



CLIMATE GOVERNANCE: COMPARING CENTRALIZED AND DECENTRALIZED APPROACHES

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ABSTRACT. *Climate governance is entering a period of turbulence, with policy reversals in some democracies and rapid expansions elsewhere. This paper compares how centralized, decentralized (federal), and polycentric/hybrid governance designs shape mitigation and adaptation outcomes. Using a qualitative comparative approach across China, the United States, Canada, Türkiye, Norway, and Saudi Arabia, assessing policy ambition, legal instruments, implementation capacity, subnational authority, stakeholder participation, finance mobilization, and equity considerations. A qualitative comparative approach is applied across six country cases - China, the United States, Canada, Türkiye, Norway, and Saudi Arabia - evaluating policy ambition, legal instruments, implementation capacity, subnational authority, stakeholder participation, finance mobilization, and equity considerations. Insights are then extended to the Central Asian context, where climate governance remains predominantly centralized, shaped by Soviet-era institutional legacies, uneven local capacity, and constrained civic participation. The analysis demonstrates that no model is universally superior; the most effective arrangements combine top-down coherence with bottom-up experimentation and social legitimacy. Norway's polycentric governance model and Türkiye's hybrid approach illustrate how localized climate planning can be integrated within broader national frameworks. For Central Asia, pragmatic hybrid pathways are recommended that align national targets and financing with empowered regional pilots, transparent monitoring, and inclusive engagement. These context-sensitive combinations offer the best prospects for durable emissions reductions, climate resilience, and just transition outcomes in the region.*

KEYWORDS: *climate governance, climate policy, China, the USA, Türkiye, Canada, Central Asia.*

INTRODUCTION

Climate change has become a defining test of governance in the twenty-first century. As impacts intensify and transition timelines compress, institutional design - who decides, how coordination occurs across levels, and how society participates - has become as consequential as technology costs or resource endowments. Effective climate action, therefore, depends not only on what policies are adopted but on how authority, capacity, and accountability are structured. As of 2023, China, the United States, India, the European Union, Russia, and Brazil account for over 62% of global greenhouse gas

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emissions (World Bank, 2023; European Commission, 2024). On a per-capita basis, the United States (14.2 tCO₂), Canada (13.1 tCO₂), and Russia (11.5 tCO₂) remain among the highest emitters, compared with 8.9 tCO₂ for China and 1.9 tCO₂ for India. To address these challenges and accelerate energy transition, countries are substantially increasing investments in clean energy (World Bank, 2023). In 2024, clean-energy investment was led by China (~USD 680B), the European Union (~USD 370B), and the United States (~USD 315B), with strategies reflecting divergent governance models and institutional capacities (International Energy Agency, 2024). These differences shape policy credibility, investor expectations, and the pace of decarbonization.

Meanwhile, countries face differing structural and contextual challenges and exhibit distinct climate action trajectories. It is therefore critical to identify the core enablers and constraints that shape the effectiveness of their climate governance, which can include political will, administrative capacity, regulatory coherence, stakeholder engagement, and alignment between national and sub-national levels. Understanding these dynamics is essential for developing context-sensitive and adaptive climate pathways.

The Central Asian region - Kazakhstan, Uzbekistan, Kyrgyzstan, and neighbors - faces acute vulnerabilities (desertification, water stress, extreme events) while operating within highly centralized governance structures marked by limited fiscal decentralization and uneven local capacity (Sabyrbekov, Overland, & Vakulchuk, 2023). Understanding which elements of centralized, decentralized, and hybrid systems travel well to Central Asia is, therefore, a practical and scholarly priority.

This paper contributes by providing a comparative evaluation of centralized, decentralized, and polycentric/hybrid arrangements across representative cases; identifying criteria that link governance design to climate outcomes; and translating these insights into actionable implications for Central Asia, where administrative legacies and capacity asymmetries constrain implementation. Authors argue that the most credible pathways for the region are hybrid: clear national targets and funding frameworks combined with empowered subnational experimentation, inclusive participation, and robust monitoring.

Moreover, climate risks vary widely across geographic, ecological, and socio-economic contexts, reinforcing the urgency of localized or bioregional approaches to both mitigation and adaptation. Such approaches are particularly important in geographically expansive and ecologically diverse countries (Aberley, 1999). In this context, Central Asia presents a compelling case. The region faces acute climate vulnerabilities, including desertification, water scarcity, and extreme weather events, while contending with governance challenges rooted in Soviet-era institutional legacies and centralized state systems.

Identifying transferable governance practices is therefore crucial. For example, China offers valuable insights into rapid and coordinated top-down policy execution. Meanwhile, the United States and Canada demonstrate the strengths and limits of decentralized, sub-national innovation. Türkiye's hybrid governance model illustrates how national coordination can be balanced with regional flexibility, an especially

relevant consideration for Central Asian states given their similar geographic and developmental profiles.

Despite emerging climate initiatives, governance in Central Asia continues to be constrained by limited civic participation, fragmented policy implementation, and insufficient resource allocation to local authorities. This research seeks to identify applicable governance models and institutional practices that can strengthen climate adaptation and mitigation in the region, drawing on lessons from diverse international cases.

In parallel, recent decades have seen the rise of climate governance and environmental governance as key concepts in international policy discourse. While sometimes used interchangeably, current research highlights essential distinctions between them, particularly in terms of institutional design, policy tools, stakeholder participation, and mechanisms for global coordination. Clarifying these differences is essential for shaping effective, inclusive, and accountable climate governance systems, especially in transitional and emerging economies.

METHODOLOGY AND LITERATURE REVIEW

This study employs a qualitative comparative research design to analyze climate governance across countries that represent three distinct institutional models: centralized (e.g., China, Saudi Arabia), decentralized (e.g., Canada, the United States), and hybrid or polycentric (e.g., Türkiye, Norway). The primary aim is to evaluate how varying policy architectures, including legal instruments, incentive schemes, multi-level coordination mechanisms, and energy transition progress, shape the effectiveness of national climate action. Particular attention is paid to climate mitigation and adaptation outcomes, as well as the degree to which equity, justice, and stakeholder participation are integrated across governance levels.

The empirical basis of this research is broad and triangulated. Data is drawn from peer-reviewed academic studies, official policy documents (including Nationally Determined Contributions, National Adaptation Plans, and climate legislation), and international clean energy investment trends from institutions such as the International Energy Agency, the International Renewable Energy Agency, the Climate Policy Initiative, and the World Bank. This is further complemented by information from global climate action tracking platforms, including the Climate Action Tracker, the United Nations Framework Convention on Climate Change, and official national climate and energy portals. Together, these sources enable a multi-dimensional assessment of governance dynamics across institutional and geographic contexts. The comparative approach allows the synthesis of cross-country insights and supports the development of policy recommendations tailored to the Central Asian states. These recommendations aim to foster climate governance systems that are context-sensitive, adaptive, and inclusive, particularly relevant for regions struggling with bureaucratic inertia, capacity asymmetries, and heightened climate vulnerability.

Climate governance theory emphasizes distributed authority, multi-level coordination, and learning across scales (Cole, 2011; Bauer et al., 2007; Bennett & Satterfield, 2018; Hey, 2006; Lemos & Agrawal, 2006; van der Molen, 2018; Bulkeley et al., 2012;

Hoffmann, 2011; Blue & Dusk, 2022b; Smoke & Cook, 2022). This scholarship highlights the shift from centralized environmental regimes to more polycentric, hybrid arrangements involving states, markets, and civil society actors. Research on power, equity, and justice explores how resource allocation, institutional veto points, and the inclusion (or exclusion) of marginalized groups shape outcomes (Paavola, 2005; Blue & Dusk, 2022b). This perspective underscores the need to integrate climate justice and procedural fairness into governance frameworks. Comparative governance performance studies produce mixed empirical findings. While decentralization and democracy are often assumed to deliver more effective outcomes through innovation and accountability, recent research questions whether regime type alone determines emissions reductions or policy coherence (Escher & Walter-Rogg, 2023; Lindvall & Karlsson, 2023). Evidence suggests that factors such as economic structure and developmental stage may weigh more heavily than political system design. National-level research provides case-specific insights into how countries design and implement climate strategies. Studies of the United States and Canada highlight the role of federalism and subnational leadership (Rabe, 2011; Harrison, 2023; Winter, 2024). Research on China illustrates centralized policy coherence but also entrenched coal dependence (Qi et al., 2020; Wu et al., 2022, 2023; Cui et al., 2021). Türkiye and Norway exemplify hybrid or polycentric approaches that balance national coordination with local innovation and stakeholder inclusion (Boasson & Jevnaker, 2019; Fauchald & Gulbrandsen, 2023; Demirci & Karabulut Uçar, 2024). Meanwhile, Saudi Arabia shows the limitations of highly centralized, resource-dependent systems with low civic engagement (Rahman et al., 2022; Scott et al., 2023).

This research also foregrounds the importance of social engagement, local authority empowerment, and community co-production of climate solutions, dimensions often overlooked in state-centric policy models. By synthesizing governance theories with region-specific insights, the study contributes to both academic discourse and applied policy development on equitable and effective climate governance in transitional contexts.

Finally, the study addresses notable gaps in the comparative literature by explicitly linking governance model effectiveness to the institutional and political realities of Central Asia. Previous scholarship rarely applies participatory governance frameworks, decentralized policy experimentation, or capacity-building approaches to this region. This research, therefore, makes a novel contribution by situating comparative lessons within Kazakhstan and neighboring states, where centralized traditions persist but demand for inclusive and adaptive climate action is rising.

THEORETICAL FRAMEWORK

Climate Governance

To clearly navigate the complexity of contemporary climate challenges, it is critical to first establish conceptual clarity by differentiating between three interconnected yet distinct terms frequently encountered in environmental studies: environmental power, environmental governance, and climate governance. Understanding these distinct yet overlapping definitions provides a foundational lens through which this paper evaluates

diverse governance models, institutional effectiveness, and their implications for policy implementation across varying national contexts.

Environmental power, as a concept, derives from a state's capacity to manage, protect, or exploit critical ecological systems such as forests, watersheds, and fossil fuel reserves or, conversely, from its potential to cause transboundary environmental harm (Buzan & Falkner, 2022). Environmental power manifests support for global cooperation and problem-solving, reinforcing notions of environmental leadership (Skodvin & Andresen, 2006; Eckersley, 2020), while the latter enables obstruction or strategic delay, often for economic or geopolitical gain. Despite the emergence of environmental stewardship as a key institution in global society, it has yet to reach systemic importance in maintaining international stability, unlike traditional security threats. Thus, environmental issues like biodiversity loss, ozone depletion, and climate change, although critical to planetary survival, still lack full integration into global power structures (Bernstein, 2020; Buzan & Falkner, 2022, p. 43).

Environmental governance encompasses the institutions, policies, regulatory mechanisms, and stakeholder interactions explicitly designed to manage environmental resources sustainably, addressing issues such as pollution control, biodiversity conservation, and natural resource management through legal instruments, international agreements, and domestic regulations (Bauer et al., 2007; Bennett & Satterfield, 2018). Environmental governance has largely relied on command-and-control regulation and binding legal instruments focused on discrete issues like air pollution or endangered species protection (Hey, 2006; Bauer et al., 2007).

Climate governance, as a core dimension of environmental governance, encompasses a wide range of methods and institutional arrangements aimed at mitigating and adapting to the adverse effects of climate change. It involves not only formal decision-making by states and international institutions, but also corporate strategies, legal frameworks, and the engagement of civil society actors (IPCC, 2022, p. 45; UNDP, 2022). Climate governance includes collaborative approaches to decision-making, the mobilization of scientific knowledge, institutional capacity-building, and actions that support conservation and sustainable management of ecosystems (Lemos & Agrawal, 2006; van der Molen, 2018).

Within this broader framework, climate governance specifically targets two interrelated goals: climate mitigation, the reduction of greenhouse gas emissions, and climate adaptation, efforts to cope with the ongoing and projected impacts of climate change (Hölscher & Frantzeskaki, 2020). The success of these objectives depends on the inclusion and active participation of a wide array of stakeholders, including civil society, political institutions, youth, Indigenous Peoples, businesses, media, and local communities (IPCC, 2022).

Effective climate governance must also address issues of equity and justice, particularly in ensuring that historically marginalized and vulnerable populations, who are often the most affected by climate impacts, are adequately represented in policy-making processes (Blue & Dusyk, 2022b). The distribution of power in multi-level governance frameworks plays a decisive role in shaping how policies are formulated and

implemented. Unequal access to institutional power and resources across governance levels may empower veto players, hinder consensus-building, and stall climate action. While multi-level governance scholarship has focused on the role of the nation-state (Bache & Flinders, 2004), scholars in environmental governance are increasingly incorporating theories of power and agency to better understand how these dynamics unfold (Nastar & Ramasar, 2012).

The complexity of climate change, with its long-term temporal scale, cross-sectoral implications, and global scope, has demanded more adaptive and experimental governance models. These include voluntary and market-based instruments such as carbon pricing, climate finance, and multi-stakeholder networks (Browne, 2022; Cole, 2011). As climate challenges increasingly intersect with trade, finance, and social justice, climate governance frameworks have come to foreground issues of power asymmetries, North-South equity, and procedural justice, dimensions less pronounced in conventional environmental regimes (Paavola, 2005; Murombedzi & Chikozho, 2023; Gough, 2013).

Climate governance initially has evolved into a polycentric, fragmented, and hybrid system, marked by the involvement of multiple levels of authority and a wide array of non-state actors such as cities, private firms, and civil society organizations (Asselt & Zelli, 2013; Bulkeley et al., 2012; Hoffmann, 2011). In contrast, traditional environmental governance remains more centralized, treaty-based, and state-centric, with compliance mechanisms embedded in formal legal regimes such as the Montreal Protocol and the Convention on Biological Diversity (Hey, 2006; Bauer et al., 2007).

At the national level, climate governance involves aligning domestic strategies and regulations with global commitments, often guided by scientific evidence and emission reduction targets (Blue & Dusyk, 2022a). One of the critical factors shaping climate governance effectiveness is the choice of governance model - centralized or decentralized - which determines how authority, resources, and responsibility are distributed across different levels of government and society (Lulham et al., 2023; Lulham & Natural Resources Canada, n.d.; Poberezhskaya & Bychkova, 2022; Upadhyaya et al., 2018).

Decentralized climate governance has emerged as an alternative to traditional top-down approaches, involving multiple actors at various levels. This polycentric model allows for greater experimentation and learning across governmental units (Cole, 2011). Examples include local climate initiatives and grassroots organizations, which form part of networked climate governance (Tosun & Schoenefeld, 2017). Administrative decentralization for climate action involves subnational governments and intergovernmental collaboration, with the appropriate mix varying based on country-specific climate needs and existing governmental structures (Smoke & Cook, 2022). While decentralized approaches offer opportunities for innovative climate policies, they also face obstacles in implementation, highlighting the need for careful design and adaptation to local contexts. Moreover, decentralized systems may encourage flexibility but often result in vague compromises at the federal level to accommodate diverse regional interests (Rabe, 2004). Thus, the choice between centralized and decentralized governance models carries profound implications for climate policy effectiveness, especially in large and diverse countries.

Overall, climate governance has evolved from a centralized approach to a more complex, fragmented, and decentralized models (Ren, 2022; Cole, 2011). Then the polycentric governance structure involves multiple centers of authority at various levels, including public and private actors (Abbott, 2017). While some scholars argue that institutional fragmentation can enhance climate governance effectiveness in the short term (Ren, 2022), others propose that a polycentric approach allows for greater experimentation, learning, and cross-influence among different governance levels (Cole, 2011). Balancing a soft and indirect mode of governance has played a significant role in shaping the polycentric climate governance system, challenging some assumptions of polycentric governance theory regarding spontaneous emergence and decentralized coordination (Abbott, 2017). To maximize benefits and minimize costs of institutional complexity, nonhierarchical orchestration of climate governance has been suggested as a potential solution (Abbott, 2012).

Centralized climate governance refers to systems where the national government holds primary authority over climate policy formulation and enforcement. This model allows for uniform policy implementation, coordinated resource allocation, and streamlined administrative processes. However, it may struggle to reflect regional diversity, address local needs, or involve stakeholders in meaningful ways, often leading to slower decision-making and reduced public engagement. In contrast, decentralized climate governance distributes authority across national, regional, and local levels, granting sub-national actors greater autonomy to tailor policies to local conditions. This fosters innovation, encourages stakeholder participation, and can yield context-sensitive solutions.

Public Involvement, Democracy and Climate Action Effectiveness

Initially, it is expected that democracy and decentralized approaches inherently leads to better climate governance and outcomes as these governance settings allow for localized policy innovation, increased accountability, and better alignment with community needs, thereby supporting emission reductions (Escher & Walter-Rogg, 2023; Povitkina, 2018), but also decentralization can also lead to fragmented efforts or regulatory capture at the subnational level if institutional oversight is weak (Allen, 2015; Steurer et al., 2019).

In contrast, autocratic regimes generally face systemic barriers to effective climate governance regardless of centralization strategy. Top-down approaches are frequently undermined by conflicting local interests, lack of incentives, and limited public participation, resulting in poor implementation and reduced accountability (Luo et al., 2023; Lee et al., 2021; Goedeking, 2023).

Meanwhile, while democracies tend to produce better climate policy outputs than autocracies, there is weak evidence linking democratic development to CO₂ emission reductions (Lindvall & Karlsson, 2023, Chesler et al. (2023). However, more evidence that there is no statistically significant relationship between regime type and greenhouse gas emissions, suggesting that democracies are no more effective than autocracies in mitigating climate change (Chesler et al., 2023). Although democracies are often assumed to promote better environmental outcomes due to political freedoms and civic

engagement, empirical evidence remains inconclusive, and recent quasi-experimental research fails to confirm a consistent link between democratization and emission reductions (Chesler et al., 2023).

Another opinion is that factors affecting the effectiveness of climate actions, associated with economic growth, income distribution, a country's developmental stage, and corruption, influence climate policy performance more significantly than regime type (Lindvall & Karlsson, 2023, Shen, 2024). In democracies, civil society participation and social equality contribute to long-term CO₂ emission reductions, while in autocracies, local democracy and social equality play a role (Escher & Walter-Rogg, 2023). Bernauer et al. (2025), using cross-national data from 161 countries (1990-2015), demonstrate that more democratic countries offshore significantly higher amounts of pollution and, in turn, experience statistically lower domestic emissions. Democracies tend to achieve lower domestic greenhouse gas emissions not solely due to superior environmental governance, but also by outsourcing pollution-intensive production to less democratic or lower-income countries, explained by “pollution offshoring”, the transfer of environmental harms through international trade (Bernauer et al., 2025).

COUNTRY CASE STUDY

Climate Action and Policy in Practice

The climate governance of core cases structures of the United States and China reflect fundamentally different institutional logics, where the U.S. employs a decentralized, “bottom-up” model driven by local governments and market mechanisms, and China implements a centralized, “top-down” approach guided by national planning and mandatory targets (Wu et al., 2022). These cases, along with the other country examples in this study, were selected not only for their governance diversity but also for their economic structures, resource dependencies, and institutional practices that offer potential parallels with Central Asian states, thereby making the political implications of their experiences especially relevant. Despite aiming for carbon neutrality, China faces a significantly shorter transition period than the United States, making its decarbonization challenge more intense due to a larger population and higher dependence on coal (Wu et al., 2022). Although China and the U.S. follow divergent policy paths, both approaches offer valuable lessons: China's centralized policy coherence accelerates mobilization, while U.S. local innovation and stakeholder involvement promote flexibility and market integration (Wu et al., 2022).

Centralized Climate Governance: China, Saudi Arabia

China's climate governance has evolved through a distinctive and state-led trajectory, marked by increasingly ambitious policy frameworks and global leadership aspirations. Initially focused on economic growth and sovereignty, China resisted binding climate obligations between 1988 and 2006, adopting a development-first posture (Xue & Poon, 2024). A shift occurred between 2007 and 2015 with the introduction of the National Climate Change Programme and the piloting of regional carbon markets, setting the groundwork for institutional and policy innovation (Gallagher et al., 2019; Qi et al., 2020). Since 2016, China has positioned itself as a leader in global climate diplomacy, formalizing commitments to peak carbon emissions by 2030 and achieve

carbon neutrality by 2060, often referred to as the “30-60” goal. These objectives are coordinated through a highly centralized governance model involving the Communist Party’s Central Committee, the National People’s Congress, and the National Leading Group for Climate Change, with provincial governments tasked with implementation via the Target Decomposition and Assessment System (Wu, 2023).

China’s climate policy toolkit blends command-and-control regulations, emerging market-based instruments such as the national Carbon Emissions Trading Scheme, and a limited role for voluntary initiatives. Key policies include coal and carbon taxes, increased environmental spending, and emissions trading systems, which have shown measurable impact on curbing pollutants and promoting energy efficiency (Parry et al., 2016; Cui et al., 2021). Despite these advancements, structural challenges persist. These include the absence of a national climate law, limited civic participation, regional disparities in policy enforcement, and knowledge gaps in estimating emissions and carbon sinks (Feng et al., 2023; Wu, 2023). Although target decomposition and emissions trading have supported carbon reductions and stimulated innovation, scholars note that more ambitious and enforceable targets are needed to address systemic inertia and administrative fragmentation (Greider et al., 2017).

China’s achievements in renewable energy are particularly notable. By mid-2024, the country had already met its 2030 renewable energy goals, signaling accelerated progress in solar, wind, and hydro deployment (Xue & Poon, 2024). However, coal still accounted for nearly 60% of electricity generation, revealing the challenge of balancing rapid decarbonization with economic and grid stability (Meidan, 2020). Globally, China’s energy investments have diversified both technologically and geographically. The China Global Energy Investment portfolio, once concentrated in fossil fuel projects, has shifted toward renewables, especially in low- and middle-income countries. Solar and wind investments, though more geographically concentrated due to technology-specific market factors, have supported clean energy access and global decarbonization goals (Xue & Poon, 2024). While private enterprise involvement expanded after 2008, denationalization stagnated post-2014. Central state-owned enterprises still control nearly 90% of energy investment, particularly in fossil, hydro, and grid infrastructure, reflecting limited market liberalization. Overall, China’s climate governance showcases the strengths of centralized, long-term planning and massive state-led investment, but also highlights challenges around institutional rigidity, energy dependency, and constrained civic engagement. While centralized control facilitates policy coherence, the absence of institutionalized civic participation limits public oversight, transparency, and grassroots innovation. Scholars argue that despite growing experimentation with market tools, public participation in China’s climate governance remains minimal, largely due to the dominance of central state-owned enterprises and the restricted civic space (Feng et al., 2023; Wu, 2023).

Saudi Arabia’s approach to energy transition and emissions reduction has shown incremental improvements, particularly in energy efficiency, though significant structural challenges remain. Between 1981 and 2019, emissions intensity in the energy sector declined from 113 to 54 gCO₂ per million joules, reflecting some success in cleaner production practices (Rahman et al., 2022). However, absolute greenhouse gas

emissions continued to rise over the same period, revealing limited overall effectiveness in achieving decarbonization goals (Rahman et al., 2022). Similarly, while energy intensity fell from 38 to 14 million joules per USD of GDP from 1988 to 2019, recent fluctuations and a slowdown in the rate of improvement suggest that efficiency gains are plateauing and call for broader systemic integration and sector-specific interventions (IEA, 2023; Rahman et al., 2022). Despite public awareness campaigns and the introduction of building efficiency standards, per capita energy consumption increased from 207 GJ in 1981 to 313 GJ in 2019, indicating that behavioral change and demand-side management remain insufficient (World Bank, 2023; Rahman et al., 2022).

Econometric analyses using a vector error correction model further emphasize the structural roots of Saudi Arabia's emissions trajectory. Total energy consumption and foreign direct investment are identified as long-term drivers of emissions, while short-term causality between population growth and emissions underscores the need for urban planning and demographic policy integration (Rahman et al., 2022). Although the Kingdom has initiated several notable programs, such as the National Renewable Energy Program, combined-cycle gas turbine efficiency upgrades, and smart grid development, most of these efforts remain in the pilot or early implementation stages, and their current scale is inadequate to meet the targets set for 2030 (Saudi Vision 2030, 2023; Rahman et al., 2022).

To accelerate progress, scholars recommend a more aggressive and comprehensive strategy combining the scale-up of renewable energy deployment, the implementation of carbon capture and storage, the introduction of carbon pricing mechanisms, and stronger regulatory enforcement (SGI, 2023; Rahman et al., 2022). Voluntary programs and campaigns, while beneficial, must be reinforced with mandatory policy tools to influence consumption behavior and ensure long-term sustainability. In sum, while Saudi Arabia has laid a foundation for transition, the path forward requires a decisive shift from pilot programs to full-scale policy enforcement and institutional integration (IEA, 2023; Carnegie Endowment, 2023).

Saudi Arabia's climate strategy also suffers from low transparency and limited civic or civil society participation. There is minimal data availability on the implementation status of national targets or stakeholder inclusion. Climate planning remains a top-down process lacking participatory governance, which hinders public accountability and behavioral change (Carnegie Endowment, 2023; Rahman et al., 2022).

Decentralized Climate Governance: Canada, the USA

Canada's climate governance reflects a complex and evolving system shaped by its decentralized federal structure and competing regional interests, where federalism historically hindered ambitious climate action due to provincial veto power, resource ownership, and remaining potent constraints on coherent and equitable national climate action (Harrison, 2023). Initially characterized by voluntary measures and subsidies (Rivers & Jaccard, 2005), Canadian climate policy has gradually shifted toward more compulsory mechanisms such as carbon pricing and regulatory frameworks (Potvin & Jodoin, 2015). This transition has been influenced by both international commitments and domestic political shifts. Canada's early engagement with global

climate governance was marked by its ratification of the Kyoto Protocol in 1997, committing to reduce GHG emissions by 6% below 1990 levels by 2012. However, under the Conservative government of Stephen Harper, Canada withdrew from Kyoto, weakening its international climate leadership and inviting criticism (Boyd & Rabe, 2019). A renewed commitment emerged with the Liberal government under Justin Trudeau, which ratified the Paris Agreement in 2016 and introduced the Pan-Canadian Framework for Clean Growth and Climate Change. Despite this progress, aligning federal ambitions with domestic implementation remains challenging, particularly due to the economy's dependence on fossil fuel extraction (Winter, 2024).

The structure of Canadian federalism allows provinces considerable autonomy, resulting in diverse and sometimes conflicting approaches to climate and energy policy. This dynamic is often termed “contested federalism,” wherein provinces such as British Columbia, Alberta, Ontario, and Quebec exhibit varied policy pathways and energy mixes (Scott et al., 2023; Harrison, 2023). Quebec, for example, generates over 90% of its electricity from hydroelectric sources and has enacted a ban on new oil, gas exploration, and nuclear energy, as well as a commitment to eliminate fossil fuel heating in buildings by 2040 (Canada Energy Regulator, 2023a, 2023b). Ontario is heavily reliant on nuclear energy, which accounts for over 50% of its electricity generation; it is currently investing in small modular reactors to meet rising electricity demands (Canada Energy Regulator, 2023a, 2023b). Alberta remains the most fossil fuel-dependent province, though it leads Canada in wind and solar capacity growth, while British Columbia benefits from a predominantly hydro-based electricity system and is expanding its renewable capacity through Indigenous-led wind projects (Canada Energy Regulator, 2023a, 2023b; World Nuclear News, 2024; BC Hydro, 2023).

These regional distinctions in energy policy and resource dependency underscore both the innovation potential and coordination challenges within Canada's decentralized governance model. While provinces have tailored climate strategies that reflect local resource endowments and political cultures, achieving coherence and accountability at the national level remains difficult. Recent developments, such as the repeal of the federal consumer carbon tax in April 2025, have further intensified debates over the limits of decentralization (Government of Canada, 2025). Critics argue that the removal of this nationwide pricing mechanism weakens Canada's climate ambition and highlights the vulnerability of decentralized systems to political fluctuation.

Notably, Indigenous participation in clean energy projects has been substantial; as of 2022, First Nations, Métis, and Inuit entities were partners or beneficiaries in nearly 20% of Canada's existing electricity-generating infrastructure, most of which produces renewable energy (Canada Energy Regulator, 2023). Furthermore, Indigenous communities have significant equity in renewable energy projects operating within their communities and, to a lesser extent, on traditional Indigenous territory. Of the projects on traditional territory, 39% are wholly or partially Indigenous-owned, while within Indigenous communities, 42% are wholly Indigenous-owned, and 92% of projects have at least some Indigenous ownership (Canada Energy Regulator, 2023). Indigenous communities across Canada are not only stewards of vast carbon sinks but also active agents in climate governance, especially in British Columbia and the

Yukon. However, they often face institutional exclusion from national climate planning structures (Zurba et al., 2021).

Although Canada has committed to reducing emissions by 40–45% below 2005 levels by 2030, reaching these targets remains politically and economically contested. Scholars argue that Canada's climate strategy would benefit from stronger intergovernmental coordination, market-based incentives for clean technology, and tighter alignment between international climate commitments and domestic enforcement mechanisms (Duff et al., 2007; Winter, 2024). In sum, Canada represents a rich but fragmented case of decentralized climate governance, balancing national objectives with provincial variation and revealing both the tensions and adaptive capacity inherent in federal environmental policymaking.

The United States exemplifies an evolving federalist model of climate governance, shaped by shifting political leadership and the interplay between national and sub-national authorities. According to Rabe (2011), U.S. climate policy has progressed through three major phases: an initial stage of symbolic federal action from 1975 to 1997, followed by a state-driven innovation phase from 1998 to 2007, and more recently, a phase of “contested federalism” in which both state and federal governments simultaneously compete and collaborate on climate policy. This model has enabled pioneering states such as California and New York to serve as incubators for ambitious climate initiatives, including vehicle emissions standards, renewable energy mandates, and cap-and-trade systems, that have subsequently influenced federal policymaking through diffusion and intergovernmental learning (Rabe, 2011; Carlson, 2009; Bednar, 2008). At this period, the dynamic intergovernmental system reflects what North (1990) and Carlson (2009) describe as adaptive efficiency, the capacity of institutions to evolve under complex conditions through experimentation and policy learning. The United States' decentralized structure enables policy innovation and regional leadership but also creates fragmentation and political polarization that complicate cohesive national climate strategies.

Then, the most significant federal development in recent years has been the passage of the Inflation Reduction Act in 2022 under the Biden administration. The IRA allocates approximately \$400 billion in investments toward clean energy infrastructure, electric vehicle deployment, and emissions mitigation technologies, representing the most substantial federal commitment to climate action to date (U.S. Department of Energy, 2022). The United States has pledged to reduce greenhouse gas emissions by 50–52% below 2005 levels by 2030 and to achieve net-zero emissions by 2050. However, according to the Climate Action Tracker, current policies are rated as “Insufficient,” indicating that additional efforts are necessary to meet the nation's climate goals (Climate Action Tracker, 2023).

Despite this federal progress, states continue to play a pivotal role in shaping U.S. climate governance. California has led with its Zero-Emission Vehicle mandates, low-carbon fuel standards, and regional emissions trading, while New York has adopted legally binding climate targets under its Climate Leadership and Community Protection Act. Yet, recent developments highlight tensions within the federal system. In 2025, the U.S. Senate voted to revoke California's waiver to set its own vehicle emissions standards,

illustrating a potential rollback of state autonomy in climate regulation (Vox, 2025). Additionally, proposed legislation threatens to eliminate critical clean energy subsidies introduced under the IRA, posing risks to the policy continuity needed for long-term decarbonization (Washington Post, 2025).

The United States' climate governance in 2025 reflects an increasingly polarized and fragmented policy landscape. Although it benefits from a federal system that allows for subnational innovation, it also suffers from political interference, inconsistent leadership, and legal volatility. A stark example was the U.S. Senate's revocation of California's Clean Air Act waiver in May 2025, effectively nullifying the state's Advanced Clean Cars II regulations mandating zero-emission vehicle sales by 2035 (The Verge, 2025). The rollback not only undermines California's autonomy but also disrupts coordinated climate efforts across 17 aligned states and Washington, D.C., illustrating the fragility of state-led transitions under contentious federal oversight (Rabe, 2011).

In parallel, the proliferation of misinformation campaigns often funded by fossil fuel interests has eroded public trust in climate science and delayed effective policy implementation. Such disinformation has been identified as a deliberate strategy to politicize environmental discourse and obstruct regulatory progress (Oreskes & Conway, 2010; UNDP, 2025). This dynamic has deepened partisan divides and complicated local-level action, particularly in conservative states where climate skepticism remains entrenched.

However, the United States also demonstrates significant regional divergence in climate performance. Leading states like California, New York, and Massachusetts have implemented aggressive climate targets, economy-wide carbon pricing, and clean energy mandates. California continues to lead in EV adoption, despite federal pushback, and New York has invested over \$30 billion in offshore wind, building retrofits, and green job creation under its Climate Leadership and Community Protection Act (NYSERDA, 2024). Massachusetts, meanwhile, has committed to net-zero by 2050 and launched programs for municipal decarbonization and social equity in transition efforts (Massachusetts Clean Energy Center, 2024).

In contrast, states like Wyoming, West Virginia, and Mississippi remain laggards in the transition. These states continue to rely heavily on coal and natural gas for electricity generation, lack enforceable climate targets, and have limited participation in national or regional carbon markets (EPA, 2024). For example, Wyoming derives over 85% of its electricity from coal and has actively challenged federal climate regulations through litigation (U.S. Energy Information Administration, 2024). Political resistance, economic dependency on fossil industries, and underinvestment in renewables further constrain their climate progress.

Polycentric (hybrid) climate governance: Norway, Türkiye.

Norway's climate governance presents a compelling case of polycentric responsibility, where local authorities play a crucial role in implementing climate policies, with municipalities acting as both policy implementers and independent actors (Aall et al., 2007; Hanssen et al., 2013). The country has adopted a wide range of climate measures

across sectors, despite its already decarbonized power production (Boasson & Jevnaker, 2019). Norway's total energy supply in 2023 consisted of approximately 43% renewable energy, primarily hydropower, while oil and natural gas together accounted for about 49%, mainly due to their roles in transport and industry (IEA, 2024). In contrast, over 90% of Norway's electricity generation comes from hydropower, making its domestic power sector one of the cleanest globally (IEA, 2024; Climate Action Tracker, 2024). However, Norway remains a major exporter of fossil fuels, especially crude oil and natural gas, which comprised 61% of total goods export value in 2023, amounting to NOK 1,100 billion, or a dominant share of national income (Norwegian Petroleum Directorate, 2024). This export dependence creates a structural contradiction: while Norway's domestic energy system supports climate goals, its economic reliance on fossil fuel exports challenges its global climate leadership and long-term sustainability transition (OECD, 2022, Sydnes, 2019). Norway's petroleum-dependent economy poses a dilemma, as carbon risk challenges existing governance structures (Bang & Lahn, 2020). Norway's commitment to climate action is codified in its Climate Change Act, which mandates a reduction of greenhouse gas emissions by at least 50-55% by 2030 and 90-95% by 2050, relative to 1990 levels (IEA, 2024). The government's Climate Action Plan outlines a multifaceted approach, incorporating taxation, regulation, public procurement, and investment in innovation to achieve these targets (Norwegian Ministry of Climate and Environment, 2021).

Recent research suggests that both politicians and the public attribute responsibility for climate action similarly, countering the notion of a "governance trap" (Falck, 2023). Oslo exemplifies polycentric urban climate governance, combining integrative and interactive approaches. This dichotomy raises questions about the efficacy and equity of Norway's climate policies, particularly in the context of global emissions accounting and responsibility (Fauchald & Gulbrandsen, 2023).

However, a critical weakness in Norway's governance model is the diffusion of responsibility, which can lead to collective inaction. By attributing high responsibility to diffuse actors like the international community and industry entities less directly accountable to citizens, there is a risk of over-dependence on external solutions and underperformance at home (Fauchald & Gulbrandsen, 2023).

Norway faces a "governance trap" where diffuse responsibility across actors reduces decisive action. While polycentric governance supports shared responsibility, surveys reveal that both the public and politicians attribute primary responsibility to external actors - especially the international community and industry - thus weakening domestic accountability and timely climate action (Falck, 2023; OECD, 2022).

Since ratifying the Paris Agreement in 2021, Türkiye has undertaken substantial reforms in its climate governance structure. Critically, Türkiye is transitioning from a traditionally centralized, top-down climate governance model toward a hybrid system that combines soft and hard law instruments while introducing limited participatory mechanisms alongside continued state leadership. This evolving structure reflects Türkiye's strategy to integrate climate objectives with ongoing economic development goals (Demirci & Karabulut Uçar, 2024).

It has elevated the Ministry of Environment, Urbanization and Climate Change as the lead institution, established the Directorate of Climate Change, and initiated the Climate Council to incorporate input from a broad range of stakeholders (Demirci & Karabulut Uçar, 2024).

Türkiye has set a national target to achieve net-zero greenhouse gas emissions by 2053, a goal first announced following its ratification of the Paris Agreement in 2021 (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021a). In 2022, Türkiye submitted its updated Nationally Determined Contributions, committing to reduce its greenhouse gas emissions by 41% by 2030 compared to a business-as-usual scenario based on 2012 levels, and to peak emissions by no later than 2038 (MEUCC, 2022). Furthermore, the government launched the Green Deal Action Plan in July 2021, led by the Ministry of Trade, to align with the European Green Deal and prepare for related external trade measures such as the EU's Carbon Border Adjustment Mechanism (Republic of Türkiye Ministry of Trade, 2021). These developments reflect Türkiye's intention to harmonize climate action with economic competitiveness and international trade obligations. Notably, both Istanbul and Izmir have made significant strides in advancing local climate action. In 2023, Istanbul was selected as one of the EU's 100 Mission Cities, committing to achieve climate neutrality by 2030. The city has developed a comprehensive Climate Action Plan, focusing on renewable energy, energy efficiency, and sustainable transportation initiatives (Istanbul Metropolitan Municipality, 2023). Additionally, Istanbul has implemented waste-to-energy projects, such as the Istanbul Waste Power Plant, which contributes to reducing greenhouse gas emissions by converting waste into electricity (Istanbul Metropolitan Municipality, 2023). Similarly, Izmir has demonstrated leadership through its Climate City Contract Action Plan, aiming for climate neutrality by 2030. The plan outlines strategies for greenhouse gas reduction, climate adaptation, and the promotion of a circular economy. Izmir's initiatives include expanding public transportation, enhancing energy efficiency in buildings, and increasing the use of renewable energy sources (Izmir Metropolitan Municipality, 2023).

Although Türkiye has introduced hybrid governance structures, the role of metropolitan municipalities remains underutilized in national climate planning. Urban areas such as Istanbul, Ankara, and Izmir have shown initiative through local climate plans, yet they lack legal mandates, stable funding, and integration into national climate strategies (Demirci & Karabulut Uçar, 2024).

Central Asia

Central Asia illustrates a fragmented and evolving model of climate governance, shaped by resource dependence, weak regional integration, and the interplay between donor influence and national development priorities. Despite contributing relatively little to global greenhouse gas emissions, the region is warming faster than the global average, amplifying water scarcity, agricultural stress, and energy insecurity (IPCC, 2022; Sabyrbekov, Overland, & Vakulchuk, 2023).

All five states, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, have submitted NDCs under the Paris Agreement. Yet these pledges are generally

modest, heavily conditional on donor support, and often misaligned with national development strategies. Kazakhstan is the regional frontrunner, pioneering carbon pricing through its emissions trading scheme and committing to carbon neutrality by 2060 (World Bank, 2022). Uzbekistan has begun attracting foreign investment in renewables, while Turkmenistan remains reliant on natural gas exports, with no operationalized decarbonization plan (Abdi, Zhakiyev, & Toilybayeva, 2023). Coal dependence continues in Kyrgyzstan and Tajikistan, constraining near-term transition prospects.

At the governance level, implementation capacity is constrained by bureaucratic inertia, overlapping institutional responsibilities, and uneven technical expertise (World Bank, 2022, 2023a). Coordination between central and local authorities is weak, with climate strategies often subordinated to energy and industrial priorities (World Bank, 2023a). Subnational authority is limited: municipalities and provinces lack stable funding and clear legal mandates to pursue independent climate initiatives (World Bank, 2022). Participation and equity mechanisms are narrow, with environmental NGOs, eco-activists, and youth groups contributing primarily through advocacy and grassroots initiatives, rather than through institutionalized policymaking (Skalamera, 2025; Tskhay, 2023; Bossuyt, 2023). Climate finance is dominated by external partners (World Bank, EBRD, ADB), with donor-funded projects accounting for much of the renewable and adaptation investment. Domestic private-sector engagement remains modest, and carbon market mechanisms are underdeveloped (World Bank, 2023a). Outcomes are uneven: renewable capacity has expanded, particularly wind and solar in Kazakhstan, but fossil-fuel dependence, methane emissions, and transboundary water conflicts continue to dominate the regional climate profile (World Bank, 2022, 2023a). Public opinion trends further complicate governance: willingness to pay for climate action in Europe and Central Asia has declined since 2016, underscoring the risks of politicization if just-transition policies are absent (World Bank, 2023b). The region's strengths lie in the ability of central governments to adopt headline commitments and mobilize donor resources rapidly. Yet weaknesses include limited subnational authority, fragmented regional cooperation, weak civic participation, and heavy reliance on external financing. This trajectory demonstrates the contradictions of fossil-fuel dependence under accelerating climate risk. A hybrid pathway anchored in national guardrails and donor finance, but broadened through subnational pilot programs, participatory forums, and transparent MRV systems, offers the most credible route for Central Asian states to achieve durable mitigation and adaptation outcomes (World Bank, 2022, 2023a).

RESULTS AND DISCUSSION

The comparative analysis of climate governance across selected country cases reveals that the effectiveness of climate action depends on more than institutional form or regime type (Table 1-3). Instead, it is shaped by context-specific combinations of centralized coordination, decentralized innovation, and hybrid governance models that accommodate national ambition and local responsiveness. Broadly, no singular governance model universally outperforms others; rather, context-specific combinations of centralized coordination, decentralized innovation, and hybrid institutional design produce different climate outcomes.

Table 1. Comparative Overview of Climate and Energy Governance in Selected Countries

	ENERGY MIX (ELECTRICITY, 2024)	ENERGY MIX (PRIMARY, 2024)	CLIMATE GOVERNANCE	STRENGTHS	WEAKNESSES	NET-ZERO COMMITMENT	NATIONAL INSTRUMENTS	COMMUNITY ENGAGEMENT	CARBON TAX / PRICING
UNITED STATES	Fossil fuels: ~60% (Nat. gas: 37%, Coal: 17%), Renewables: 21%, Nuclear: 19%	Oil: 36%, Nat. gas: 33%, Renewables: 12%, Coal: 10%, Nuclear: 9%	Federal, with strong state-level roles; EPA and DOE	Subnational innovation; civic engagement; strong legal precedents	Policy inconsistency; partisan conflict; limited federal coherence	2050 (official commitment)	IRA, EPA standards, clean energy tax credits	Strong state/local variation; grassroots campaigns	No federal carbon tax; some state-level programs (e.g., California cap-and-trade)
CANADA	Renewables: 70% (Hydro: 62%), Non-GHG: 82% (incl. nuclear)	Oil: 39%, Nat. gas: 39%, Coal: 2%, Renewables: 10%, Nuclear: 10%	Federal-provincial, with Environment and Climate Change Canada	Provincial leadership (e.g., Quebec, BC); Indigenous participation; carbon pricing	Jurisdictional overlaps; risk of rollback under new leadership	2050 (legally binding)	Carbon pricing, Clean Electricity Regs, Net-Zero Act	Municipal action, Indigenous ownership in energy	Yes; federal carbon tax (currently CAD \$80/tonne CO ₂ in 2024), upheld by Supreme Court
TURKEY	Fossil fuels: ~99% (Coal: 35%, Gas: 19%), Renewables: ~46%	Oil: 28%, Coal: 27%, Nat. gas: 23%, Renewables: 19%, Nuclear: 3%	Emerging hybrid model; central government coordination	Growing multilevel coordination; local urban innovation; alignment with EU	Limited enforcement; institutional fragmentation	2053 (announced target)	Renewable Energy Roadmap, draft Climate Law	Growing local initiatives, Climate Council	No carbon tax; early-stage discussions on carbon pricing and market design
SAUDI ARABIA	Fossil fuels: ~99%, Renewables: <1%	Oil: ~60%, Nat. gas: ~38%, Renewables: <2%	Centralized under Vision 2030 and SGI	Top-down coordination; massive investment in clean energy	Low public engagement; lack of transparency; fossil dependency	2060 (net-zero goal)	Energy efficiency and hydrogen strategy	Government-led; limited civic participation	No carbon tax; alternative mechanisms like Circular Carbon Economy promoted
CHINA	Coal: ~53%, Renewables: ~44% (Hydro: 13%, Wind: 10%, Solar: 8%, Nuclear: 4%)	Coal: 57%, Oil: 19%, Renewables: 14%, Nat. gas: 8%, Nuclear: 2%	Centralized; led by Ministry of Ecology and Environment	Rapid mobilization; target achievement; global industrial leadership	Coal dependence; limited civic participation; policy rigidity	Carbon neutrality by 2060, peak by 2030	CETS, Five-Year Plans, '1+N' Framework	Top-down with growing public awareness	No carbon tax; operates national ETS covering power sector
NORWAY	~90% Hydropower, ~7% Wind, ~3% Other (bio/gas)	Oil: 40%, Gas: 27%, Renewables: 31% (mostly hydro + bioenergy)	Unitary system; cross-level coordination; Climate Change Act (2018); Climate Action Plan (2021); strong municipal role	High policy coherence; citizen trust; climate tech innovation	Export reliance on oil/gas; diffusion of responsibility	2050 (legally binding); 50–55% GHG reduction by 2030 vs. 1990	Carbon tax; participation in EU ETS; municipal climate budgeting; Enova programs; CCS strategy	High municipal capacity; participatory budgeting in Oslo; Sæmi protest over wind projects highlights need for just transition	Yes; CO ₂ tax ~€80/t (2024); covers oil, gas, transport; integrated with EU ETS
KAZAKHSTAN	Coal: ~66%, Gas: ~20%, Renewables: ~10%, Hydro: 4%	Coal: 50%, Oil: 26%, Nat. gas: 19%, Renewables: ~5%	Centralized; Ministry of Ecology and Natural Resources coordinates NDC	Strategic planning; international alignment via NDCs; growing awareness	Weak implementation; limited civic input; outdated bureaucracy	2060 (strategic objective, not legally binding)	National ETS, Green Economy Concept 2050, updated NDCs	Limited but growing; pilot projects for energy efficiency and renewables in schools and public buildings	No carbon tax; national ETS in place since 2013

Source: EIA (2024); Climate Action Tracker (2024); Government of Canada (2025); LowCarbonPower (2024); Ember (2025); IEA (2023, 2024); Saudi Green Initiative (2023); CarbonBrief (2024); Gallagher et al. (2019); Norwegian Ministry of Climate and Environment (2021); Falck (2023); OECD (2022); UNFCCC (2023); Ministry of Ecology Kazakhstan (2024); EBRD (2023); World Bank (2022, 2023a, 2023b).

To move beyond country-by-country description, we evaluate each case against seven explicit criteria derived from this study's design: (C1) policy ambition & legal form; (C2) implementation capacity; (C3) multi-level coordination; (C4) subnational authority; (C5) participation & equity/justice; (C6) climate-finance mobilization & instruments; (C7) indicative outcomes (mitigation, adaptation, clean-energy deployment). Ratings below are qualitative (1-5) and are interpreted from evidence summarized in this manuscript and its cited sources; they serve as a comparative heuristic rather than a normative index.

Rating scale (for all tables/figures)

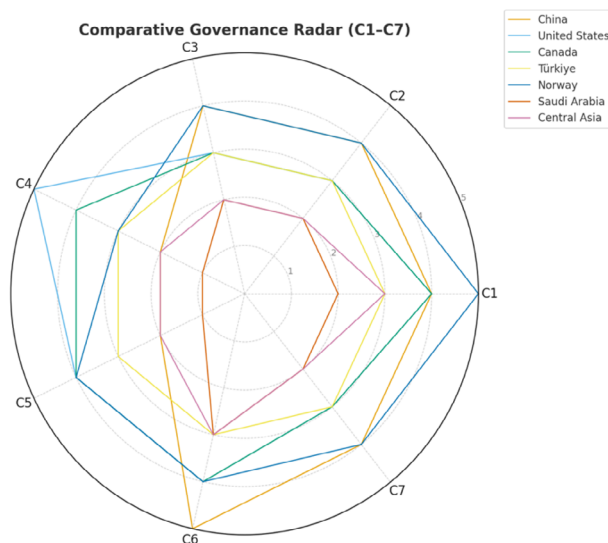
1 = very low; 2 = low; 3 = moderate; 4 = high; 5 = very high.

Table 2. Governance performance by criteria (qualitative ratings)

Country	C1 Policy ambition & legal form	C2 Implementation capacity	C3 Multi-level coordination	C4 Subnational authority	C5 Participation & equity	C6 Finance & instruments
China	4	4	4	2	2	5
United States	4	3	3	5	4	4
Canada	4	3	3	4	4	4
Türkiye	3	3	3	3	3	3
Norway	5	4	4	3	4	4
Saudi Arabia	2	2	2	1	1	3
Central Asian States	3	2	2	2	2	3

Based on sources: EIA (2024); Climate Action Tracker (2024); Government of Canada (2025); LowCarbonPower (2024); Ember (2025); IEA (2023, 2024); Saudi Green Initiative (2023); CarbonBrief (2024); Gallagher et al. (2019); Norwegian Ministry of Climate and Environment (2021); Falck (2023); OECD (2022); UNFCCC (2023); Ministry of Ecology Kazakhstan (2024); EBRD (2023); World Bank (2022, 2023a, 2023b).

Notes: China's strong plan-led ambition, national ETS and state investment (C1,C6) co-exist with limited civic participation and weak local discretion (C4,C5); U.S./Canada exhibit high subnational authority and participation (C4,C5) but coordination frictions and policy volatility (C2,C3); Türkiye transitions toward a hybrid model (balanced 3s); Norway shows high ambition and municipal roles yet faces responsibility diffusion and export contradictions; Saudi Arabia remains top-down with incremental efficiency and early-stage instruments.

Figure 1. Comparative governance radar (C1-C7). Ratings are qualitative (1-5) across seven criteria for six country cases and Central Asia.

Based on sources: EIA (2024); Climate Action Tracker (2024); Government of Canada (2025); LowCarbonPower (2024); Ember (2025); IEA (2023, 2024); Saudi Green Initiative (2023); CarbonBrief (2024); Gallagher et al. (2019); Norwegian Ministry of Climate and Environment (2021); Falck (2023); OECD (2022); UNFCCC (2023); Ministry of Ecology Kazakhstan (2024); EBRD (2023); World Bank (2022, 2023a, 2023b).

Centralized models (China; Saudi Arabia)

Centralized systems like China demonstrate the capacity for rapid policy mobilization and large-scale investment in clean energy. China's early achievement of its 2030 renewable targets and continued leadership in solar and wind capacity highlight the advantages of top-down coordination (Xue & Poon, 2024). However, the absence of national climate legislation, ongoing coal reliance, and limited civic participation undermine the legitimacy and inclusiveness of its transition (Feng et al., 2023).

China's centralized model enables coherent targets ("30-60"), rapid scaling of renewables, and a national ETS, reflected in high C1/C6 scores. Coordination is vertically enforced through target decomposition (high C3) and strong administrative capacity (high C2). However, limited civic participation and restricted local discretion (low C4/C5) constrain transparency and policy learning, while coal dependence complicates outcomes despite clean-energy surges (C7 = 4).

Saudi Arabia's central steering delivers defined strategies and efficiency programs, but implementation remains pilot-heavy, with low transparency and minimal civil society engagement (C2, C5 = low). Finance mobilization is rising yet narrowly focused (C6 = 3), and outcomes lag (C7 = 2).

Synthesis - centralized strengths & risks. Strengths: uniform rules, capital mobilization at scale, fast execution (C1/C2/C6). Risks: information bottlenecks, lock-in, and weak accountability where civic participation is limited (C4/C5).

Decentralized models (United States; Canada)

In systems such as Canada and the United States, subnational leadership, civil society mobilization, and public accountability are pivotal drivers of progress. Provinces like British Columbia and Quebec, and states like California and New York, have pioneered ambitious climate initiatives from carbon pricing to renewable mandates, often exceeding national ambitions. However, these gains are frequently offset by federal inconsistencies, jurisdictional fragmentation, and partisan divides, which challenge long-term coherence. For example, the recent revocation of California's emissions waiver by the U.S. Senate in 2025 (San Francisco Chronicle, 2025) demonstrates the fragility of subnational climate autonomy under shifting federal leadership.

In the **United States**, strong subnational authority creates policy laboratories (California/New York), high participation and innovation (C4/C5 = high). Yet federal-state contestation and policy volatility depress implementation coherence (C2/C3 = 3). IRA-era finance is significant (C6 = 4) but subject to political risk; outcomes are uneven across states (C7 = 3).

Provincial autonomy in **Canada** fosters tailored policy mixes and Indigenous energy leadership (C4/C5 = 4), but intergovernmental frictions and sectoral dependence complicate coordination and implementation (C2/C3 = 3). Finance and instruments (pricing, standards, credits) are substantial (C6 = 4), while outcomes vary by province (C7 = 3).

Synthesis - decentralized strengths & risks. Strengths: contextual innovation, legitimacy, diffusion of best practice. Risks: fragmentation, inconsistent national trajectories, and exposure to partisan cycles.

Polycentric/hybrid models (Türkiye; Norway)

Türkiye has gradually introduced climate legislation, multistakeholder institutions, and net-zero targets by 2053. Its urban innovation hubs, notably Istanbul and Izmir, demonstrate subnational leadership in transport decarbonization, energy efficiency, and climate neutrality planning (Izmir Metropolitan Municipality, 2023). While coordination and legal mandates remain partial, Türkiye's trajectory illustrates how transitional regimes can incrementally embed climate governance within national development frameworks. Institutional reforms (MEUCC elevation, Climate Council, 2053 net-zero) and urban pilots (Istanbul, Izmir) signal hybridization; yet mandates, funding certainty, and legal integration remain partial (balanced 3s across criteria). This trajectory illustrates sequenced decentralization under national guardrails.

Norway's high ambition and strong municipal roles yield solid implementation and coordination (C2/C3/C7 = 4-5). However, responsibility diffusion and export-led fossil dependence complicate global alignment. This underscores that polycentric strength can be tempered by structural contradictions.

Synthesis - polycentric strengths & risks. Strengths: structured discretion, deliberate coordination forums, learning networks, and equity mechanisms. Risks: coordination costs and diluted accountability if responsibility is spread too widely.

Cross-cutting patterns show that no single model dominates: effective systems blend national coherence (C1/C2/C3) with empowered local experimentation and participation (C4/C5). Finance is necessary but not sufficient: high C6 improves deployment, but C4/C5 shapes legitimacy and persistence. Trade-offs are model-specific: centralized coherence vs. innovation; decentralized innovation vs. fragmentation; polycentric learning vs. diffusion of responsibility.

Implications for Central Asia

Across cases, findings reinforce that centralized models can offer regulatory uniformity, efficient capital deployment, and administrative clarity, especially where institutional capacity is high. However, such models are also vulnerable to bureaucratic rigidity, elite capture, and limited feedback mechanisms. Conversely, fragmented or decentralized systems foster contextual innovation and greater public legitimacy, but often struggle with coordination, scale, and inconsistency (Cole, 2011; Rabe, 2011).

For Central Asia, where governance is highly centralized, capacities are uneven, and civic space is limited, the most credible near-term pathway is a hybrid configuration:

- National guardrails: statutory targets; unified MRV; ring-fenced transition funds (C1/C2/C6).
- Structured subnational pilots: legally authorized municipal/provincial programs with devolved budgets (C4).
- Institutionalized participation: standing forums with civil society, youth, Indigenous/traditional communities; just-transition compacts (C5).
- Meta-coordination: an intergovernmental platform to scale successful pilots and prevent fragmentation (C3).

This aligns global commitments with place-based implementation and builds legitimacy critical for durable outcomes

Table 3. Model-level strengths, risks, and design responses

Model	Core strengths	Core risks	Design responses for the CA region
Centralized	Coherence; speed; capital scale	Rigidity; weak feedback; lock-in	Add formal participation; publish MRV; pilot windows under national plans
Decentralized	Innovation; legitimacy	Fragmentation; uneven capacity	National floor standards; equalization funds; interprovincial learning
Polycentric/Hybrid	Learning; resilience; equity instruments	Coordination cost; diffuse accountability	Meta-governance body; time-bound mandates; clear escalation rules

Based on sources: EIA (2024); Climate Action Tracker (2024); Government of Canada (2025); LowCarbonPower (2024); Ember (2025); IEA (2023, 2024); Saudi Green Initiative (2023); CarbonBrief (2024); Gallagher et al. (2019); Norwegian Ministry of Climate and Environment (2021); Falck (2023); OECD (2022); UNFCCC (2023); Ministry of Ecology Kazakhstan (2024); EBRD (2023); World Bank (2022, 2023a, 2023b).

CONCLUSION

This study compared centralized, decentralized, and polycentric governance models across six countries and drew lessons for Central Asia, a region where climate governance remains highly centralized but increasingly subject to external and internal pressures. The comparative analysis shows that no single model is universally superior; rather, each offers distinct strengths and risks that can inform the design of more adaptive and legitimate systems in transitional contexts.

Centralized models, as in China and Saudi Arabia, demonstrate how uniform national targets and strong state financing can mobilize large-scale transformation. For Central Asia, such coherence is valuable, but without mechanisms for transparency and feedback, it risks locking in fossil-fuel dependence and suppressing innovation. Decentralized models, exemplified by Canada and the United States, highlight the power of subnational experimentation and stakeholder engagement, yet also reveal the dangers of fragmentation and political volatility, findings that align with multi-level governance theory, which emphasizes both the potential and pitfalls of devolved authority. Polycentric or hybrid models, visible in Türkiye and Norway, show that structured discretion, multi-level learning, and civic participation can balance national coordination with local initiative, consistent with polycentric governance theory that highlights experimentation and cross-level feedback. Legitimacy and justice are decisive, supporting scholarship that emphasizes procedural and social justice as conditions for policy durability. Importantly, the concept of climate governance itself is founded on broad community and societal participation, where state action is complemented by the engagement of citizens, NGOs, and local institutions. For Central Asia, this underscores that climate strategies cannot succeed through state mandates alone. Building participatory mechanisms such as structured consultations, just-transition compacts, and stakeholder forums should be seen not as optional add-ons but as core requirements of effective governance.

Across all models, three cross-cutting findings are particularly relevant for Central Asia. First, finance is necessary but not sufficient: Kazakhstan's ETS and donor-funded renewable projects demonstrate that investment must be paired with accountability and inclusion, echoing theories of distributive justice in climate governance. Second, regional cooperation is indispensable, reinforcing insights from multi-level and

transnational governance scholarship that coordination across borders is essential for effectiveness. Legitimacy and justice are decisive, supporting scholarship that emphasizes procedural and social justice as conditions for policy durability.

Taken together, these insights suggest that the most credible future for Central Asian states lies in a hybrid pathway: firm national guardrails and financing mechanisms; structured subnational pilots with devolved budgets; institutionalized stakeholder forums; transparent monitoring, reporting, and verification; and coordinated regional platforms for water and energy governance. Such an approach blends the coherence of centralized systems, the innovation of decentralized experiments, and the resilience of polycentric networks.

By situating Central Asia within global debates on climate governance design, this study both enriches comparative scholarship and highlights the urgency of context-sensitive pathways. Climate risks in the region, ranging from water scarcity to energy insecurity, are intensifying faster than global averages. Whether Central Asia can move from fragmented, donor-dependent governance toward inclusive, adaptive, and resilient systems will be a defining question for both regional sustainability and global climate cooperation.

For policymakers in Central Asia, the authors suggest that effective climate governance requires embedding polycentric features, stakeholder forums, subnational pilots, and just-transition strategies within existing centralized systems. International donors should support these efforts not only with finance but also with capacity-building for participation and monitoring.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTIONS

Both authors contributed to the design, writing of the manuscript, reviewed and approved the final version of the manuscript. SI: methodology, writing–review and editing, funding acquisition. RF: conceptualization, investigation, data curation, writing–original draft, visualization, formal analysis.

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REFERENCES:

1. Aberley, D. (1999). Interpreting bioregionalism: A story from many voices. In M. V. McGinnis (Ed.), *Bioregionalism* (pp. 13-42). Routledge.
2. Alberta Electric System Operator. (2023). Alberta's power system in transition. <https://www.aeso.ca/future-of-electricity/albertas-power-system-in-transition>
3. Asselt, H. van, & Zelli, F. (2013). Connect the dots: Managing the fragmentation of global climate governance. *Environmental Economics and Policy Studies*, 15(4), 409-430. <https://doi.org/10.1007/s10018-013-0060-z>
4. Bache, I., & Flinders, M. (2004). *Multi-level governance*. Oxford University Press.
5. Bauer, S., Busch, P.-O., & Siebenhüner, B. (2007). Administering international governance: What role for treaty secretariats? *Global Governance*, 13(1), 23-36.
6. BC Hydro. (2023). Our clean system. <https://www.bchydro.com/toolbar/about/sustainability/our-clean-system.html>
7. Bednar, J. (2008). *The robust federation: Principles of design*. Cambridge University Press.
8. Bennett, N. J., & Satterfield, T. (2018). Environmental governance: A practical framework to guide design, evaluation, and analysis. *Conservation Letters*, 11(3), e12404. <https://doi.org/10.1111/conl.12404>
9. Blue, G., & Dusyk, N. (2022a). Climate governance in Canada: Shifting power, structures, and ideas. *Canadian Journal of Political Science*, 55(1), 120-138.
10. Blue, G., & Dusyk, N. (2022b). Equity and inclusion in climate governance: The role of marginalized voices. *Global Environmental Politics*, 22(2), 45-66.
11. Bossuyt, F. (2023). The importance of boosting societal resilience in the fight against climate change in central Asia. In *Climate Change in Central Asia: Decarbonization, Energy Transition and Climate Policy* (pp. 149-159). Cham: Springer Nature Switzerland. <https://library.oapen.org/bitstream/handle/20.500.12657/63009/1/978-3-031-29831-8.pdf#page=149>
12. Boyd, D. R., & Rabe, B. G. (2019). Canada and the Kyoto Protocol: A cautionary tale. In B. G. Rabe (Ed.), *Can we price carbon?* (pp. 85-104). MIT Press.
13. Browne, K. (2022). Rethinking governance in international climate finance: Structural change and alternative approaches. *WIREs Climate Change*, 13(1), e795. <https://doi.org/10.1002/wcc.795>
14. Bulkeley, H., Andonova, L. B., Bäckstrand, K., Betsill, M., Compagnon, D., Duffy, R., Kolk, A., Hoffmann, M., Levy, D., Newell, P., Milledge, T., & Paterson, M. (2012). Governing climate change transnationally: Assessing the evidence from a database of sixty initiatives. *Environment and Planning C: Government and Policy*, 30(4), 591-612. <https://doi.org/10.1068/c11126>
15. Canada Energy Regulator. (2023a). Market snapshot: Indigenous ownership of Canadian renewable energy projects is growing. <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2023/market-snapshot-indigenous-ownership-canadian-renewable-energy-projects-growing.html>
16. Canada Energy Regulator. (2023b). Provincial and territorial energy profiles - Alberta. <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-alberta.html>
17. Carlson, A. E. (2009). Iterative federalism and climate change. *Northwestern University Law Review*, 103(3), 1097-1161.
18. Carnegie Endowment. (2023). Climate activism and civil society in the MENA region. <https://carnegieendowment.org>
19. Catherine, P., & Sébastien, J. (2015). Acting on climate change: Solutions from 60 Canadian scholars.
20. Challe, S., Christopoulos, S., Kull, M., & Meuleman, L. (2018). Steering the poverty-environment nexus in Central Asia: A metagovernance analysis of the Poverty-Environment Initiative (PEI). *Development Policy Review*, 36(4), 409-431. <https://doi.org/10.1111/dpr.12237>
21. Chesler, A., Javeline, D., Peh, K., & Scogin, S. (2023). Is democracy the answer to intractable climate change? *Global Environmental Politics*, 23(4), 201-216. https://doi.org/10.1162/glep_a_00710
22. Climate Action Tracker. (2023). United States. <https://climateactiontracker.org/countries/usa/>
23. Climate Action Tracker. (2024). Norway - Policies & action. <https://climateactiontracker.org/countries/norway/policies-action/>
24. Cole, D. H. (2011). From global to polycentric climate governance. *Climate Law*, 2(3), 395-413.

25. Cui, L., Hunt, A., & Morley, B. (2021). The effectiveness of environmental spending in China and the environmental Kuznets curve. *Sustainability*, 13(21), 12141. <https://doi.org/10.3390/su132112141>
26. Demirci, B., & Karabulut Uçar, E. (2024). Role of public institutions and soft law in climate change governance after Paris Agreement: European Green Deal as a catalyst and the change in the administrative and legal set-ups in the case of Türkiye. *Ankara Avrupa Çalışmaları Dergisi*, 23(2), 229-259. <https://doi.org/10.32450/aacd.1491546>
27. Demirci, M., & Karabulut Uçar, S. (2024). Reconfiguring climate governance in Türkiye: Between centralization and local participation. *Turkish Journal of Climate Policy*, 5(1), 67-85.
28. Duff, D. G., Gignac, M., & Smith, C. (2007). Federal and provincial tax treatment of the clean energy sector in Canada: Policies and barriers. *Canadian Tax Journal*, 55(1), 1-63.
29. European Commission. (2024). Global greenhouse gas emissions: EDGAR Emissions Database for Global Atmospheric Research. https://edgar.jrc.ec.europa.eu/report_2024
30. Energy Information Administration (EIA). (2024). Norway: Country analysis. U.S. Energy Information Administration. <https://www.eia.gov/international/analysis/country/NOR>
31. Environmental Protection Agency (EPA). (2024). State climate policy tracker. U.S. Environmental Protection Agency. <https://www.epa.gov/statelocalenergy>
32. Falck, R. (2023). How politicians and the population attribute responsibility for climate change mitigation: No indication of a 'governance trap' in Norway. *Environmental Politics*, 32(1), 1-20. <https://doi.org/10.1080/09644016.2023.2274721>
33. Fauchald, O. K., & Gulbrandsen, L. H. (2023). Paradoxes of Norway's energy transition: Controversies and justice. *Climate Policy*, 23(2), 123-135.
34. Feng, K., et al. (2023). Emissions governance and public participation in China's carbon market evolution. *Environmental Policy Journal*, 45(3), 311-334.
35. Feng, R., Hu, L., Hu, X., & Fang, X. (2023). Knowledge gaps are making it harder to formulate national climate policies. *Proceedings of the National Academy of Sciences*, 120(23). <https://doi.org/10.1073/pnas.2218563120>
36. Gough, I. (2013). Climate change, social policy, and global governance. *Journal of International and Comparative Social Policy*, 29(3), 185-203. <https://doi.org/10.1080/21699763.2013.852128>
37. Government of Canada. (2025). Removing the consumer carbon price, effective April 1, 2025. Department of Finance Canada. <https://www.canada.ca/en/department-finance/news/2025/03/removing-the-consumer-carbon-price-effective-april-1-2025.html>
38. Gallagher, K. S., Zhang, F., Orvis, R., Rissman, J., & Liu, Q. (2019). Assessing the policy gaps for achieving China's climate targets in the Paris Agreement. *Nature Communications*, 10(1). <https://doi.org/10.1038/s41467-019-09159-0>
39. Harrison, K. (2023). Climate governance and federalism in Canada. In A. D. Jordan, R. O. Keohane, & E. Ostrom (Eds.), *Governing Climate Change: Polycentricity in Action?* (pp. 64-83). Cambridge University Press. <https://doi.org/10.1017/9781009249676.005>
40. Hey, E. (2006). International institutions and global environmental governance. *Proceedings of the ASIL Annual Meeting*, 100, 339-341. <https://doi.org/10.1017/S0272503700024538>
41. Hoffmann, M. J. (2011). Climate governance at the crossroads: Experimenting with a global response after Kyoto. Oxford University Press.
42. Hölscher, K., & Frantzeskaki, N. (2020). Climate governance and urban resilience. In N. Frantzeskaki (Ed.), *Research handbook on urban transitions* (pp. 17-38).
43. International Energy Agency (IEA). (2024). Norway: Energy mix. International Energy Agency. <https://www.iea.org/countries/norway>
44. International Energy Agency (IEA). (2024). World energy investment 2024. <https://www.iea.org/reports/world-energy-investment-2024>
45. International Energy Agency (IEA). (2023). Energy efficiency indicators for Saudi Arabia. <https://iea.org>
46. Inglesi-Lotz, R., Oosthuizen, A. M., Jumaniyazova, S., Kuziboev, B., & Liu, J. (2024). Exploring the impact of women governance on CO₂ emissions in the European Union and Central Asia. *International Journal of Energy Economics and Policy*, 14(3), 639-646. <https://econjournals.com/index.php/ijee/article/view/15933>
47. Intergovernmental Panel on Climate Change (IPCC). (2022). Sixth Assessment Report. Intergovernmental Panel on Climate Change.

48. Intergovernmental Panel on Climate Change (IPCC). (2022). Climate change 2022: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the IPCC. Cambridge University Press.
49. Istanbul Metropolitan Municipality. (2023). Istanbul climate change action plan. https://cevre.ibb.istanbul/wp-content/uploads/2022/06/istanbul_climate_change_action_plan_v03.pdf
50. Izmir Metropolitan Municipality. (2023). 2030 Climate Neutrality Action Plan. https://netzerocities.app/_content/files/knowledge/4184/izmir_nzc_ccc_ok.pdf
51. Massachusetts Clean Energy Center. (2024). Net zero by 2050 roadmap. <https://www.masscec.com/net-zero>
52. Murombedzi, J., & Chikozho, C. (2023). Westphalian sovereignty and the free-rider conundrum in the atmospheric commons: Examining global governance regimes for addressing climate change adaptation. *International Journal of the Commons*, 17(1), 1-21. <https://doi.org/10.5334/ijc.1159>
53. Mirzabaev, A. (2023). Climate change research gaps in Central Asia: Towards a social science agenda. *Central Asian Journal of Environmental Science and Policy*, 1(2), 55-72.
54. New York State Energy Research and Development Authority (NYSERDA). (2024). Climate Act implementation updates. <https://www.nysedra.ny.gov/CLCPA>
55. North, D. C. (1990). Institutions, institutional change and economic performance. Cambridge University Press.
56. Norwegian Ministry of Climate and Environment. (2021). Norway's climate action plan for 2021-2030. <https://www.regjeringen.no/contentassets/a78ecf5ad2344fa5ae4a394412ef8975/en-gb/pdfs/stm202020210013000engpdfs.pdf>
57. Norwegian Petroleum Directorate. (2024). Exports of oil and gas. <https://www.norsketroleum.no/en/production-and-exports/exports-of-oil-and-gas>
58. Paavola, J. (2005). Seeking justice: International environmental governance and climate change. *Globalizations*, 2(3), 309-322. <https://doi.org/10.1080/14747730500367850>
59. Potvin, C., & Jodoin, S. (2015). Advancing Canada's climate policy through carbon pricing and regulations. *Policy Options*. <https://policyoptions.irpp.org>
60. Qi, Y., Stern, N., He, J.-K., Lu, J.-Q., Liu, T.-L., King, D., & Wu, T. (2020). The policy-driven peak and reduction of China's carbon emissions. *Advances in Climate Change Research*, 11(2), 65-71. <https://doi.org/10.1016/j.accre.2020.05.008>
61. Rahman, S., Alharthi, A., & Hossain, M. (2022). A critical temporal analysis of Saudi Arabia's initiatives for greenhouse gas emissions reduction in the energy sector. *Energy Reports*, 8, 1105-1118.
62. Rabe, B. G. (2011). Greenhouse governance: Addressing climate change in America. Brookings Institution Press.
63. Rabe, B. G. (2011). Contested federalism and American climate policy. *Publius: The Journal of Federalism*, 41(3), 494-521.
64. Ren, Y. (2022). Centralization or decentralization? The future of global climate governance. In *Proceedings of the 2021 International Conference on Social Development and Media Communication* (pp. 161-165). Atlantis Press. <https://www.atlantis-press.com/article/125968673.pdf>
65. Republic of Türkiye Ministry of Environment, Urbanization and Climate Change (MEUCC). (2021a). 2053 net sıfır emisyon hedefimize giden yolda uzun dönemli stratejimizi hazırlıyoruz [We are preparing our long-term strategy for the 2053 net zero emissions target]. <https://iklim.gov.tr/2053-net-sifir-emisyonhedefimize-giden-yolda-uzun-donemli-stratejimizi-hazirliyoruz-haber-33>
66. Republic of Türkiye Ministry of Environment, Urbanization and Climate Change (MEUCC). (2022). Güncellenmiş birinci ulusal katkı beyanı sunuldu [Updated first nationally determined contribution submitted]. <https://www.iklim.gov.tr/guncellenmis-birinci-ulusal-katki-beyani-sunuldu-haber-1139>
67. Republic of Türkiye Ministry of Trade. (2021). Turkey Green Deal Action Plan. <https://ticaret.gov.tr/data/60f1200013b876eb28421b23/MUTABAKAT%20YE%C5%9E%C4%B0L.pdf>
68. Reuters. (2025, January 2). In Norway, nearly all new cars sold in 2024 were fully electric. Reuters. <https://www.reuters.com/business/autos-transportation/norway-nearly-all-new-cars-sold-2024-were-fully-electric-2025-01-02/>
69. Rivers, N., & Jaccard, M. (2005). Canada's efforts towards greenhouse gas emission reduction: a case study on the limits of voluntary action and subsidies. *International journal of global energy issues*, 23(4), 307-323.

70. Sabyrbekov, R., Overland, I., & Vakulchuk, R. (2023). Climate change in Central Asia: Decarbonization, energy transition and climate policy (p. 170). Springer Nature.
71. San Francisco Chronicle. (2025, May 22). The Senate just gutted California's signature climate change policy. San Francisco Chronicle. <https://www.sfchronicle.com/politics/article/california-electric-vehicle-mandate-revoke-senate-20339272.php>
72. Saudi Green Initiative (SGI). (2023). Carbon capture projects and emission goals. <https://www.sgi.gov.sa>
73. Saudi Vision 2030. (2023). National Renewable Energy Program: Project status and goals. <https://www.vision2030.gov.sa>
74. Scott, D., Lemphers, N., & MacNeil, R. (2023). Decentralization and climate governance: Learning from Canadian provincial innovation. *Environmental Politics*, 32(3), 379-402.
75. Scott, W. A., Rhodes, E., & Hoicka, C. (2023). Multi-level climate governance: Examining impacts and interactions between national and sub-national emissions mitigation policy mixes in Canada. *Climate Policy*, 23(8), 1004-1018. <https://doi.org/10.1080/14693062.2023.2185586>
76. Skalamera, M. (2024). The varying levels of contrasting adaptation in Central Asia's climate change politics. *Central Asian Survey*, 44(1), 85-104. <https://doi.org/10.1080/02634937.2024.2373086>
77. Tskhay, A. (2023). Emerging polycentric governance in Central Asia: The role of local communities and eco-entrepreneurs. *Journal of Environmental Policy & Planning*, 25(4), 621-638.
78. The Verge. (2025, May 22). Senate Republicans vote to revoke California's right to set its own tailpipe pollution rules. The Verge. <https://www.theverge.com/news/672092/senate-republican-vote-car-truck-pollution-ev-waiver-california>
79. U.S. Department of Energy. (2022). Inflation Reduction Act of 2022. <https://www.energy.gov/lpo/inflation-reduction-act-2022>
80. U.S. Energy Information Administration (EIA). (2024). State energy profiles. <https://www.eia.gov/state/>
81. UNDP. (2025). Tackling climate misinformation and disinformation. United Nations Development Programme. <https://climatepromise.undp.org>
82. Vakulchuk, R., Daloz, A. S., Overland, I., Sagbakken, H. F., & Standal, K. (2023). A void in Central Asia research: climate change. *Central Asian Survey*, 42(1), 1-20.
83. Vox. (2025, May 23). The GOP says states' rights matter - unless it's California. Vox. <https://www.vox.com/climate/414243/senate-california-electric-vehicles-gas-car-ban-repeal>
84. Washington Post. (2025, May 23). Clean energy cash gushing into red states puts GOP senators in a bind. Washington Post. <https://www.washingtonpost.com/business/2025/05/23/senate-clean-energy-tax-credits/>
85. Winter, J. (2024). Exploring the landscape of Canadian climate policy. *Canadian Public Policy*, 50(S1), 73-102.
86. Winter, J. (2024). The evolution of climate policy instruments in Canada: Political economy, federalism, and institutional design. *Energy Policy*, 180, 113728.
87. World Bank. (2022). Kazakhstan: Country climate and development report. Washington, DC: World Bank. <https://openknowledge.worldbank.org/handle/10986/38190>
88. World Bank. (2022). Administrative decentralization and climate change: Concepts, experiences, and opportunities. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099040001252284476/p1725690d761df0fa08f5e0c9bd504c19ae>
89. World Bank. (2023). CO₂ emissions (metric tons per capita). World Development Indicators. <https://data.worldbank.org/indicator/EN.ATM.CO2E.PC>
90. World Bank. (2023a). Climate and development report for Central Asia. Washington, DC: World Bank. <https://openknowledge.worldbank.org/handle/10986/40384>
91. World Bank. (2023b). Europe and Central Asia economic update: Coping with shocks, adapting to climate change. Washington, DC: World Bank. <https://openknowledge.worldbank.org/handle/10986/39761>
92. World Nuclear News. (2024). Nuclear at heart of Ontario growth plans. <https://www.world-nuclear-news.org/Articles/Nuclear-at-heart-of-Ontario-growth-plans>
93. Wu, S. (2023). A systematic review of climate policies in China: Evolution, effectiveness, and challenges. *Environmental Impact Assessment Review*, 99, 107030. <https://doi.org/10.1016/j.eiar.2022.107030>
94. Wu, Y. (2023). Climate centralism in China: Innovation with limited civic engagement. *Climate Governance Review*, 12(2), 145-169.

95. Wu, Z., Huang, X., Chen, R., Mao, X., & Qi, X. (2022). The United States and China on the paths and policies to carbon neutrality. *Journal of Environmental Management*, 320, 115785. <https://doi.org/10.1016/j.jenvman.2022.115785>
96. Xue, J., & Poon, J. P. H. (2024). Transition of China's global energy investment: Decarbonization, dispersion and denationalization. *Transactions in Energy and Sustainability*, 1(1), 5-23. <https://doi.org/10.1177/29768632241293400>
97. Zurba, M., et al. (2021). Indigenous climate leadership in Canada: Bridging governance gaps through self-determination and place-based knowledge. *Climate Policy*, 21(4), 478-494.