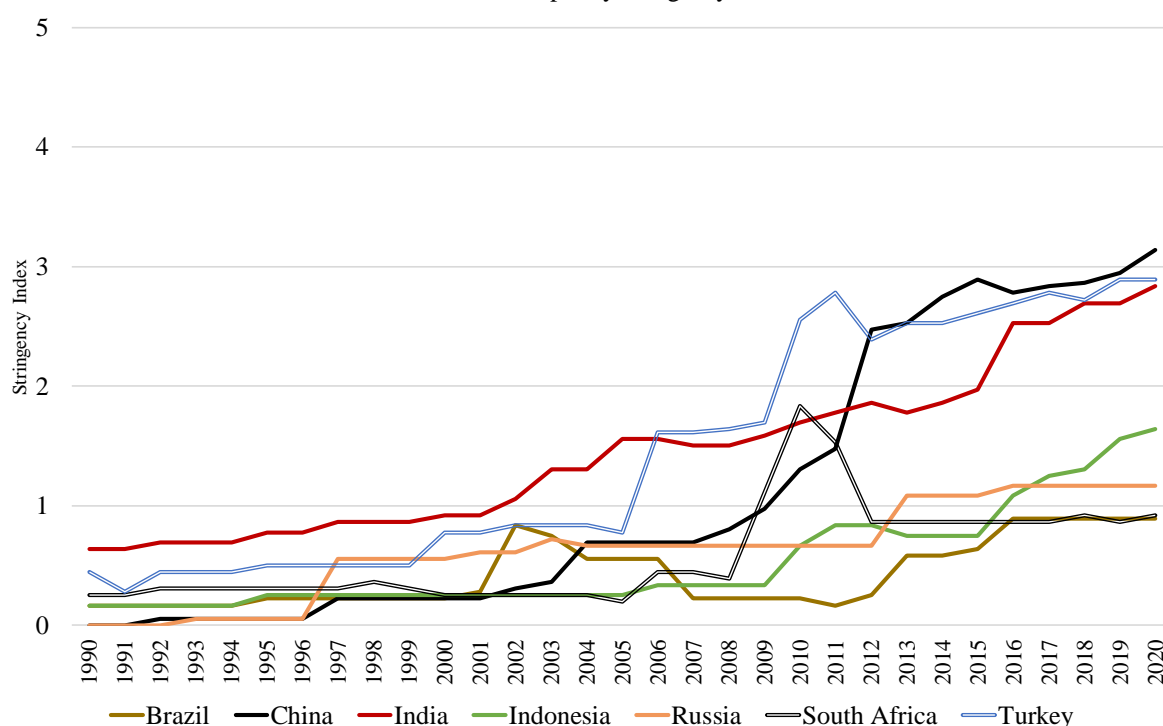
Panel4. OECD environmental policy index in G20 countries

Chart 4.1. Environmental policy stringency in G20 AEs



¹² <https://www.oecd.org/economy/greeneco/how-stringent-are-environmental-policies.htm> . Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour

Chart 4.2. Environmental policy stringency in G20 EMDEs



Source: Author's compilation

The policies have become more stringent in AEs over the years, especially in France, Japan, Italy, and United Kingdom (Chart 4.1). However, the pace reduced considerably in recent years as these plateaued. While most continued to increase policy stringency in the mid-2000s, there is a considerable reduction in the extent of stringency in AEs post 2010. AEs have been attempting to improve stringency measures since 2015.

On the other hand, EMDEs were late entrants to introduce stringent policy measures. Countries like India, China, and Turkey have also progressed significantly in making their policies more stringent over time (Chart 4.2). Nevertheless EMDEs (except Russia, and South Africa) have not observed a significant decline in the pace of stringency. The EMDEs have rather maintained a positive change trajectory, more so, post 2015. Hence, there is an evidence that EMDEs have significantly increased the burden sharing of climate change through its policy measures.

The OECD Climate actions and policies measurement framework database also provides a comprehensive coverage of policy instruments¹³. G20 countries have mixed experiences in terms of policy stringency across instrument types. Argentina and Saudi Arabia have the least stringent policies on air emission standards. 11 countries have least stringent policies on ban and phase out of coal power plants. Korea and Mexico are at the bottom for building energy codes standards. France is the only country with highest policy stringency on carbon tax in buildings whereas Canada, Japan, and South Africa have high stringent policies for carbon tax in electricity sector. Except Brazil, Canada, Indonesia, and Mexico, all other countries have the highest policy stringency on labels for vehicles. Russia is the only country with low stringent policy on mandatory energy labels for appliances. Mexico is the only country with

¹³ <https://oecd-main.shinyapps.io/climate-actions-and-policies/>

higher policy stringency on methane reduction. Argentina, China, India, Indonesia, and Russia have low stringent policies for planning renewable capacity expansions.

IV. Conclusion

This paper considers the cross-country experience with non-price policy levers for lowering carbon emissions. It takes stock of the variety of such measures employed by the G20 countries and their coverage across sectors. It digs deeper by differentiating the non-price policies by the commonness of their use, purposes and broad targets sought to be achieved. For a richer analysis, it examines the complementarity of their use along with price-based measures, both explicit ones like carbon taxes and emissions trading schemes (ETS), or otherwise such as feebates, subsidies in different sectors, and such like. In addition, the sequencing patterns and the respective stringency levels across these countries are also analysed.

The review of experiences offers several insights that merit deliberation and further discussion by countries in the context of search for the best way forward to involve the private sector in the low-carbon transition. One, most countries have instituted multiple non-price policy levers that cut across sectors in a complex interplay, which can be difficult or impossible to disentangle. This points towards challenges of causal interpretations, evaluation, and comparative assessments. Two, the main policy motivations are often diffused; this may be to reduce greenhouse gas emissions or another primary goal that is extremely climate relevant. These correspond or align to an overall climate policy framework. Three, there is frequent complementarity with price-based policy measures, whose support to incentivize behavioural changes or encourage private investments is noticeable.

Four, and notwithstanding some common patterns, the adoption of non-price measures is quite unique amongst countries. These usually reflect or correspond to respective economic structures, climate-specific vulnerabilities, mitigation requirements, the availability of financial resources, amongst other factors. This points to both the need to appreciate and adapt price-based policies in accordance, as also the limits to harmonization possibilities.

Five, although many non-price policy levers have for long been in place as well as increased over time across countries, the evidence on their efficacy is inconclusive. The gaps in evidence are large: These range from implementation and enforcement slippages, effectiveness in reducing GHG emissions, their impact upon firms' costs and competitiveness losses and that upon households along with balance between the two, being the major ones.

Six, the challenges to evaluating the efficiency and impact are complex and several. *Inter alia*, causal inferences due to multiplicity and the variations in responses across sectors, quantification difficulties, etc impede empirical assessment. Seven, the comparative effectiveness with price-based measures in reducing emissions is complicated likewise. Specifically, the frequent overlap of price- and non-price-based mitigation instruments makes it extremely difficult to disentangle the contribution of separate measures to emissions, risks double-counting, amongst major issues. A recent analysis of the IMF-OECD (2022) on the combined effect of the key measures (price and non-price ones) used by the majority of G20 countries in advancing their mitigation commitments reveals substantial variation across countries. This underlines how differences in policy levers, their coverage, and other variations can render estimating their sufficiency or otherwise in meeting net-zero emissions

targets extremely difficult. There is also the related concern about convincing private participants in this regard.

To conclude, the need for better understanding about the efficiency of non-price policy instruments, exclusive and in comparison, with price-based measures, must be emphasized. Besides illuminating possibilities of a policy-mix and associated trade-offs, this is essential to support international negotiation and coordination on climate policies, competitiveness, and carbon leakages. The inability to decompose the relative emission impacts of price- and non-price mitigation instruments has withheld progress in agreement on assessing the likely reduction in emissions from policies or sets thereof until now.

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Data and methodology

The major climate policy databases available and widely used include:

- i. *Climate change laws database* of the Grantham Research Institute at LSE and the Sabin Center at Columbia Law School available at https://climate-laws.org/legislation_and_policies?geography%5B%5D=36 ;
- ii. *OECD Policy Instrument Database for Environment* available at <https://www.oecd.org/environment/indicators-modelling-outlooks/policy-instrument-database/> ; and
- iii. *Climate Policy Database*, maintained by New Climate Institute with support from PBL Netherlands Environmental Assessment Agency and Wageningen University and Research available at <https://climatepolicydatabase.org/>

We have relied on the Climate Policy Database for its wider and more comprehensive coverage over other data sources including the databases mentioned above. The database attempts to provide updated information especially for G20 countries. For our purpose, we explicitly excluded price instruments-based policies in G20 countries. Many of the policies have multi-sector and multi-instruments coverage across G20 countries. We thus assimilated the information across five major mitigation areas of energy efficiency; energy service demand reduction and resource efficiency; low carbon technology and fuel switch; renewables; and non-energy use as grouped by the database.

We have also followed UNFCCC (2014) broader classification of non-market approaches such as- economic and fiscal instruments; regulations; voluntary agreements; framework targets; information; education and awareness programs; and research and development. For detailed policy instruments analysis, we further grouped the policies (similar to Linsenmeier et.al (2022)).

Table1. Selected targets of G20 countries across sectors to be achieved through non-pricing tools

Country	Sector	Targets
Australia	Energy efficiency, Building	Building Energy Efficiency Disclosure Act aims to deliver more than \$50 million in energy savings, and approximately 3.5 million tonnes of emission reductions over five year
Argentina	Non-fossil fuels, Energy	Regimen of Regulation and Promotion of the Production and Sustainable Use of Biofuels requires all gasoline produced and consumed in Argentina must be composed of no less than 5% biofuels
	Energy, renewable infrastructure	The law on renewable energy sets a minimum of 18% of total electricity consumed from renewable sources by 2023
	AFOLU	Environmental Sustainability and Insurance Program entails the creation of an insurance programme to sustain forestry activities dedicated to reforestation and enrichment of primary forests
Brazil	Public awareness	Policy for Education on Sustainable Consumption requires public awareness and media campaigns and train teachers on including sustainable consumption in their curriculum for primary and secondary education
	Energy efficiency	National Program for Energy Conservation requires 20 per cent of the funds by electricity distributors to invest in energy efficiency actions.
Canada	Emission reductions	Emission reduction plan 2030 provides \$9.1 billion public investment with sectoral targets
China	Renewable energy	Implementation Plan for Carbon Peaking in Urban and Rural Construction aims at new-build public buildings and factories in town and cities should be covered at 50% by solar panels by 2025
	Emission reductions, Industry	Plan on reaching peak CO2 emissions by 2030 in polluting industries aims to slash energy use by 13.5% from 2020 levels in 2025, and to reach peak carbon emissions by 2030
EU	Transport	Directives for setting the legal framework to transition from yearly taxation to a pay-per-kilometre system (road pricing)

	Energy efficiency	and to favour low-emitting vehicles RePowerEU plan and Save Energy Communication targets an increase from 9% to 13% of the binding Energy Efficiency Target under the 'Fit for 55' package
France	Energy, emission reductions	Energy transition law aims at decreasing GHG emissions by 75% by 2050, cut the national energy usage by at least 50% by 2050; reduce the share of fossil fuels in energy production by 30% compared to 2012; increase share of renewables up to 32% of the energy mix by 2030,
	Sustainable mobility	Mobility orientation law imposes ban on sales of fossil-fuelled cars (petrol or diesel) by 2040;
Germany	Public sector, emission reductions	Directive on the Promotion of Climate Protection Projects in the Municipal Environment aimed at achieving cumulative annual greenhouse gas reductions of around 1,200,000 tonnes of CO2 equivalent (net); limit the subsidy input per avoided tonne of CO2 equivalent to an average of 70 euros per tonne (net)
	Renewable Energy	Renewable Energy Sources Act set a goal of generating 80% of electricity supply from renewable energy resources by 2030 Law on the reduction and termination of coal-fired power generation by 2038 and an economic package to support coal regions
India	Non-fossil fuels, Energy	Green Hydrogen / Green Ammonia Policy provides waiver of inter-state transmission charges for a period of 25 years with conditions
	Sustainable mobility	Union budgets incentives through tax rebates on loans, reduction in GST rates for electric vehicles
Indonesia	Sustainable mobility	Decree targets 4-wheel Battery Electric Vehicles in 2030 will be 750,000 units, while 2-wheel BEV will be 2,450,000 units
	Energy	Presidential Regulation mandates the target of 23% New Renewable Energy in national energy mix by 2025 and 1% reduction in energy intensity per year
Italy	Multisectoral	National plan for resilience and recovery aims at 32.1 billion-euro investments for sustainable mobility; 12.1 billion for energy

		efficiency; and 11.2 billion for renewable energy
Japan	Renewable energy	Act on purchase of renewable energy provides for surcharge for renewable energy to be paid by consumers with exemptions; a feed-in-premium scheme; obligations to maintain funds for decommissioning etc.
Mexico	Energy	National electric system development plan aims at electricity with 35% clean energy by 2024; additional electric capacity with a share of 83.4% of clean energies between 2026-36;
Russia	Emission reductions	Federal law on GHG emissions for mandatory carbon reporting for most polluting companies and carbon offsetting schemes
Saudi Arabia		50% energy from renewables by 2030
Turkey	Renewable energy	Utilisation of renewable energy sources aims to increase the share by 30% in 2023
UK	Non-fossil fuels	2GW of low carbon hydrogen production capacity in operation or construction by 2025
USA	Public sector	Zero GHG emissions of the federal portfolio of 300,000 buildings, and 600,000 cars and trucks, by 2050

Source: Author's compilation, climate policy database