

A Framework for Integrating Subnational Action into Climate Governance Research

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Summary

On the national level, governments can establish laws, allocate finances and research, and encourage subnational entities to act through incentives and enforcement mechanisms. Subnational actors often receive delegated climate policy authority from their national governments. With a clearer sense of regional priorities and capacities, subnational actors are well situated to take effective climate policy measures. Subnational actors can play a crucial role in amplifying national climate goals through a bottom-up approach by filling climate governance gaps with innovative policies and commitments to implement national ambition through the lens of local needs. Reinforcing subnational climate action is vital in achieving national climate goals and supporting global ambition.

Research analyzing the climate governance approaches of selected countries was conducted,¹ but most did not integrate subnational perspectives into broader climate governance. While existing literature has significantly advanced the understanding of subnational roles in climate governance, particularly through assessments of climate action plans, policy alignment, and local performance, most studies leave critical gaps in their examination of the institutional potential that enables or constrains subnational climate action.

These key gaps include the absence of systematic distinctions between full policy potential and policy implementation potential, insufficient attention to legal checks and financial capabilities, and limited integration of national-subnational governance linkages. The proposed research framework addresses the respective gaps by offering a comprehensive, institutionally grounded approach for analyzing subnational climate governance potential and identifying feasible, yet ambitious, policy approaches within existing governance systems. Building on federalism and multilevel governance theory, it explores how authority, discretion, and resources are distributed across levels of government, and identifies the leverage points through which subnational actors can meaningfully contribute to national climate goals, particularly in politically or administratively constrained contexts.

Key objectives of the framework:

- ▶ Identify strengths and gaps in climate governance based on international and intergovernmental relationships of subnational entities, their governance systems, and civic organizations focused on subnational climate action;
- ▶ Assess regional needs in sustainability policy response based on local environment, ecology, political economy, and social systems;
- ▶ Link subnational government's financial position and political willingness to implement strong climate policies;
- ▶ Map out existing hierarchies of different government and social structure levels;
- ▶ Identify policy levers by pinpointing sectors in which different levels of government can most effectively design and implement climate policies;
- ▶ Recommend potential strategies for cooperation and policy empowerment for different levels of government and social structures in countries with less ambitious climate policies.

1. Introduction

Climate action is no longer the sole policy domain of national governments: regions (states or provinces), cities, and other subnational and non-governmental actors are increasingly involved in shaping the direction of climate action.² As global climate goals tighten, subnational entities become essential for translating high-level commitments into tangible results on the ground, scaling up sustainability practices and green technologies, and leveling up the national ambition bar. In some countries, subnational entities may in certain contexts have the capacity to surpass national-level climate actions to make additional contributions to global climate goals. Understanding the existing governance systems, institutional capacities, fiscal realities, and sustainable development needs of subnational actors is critical for conducting accurate climate action potential and policy design assessments.

Looking across the existing literature, three themes emerge: 1) case studies that recommend scaling successful policies or raising the local ambition to meet national and international targets, following the most successful cases;^{3,4} 2) comparative analyses that assess ambition across jurisdictions and identify common strengths and weaknesses of subnational actors from a practical perspective;^{5,6} and 3) governance studies that examine systemic constraints through the lens of governance theories.^{7,8,9,10,11} Most existing research draws on climate action plans, the observed performance of local governments, and the alignment between subnational initiatives and national or global climate goals.

What is missing, however, is a systematic assessment of subnational climate action potential, especially a clear distinction between full policy potential (e.g., discretion to define, design and implement its own regional climate policies) and policy implementation potential (e.g., ability to select the instruments used to implement policies defined by a higher level of government or to adapt them to local needs by adjusting implementation priorities). Equally critical are the financial and legal constraints that determine the scope of subnational climate action, e.g. revenue generation or budgetary autonomy. Yet such factors are frequently overlooked, limiting the applicability of many policy recommendations provided in the analyzed literature. While most studies focus on outputs such as climate plans or emissions reduction targets, they often neglect the underlying institutional structures that determine whether subnational governments can actually pursue climate action. There is also limited examination of how subnational climate action capacity interacts with national governance and political systems, leaving a critical gap in understanding how local actions can support or advance national efforts.

While the role of subnational actors in national and global climate action has gained growing attention, the current climate governance research extensively focuses on descriptive policy mapping and individual case studies. Approaches to conceptualizing and systematically assessing subnational climate action are fragmented and lack a comprehensive framework that distinguishes between full policy potential and policy implementation potential alone, especially given the nuanced fiscal and structural factors that shape opportunities and limitations for subnational actors.

This study addresses that gap by proposing a framework that incorporates a deeper institutional perspective by explicitly examining the full policy and policy implementation potentials of subnational actors across a variety of country contexts. This approach emphasizes not only what subnational actors are currently doing, but what they are potentially capable of doing within their existing institutional environments, linking it with the national context. These contextual factors can serve as leverage points important for enhancing national climate ambition through subnational empowerment, especially where central government action is limited or inconsistent.

2. Existing research

A first strand of work consists of case studies of cities and regions. They are popular among policy-makers and policy organizations seeking to identify the best examples of successful action assessing if the current level of subnational ambition matches the national or international commitments, and how the ambition could be bolstered.

Hsu et al. (2015) conducted studies across cities (Algeria, Brazil, Germany, and South Africa) and regions (Brazil, Canada, China, India, and the United States of America (USA)).¹² The case studies set out to identify the most successful subnational climate initiatives and quantify their impact to curate policy recommendations for the cities and regions with less ambitious climate policies. The report first quantifies the benefits of particular subnational climate initiatives and then provides recommendations for the best approaches to the bottom-up scaling of the respective initiatives. Applying this method, the study identifies that British Columbia's carbon tax system could have a potential of accelerating Canada's climate action by 35%.

Landauer et al. (2017) examine the interaction of mitigation and adaptation policies by using the case of the cities of Copenhagen and Helsinki.¹³ The paper explores the current mitigation and adaptation initiatives pursued by the cities and identifies the potential pipelines for policy scale up, either through institutional, management, or jurisdictional domains, which should further allow for more integrative policy approaches. Despite looking at the different domains, the study's framework may not be applicable to non-Nordic countries due to the lack of a generalization check.

Additionally, a large number of the bottom-up, scale-up focused case studies were identified, representing the most common type of analysis across the current subnational climate action research landscape. However, such studies focus on separate regions or projects and heavily rely on assumptions and modeling, without providing a feasibility check. While these case studies may contain unique modeling, cost-benefit, and scale-up analyses, their recommendations may still be unfeasible, even for the entities included in the cases, due to the lack of attention to governance, fiscal, legal, and other related factors that are key in scale-up decision-making.

A second strand of work employs comparative analyses. These studies derive policy recommendations by identifying common challenges subnational actors face in pursuing climate action, and the strengths they can leverage to overcome them. Kane et al. (2022) comparatively assess policy gaps in city-level climate planning across the largest 50 US cities, scoring their climate action plans based on goal-setting, sectoral strategies, ownership, funding, and equity considerations.¹⁴ While their findings contribute to understanding the policy mismatch between the cities' climate action plans and their actual policy action preparedness and capacity, the authors do not explore the institutional landscapes behind such mismatches. Such research is beneficial if a subnational entity seeks to learn what climate action opportunities exist, but such actions may still not be feasible, given the entity's unique political or economic context. Many comparative case studies tend to generalize a few high-performing cases, assuming that the same success formulas can be replicated elsewhere. Additionally, most of the existing studies lack a governance analysis approach, focusing on the output content instead of the enabling or disabling governance landscapes, which often results in case-based but still realistically unfeasible policy recommendations for entities with different governance and economic profiles.

Additionally, de Oliveira (2009) explores the implementation of climate mitigation policies by subnational governments in Brazil (São Paulo), Germany (Saxony-Anhalt), and Japan (Mie Prefecture), offering a comparative view across sectors and the developing versus developed contexts.¹⁵ The study

concludes that the success of subnational climate initiatives is highly dependent on how they are integrated across sectors, different levels of government, and with civil society. However, the research does not elaborate on what effective cross-sectoral, governmental, and civil society integration should look like in the context of subnational mitigation action.

The comparative studies are horizontal in their scope, i.e. they often lack a national-subnational nexus, which could allow for customizing the potential policy options in accordance with how the national governance systems and local stakeholders interact and what they prioritize. Looking at the vertical governance and stakeholder components at the national level could provide an explanation of why different subnational actors choose different climate policy paths, depending on their position in and nature of governance and stakeholder hierarchies. In other words, there is a need for analysis that bridges subnational climate policy analysis with governance and stakeholder analysis.

A third strand of work focuses on climate governance. Climate governance analyses integrate institutional and legal components to map authority hierarchies and coordination mechanisms, uncover existing gaps, and inform policy design. Der Heijden (2021) examines climate governance models by using the case of building energy efficiency policies in three major US cities (Chicago, New York, and San Francisco), revealing the challenges and unintended consequences of decentralized governance approaches.¹⁶ The paper highlights the governance constraints that “climate forerunner” cities face when attempting to implement ambitious policies. The main constraint illustrated is that, while there is enough political ambition, there is a lack of administrative organization to implement those initiatives on the ground, due to little understanding of the interactions between the government levels and stakeholders involved. Despite acknowledging this issue, the paper does not propose a generalized policy structure that could serve as a template for other cities and local governments. This leaves a research gap regarding the best criteria to apply when assessing governance and other bureaucratic factors in the feasibility analysis of a subnational climate initiative.

Kastelein (2024) explores the role of local governments within national climate policy frameworks in the European Union (EU).¹⁷ The study provides insights into the legal and institutional constraints shaping subnational climate action in the EU, categorizing subnational climate action plans into local, national, and supranationally-driven initiatives and comparing them within the respective categories. The study attempts to identify the key factors that differentiate successful systems of local climate governance in the EU and to determine the scope of opportunities for subnational actors in climate regulations, listing cooperation, legal restrictions, and financial dependence. Nevertheless, the study lacks a comprehensive governance assessment that includes the steps needed to achieve fruitful cooperation, overcome the existing restrictions, and resolve the issue of financial dependence.

Evers and Schmid (2024) analyze climate governance interactions in seven German towns through document analysis and expert interviews, highlighting the complexities of governance dynamics in local climate policy implementation.¹⁸ They identify that public participation, stakeholder involvement, climate politics, and forms of co-production in policy implementation are among the factors which determine the success of a local climate initiative. The paper looks at the political, administrative, stakeholder, and other cross-sectoral aspects of local climate policy-making processes, utilizing the concept of an “interactive government” to map out the potential stakeholders who could be involved in a particular climate initiative. However, the study concentrates only on cooperative forms of local climate action, assuming the national pro-climate agenda. Many subnational governments, by contrast, act independently for the reasons of national government’s inertness or the subnational entity’s ambition to exceed the national goals. However, the study does not look at these cases, leaving a gap in understanding what enables subnational governments to pursue climate regulation independently, without strong national leadership.

In an attempt to find answers to what enables subnational actors to choose independent climate policies or what forces them to align their policy choices with the national policy narrative, Xu (2021) proposes to look at the national and subnational actors through the prism of policy conflicts.¹⁹ The paper identifies three types of conflict over climate policy-making in a multi-governance system: conflict in problem framing, conflict in benefit sharing, and conflict in capacity building, which departs from the essence of the policy stakeholder analysis and goes more into a debate regarding the scope of the action potential. Essentially, the paper explores if conflict arises for competition over what this framework calls full policy potential²⁰ (conflict over problem framing), or policy implementation (conflict over capacity building), with conflict over benefit sharing applied to both. The paper raises an important question about where subnational action potential lies but lacks a framework to analyze the types of potential stakeholder interactions.

Eckersley (2017) looks more into different types of relations among the national, subnational, and non-governmental stakeholders, outlining a framework of such interactions²¹ that accounts for both vertical and horizontal engagements. The framework assesses the degree of the de facto dependence of actors within the existing vertical and horizontal structures and outlines the best forms of collaboration. Applying this, the paper advises subnational actors, which are independent from higher levels of government and can act independently from same-level entities, to opt for engagements with other subnational actors leading the local climate action in the respective country. Eckersley's framework puts forward a valuable insight to the assessment of subnational climate action potential and is conceptually incorporated in a modified way further in the stakeholder analysis component of the framework proposed here.

"A Forum of Federations Comparative Policy Analysis of Climate Governance and Federalism" edited by Fenna et al. (2023) contains the most comprehensive governance-focused case studies of subnational action, focusing both on governance and stakeholders, but without a systematized framework structure.²² Through examining the existing intersections of national and subnational governance systems, jurisdictional limitations and opportunities, national and local politics, stakeholders, economic specializations, and climate features, the papers included in the analysis compare the concepts of compensatory, dual, quasi-, and executive federalism, looking at the varying degrees of discretionary power held by regional governments. The extensive analysis of the national and regional climate governance patterns allows for policy recommendations which can enable meeting national climate needs with subnational action within the existing administrative systems. However, the lack of attention to local investment and capital generation patterns leaves the governance recommendations without a financial feasibility check. Jorgensen et al. (2015) follow a similar approach in a cross-case study of subnational climate action in Belgium, Germany, and India, but do not offer a systematic framework either.²³ Therefore, a more comprehensive approach is needed when building a framework, accounting for the governance systems and patterns, regional specifications in climate and politics, financial components, engaged stakeholders, etc.

3. Research Framework

Figure 1 presents the structure of the research framework. A particular emphasis was placed on building up the methods for analyzing climate governance gaps, subnational action potential, and financing capabilities. In the framework's final stage, we incorporate stakeholder analysis and sectoral application to map multi-level and multi-sectoral stakeholders. The remainder of this section provides a high-level overview of the framework, followed by detailed discussion of each component.

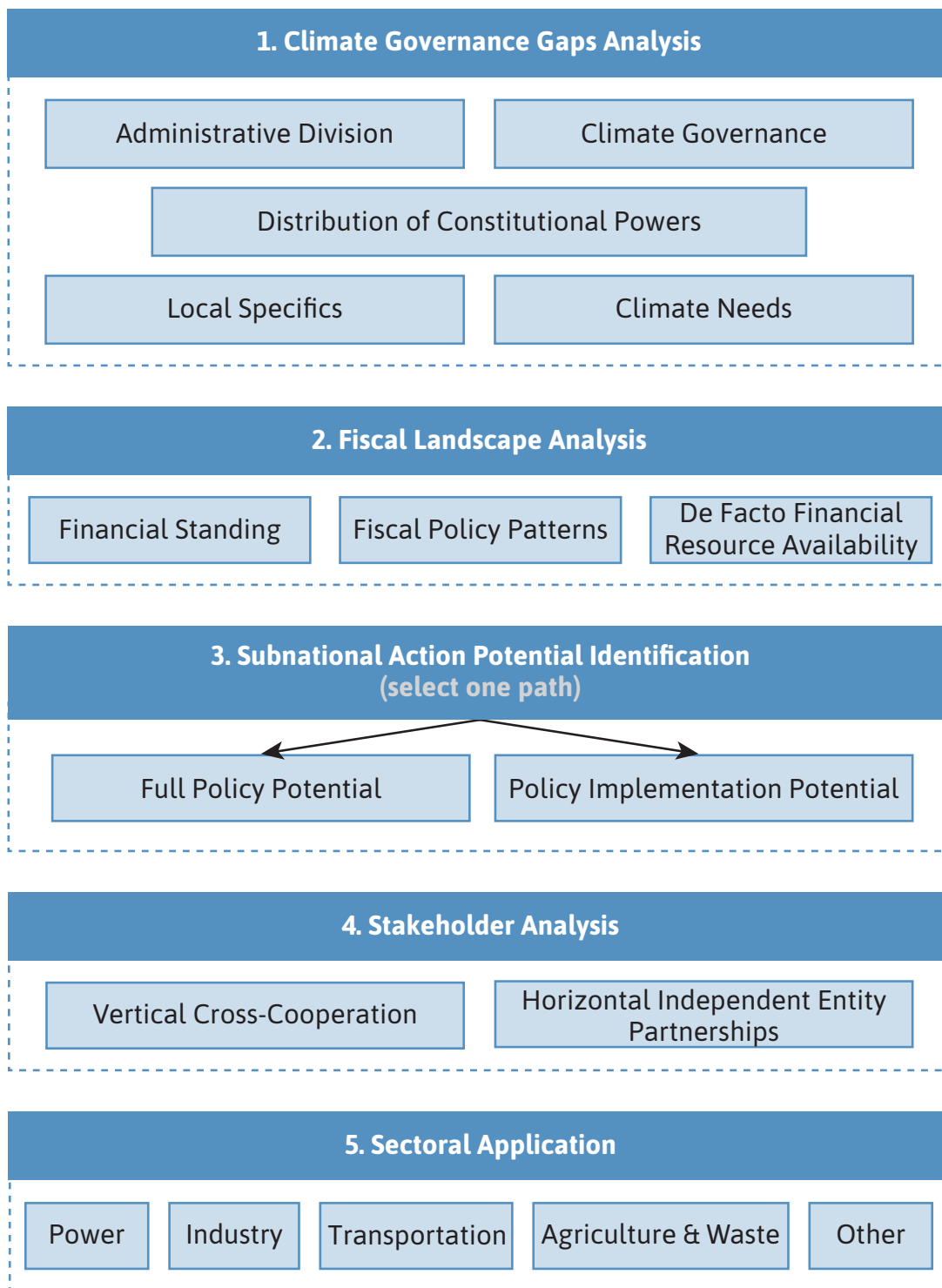


Figure 1: Framework Flowchart. The dark blue boxes represent major steps in the subnational analysis framework, while the light blue boxes represent the different components which are necessary to account for at each step.

The first step is a climate governance gaps analysis. By examining the administrative division, distribution of constitutional powers, climate governance, local specifics, and climate needs, this step identifies the de jure potential for subnational action. Recommending effective and feasible

subnational climate policies requires a clear view of a country's overarching administrative architecture and its climate governance principles. Deep understanding of the nuances and particularities of the government structures and politics at the mid- and lower levels is essential, as well as the key policy mechanisms at all the levels involved in climate regulations. This sets the foundation for understanding the legislative-administrative context, enabling a more accurate allocation of climate action pathways for different subnational entities.

The second step is the fiscal landscape analysis which assesses the financial policy capacity of subnational governments to implement climate action. Understanding the financial capacity and economic context of the respective subnational governments is crucial for providing realistic policy recommendations. A flexible budget, national support, and/or a track record of funding to follow-through on ambitious policies is vital to conduct an accurate assessment of the feasibility of subnational climate policy implementation. Areas for study within the fiscal landscape analysis include 1) financial standing, 2) fiscal policy patterns, and 3) de facto financial resource availability.

At the core of the framework (Step 3), the assessment of subnational action potential, two diverging dimensions emerge (as highlighted by arrow pathways) depending on the existing governance structure and financial capacity: 1) full policy potential (independent policy-making plus subsequent policy implementation) and 2) policy implementation potential. The distinction stems from the degree of political and economic independence that subnational actors possess within their respective national governance structure. Higher levels of independence and operation allow for subnational governments to directly create their own ambitious climate policies for further local implementation, whereas lower levels of independence may only leave room for the implementation of nationally-decided policies. Differentiating these action potential dimensions is critical in developing feasible policy recommendations.

In the fourth step, stakeholder analysis, different levels of government and other non-governmental stakeholders are examined in order to assess which stakeholders can work together to achieve a national goal or substitute for a lack of national action. The framework identifies two main types of stakeholder engagements: 1) vertical cross-governmental cooperation; and 2) horizontal independent entity partnerships. The former includes: a) strategic inter-governance mechanisms for climate policy-making; and b) two-level cooperation for policy implementation, accountability, and feedback loops. Whereas, the latter includes: a) public-private partnerships (PPPs) of a subnational entity with non-governmental stakeholders such as industry actors, civil organizations, etc.; and b) peer networks consisting of entities with the same position in the governance systems for the purposes of knowledge and experience sharing, such as international or national alliances and leagues of regions or municipalities.

The fifth step, sectoral application, analyzes how subnational climate governance systems operate across different sectors and explores the nuances of these interactions in each country and region, allowing for sector-specific recommendations for subnational climate action empowerment. Detailed breakdowns of the procedures, recommendations, and examples for each component of the framework can be found in the proceeding sections.

3.1. Climate Governance Gaps Analysis

The first step in the research framework aims to identify the nuances and particularities of government structures and political dynamics at both the national and subnational levels. This analysis is essential for establishing the foundation of subnational action potential assessment, as it defines the capacities,

constraints, and power dynamics that shape the level of realistic action that can be achieved within a region based on its country context and local specifications. A robust understanding of each country's operations, demographics, distribution of wealth and resources, and politics allows for realistic policy recommendations. This step involves describing five key components, as detailed below in Table 1 and illustrated through examples:

Table 1: Climate Governance Gaps. Steps of the climate governance gaps analysis broken down into five sections with objectives and respective example considerations listed.

Component	Objectives	Example Considerations
Administrative Division	Classify the administrative-territorial organization of the country.	Form of administrative division (confederation, federation, or unitary state).
	Identify and analyze country-specific nuances for the country's administrative-territorial divisions (government delegation, actual governance hierarchy, special status territories or autonomies, etc.).	Current specifications (regional autonomies, associated and dependent territories, tribal rights, etc.) and hybrid/intermediate forms of administrative-territorial divisions (asymmetric/quasi-federation, executive federation, regional state, devolved unitary states, etc.).
Distribution of Constitutional Powers	Understand how legislative and administrative powers are distributed based on the constitutional allocation of powers, ²⁴ with a particular emphasis on fiscal matters.	Primary powers of central, regional, and local governments (vertical distribution) and primary powers of ministries and agencies (horizontal distribution).
Climate Governance	Take a focused look at the distribution of climate-related policies and powers.	Distribution of control over the electric grid, transportation infrastructure, regional zoning regulations, climate strategy setting, etc.
Local Specifics	Determine the geographical, socioeconomic, and political specifics of each country as they relate to climate issues.	Location (coastal, arid, mountainous, farmland regions, etc.), demographics (indigenous peoples, rural and urban populations, farmers and working class populations, etc.), distribution of wealth and resources (equitable access to funds, differing levels of aid/mitigation for climate hazards, etc.), political stance on climate measures, etc.
Climate Needs	Identify what climate needs are not met by the national government that can be met through subnational action.	Local climate mitigation needs based on the local climate hazards, vulnerabilities, and greenhouse gas (GHG) emissions profile.

Example of the Climate Governance Gaps Analysis (Japan):

Summary

Japan's climate governance system is focused on cross-sectional or intra-societal approaches with a major decision making power vested in the central government. Given the high emphasis of the Japanese constitutional laws on the importance of subnational entities' compliance with the central government's laws and ordinances, local governments are given a role of an administrator rather than of an innovator.²⁵ However, the devolution of significant administrative powers to subnational entities in economic development, public infrastructure, public transport, public housing, local roads and harbors management, water, waste, and environment provides subnational entities in Japan with an opportunity for local innovative administrative approaches that account for local climate change mitigation and adaptation priorities.²⁶

1. Administrative division

Japan's multi-level governance operates as a decentralized unitary state comprising a central government and a two-tier subnational structure of prefectures and municipalities,²⁷ with no clear-cut differences between its prefectures and municipalities.²⁸ Its governance system allows for the transfer of administrative authority from prefectural governments to large cities through two designations: government ordinance-designated cities, with populations of at least 500,000, and core cities, with populations of at least 200,000.²⁹ Currently, Japan encompasses 47 prefectures and approximately 1,741 municipalities.³⁰

2. Distribution of constitutional powers

Although Japan's Constitution established a unitary state system, its provisions still grant prefectures and municipalities an authority to make their decisions within the limits of the constitutional law (Articles 92-95),³¹ which makes the local autonomy provision more administrative rather than sovereign. The Local Autonomy Act (1947) additionally distinguishes the functions of self-governance and those delegated by the central authorities to prefectures and municipalities.³²

Despite some administrative autonomy entrusted to Japan's prefectures and municipalities, the National Diet (legislature) plays a major role in Japan's climate policy decision-making, due to the parliamentary nature of Japan's democracy. The outcomes of parliamentary elections determine the composition of Japan's government, which eventually impacts all the policy spheres, i.e., large-scale and frequent political shifts are inherent in Japan's system of governance, including the matters of climate policy.

3. Climate governance

The climate policy-making process is highly centralized in Japan, with the Ministry of Economy, Trade and Industry (METI), Ministry of the Environment (MOE), and the Ministry of Agriculture, Forestry and Fisheries (MAFF) playing key roles in determining Japan's climate policies. After a 1998 revision of the Global Warming Countermeasures Act, prefectures and municipalities in Japan are required to develop local climate action plans, administer central government-initiated climate programs, implement local measures, and ensure timely and effective coordination with the central government on such matters.³³

Besides specifically designated ministries and agencies, the Cabinet of Japan includes a number of multi-level councils and committees whose work is focused on climate policies. The Global

Warming Prevention Headquarters was established inside the Cabinet of Japan in 1997 with the aim of facilitating the implementation of the Kyoto Protocol (1992).³⁴ The Headquarters is chaired by the Prime Minister of Japan and includes ministers and experts from specifically designated agencies (METI, MAFF, MFA, etc.), with the MOE Minister serving as its Vice President. The Headquarters serves as a major platform for discussion and decision making on matters relative to comprehensive climate change policies in Japan. The Headquarters oversees the Nationally Determined Contributions (NDCs) of Japan, promotes the inter-ministerial integration of the climate agenda, and promotes all-of-society cooperation, with a focus on the involvement of non-state and lower-level state actors.

While the Headquarters serves as a platform of discussion and cooperation for the key decision-makers, the Central Environment Council serves as an advisory board to the MOE, composed of the representatives of academia, business, and civil society.³⁵ The major mission of the Council is to promote democratic and scientific approaches to climate policy making.³⁶ Some of the central agencies, whose work is related to climate issues, have their own advisory boards established to account for additional expertise and advice. The Advisory Committee for Natural Resources and Energy within the METI serves as a venue for resource conservation discussions and as a clean energy advising board composed of representatives of the respective industries and academia.³⁷

Additionally, the Center for Climate Change Adaptation was established in 2018 after the adoption of the Climate Change Adaptation Act³⁸ and is responsible for collecting, organizing, analyzing, and providing information on climate change impacts and adaptation, as well as providing technical advice to local governments and Local Climate Change Adaptation Centers (LCCACs) on their climate change adaptation efforts.³⁹ The LCCACs serve as local providers and advisors on climate adaptation policies, collaborating with regional governments.⁴⁰ The LCCACs are supposed to be established and operated in each of the regions, according to the Climate Change Adaptation Act (Articles 13-14).⁴¹ These examples demonstrate that Japan has multi-level governance mechanisms for climate regulations both on the mitigation and adaptation tracks, with the engagement of different types of actors from private, academic, and regional entities to central agencies.

4. Example of local specifics

Given the reliance on energy-intensive manufacturing and the importance of electricity reliability, many renewable policies face opposition (reluctance of electric utilities towards renewables investment, underutilization of non-fossil certificates, solar installation regulatory bottlenecks in urban areas, etc.).⁴² The multilevel governance institutions are primarily focused on bringing together central government officials, industry and academic representatives, with limited engagement of local governments and communities.^{43,44,45} As a result, 290 municipalities in Japan have imposed regulatory restrictions on solar deployment by 2025, in order to prevent potential disputes between developers and local communities due to concerns over the impact of potential natural disasters, consequential land degradation, and general community opposition.⁴⁶

At the same time, there is a relatively high interest and potential in renewables deployment in urban areas. Tokyo recently launched a new building solar rooftop mandate, special green leases, shared-benefit mechanisms, and other financial incentives.⁴⁷ Still, urban areas lag behind suburban communities and prefectures due to the landlords' and developers' reluctance and the technical difficulty of switching to renewables in multi-apartment complexes, since around 49% of urban residents live in rental properties with inherent structural disadvantages.⁴⁸

Japan is the third largest producer of motor vehicles in the world,⁴⁹ which makes Japan one of the major emitters in the automotive industry. Current battery electric vehicle (BEV) shares in car sales in Japan are very low, only comprising around 2% of total new car sales in 2023.⁵⁰ Japanese companies are currently prioritizing development of hybrid and fuel-cell EVs.⁵¹ Japan's automotive companies targets for zero emission vehicles (ZEVs) include both battery and fuel cell EVs, and goals vary significantly across manufacturers.⁵² Additionally, around $\frac{2}{3}$ of Japanese vehicles are produced today overseas, and some overseas branches stated opposition to proposed internal combustion engine (ICE)-powered⁵³ vehicle phase-out policies in other countries.⁵⁴ An incorporation and full implementation of a climate agenda in the business strategies of the Japan's leading multinational corporations in automotive industry would allow for less polluting automotive production domestically in the car-producing prefectures (Aichi,⁵⁵ Shizuoka, Kanagawa, Hiroshima, and Fukuoka).⁵⁶

5. Climate needs

There is significant complexity and diversity of GHG emissions profiles across Japan's prefectures and municipalities. Some entities heavily rely on fossil fuels and drive national emissions up, such as the industrial areas of Chiba, Kanagawa, Osaka, and Tokyo in the Southeast Coast, while southernmost prefecture of Okinawa has the lowest total emissions due to limited industrial presence in comparison to the Southeast and very low demand for residential heating in comparison to the North.^{57,58}

According to the Tokyo Metropolitan Government's Bureau of Environment, energy-derived CO₂ emissions in Tokyo in 2019 accounted for 4.7% of domestic emissions, which was approximately equivalent to the amount of GHG emissions of one country, such as Austria or Greece.⁵⁹ According to the same Bureau, even though the overall GHG emissions in Tokyo decreased, the energy-derived emissions did not, due to the increasing reliance on carbon-intensive energy sources after the closure of nuclear power plants.

Meanwhile, some subnational entities in Japan function as natural carbon sinks, playing a major role in offsetting part of the increasing levels of GHG emissions in Japan, e.g. between 2001 and 2023, forests in Hokkaido emitted 3.98 MtCO₂ per year but removed 31.0 MtCO₂ per year, yielding a net carbon sink of -27.0 MtCO₂ per year.⁶⁰ This underscores the need for a balanced mixture of climate mitigation policies focused on green energy transition in industrialized prefectures and cities and with nature-based carbon removal policies in less populated prefectures.

After the climate governance gaps between the national and subnational level are identified, it becomes crucial to understand the dynamics, restraints, and opportunities for subnational actors to generate and maintain revenue needed to fund climate action. The Fiscal Landscape Analysis section below sets a foundation for the feasibility of the suggestions derived from the following steps to be tested against.

3.2. Fiscal Landscape Analysis

Assessing the financial capacity of subnational governments to support ambitious climate action is crucial, as policies cannot be realized without adequate funding. Here, fiscal capacity primarily refers to the authority and resources to allocate budgets, levy taxes, and invest in climate solutions. Key areas of analysis include: (1) financial standing (e.g., revenue base, debt, reserves); (2) fiscal policy patterns (e.g., spending priorities, tax expenditures); and (3) de facto financial resource availability, as detailed below.

First, an analysis on financial standing includes economic factors such as the gross domestic product (GDP) of the country and its regions, which allows for an assessment of the regional poverty and wealth distribution, and the degree of the fiscal system’s centralization, which allows for assessing the degree of fiscal discretion levied by subnational governments. This step allows for the identification of regions with higher capacities to finance independent climate action. Whereas, for regions with a weaker financial standing, this step explores a local government’s ability to financially support and/or retrain workers that lose their jobs in the green transition and the local ability to mitigate the social controversies of fossil fuel abatement in sensitive regions, with a specific focus on the equitable distribution of compensation.

Second, the fiscal policy pattern analysis examines how taxes are levied and funds are distributed, focusing on the political implications of potential national backsliding, past trends in climate funding, the level of industry/private influence on local and national fiscal policy, potential risks of corruption, and loopholes which could allow subnational actors to compensate for potential funding losses. The goal of this step is to identify the fiscal interaction patterns which persist between different levels of government, e.g. identifying whether the national government supports subnational climate policies financially or whether subnational actors have to create independent schemes of revenue generation for future climate projects.

Last, the analysis of de facto financial resource availability aims to understand what climate budget resources already exist at the national and subnational levels to finance new climate projects. This includes looking at regional investment flows, financial capacities to develop domestic production, capabilities to provide for infrastructure renovation and modernization, existing investment regulations, and a region’s ability to search for/extract critical minerals for renewable energy machinery. Frequently, new ambitious climate projects require significant investment, and even financially well-off regions may lack capacity for additional investment, despite having enough budget for the current policies. This step is crucial to understand the level of upfront and sustained investment needed to create and maintain critical resources required for the green transition and the adoption of heightened sustainable practices.

Below, these recommendations can be found on Table 2. However, this is not a comprehensive list and it is recommended to expand based on the needs/nuances of each country.

Table 2: Financing Potential Analysis. Components and respective steps of the financing potential analysis broken down into three sections with considerations listed.

Component	Steps
Financial standing	1. Economic standing assessment (GDP, investment indicators, etc.) 2. Degree of fiscal centralization/decentralization 3. Regional distribution of wealth and regional concentration of poverty 4. Ability to fund just green transition benefits and compensations, re-training programs, and facility re-purposing, with an additional focus on the equitable distribution of these benefits.
Fiscal Policy Patterns	1. Frequency/quality of subnational fiscal interaction with the central, i.e. national, entities 2. Changes in political views on the federal-subnational funding patterns and the implications of potential changes in the fiscal system 3. Subnational green fund raising 4. Past prioritization trends in discretionary appropriations in the respective regions 5. Level of industry/private engagement in local national investment projects.

Component	Steps
De Facto Financial Resource Availability	1. National and regional investment portfolios 2. Supply and value chains, with a special focus on the availability of green technologies and access to critical minerals 3. Strength of production capability 4. Potential risk of corruption.

Example of the Financial Potential Analysis (Mexico):

Mexico's fiscal intergovernmental relations can be characterized as complex, featuring a relatively high degree of expenditure centralization and limited fiscal revenue collection powers of the state and municipal governments, with Mexico City having the highest proportion of its own fiscal revenues in total revenues, and with the states of Tabasco, Oaxaca, and Tlaxcala having the lowest respective proportion and demonstrating the highest-in-the-country reliance on federal transactions.⁶¹ Since the 1980s, Mexico's states and municipalities relinquished their authority to collect certain taxes in exchange for larger federal transfers which reached 74% of total state revenues in 2024.⁶² The federal government is responsible for levying income and social security taxes, VAT, excises, tariffs, etc., while the state governments can levy payroll, vehicle ownership, hospitality, entertainment, and lottery taxes and civil service fees, with the municipalities being able to levy property taxes, user fees for utilities and parking, and minor levies for permitting, licensing, and inspecting.⁶³

As regards the fiscal revenues structure, Mexico has one of the lowest tax revenue to GDP proportion (10.3%) due to the high reliance on oil revenues,⁶⁴ which means that a green energy transition poses a significant fiscal challenge to Mexico. In 2023, the oil and gas industry contributed 22% to public income and 4.9% to GDP.⁶⁵ Of this, 62% of the oil and gas resources came from Pemex, the national oil company.⁶⁶ Since the oil prices may often be lower than the price rates assumed in the budget law due to various exogenous factors, any oil price fluctuations directly affect the federal, state, and local budgets.

The current system, in which the majority of state revenues come from federal transfers, often ties funding to specific federal priorities. The centralization allows the federal government to steer or withhold support for subnational climate initiatives depending on political preferences. Although the federal government can and currently supports climate projects through conditional transfers, this support is still much discretionary and contingent on federal willingness to prioritize climate spending. The decentralization of fiscal revenue could strengthen subnational fiscal stability and autonomy during the green energy transition. This, in turn, would support more independent subnational climate action, in the event of a federal policy reversal, giving states and local governments more budgetary independence and a more stable revenue stream.

After the financing potential at the subnational level has been identified, it becomes crucial to analyze the extent to which subnational actors can create their own and/or implement national climate policies to meet their climate and sustainability needs within their framework of governance. The Subnational Action Potential section below applies the Climate Governance Gaps Analysis to the genuine potential for subnational actors to drive climate policy.

3.3. Subnational Action Potential Identification

Subnational actors, including regional, municipal, and local governments, can play a critical role in climate policy-making and implementation of national goals. While national governments typically set overarching climate strategies, subnational entities may contribute meaningfully depending on their political, legal, and fiscal capabilities that have been identified in the Climate Governance Gaps and Fiscal Landscape analyses. Their contributions can be categorized as **full policy potential** or **policy implementation potential**.

Full policy potential involves the ability to both independently create/select and implement climate policies, which is often showcased through subnational climate action plans and enabled by legal and fiscal autonomy. Full policy potential can amplify national climate policies or compensate for their absence.

In contrast, policy implementation potential refers to the sole capacity to execute policies set up by the higher levels of government, by using local tools, resources, and priorities. This may increase the sustainability of the nationally defined policy, but does not include the autonomous ability to design the policies being implemented. However, there is still some possibility for policy alterations and adjustments, which constitutes the core of the policy implementation potential, consisting in not just implementing the policy but also in customizing the policy implementation instruments and practices. While this form of influence is less powerful in shaping national outcomes, it embeds sustainability into practice through local decisions on instruments, contractors, and projects.

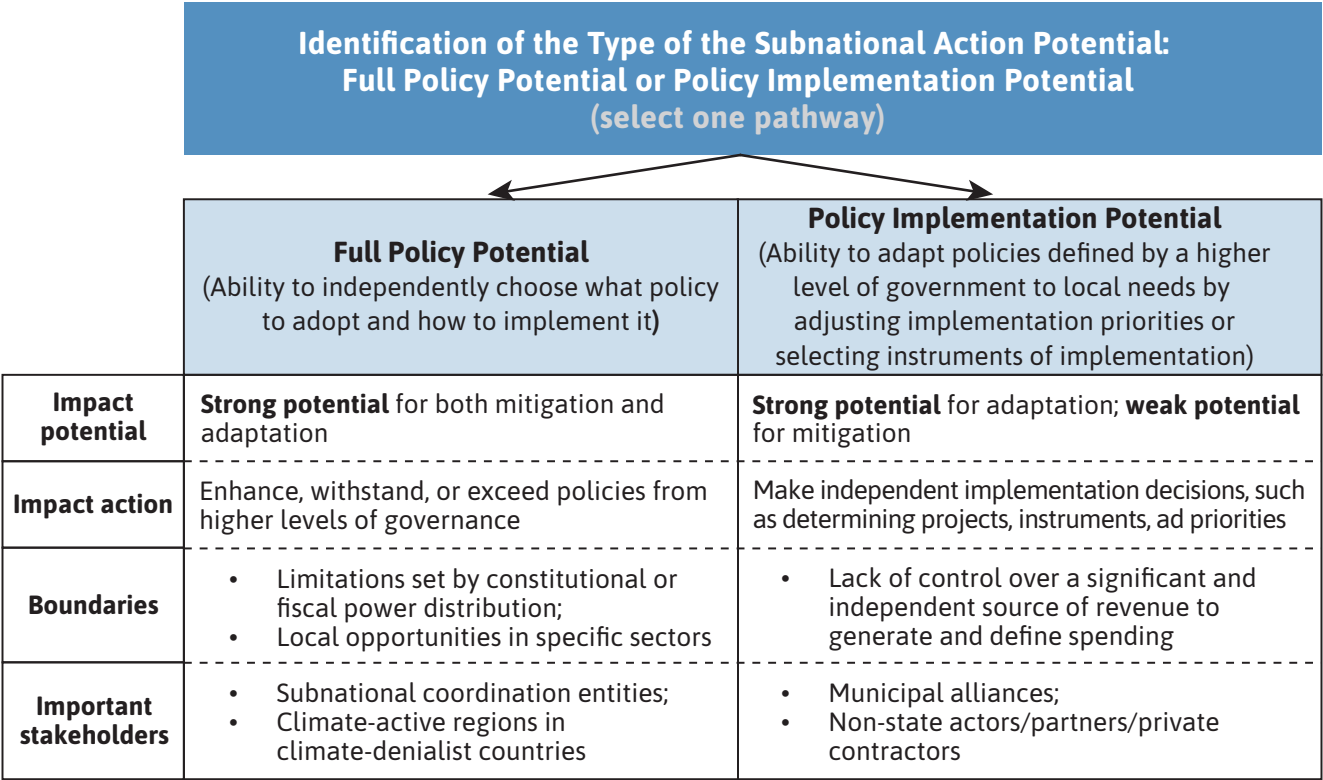


Figure 2: Subnational Action Potential. Subnational action potential procedure. Routes of full policy potential and policy implementation potential can be separated based on governance system specifications.

This element of the framework decomposes the two dimensions of subnational climate action potential. It clarifies what each type is, where it is strongest, what its limitations are, how it can be operationalized, and what influence it can bear on the national level. It also identifies major enabling

conditions and institutional mechanisms that can enhance or constrain action, as well as the key documents through which subnational actors articulate their climate agendas. Figure 2 summarizes this analytical workflow.

3.3.1. Full Policy Potential

Full policy potential refers to the ability of subnational actors to independently choose which policy paths to pursue, as well as directing the processes and instruments necessary for their implementation. This applies across both climate mitigation and climate adaptation domains.

When exercised, full policy potential can significantly influence national climate efforts, either by enhancing national strategies through innovative subnational policies or by providing resilience when national-level climate ambition is lacking. However, the full policy potential is not uniform across climate sectors and can be constrained by the distribution of constitutional and fiscal powers. In many cases, subnational governments may lack authority over certain sectors or may be restricted in their ability to allocate budgets for specific projects. A particular emphasis on the enabling condition of the financing component of the framework must be placed on this section to determine genuine rule-making ability, which is the main enabling factor of a full policy potential.

Subnational climate action plans are the key documents which reflect or formalize subnational climate ambition. These plans serve as platforms for subnational governments to articulate their climate goals and strategies. Such documents may contain subnational actions in support of the national strategies, or a proclamation of differentiation from national-level rhetoric through independent climate policies.

The key channels of support for subnational entities exercising full policy potential are the subnational coordination entities, e.g. inter-governmental or regional associations, leagues, alliances, etc. Climate-forward regions can play a strategic role as models of climate leadership, especially in countries where climate action is politically contested. These regions can highlight successful strategies and delineate potential pathways for policy innovation, serving as showcases that inspire and guide other subnational entities.

Example of the Full Policy Potential Analysis (Australia):

Australia's compensatory federalism affords substantial latitude for states to define their own policies across multiple domains,⁶⁷ which creates notable gaps in climate goals between states and the Commonwealth. These policy gaps can be effectively filled in by state action, since the states retain authority in main sectors central to climate policy: land and resource management, transportation, urban planning, infrastructure, network utilities, public services, and the environment.⁶⁸

The power sector falls primarily under the Commonwealth's jurisdiction, but timely and effective renewable energy (RE) deployment depends on state-to-Commonwealth cooperation, especially in permitting and siting.⁶⁹ Conversely, the National Electric Vehicle (EV) Strategy set no national quantitative EV goal,⁷⁰ which provides subnational actors with significant potential for detailed and practical EV adoption policies under an overarching federal framework. While state authority in the power sector is comparatively constrained, states can both elevate national EV ambition and compensate for the absence of a federal target through robust state-level EV measures.

3.3.2. Policy Implementation Potential

Policy implementation potential refers to the ability of subnational actors to select the instruments used to carry out policies defined by a higher level of government or to adapt those policies to local needs by adjusting implementation priorities. This form of potential is more visible within the domain of climate adaptation, where localized approaches and context-specific strategies are often necessary for success.

Adaptive measures often involve responsive, urgent, tangible, and localized micro- or middle-scale measures, e.g. infrastructure reinforcement, emergency response systems, flood or fire control systems, etc., that require rapid deployment and draw on local capacities and expertise.⁷¹ For those reasons, climate adaptation measures tend to be perceived as less politically contentious, compared to climate mitigation measures that involve future-oriented macro-strategies and are therefore more politically and economically disputed among both the policy-makers and the electorate.⁷² Therefore, it is easier for national governments to delegate a significant degree of discretion to subnational governments in adaptation policy, while climate mitigation policies involve tighter control from the national government and more cross-governmental coordination. The impact of the policy implementation potential is therefore limited in the realm of climate mitigation, as the lack of the rule-making component in the policy implementation potential means little or no control over strategic policy design,⁷³ which is key for outlining mitigation policies.

Subnational entities that are limited to implementation roles generally lack authority to influence the broader national climate outcomes, as they are not empowered to independently create climate policies per se. As a result, their direct influence on national climate policy decision-making is typically minimal. However, the importance of policy implementation potential is derived through regional efforts to make existing top-down policies more sustainable by adapting national policies to the local level-needs and interests in a timely manner and by selecting sustainable implementation instruments. Subnational actors with policy implementation potential can still play a crucial role by directing projects, tools, and contractors that best promote sustainable practices and optimize their capacities in accordance with the administrative frameworks they operate within. By embedding sustainability into local level implementation, such actors can help mainstream and optimize climate-conscious approaches and make long-term contributions to climate resilience.

The extent of policy implementation potential is often tied to a subnational government's control over spending, which may include its ability to generate independent revenue streams outside of the national budget. These financial capabilities largely determine how flexibly and effectively subnational governments can pursue implementation strategies.

Municipal and local-level action plans are the primary documents that capture subnational climate policy implementation steps. As implementation tools and decisions are most often made at the lowest level of governance, these documents can offer valuable insights into how subnational entities plan to operationalize broader policies.

Municipal alliances are key channels that can support implementation through additional and independent knowledge sharing and coordination among local governments. These alliances are particularly valuable due to the practical experience and sector-specific expertise that municipalities bring. Additionally, non-state actors, especially private sector partners involved in project or grant implementation, are critical stakeholders in this space, given their operational (and practical) role in turning policies into action. Private sector and non-governmental entities who operate in multiple communities can also play a role in spreading knowledge and experience.

Example of Policy Implementation Potential Analysis (China):

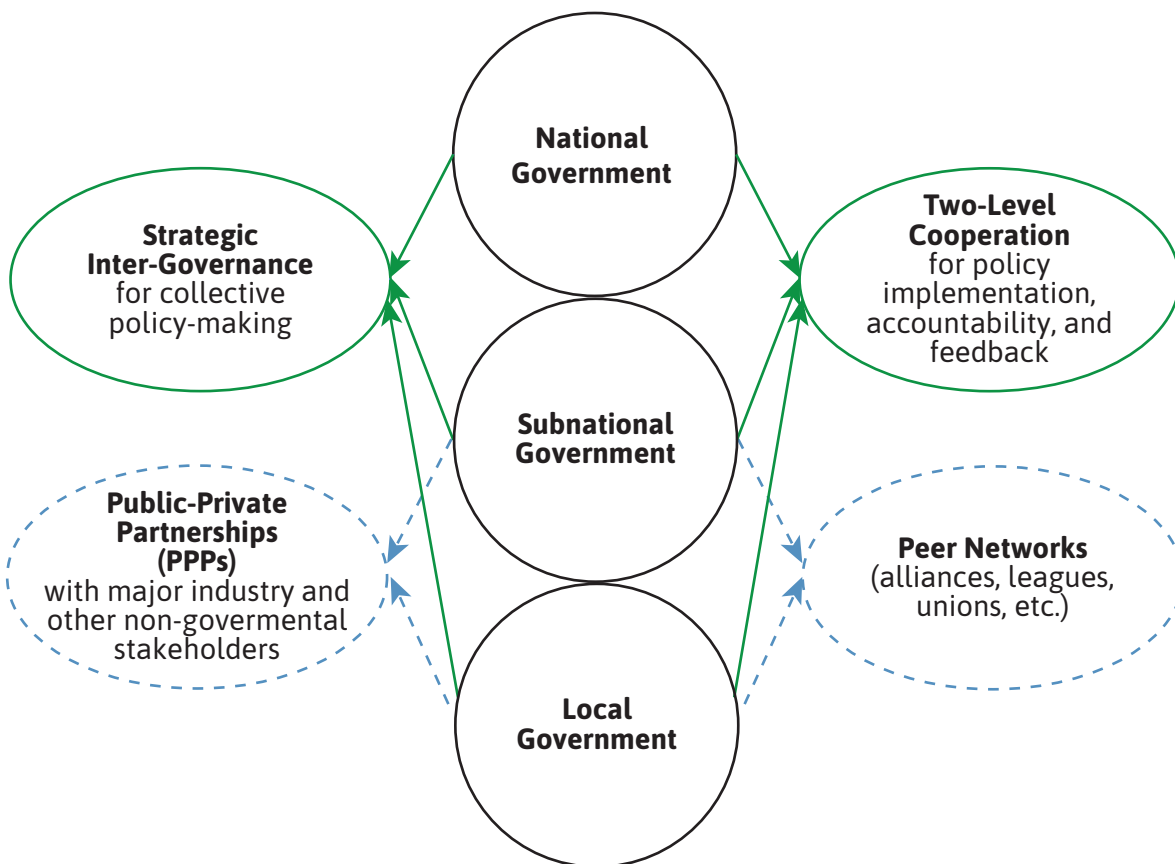
China's structure for provincial-level implementation of national policies creates space for subnational actions to reduce emissions in industry and methane,⁷⁴ with industry accounting for 21% of overall emissions in China, and methane accounting for 9%, half of which comes from coal.⁷⁵ Methane emissions reductions through waste reduction and reuse would be implemented predominantly at the city level.

Provincial governments in China also have significant influence in their jurisdictions within the national power grid system,⁷⁶ giving them quasi-federal authority in the power sector. This enables provinces to steer the transition to renewable energy, e.g. the local management of small-scale power stations and coal power station closure planning. Provinces that are rich in renewable energy resources will require even greater investment in renewable energy technologies because of their role as exporters of clean electricity to neighboring provinces with fewer renewable energy resources,⁷⁷ which means a higher need in provincial and local action on energy grids in electricity-exporting provinces.

Both of these action potential types are shaped by national and subnational institutional arrangements, financial independence, and various coordination mechanisms, i.e. regional alliances and municipal networks. In order to understand how subnational climate capacities interact on the national and global stages, the stakeholder analysis section applies the subnational potential determined in this section to the intricacies of climate stakeholder interactions and hierarchies.

3.4. Stakeholder Analysis

The stakeholder analysis component uses a whole-of-society approach to assess how different levels of government and non-state actors coordinate to achieve climate targets. Stakeholders include national, subnational and local governments, international intergovernmental organizations, e.g. alliances and leagues, and private stakeholders such as industry representatives and civil society organizations. Figure 3 visualizes potential networks and streams of cooperation between the respective stakeholders, and we highlight two options: cross-governmental cooperation (green lines) and independent entity partnerships (blue lines).



— Requires cross-cooperation of different government levels

- - - Does not require an interaction with a different level of government, i.e. it can be done in cooperation with the same level-entities and other non-governmental actors

Figure 3: Stakeholder Analysis. Stakeholder interactions within the varied levels and forms of cooperation available on the global and national climate policy stages. Green solid lines represent vertical cross-governmental cooperation and blue dotted lines represent horizontal, i.e. non-hierarchical, independent partnerships.

Cross-governmental cooperation options (green solid lines) encompass inter-level collaboration networks between national and subnational governments, as well as between subnational and local governments. The differences are detailed below:

1. **Strategic inter-governance** allows for collective policy-making and knowledge sharing. This type of coordination is primarily executed between national and subnational governments, often in the form of inter-governmental organizations or councils. These groups serve as a meeting platform for national and subnational policy-makers for joint decision-making or consultations.
2. **Two-level cooperation** allows for policy implementation, accountability, and feedback channels. This type of cooperation is primarily executed between subnational and local governments to ensure the effective implementation of subnationally defined strategies, often in the form of a task or project delivered by subnational governments for their local counterparts.

Example of the Cross-Governmental Cooperation Analysis (Canada):

Federal-provincial cooperation in Canada is based on the principles of “executive federalism”, e.g. Canada’s federal and provincial environment ministers meet yearly in the Canadian Council of Ministers of the Environment (CCME), where decisions are to be made in consensus.⁷⁸ This mechanism of inter-provincial cooperation can allow either for subnational climate action acceleration or its impediment due to the high concentration of sovereignty in the matters of subnational jurisdiction, e.g. the principle of intergovernmental consensus has been historically used by climate action-resistant provinces to impede the national climate ambition, but the period after 2015 has been marked by a stronger federal role in climate policy-making, supported by the Supreme Court’s decision in favor of national carbon pricing and demonstrated through a unilateral federal change of Canada’s 2030 climate ambition from 30% to 40-45% reduction of GHG emissions.^{79,80}

The diversity of energy policy interests and climate policy perspectives is a challenge for intergovernmental cooperation on climate in Canada: five provinces and one territory have set legally binding climate goals (British Columbia, New Brunswick, Nova Scotia, Prince Edward Island, Quebec, and Yukon), four provinces and one territory have set non-binding climate goals (Alberta, Manitoba, Newfoundland and Labrador, the Northwest Territories, and Ontario), and Saskatchewan is the only province and Nunavut is the only territory without any climate goals.⁸¹

Fossil fuels have historically been credited for the economic development in oil and gas-mining provinces, e.g. oil and gas account for 31% of Alberta’s GDP, 25% of Newfoundland and Labrador’s GDP, and 22% of Saskatchewan’s GDP,^{82,83,84} and were incorporated by provincial conservative governments in the concept of Canada’s national security. The Pathways Alliance represents Canadian Natural, Cenovus, ConocoPhillips Canada, Imperial, MEG Energy, and Suncor Energy, which together comprise about 95% of Canada’s oil sands production, and operates as Canada’s top fossil fuel lobbyist,⁸⁵ leveraging its strong political influence to defend the interests of the fossil fuel industry in Canada.

The inter-provincial challenges of RE deployment include the different levels of RE resource wealth, ramification of the legacy distribution system built around centralized fossil fuel power plants, and geographic RE affordability differences among provinces dictated by climate and geography.⁸⁶ Limited interjurisdictional coordination towards electricity system innovation and information asymmetry are slowing down the build-out of additional electricity grid capacities for accelerated RE and EV deployment, which could be addressed through more active leveraging of the inter-provincial cooperation components of the executive federalism system.

Direct consultations with local communities and inter-provincial communication could ensure accountability and timely knowledge-sharing, respectively. Creating inter-provincial partnerships based on extra electricity grid capacity exports could address the cross-country disparities in RE resource wealth and RE affordability,⁸⁷ which would make an RE transition economically and socially easier in fossil fuel-dependent regions.⁸⁸

Independent entity partnership options (blue dotted lines) do not require cross-governmental collaboration and can be implemented horizontally. This type of cooperation takes place among entities at the same level of governance or with stakeholders outside of the governance system. Here, international organizations and private stakeholders are introduced as key players in implementing climate policies. The differences are detailed below:

1. **Public-private partnerships (PPPs)** take place between civil, industry, and private stakeholders. A subnational entity can independently cooperate with non-state owned or non-state controlled actors to implement specific projects with instruments preferred by the subnational entity. This discretion allows for the outsourcing of specific policy implementation projects to independent providers. No cooperation with a higher or level governance entity is required.
2. **Peer networks** allow a subnational entity to be an active member of an international alliance uniting other subnational entities across the world to share knowledge, ambition plans, and experiences. No cooperation with different levels of governance is required.

Example of the Independent Entity Partnerships Analysis (Brazil):

Brazil's subnational and municipal governments have a history of engaging in climate-focused para-diplomatic processes since the 1990s, despite a lack of clear framework for engaging nationally and globally. It should be noted that subnational authority to act on broader political stages is relatively conditional on their political influence and financial capacity within Brazil,⁸⁹ i.e. larger and wealthier subnational entities have more resources to participate in independent partnerships at the international level.

Brazilian states and cities have increasingly engaged with global climate alliances to advance ambitious climate action despite occasionally fluctuating federal policies. Key networks include C40 Cities, Local Governments for Sustainability (ICLEI), the Under2 Coalition, and Regions4. São Paulo and Rio de Janeiro are the members of C40 and are actively involved in the Urban 20's (U20) work on uniting other large metropolitan areas across the world in order to boost city-level climate ambition through governance reform discussions and climate mitigation experience sharing.⁹⁰ The states of Mato Grosso (carbon neutrality by 2035), São Paulo (net zero by 2050), Pernambuco (net zero by 2050), etc. are participants of the Under2 Coalition, and have engaged with investors from the U.S. and UK through the Under2 Coalition in order to attract additional investment for the state-level green transition projects.⁹¹

Such engagements enhance local capacity, ensure policy continuity across administrations, and strengthen Brazil's decentralized climate governance model, while positioning its subnational actors as global leaders in climate resilience and mitigation.

After understanding how different governmental actors and other stakeholders can cooperate to achieve climate policy goals, the final step is to apply these interactions to specialized climate sectors.

3.5. Sectoral Applications

This component applies the governance and high-level climate action potential analyses described, but in application to the sector level. We begin with each country/region's highest-emitting or highest-production sectors. The framework focuses on several sectors such as power, transportation, industry, agriculture, waste, fossil fuel extraction, and buildings, given their outsized contribution to emissions across countries. The proposed framework is designed to be applicable to all climate policy sectors, and other sectors such as buildings can be added based on differing country priorities.

Figure 4 summarizes possible areas of policy research within some of the most common climate sectors, including common policy considerations. The options described in the figure include some common policies pursued by subnational governments in the power, transportation, industry, and agriculture and waste sectors.

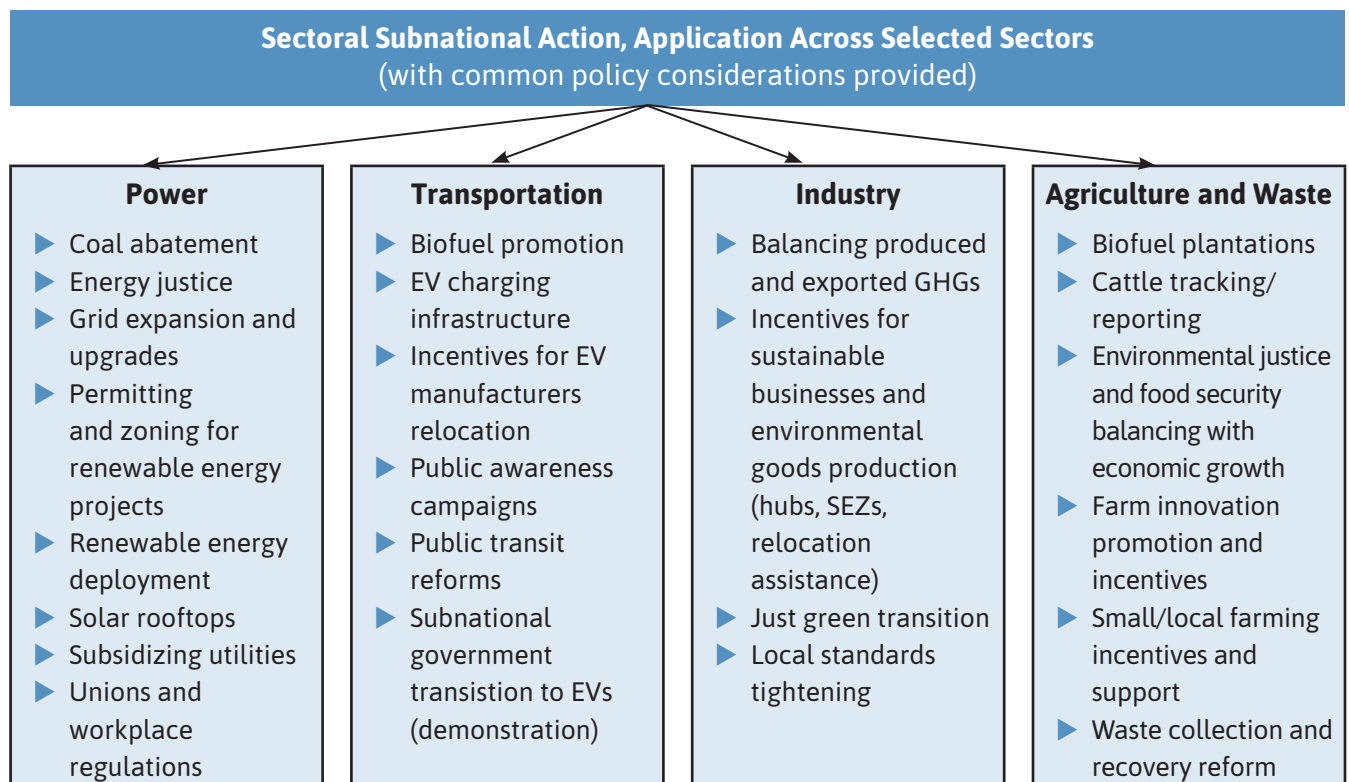


Figure 4: Sectoral Pillars.⁹² Exemplary application of the framework to four sectoral pillars: power, transportation, industry, and agriculture and waste. A non-exhaustive list of potential policies to research for each sector.

In the power sector, coal abatement, utility subsidies, and energy justice programs offer local opportunities for decarbonization, cleaner air, and an easier energy transition. Transportation highlights local levers like electric vehicle (EV) infrastructure build-up facilitation for faster EV adoption, public transit reforms for the vehicle miles traveled (VMT) reductions, and public fleet electrification for demonstration effects. In industry, subnational governments can spur low-carbon transitions by incentivizing sustainable business clusters through fiscal benefits and exemptions, tightening local standards for business operations, and addressing the balance of GHG emissions exports/imports through inter-regional corporations. While agriculture involves more private stakeholders and requires more local private-public partnerships, the waste sector is managed by local governments and relies both on public resources and semi-public partnerships.

Preliminary regional comparisons suggest that regions with coal-heavy grids or rapid urbanization tend to have administratively strong yet not fully realized subnational climate action potential, requiring investment and innovation attraction/facilitation, new private-public partnerships, clear standards and accountability mechanisms, and transparency.

Example of the Sectoral Applications (Indonesia):

Indonesia faces low recycling rates and relies heavily on informal waste management systems, including city or village waste pickers who lack adequate income and organization to facilitate recycling. Consequently, they often transport solid waste from residential areas to trash islands on the metropolitan outskirts, such as the Bantar Gebang trash island near Jakarta.⁹³ This reliance on informal networks stems from insufficient funding for waste management. Indonesian city governments allocate an average of only 2.5% of their municipal budgets to solid waste management, whereas a more effective allocation would be 5% or more.⁹⁴

To address the problem of trash islands, President Joko Widodo signed Presidential Regulation No. 35 to accelerate the deployment of waste-to-energy facilities in 12 major cities including Jakarta, Bandung, Bekasi, and Tangerang, with the state-owned Perusahaan Listrik Negara (PLN) being the sole government entity authorized to purchase power generated from these facilities.⁹⁵ Additionally, cities like Jakarta and Surabaya are taking steps to formalize solid waste management, streamline recycling efforts, and address the garbage islands by investing in municipal waste recovery facilities, introducing service-free trash collection, installing garbage bins, and banning single-use plastics.^{96,97}

Enhancing these informal waste management systems could involve implementing policies that promote formalization. Potential formalization strategies range from building municipal trash collection infrastructure and ensuring the affordability of municipal services, which would help structure local waste management and improve data collection, to investing in waste-to-energy and other waste recovery facilities that could mitigate the growth of trash islands and boost recycling rates. However, the formalization of waste collection should account for adverse economic impacts on the informal waste pickers, supporting their gradual integration into a formalized sector through training.

4. Conclusion

The subnational analysis framework provides a comprehensive understanding of a subnational entities' potential for advancing climate action. Grounded in the concepts of federalism and multilevel governance, it accounts for a country's systemic features, local climate needs and various socio-economic, political, institutional, and climate conditions at the subnational level, along with stakeholder interaction dynamics, which enables detailed sectoral applications to identify the areas with the high concentration of potential for impactful subnational climate policy action.

The framework uses governance context as a foundational layer, providing an understanding of the distributions of power vital for enabling regional and local climate action. The framework then accounts for the fiscal landscape, which ensures the adequacy and feasibility of the further climate action potential assessment. Following this, the framework offers a dual-path approach to categorizing subnational climate action potential: full policy potential (discretion to define, design, and implement its own regional climate policies) and policy implementation (some discretion in choosing the instrument of implementation of the policies defined by a higher level of government).

The framework then identifies possible pathways for cooperation within the existing climate governance systems, either vertically (entities from different levels can cooperate with each other following the existing systemic hierarchies) or horizontally (entities of the same government level can partner with each other or other independent entities). The framework was applied to selected sectors: power, industry, transportation, agriculture, and waste, and we illustrate its use with six country cases. In Australia, state-level strategies compensate for federal inaction in EV deployment. In Canada, dual federalism leads to significant divergence in provincial policy choices in the oil and gas sector. In Brazil and Mexico, centralized climate policies nudge subnational entities to independently enter international coalitions, e.g. São Paulo's (Brazil) membership in C40 and the participation of Mexico's Jalisco and Baja California in the regional US California-joint emissions trading system (ETS). In the unitary systems of China and Japan, policy implementation potential is observed at provincial, prefectural, and municipal levels through active local coal abatement.

Although this analysis included a number of factors shaping subnational action potential, not all variables could be incorporated at this stage. Going forward, future areas of research may include a heightened emphasis on equity (prioritizing local resource distribution patterns), national and local corruption factors, climate risks, and historical data. A heightened focus on potential concentrations of disproportionately overburdened populations (economic wellbeing, environmental determinants of health, access to education, etc.) may help to illustrate where accelerated subnational climate action may be most helpful and where there are additional limitations for subnational action. An assessment of climate risks may help to understand the potential socio-economic ramifications of green transition policies, allowing for more equitable policy recommendations. Further, an assessment of corruption may aid in boosting the feasibility checks embedded in the framework. Finally, an analysis of historical data, such as the history of green technology development and adoption by state, may help to further understand regional capacities.

A keen focus on subnational climate governance and a strong understanding of policy gaps across different legislative, administrative, and fiscal policy approaches are critical to ensuring robust global, national, and subnational climate action potential assessments and respective policy recommendations across countries. Through this, subnational governments can deepen their practice-based understanding of local climate issues and priorities, economic capabilities, and political constraints, which helps to better equip them to set effective climate agendas.

References

1. Ryna Yiyun Cui, *Enhancing Global Ambition for 2035: Assessment of High-Ambition Country Pathways* (Center for Global Sustainability, University of Maryland, 2024), https://cgs.umd.edu/sites/default/files/2024-11/Global%202035%20NDC%20Report_Final.pdf.
2. Nathan E. Hultman et al., "Fusing Subnational with National Climate Action Is Central to Decarbonization: The Case of the United States," *Nature Communications* 11, no. 1 (2020): 5255, <https://doi.org/10.1038/s41467-020-18903-w>.
3. Angel Hsu et al., *Scaling Up. Local to Global Climate Action* (Stanley Center for Peace and Security and the Yale School of Forestry and Environmental Studies, 2015), <https://stanleycenter.org/publications/report/WhitePaperScalingUp12-2015.pdf>.
4. Mia Landauer et al., "The Role of Scale in Integrating Climate Change Adaptation and Mitigation in Cities," *Journal of Environmental Planning and Management* 62, no. 5 (2019): 741–65, <https://doi.org/10.1080/09640568.2018.1430022>.
5. Joseph Kane et al., *Not According to Plan: Exploring Gaps in City Climate Planning and the Need for Regional Action*, Brookings Metro (The Brookings Institution & San Diego Regional Policy and Innovation Center, 2022), https://www.brookings.edu/wp-content/uploads/2022/09/Decarbonization_final.pdf.
6. Jose Antonio Puppim de Oliveira, "The Implementation of Climate Change Related Policies at the Subnational Level: An Analysis of Three Countries," *Habitat International*, Climate Change and Human Settlements, vol. 33, no. 3 (2009): 253–59, <https://doi.org/10.1016/j.habitatint.2008.10.006>.
7. Jeroen van der Heijden, "When Opportunity Backfires: Exploring the Implementation of Urban Climate Governance Alternatives in Three Major US Cities," *Policy and Society* 40, no. 1 (2021): 116–35.
8. Robert Kastelein, "Role of Local Governments in EU Member States' Climate Policy and Legislation," *Nature Partner Journals (NPJ): Climate Action* 3, no. 1 (2024): 92, <https://doi.org/10.1038/s44168-024-00177-3>.
9. Adalbert Evers and Verena Schmid, "Local Climate Governance: Towards More Interactive Practices and Settings?," *Voluntas* 36, no. 1 (2025): 113–24, <https://doi.org/10.1007/s11266-024-00698-9>.
10. Jingyuan Xu, "Conflicts in Multi-Level Governance: An Analysis of International Climate Policy Implementation at the Sub-National Level," *Global Public Policy and Governance* 1, no. 4 (2021): 401–20, <https://doi.org/10.1007/s43508-021-00029-4>.
11. Peter Eckersley, "A New Framework for Understanding Subnational Policy-Making and Local Choice," *Policy Studies* 38, no. 1 (2017): 76–90, <https://doi.org/10.1080/01442872.2016.1188910>.
12. Hsu et al., *Scaling Up. Local to Global Climate Action*.
13. Landauer et al., "The Role of Scale in Integrating Climate Change Adaptation and Mitigation in Cities."
14. Kane et al., *Not According to Plan: Exploring Gaps in City Climate Planning and the Need for Regional Action*.
15. de Oliveira, "The Implementation of Climate Change Related Policies at the Subnational Level."
16. van der Heijden, "When Opportunity Backfires."
17. Kastelein, "Role of Local Governments in EU Member States' Climate Policy and Legislation."
18. Evers and Schmid, "Local Climate Governance."
19. Xu, "Conflicts in Multi-Level Governance."

20. Xu coins only the categories of conflict and mentions a concept of subnational action potential but does not identify the types of such potential. The types of subnational climate action potential, which are mentioned in this section, are derived from the proposed subnational analysis framework, about which the present paper elaborates further on.
21. Eckersley, "A New Framework for Understanding Subnational Policy-Making and Local Choice."
22. Alan Fenna et al., eds., *Climate Governance and Federalism: A Forum of Federations Comparative Policy Analysis* (Cambridge University Press, 2023), <https://doi.org/10.1017/9781009249676>.
23. Kirsten Jörgensen et al., "Multi-Level Climate Governance and the Role of the Subnational Level," *Journal of Integrative Environmental Sciences* 12, no. 4 (2015): 235–45, <https://doi.org/10.1080/1943815X.2015.1096797>.
24. Note that constitutional powers are not always aligned with the empirical distribution of powers. Source literature from local news and political science publications.
25. Purnendra Jain, "Japan's Subnational Government: Toward Greater Decentralization and Participatory Democracy," in *Japanese Politics Today: From Karaoke to Kabuki Democracy*, ed. Takashi Inoguchi and Purnendra Jain (Palgrave Macmillan, 2011), https://doi.org/10.1057/9780230370838_10.
26. Organization for Economic Co-operation and Development (OECD) and United Cities and Local Government (UCLG), *Subnational Governments around the World. Structure and Finance* (Global Observatory on Local Finances, 2016), https://uclg-localfinance.org/sites/default/files/Observatory_web_0.pdf.
27. Enrico D'Ambrogio, *Japan's Parliament and Other Political Institutions*, Briefing PE 651.951, Continental Democracies (European Parliamentary Research Service (ERPS), 2025), https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/651951/EPRS_BRI%282020%29651951_EN.pdf.
28. OECD, "Regional Development," Organization for Economic Cooperation and Development (OECD), 2023, <https://www.oecd.org/en/topics/regional-development.html>.
29. Masatsugu Ito, "Central and Local Government Relations," in *Public Administration in Japan*, ed. Koichiro Agata et al., International Institute of Administrative Sciences (IIAS) Series: Governance and Public Management (Palgrave Macmillan, 2024), https://doi.org/10.1007/978-3-031-58610-1_3.
30. Akihide Hirashima, "Japan's Local Government Debt Control System," Asian Development Bank (ADB) Institute, Asia Pathways, July 11, 2018, <https://www.asiapathways-adbi.org/2018/07/japans-local-government-debt-control-system/>.
31. Japan, "The Constitution of Japan (Constitution 1946)," Japanese Law Translation, 2025, <https://www.japaneselawtranslation.go.jp/en/laws/view/174/tb>.
32. Japan, "Local Autonomy Act, Act No. 67 of April 17, 1947," Japanese Law Index, 2017, <https://hourei.ndl.go.jp/#/detail?billId=009212024>.
33. Japan, "Act on Promotion of Global Warming Countermeasures - Act No. 117 of 1998, Reviewed in 2021," Cabinet Secretariat (CAS) of Japan, 1998, <https://www.cas.go.jp/jp/seisaku/hourei/data/APGWC.pdf>.
34. Government of Japan, "Global Warming Prevention Headquarters," Prime Minister of Japan and His Cabinet, 2007, https://japan.kantei.go.jp/policy/ondanka/index_e.html.
35. Japan, "The Basic Environment Law," FOALEX Database, 1993, <https://faolex.fao.org/docs/pdf/jap4747.pdf>.
36. Yong Ren, "Japanese Approaches to Environmental Management: Structural and Institutional Features," *International Review for Environmental Strategies* 1, no. 1 (2000): 79–96.
37. METI, "Advisory Committee for Natural Resources and Energy," Ministry of Economy, Trade and Industry (METI), 2019, https://www.enecho.meti.go.jp/en/committee/council/basic_policy_subcommittee/.
38. Japan, "Climate Change Adaptation Act (Act No. 50 of 2018)," Japanese Law Translation, 2018, <https://www.japaneselawtranslation.go.jp/en/laws/view/3212/en>.

39. CCCA, “Background of the Establishment,” Center for Climate Change Adaptation, 2019, <https://ccca.nies.go.jp/en/about/index.html>.
40. A-PLAT, “What Is the Local Climate Change Adaptation Center?,” Climate Change Adptation Information Platform (A-PLAT), 2021, <https://adaptation-platform.nies.go.jp/en/local/lccac/lccac.html>.
41. Japan, “Climate Change Adaptation Act (Act No. 50 of 2018),” Japanese Law Translation, 2018, <https://www.japaneselawtranslation.go.jp/en/laws/view/3212/en>.
42. Michiyo Miyamoto, *Key Barriers in Japan’s Renewable Energy Development* (Institute for Energy Economics and Financial Analysis (IEEFA), 2025), <https://ieefa.org/resources/key-barriers-japans-renewable-energy-development>.
43. METI, “Advisory Committee for Natural Resources and Energy.”
44. Government of Japan, “Global Warming Prevention Headquarters,” Prime Minister of Japan and His Cabinet, 2024, <https://japan.kantei.go.jp/103/actions/202412/27ondanka.html>.
45. Government of Japan, “Law No. 91 ‘The Basic Environment Law,’” FOALEX Database, November 19, 1993, <https://faolex.fao.org/docs/pdf/jap4747.pdf>.
46. Miyamoto, *Key Barriers in Japan’s Renewable Energy Development*.
47. Tokyo Metropolitan Government, “A New System Requiring the Installation of Solar Power Generation Systems Will Begin in April 2025,” Tokyo Metropolitan Government News, January 2023, https://www.koho.metro.tokyo.lg.jp/2023/01/04.html#tmp_honbun.
48. e-Stat, “2023 Housing and Land Statistics Survey,” e-Stat (Government statistics portal), 2024, <https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00200522&tstat=000001207800&cycle=0&tclass1=000001207808&tclass2=000001207809&tclass3val=0>.
49. OICA, “2021 Statistics,” International Organization of Motor Vehicle Manufacturers (OICA), 2022, <https://oica.net/statistics-production/>.
50. Felix Kuhnert et al., *Electric Vehicle Sales Review Q1 2023* (PwC Network, 2023), <https://www.strategyand.pwc.com/tr/tr/pdf/2023-yilinin-ilk-ceyreginde-elektrikli-arac-satislari.pdf>.
51. IEA, “Prospects for Electric Vehicle Deployment – Global EV Outlook 2023,” International Energy Agency (IEA), 2024, <https://www.iea.org/reports/global-ev-outlook-2023/prospects-for-electric-vehicle-deployment>.
52. Ilma Fadhil, “Which Automakers Are Keeping the ZEV Momentum Strong?,” *The International Council on Clean Transportation* (ICCT), October 20, 2023, <https://theicct.org/automakers-are-keeping-the-zev-momentum-strong-oct23/>.
53. ICE - internal combustion engine.
54. *Japanese Automotive Sector And Climate Policy. An Investor Briefing* (Influence Map, 2023), https://influencemap.org/site//data/000/020/Japanese-Automakers-Investor-Brief_Jan2023.pdf.
55. Aichi Prefectural Government and Investment and Trade Division of the Aichi Prefectural Government, “Automotive Industry,” Aichi Prefectural Government, 2023, https://www.pref.aichi.jp/ricchitsusho/en/industrial_capital/#:~:text=the%20manufacturing%20industry.-Automotive%20Industry.CORPORATION%2C%20and%20TOYOTA%20BOSHOKU%20CORPORATION.
56. JETRO, “Regional Information: Industrial Cluster Information. Automobile and Transport Equipment,” Japan External Trade Organization (JETRO), 2017, https://www.jetro.go.jp/ext_images/mexico/topics/cluster_auto_en_2018.pdf.
57. Yin Long et al., “Japanese Urban Household Carbon Footprints during Early-Stage COVID-19 Pandemic Were Consistent with Those over the Past Decade,” *Nature Partner Journals (NPJ): Urban Sustainability* 3, no. 1 (2023): 19, <https://doi.org/10.1038/s42949-023-00095-z>.

58. Yin Long et al., "Fuel-Specific Carbon Footprint Embodied in Japanese Household Lifestyles," *Earth's Future* 9, no. 1 (2021), <https://doi.org/10.1029/2021EF002213>.
59. Bureau of Environment, *Final Energy Consumption and Greenhouse Gas Emissions in Tokyo*. FY 2019 (Tokyo Metropolitan Government, 2022), https://www.kankyo.metro.tokyo.lg.jp/documents/d/kankyo/climate-index-files-tokyo_ghg_2019.
60. GWF, "Hokkaido, Japan: Deforestation Rates & Statistics," Global Watch Forest (GWF), 2025, <https://www.globalforestwatch.org/dashboards/country/JPN/12?category=climate>.
61. Teresa Ter-Minassian, *Fiscal Federalism in Theory and Practice* (International Monetary Fund, 1997), <https://doi.org/10.5089/9781557756633.071>.
62. Mariela Dal Borgo, "Effect of a Transfer Shock on Subnational Debt: Micro Evidence from Mexico," *Journal of Public Economics* 239 (November 2024): 105251.
63. Luis Felipe Munoz et al., "Mexico - Overview," PwC, *Worldwide Tax Summaries*, April 2025, <https://taxsummaries.pwc.com/mexico>.
64. Luis Cesar Castañeda and Juan E. Pardini, *Sub-National Revenue Mobilization in Mexico*, Working Papers (Inter-American Development Bank (IDB), 2012), Mexico, <http://dx.doi.org/10.18235/0011423>.
65. Taborga Sergio, "Mexico's Energy Transition: New Government, New Opportunities," *Mexico Business News*, June 23, 2024, <https://mexicobusiness.news/energy/news/mexicos-energy-transition-new-government-new-opportunities>.
66. CIEP Staff, "La Importancia Fiscal de Pemex: Hacia la Era Post-Petróleo," *El Centro de Investigación Económica y Presupuestaria, A.C. (CIEP)*, 2023, <https://ciep.mx/la-importancia-fiscal-de-pemex-hacia-la-era-post-petroleo/>.
67. Alan Fenna, "Climate Governance and Federalism in Australia," in *Climate Governance and Federalism: A Forum of Federations Comparative Policy Analysis*, ed. Joana Setzer and Sébastien Jodoin (Cambridge University Press, 2023), <https://doi.org/10.1017/9781009249676.003>.
68. Fenna, "Climate Governance and Federalism in Australia."
69. Madeline Taylor, "Planning the Energy Transition: A Comparative Examination of Large-Scale Solar Energy Siting on Agricultural Land in Australia," *Utrecht Law Review* 18, no. 2 (2022): 70–86, <https://doi.org/10.36633/ulr.814>.
70. Commonwealth of Australia, "National Electric Vehicle Strategy," 2023, <https://www.dccew.gov.au/sites/default/files/documents/national-electric-vehicle-strategy.pdf>.
71. Astrid Molenveld et al., "Governance of Climate Adaptation, Which Mode? An Exploration of Stakeholder Viewpoints on How to Organize Adaptation," *Climatic Change* 162, no. 2 (2020): 233–54, <https://doi.org/10.1007/s10584-020-02683-9>.
72. Nives Dolšak and Aseem Prakash, "The Politics of Climate Change Adaptation," *Annual Review of Environment and Resources* 43, no. Volume 43, 2018 (2018): 317–41, <https://doi.org/10.1146/annurev-environ-102017-025739>.
73. Simon Touboul et al., *Climate Adaptation: Why Local Governments Cannot Do It Alone* (Organization for Economic Cooperation and Development (OECD), 2023), https://www.oecd.org/en/publications/climate-adaptation-why-local-governments-cannot-do-it-alone_be90ac30-en.html.
74. Hongtao Yi and Shuai Cao, "Climate Governance and Quasi-Federalism in China," in *Climate Governance and Federalism: A Forum of Federations Comparative Policy Analysis*, ed. Alan Fenna et al. (Cambridge University Press, 2023), <https://doi.org/10.1017/9781009249676.006>.
75. Rachel Hoesly et al., "CEDS V_2025_03_18 Gridded Data 0.5 Degree," version v_2025_03_18, Zenodo, March 18, 2025, <https://doi.org/10.5281/zenodo.15001544>.

76. Yi and Cao, "Climate Governance and Quasi-Federalism in China."
77. Jiehong Lou et al., "A Provincial Analysis on Wind and Solar Investment Needs towards China's Carbon Neutrality," *Applied Energy* 378 (January 2025): 124841, <https://doi.org/10.1016/j.apenergy.2024.124841>.
78. Government of Canada, "About CCME," Canadian Council of Ministers of the Environment (CCME), 2025, <https://ccme.ca/en/about>.
79. Supreme Court of Canada (SCC), "Case in Brief: References Re Greenhouse Gas Pollution Pricing Act," March 25, 2021, <https://www.scc-csc.ca/judgments-jugements/cb/2021/38663-38781-39116/>.
80. Stephanie Taylor, "Ottawa Pushes Back on Ontario, Prairies Crying No Consultation on 2030 Emissions Goal," *Toronto Sun*, April 26, 2021, <https://torontosun.com/news/national/prairie-provinces-ontario-say-no-consultation-on-new-2030-emissions-target>.
81. Government of Canada, *2023 Progress Report on the 2030 Emissions Reduction Plan* (Ministry of Environment and Climate Change, 2023), <https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/emissions-reduction-2030/2023-progress-report/table-contents.html>.
82. Anna Kuteleva and Justin Leifso, "Contested Crude: Multiscalar Identities, Conflicting Discourses, and Narratives of Oil Production in Canada," *Energy Research & Social Science* 70 (December 2020): 101672.
83. Job Bank - Government of Canada, "Saskatchewan Sector Profile: Mining, Quarrying, and Oil and Gas," 2023, <http://www.jobbank.gc.ca/contentjmr.xhtml>.
84. Weimin Wang, "The Oil and Gas Sector in Canada: A Year after the Start of the Pandemic," *Statistics Canada*, July 28, 2021, <https://doi.org/10.25318/36280001202100700003-eng>.
85. John Woodside, "Big Oil Is Lobbying Aggressively against Climate Action | Canada's National Observer: Climate News," *Canada's National Observer*, August 12, 2024, <https://www.nationalobserver.com/2024/08/12/news/big-oil-lobbying-feds-2023>.
86. Kathryn Harrison, "Climate Governance and Federalism in Canada," in *Climate Governance and Federalism: A Forum of Federations Comparative Policy Analysis*, ed. Alan Fenna et al. (Cambridge University Press, 2023), <https://doi.org/10.1017/9781009249676.005>.
87. Jason Wang and Scott MacDougall, "Walk the Line: Cross-Border Transmission Infrastructure Can Help Secure Economic Growth and Strengthen Grid Resilience," *Pembina Institute*, April 4, 2025, <https://www.pembina.org/op-ed/walk-line>.
88. IEA, "Canada Electricity Security Policy – Analysis," *International Energy Agency (IEA)*, June 30, 2022, <https://www.iea.org/articles/canada-electricity-security-policy-2>.
89. Laura Silvia Valente de Macedo and Pedro Roberto Jacobi, "Subnational Politics of the Urban Age: Evidence from Brazil on Integrating Global Climate Goals in the Municipal Agenda," *Palgrave Communications* 5, no. 1 (2019): 18, <https://doi.org/10.1057/s41599-019-0225-x>.
90. "São Paulo and Rio de Janeiro Gather Global Cities to Influence G20 at Urban 20 Summit of Mayors," *C40 Cities*, June 1 92024, <https://www.c40.org/news/sao-paulo-rio-de-janeiro-global-cities-g20-urban20-summit-mayors/>.
91. Climate Group, "Mobilising Green Investment in Brazilian States," *Climate Group*, 2025, <https://www.theclimategroup.org/mobilising-green-investment-brazilian-states>.
92. SEZs - special economic zones (see the table).
93. Shunsuke Sasaki et al., "Economic Status of Waste Pickers in Bantar Gebang Compared to Other Workers in Indonesia," *Habitat International* 119 (2022): 102501, <https://doi.org/10.1016/j.habitatint.2021.102501>.

94. Victoria Kwakwa et al., "Project Appraisal Document on a Proposed Loan in the Amount of \$100 Million to the Republic of Indonesia for a Improvement of Solid Waste Management to Support Regional and Metropolitan Cities," The World Bank, 2019, <https://documents1.worldbank.org/curated/en/608321575860426737/txt/Indonesia-Improvement-of-Solid-Waste-Management-to-Support-Regional-and-Metropolitan-Cities-Project.txt>.
95. "Indonesia: Waste-to-Energy Industry Market," International Trade Administration (ITA), 2022, <https://www.trade.gov/market-intelligence/indonesia-waste-energy-industry-market>.
96. I Wayan Koko Suryawan and Chun-Hung Lee, "Achieving Zero Waste for Landfills by Employing Adaptive Municipal Solid Waste Management Services," *Ecological Indicators* 165 (2024): 112191, <https://doi.org/10.1016/j.ecolind.2024.112191>.
97. Arun Rajamani and Kar Min Lim, "Taking Plastics Full Circle: Creating a Sustainable Future in Indonesia," The Jakarta Post, 2024, <https://www.thejakartapost.com/business/2024/05/02/taking-plastics-full-circle-creating-a-sustainable-future-in-indonesia.html#:~:text=Companies-,Taking%20plastics%20full%20circle%3A%20Creating%20a%20sustainable%20future%20in%20Indonesia,to%20reduce%20harm%20to%20nature>.

