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Review Article

Contextual factors for effective climate policies in the energy sector: a systematic review of entry points

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ABSTRACT

Background: The effectiveness of climate policies in the energy sector depends on contextual factors specific to the implementing region. Understanding which contextual factors co-occur with policies supporting the energy sector transition towards climate neutrality is central to determining promising policy interventions in regions with similar characteristics.

Methods: We conduct a machine learning-assisted systematic literature review to answer the following question: which combinations of effective policy interventions and contextual factors are identified in the empirical literature as contributing to the deployment of mitigation technologies or transitioning away from fossil fuels? These combinations of contextual factors and effective policy interventions are distinct opportunities for change, and thus entry points for a transition to climate neutrality. Our review exclusively covers studies that conduct an ex-post evaluation of climate policies in the energy sector and are published after the decision on the Paris Agreement in 2015.

Results: We find that the three enabling contextual factors most frequently cited by the literature are institutional capacity (institutional feasibility), interest group support (social feasibility), and market structure (economic feasibility). Overall, the majority of enabling contextual factors identified in the literature relate to 'economic feasibility'. Further, we identify distinct regional groups that share similar entry points supporting the transition in the energy sector. Our findings offer actionable guidance for policy makers seeking feasible energy transition pathways in their national context.

Key policy insights

- Climate policy effectiveness in the energy sector varies systematically across regional contexts: institutional capacity, interest group support, and market structure are the key contextual factors shaping effective policy intervention.
- We identify five regional groups for renewable deployment: in developed economies, (i) advanced financial markets use portfolio standards and market certificates; (ii) institutional capacity and policy continuity contexts use FiTs and state loans; (iii) local governance contexts enable regulatory streamlining. In emerging economies, (iv) strong state control contexts use FiTs, auctions, subsidies, and state investment; (v) cost-driven regions use auctions and risk-sharing to meet rising energy demand.
- For transitioning away from coal: (i) institution-based transitions use stakeholder commissions and retirement premiums; (ii) market-driven exits rely on substitution and regulatory pressure; (iii) financially constrained contexts depend on international climate finance.

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1 . Introduction

More than ten years after agreeing on the goal to limit global warming to 1.5 °C in the Paris Climate Agreement, there remains a significant gap between climate policy ambition and real-world implementation. Whether a climate policy is implemented and effectively influences the deployment of climate mitigation technologies in a given jurisdiction varies depending on various contexts.

In economic literature, carbon pricing is viewed as the most economically efficient and thus the first-best solution to tackle climate change-related externalities (Bennear & Stavins, 2007). However, contextual factors, also described as country characteristics, can significantly influence the likelihood of climate policy implementation (Jewell et al., 2019) and policy outcomes (Döbbeling-Hildebrandt et al., 2024; Jakob et al., 2020).[1] For example, political economy factors (e.g. lobbying, seeking loopholes, crowding in/out, vested interests) can constrain the implementation of stringent carbon prices required to achieve emission reductions in line with the 1.5 °C goal. Indeed, the use of multiple policy instruments can result in superior outcomes in practice, leading to a so-called second-best world (Jenkins, 2014). Empirical evidence suggests that the majority (70%) of climate policies are effective as a combination of two or more policies, and carbon taxation belongs to the few exceptions that cause large emission breaks as a single policy instrument (Stechemesser et al., 2024). Several strands of literature study contextual factors, effective policies, and the feasibility of transformation pathways towards the implementation of the Paris goals.

First, feasibility research aims to develop analytical tools to assess the feasibility of long-term mitigation scenarios aligned with the goals of the Paris Agreement, as presented in the latest IPCC reports. Brutschin et al. (2021) provide a multidimensional feasibility evaluation of low carbon scenarios. They argue that the implementation of mitigation scenarios depends on five dimensions: (1) Geophysical feasibility, (2) Economic feasibility, (3) Technological feasibility, (4) Socio-cultural feasibility, and (5) Institutional feasibility. Steg et al. (2022) derive from existing literature and reviews whether key indicators along these dimensions tend to be enablers or barriers for the implementation of specific mitigation options.[2] For example, they find that 'costs in 2030 and the long term' are enablers for the economic feasibility of solar energy universally. In contrast, 'Distributional effects' may have both enabling or hindering effects on the socio-cultural feasibility of solar energy deployment, depending on the context. Steg et al. (2022) thus provide an overview of relevant enablers and barriers for implementation, while they do not focus on additional country-specific contextual factors that lead to the indicators playing out as either an enabler or a barrier, nor do they analyse underlying policies, as this is not the focus of this strand of literature.

A second strand of research concerns successful or good practice policies. Beyond single-country cases (Lu et al., 2020; Thapar et al., 2016), several review studies have emerged. Abdmouleh et al. (2015) provide a review of the most relevant publications, reports, and scientific articles dealing with policies encouraging renewable energy integration. They provide an overview of successful and failed policy cases in Australia, China, Europe and Nepal, categorizing important policy design factors. Fekete et al. (2021) conduct a review of successful climate change mitigation policies in five major emitting economies for the electricity generation and further sectors. They translate these policies into quantifiable indicators that are then used for scenario analysis. A central grey literature source for climate policies is the Climate Policy Database[3] (NewClimate Institute et al., 2024), which covers more than 6,000 climate policies spanning 198 countries and 6 sectors. This source provides valuable details on high-impact climate policies or policy mixes but does not include detailed information on contextual factors enabling good practice policy cases.

Third, empirical case studies highlight country-specific contextual factors relevant for deployment or phase-out of specific technologies. For instance, Jakob et al. (2020) propose a generalized framework suited for organizing political economy contextual factors of climate and energy policy – the AOC (actors, objectives, context) framework. Through detailed qualitative interviews, they identify (i) the relevant actors, (ii) their objectives, and (iii) the context, determining how certain objectives matter for each actor and how these actors can influence policy formulation. Steckel and Jakob (2022) provide recommendations to transition towards a coal phaseout in different country groups, based on their interview-based study of 15 country case studies using the AOC framework. Ohlendorf et al. (2022) provide actors, objectives, arguments, and contextual factors influencing coal-sector developments in eight countries based on expert interviews. However, while these broader comparative frameworks valuably capture countries across different stages of coal transition, those that have successfully committed to or achieved a phase-out are grouped into the single category 'phase-out country group', without distinguishing generalizable sub-groups that share common contextual factors. This limits differentiation among the distinct policy strategies and contextual factors that drive effective transitions.

Our literature review addresses a critical gap in the literature by synthesizing empirical evidence on the co-occurrence of effective policy interventions and contextual factors from different strands of literature in a systematic way. The limited existing synthesis research on climate policy that accounts for contextual factors and policies tends to either have a narrow focus on one technology (Abdmouleh et al., 2015; Diluiso et al., 2021) or one region (Bhatia, 2023). In addition, we add to the literature by differentiating and categorizing different combinations of contextual factors and policy instruments that have shown effectiveness for the energy sector transition.

Our research question is: which combinations of effective policy interventions and contextual factors are identified in the empirical literature as contributing to the deployment of mitigation technologies or transitioning away from fossil fuels in the energy sector? We refer to the alignment between an effective climate policy and its enabling context as an '*entry point*' (see Figure 1). For the categorization and further analysis of policy interventions, enablers, and further contextual factors, we build on analytical concepts from Brutschin et al. (2021) and Jakob et al. (2020). We conduct a machine-learning assisted systematic literature review to synthesize relevant literature on all countries and energy sector technologies published since 2015. The empirical cases are then grouped by common combinations of effective policy interventions and contextual factors, revealing key entry points that can serve as examples and offer valuable insights.

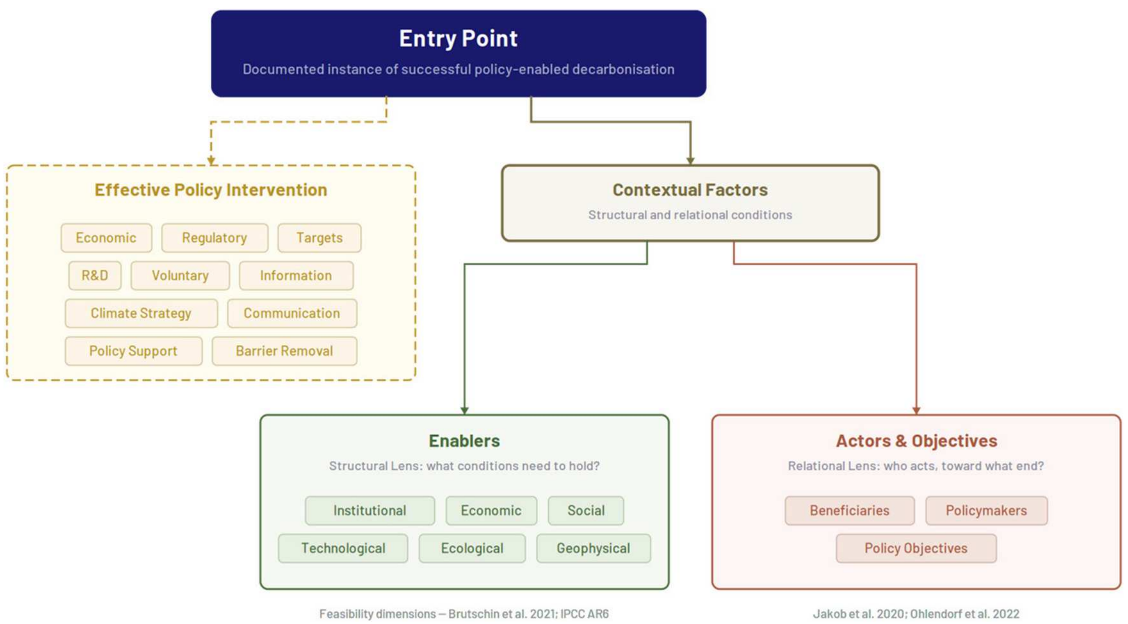

Figure 1. Concept overview. We classify policy instruments following the taxonomy of the Climate Policy Database (NewClimate Institute et al., 2024), which itself builds on the IEA Policies and Measures database (IEA, 2024). The classification scheme includes the following categories: (1) Economic Instruments, (2) Regulatory Instruments, (3) Information and Education, (4) Policy Support, (5) Research, Development and Demonstration, (6) Voluntary approaches, (7) Barrier removal, (8) Climate strategy, and (9) Target. We analyse contextual factors through two lenses: a structural lens, identifying country-level conditions that enable or constrain climate change mitigation, and a relational lens. Since we focus exclusively on good practice cases, all conditions are framed as enablers, including cases where a policy removes a prior barrier (e.g. fossil fuel subsidy removal is framed as an economic enabler for renewable deployment). Building on the analytical framework by Brutschin et al. (2021) and Steg et al. (2022), we categorize the enablers we find using the feasibility dimensions. Second, the structural lens identifies who acts and towards what end. We thus extract and analyse additional information on relevant actors in the policy-making process and their objectives, as proposed by the AOC ('Actors, Objectives, Context') framework (Jakob et al., 2020).

This systematic literature review provides a global synthesis of entry points for renewable energy deployment and transitioning away from fossil fuels. Through thematic coding and typological analysis, we identify distinct regional groups of effective policy intervention and their respective regional contextual factors, demonstrating that context-specific configurations of policy instruments can drive technology change. Our findings offer actionable guidance for policy makers seeking feasible transition pathways in their national context, and provide an empirical basis for improving the representation of policy feasibility in integrated assessment models.

2 . Research method

We employ a machine learning-assisted systematic literature review to answer our primary research question. Our sample selection process in Figure OC 1 follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework developed by Moher et al. (2010).

To identify potentially relevant articles, we first developed a broad search string using the SPIDER framework as presented by Cooke et al. (2012) (see Table OA 1). We search the databases Scopus and Web of Science using the search string in Table OA 2 and filter for publication dates in or after 2015, the year of the decision on the Paris Climate Agreement. This yields a total of 7,997 unique, potentially relevant articles. In a next step, we refine the screening for articles relevant to the research question and scope of this review. The identified articles are selected for their eligibility subject to the following inclusion criteria:

1. Study includes an effective climate policy intervention regarding the expansion of renewable energy or the transition away from fossil fuels;[4]
2. Study analyses contextual factors for the policy intervention or context-specific barriers that the policy intervention overcomes;
3. Study analyses technology deployment in the energy sector;
4. Study is not a single-method literature review; and
5. Study uses an empirical ex-post evaluation method (qualitative or quantitative).

To operationalize the screening for these criteria, we use a two-step process: A machine learning-assisted title and abstract screening followed by a human-only full paper screening. The screening at the title and abstract level is supported by an active learning algorithm, the language processing model DistilRoBERTa.[5] As the authors take a human-based decision on whether an article is likely to meet the inclusion criteria or not, the algorithm ranks remaining studies in order of relevance. Using a conservative stopping criterion through ranked quasi-sampling developed by Callaghan and Müller-Hansen (2020), we screen until we identify at least 90 percent of relevant articles with a level of confidence that is above 95 percent (the screening is stopped at a p value of 0.023[6]). Overall, we manually screen 2,924 article abstracts and titles, and 5,073 articles are excluded automatically by the active learning algorithm (see Figure OB 1). Of the screened articles, 207 are classified as potentially relevant. After a manual full paper screening, 58 articles are identified as relevant and extracted (see Table OB 1). Based on a detailed article assessment, we code the central elements: geography, research method, enabler, further contextual factors, actors, objectives, and the effective policy intervention.

Building on coded features and their qualitative descriptions in the codebook, we identify recurring themes across entry points. We organize these into a property based typology following Collier et al. (2012) by setting governance scale and central enabler profile as the two properties. For both dimensions, we take first the coded features, their presence and relative frequency, and synthesize these against the qualitative descriptions to assign each entry point to a position in the typology. Further, using World Bank income classifications (Metreau et al., 2024), we distinguish between high-income and emerging or lower-income contexts within the same cell to surface how similar governance-enabler configurations play out differently across development levels (see Figure 3).

3 . Results

Building on the framework developed by Brutschin et al. (2021), we assign enablers to six feasibility dimensions, including ecological feasibility as proposed by Steg et al. (2022). The three enablers most frequently cited in the literature (see Figure 2) are institutional capacity (institutional feasibility), interest group support (social feasibility), and market structure (economic feasibility). Overall, most enablers identified in the literature fall within the economic and social feasibility categories, whereas geographical and ecological dimensions are mentioned less frequently.

Our analysis identifies eight distinct regional groups of similar entry points for renewable energy deployment and transitioning away from coal along the two dimensions: the dominant enabler type (economic and institutional) and the governance level of the primary actor (subnational, national, or international). A further distinction emerges between high-income and emerging and middle-income country contexts, reflecting differences in the structural context that centrally shapes the entry points (see Figure 3).

3.1 . Renewables: solar and wind

Technological advancements in solar and wind have consistently driven down risks and costs while increasing efficiency. This progress can be partially attributed to Germany's early adoption of renewable energy

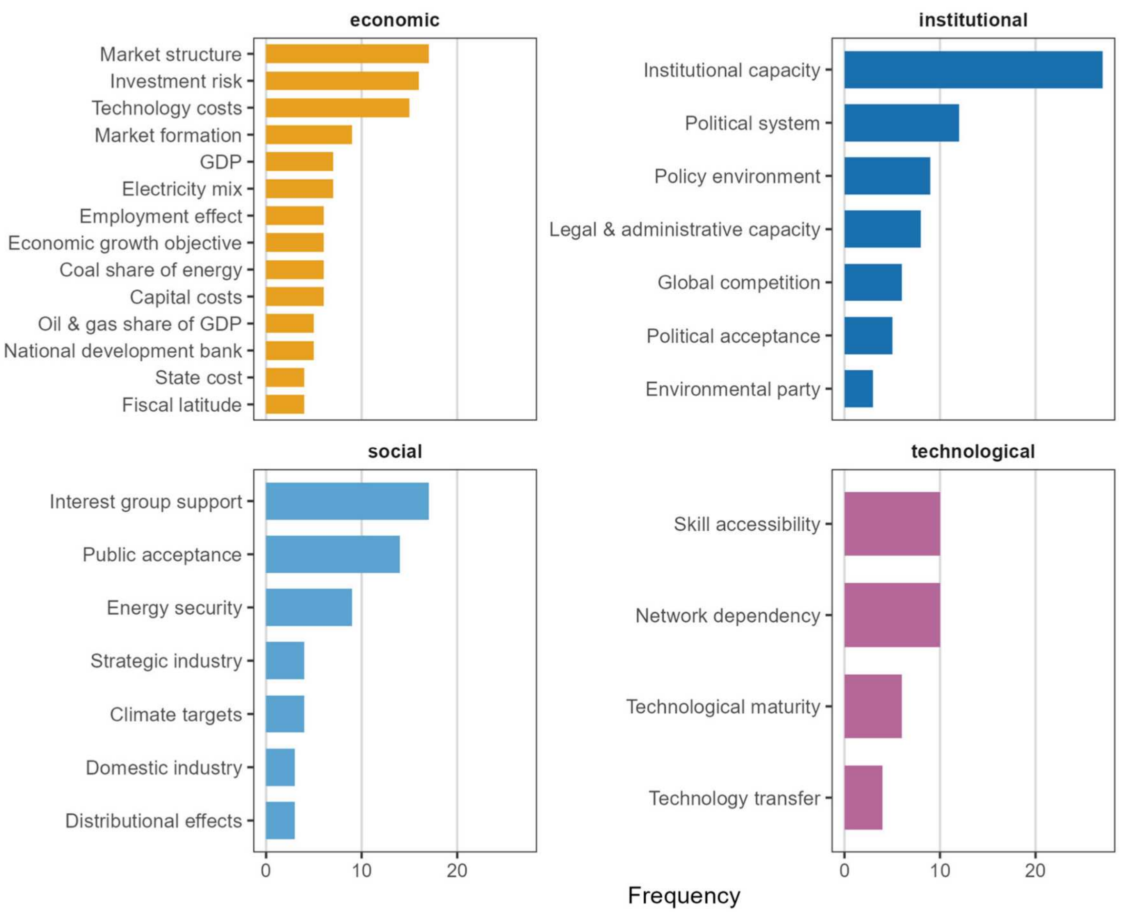

Figure 2. Overview of most frequent enablers. Note. The overview presents the most frequent enablers that are extracted from the literature at least four or more times and allocated to the feasibility dimension by the Steg et al. (2022) and Brutschin et al. (2021) framework. Categories omitted for readability: geophysical feasibility (resource availability, n = 9), ecological feasibility (health and wellbeing, n = 5, environmental impacts, n = 4). The presented technologies for the enabler overview include renewables and transitioning away from coal.

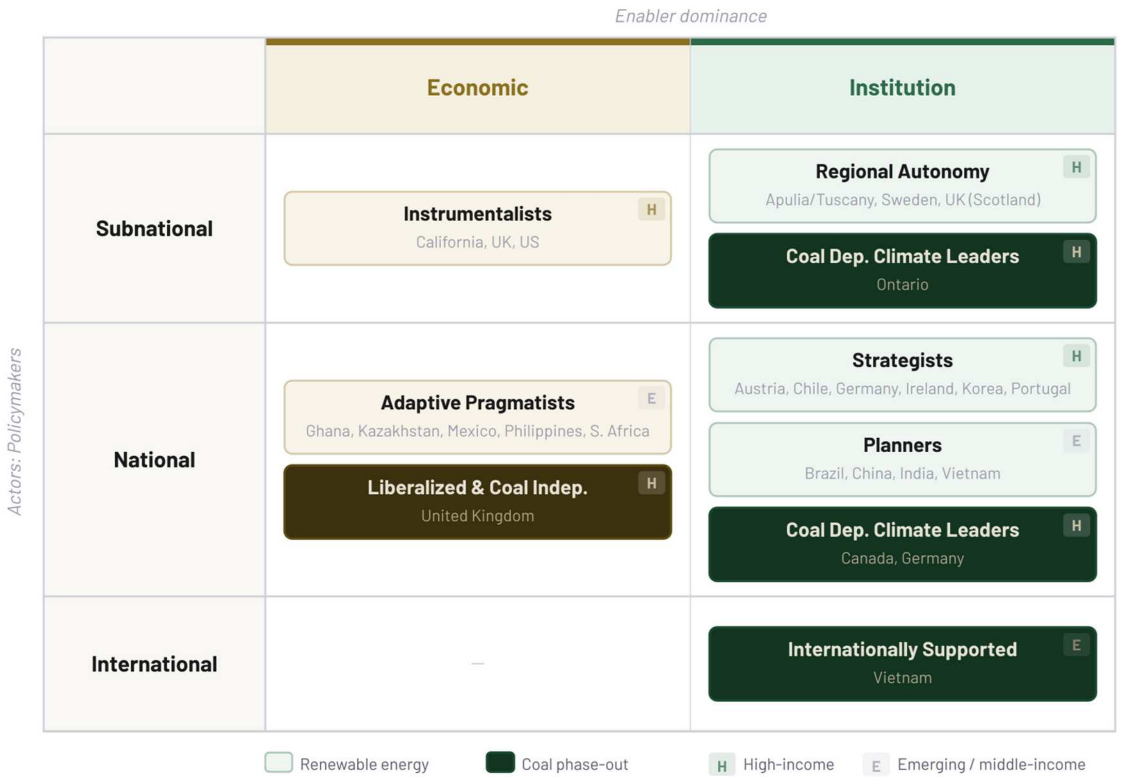

Figure 3. Regional groups of entry points.

technologies with its generous subsidy regime (Rechsteiner, 2020), which is later amplified by China's large-scale industrial policy efforts to boost renewable energy manufacturing, creating massive cost reductions in the technologies (Andrews-Speed, 2015; Dent, 2015).

Within the renewable technology deployment, we identify five distinct regional groups (see Figure 3 and Table 1). Three groups: Instrumentalists, Strategists and Regional Autonomy are primarily observed in high-income economies. The remaining two groups: Planners and Adaptive Pragmatists are associated with emerging and middle-income economies.

Among the first set of earlier forays into renewable energy (RE) policy are observed, with regions starting as early as the 1990s (Andrews-Speed, 2015; Rechsteiner, 2020; Shrimali et al., 2015). This is coupled with a larger set of entry points, reflecting the experimentation phases. Common enablers include high public acceptance and support for renewables, and a political environment that prioritizes environmentally friendly measures (see Table 1).

The regional group of **Instrumentalists** represents regions like the United Kingdom (UK), and the United States of America (USA). They are characterized by their liberal markets and use of economic as well as regulatory instruments (e.g. market certificates and sectoral standards) to incentivize renewables. Renewable portfolio standards (RPS) or similar quota-based systems are common effective policy interventions. In the USA, RPS policy is a main driver for renewables growth; they target state-run utilities and are amplified by federal support measures like production tax credits. Sophisticated financial markets enable tax credit policies to leverage financial actors for financing and risk reduction (Ameli et al., 2017; Zhang, 2023; Zhou & Solomon, 2020). The state of California tackles regulatory and entry barriers for homeowners, through a simplified approval process, resulting in increased residential solar installations (Hsu, 2018). The UK similarly has experimented with different measures leading to an initially technology neutral Renewable Obligation Certificate (ROC), which offers different levels of support based on technological maturity (Andrews-Speed, 2015), with later

Table 1. Central enablers and policy interventions by entry point type. The allocation of clusters in the selected articles is presented in Table OB1.

	Regional group	Central enablers	Central policy interventions
Renewables	**Instrumentalists** (e.g. California, UK, US)	• Financial market depth • Private capital mobilization • Investor risk absorption	• Renewable portfolio standards (supply-side) • Tax credits (supply-side) • Market certificates
	Strategists (e.g. Germany, Chile)	• Institutional capacity • Interest group support • Policy continuity	• Feed-in tariffs • Strategic planning • State loans
	Regional Autonomy *(e.g. Sweden,UK (Scotland))*	• Devolved governance authority • Local administrative capacity • Public acceptance	• Land-use consenting • Regulatory streamlining • Community energy projects
	Planners *(e.g. China, India)*	• State control of the energy sector, • Institutional capacity, • Energy security	• Feed-in tariffs • Auction based tenders • Production subsidies • Renewable energy targets • State investment
	Adaptive Pragmatists *(e.g. Mexico, South Africa)*	• Rising energy demand, • Limited institutional frameworks, • Cost reduction imperative	• Auction-based tenders • Risk-sharing mechanisms • Infrastructure investment
Coal	**Coal Dep. & Climate Leaders** *(Germany, Canada)*	• Interest group engagement, • Institutional capacity • International climate commitment, high coal dependence	• Stakeholder commissions • Retirement premiums • Fossil fuel subsidy removal
	Liberalized & Coal Independent *(UK)*	• Market-driven declining coal share • Fuel substitutability • Weak vested interest opposition	• National climate policy • EU regulatory pressure
	Internationally Supported *(Vietnam)*	• Limited domestic coal financing, • International political support, • Environmental impact concerns	• International financial support • Policy targets

evolutions including differentiation of ROC payment to different renewable energy technologies (Cowell et al., 2017).

Strategists are a collection of regions with advanced economies, strong institutional capacities and a strategic effort to boost renewable energy deployment at a federal level. They feature more multipronged political interventions via laws and programmes in addition to fiscally robust subsidy mechanisms. The most important interventions include Feed-in Tariffs (FiTs), which pay fixed rates for a long contract period, with procurement guarantees for producers (Strunz et al., 2016). The presence of a large network of smaller, heterogenous power producers is a key enabler allowing FiTs to have a wide impact. Interest group support and a long-term, stable policy strategy enable consistent progress in renewable energy deployment.

Germany is the archetypical example among this regional group. Its transition effort, known as 'Energiewende', demonstrates a long-term strategic effort to create an emissions-avoidance energy industry through a bottom-up technology-neutral FiT policy with long duration and high rates (Rechsteiner, 2020). Across German states, two influential factors for renewable energy deployment are the participation of the Green Party in the governments of wealthier states, and the modernization strategies adopted by states with high renewable energy potential but limited financial capacity (Wurster & Hagemann, 2019, 2018). The costs of German FiT policy are primarily passed along to consumers. Other members that are associated with this policy intervention include Austria, Chile, Ireland, Korea, and Portugal. In both the Portuguese case and the Austrian case, the costs for FiTs are not passed along to consumers, rendering the cost-effectiveness of the policy in question (Peña et al., 2017; Wurster & Hagemann, 2019).

The regional group of **Regional Autonomy** comprises a set of national and sub-national regions characterized by a devolved governance structure, like the United Kingdom (Scotland) and Sweden. In the UK, market support schemes remain reserved to the national level, while devolved administrations like Scotland control planning, consenting, and target-setting, creating distinct sub-national entry points. Local authorities have considerable power and accountability to locals, particularly when facing challenges related to wind power. The space-intensive characteristics of wind, along with its noise and visual pollution effects, can elicit opposition from locals. Gaining public support is essential for success (Cowell et al., 2017; De Laurentis & Pearson, 2021).

Policy interventions like land use consenting via public private agreements can increase fairness and equity in project planning and execution, mitigating local opposition to new projects. Emphasizing co-benefits of renewable energy deployment like employment and economic growth, through professional training and narrative construction, are found to boost public support (De Laurentis & Pearson, 2021; Giest, 2015).

The devolved governance structure allows for tailored policy interventions for the local context. Regulatory streamlining shows how local authorities can shape regulations to simplify the process and make it more specific. In the Scottish case, the One-Stop-Shop for wind energy simplified the approvals process. It is enabled by sustained political consensus and policy entrepreneurship. Existing industry expertise can also be of benefit, for instance, Scotland's offshore oil and gas industry enabled skill transfer into offshore wind (Cowell et al., 2017; O'Hanlon & Cummins, 2020).

Compared to the high-income types, emerging and middle-income economies show a later start of renewable energy policy interventions. **Planners** feature countries with a strong executive and extensive state involvement in the energy sector. These create an enabling framework of a concentrated market guided by the state, with high institutional capacity and interest group support. In contrast to strategists, planners rather follow a top-down approach to policymaking, with more direct interventions via state investments.

This is particularly true for China, where the state is involved in the energy sector and the supply chain for renewable energy (Dent, 2015; Gao & Yuan, 2020). Other members include Brazil, India, and Vietnam, with Vietnam currently making considerable progress in its solar photovoltaic (PV) deployment (Do et al., 2021, 2020).

The core policy interventions include a FiT system with generous price guarantees (no procurement guarantees) without passing the costs to consumers. Aside from FITs, Planner regions also incorporate auction based systems like in the case for Brasil and India (Costa et al., 2022; Shidore & Busby, 2019 ; Thapar et al., 2018). In China, this is complemented with renewable portfolio shares targeted at utilities companies, national development bank lending and state subsidies. These measures address investment risk, access to capital and coordinated market activity (Andrews-Speed, 2015; Dent, 2015; Gao & Yuan, 2020; Zhang, 2023, 2020). In Vietnam, FiTs are used on a shorter timescale along with higher rates for solar installations. In addition, regulatory interventions are made to enable easier land-leasing, private sector investment and grid connection.

Adaptive Pragmatists describe a set of regions that mostly capture emerging markets. Further, these countries see renewable energy as an opportunity to tackle economic development, energy security, and sustainability. They face challenges in availability and access to financing, institutional capacity, skill, and knowledge gaps. They have high dependency on fossil fuels, where renewables reflect capacity additions rather than energy substitutions (Bradshaw & de Martino Jannuzzi, 2019; Kruger & Eberhard, 2018; Shidore and Busby). Members include countries like Ghana, Kazakhstan, Mexico, the Philippines and South Africa. Among policy interventions, auction systems are used in innovative ways to reach cost-reduction, risk mitigation and capture local benefits. These are coupled with infrastructure investments and institutional creation.

South Africa pioneered with its auction design, which involved extensive project due-diligence criteria, along with local-socio-economic benefit provisions (Eberhard & Kåberger, 2016; Kruger & Eberhard, 2018; Matsuo & Schmidt, 2019). An innovative approach is observed in Ghana, leveraging public-private partnerships by using a fee-for-service scheme to overcome high upfront costs via monthly instalments. This is coupled with a solar testing and training centre to enhance technological knowledge and expertise (Amankwah-Amoah & Sarpong, 2016).

3.2 . Transitioning away from coal

In the debate on transitioning away from fossil fuels, well-designed international agreements seem to have the potential to overcome certain political economy factors. For example, the fossil fuel subsidy phase-out agreement at the 2009 Pittsburgh Summit demonstrates how transparency and oversight in non-binding international open club approaches can facilitate participation in global agreements (Aldy, 2017). At the same time, the national context is decisive for participation in international agreements. For instance, the probability of joining the Powering Past Coal Alliance (PPCA) increases with higher GDP per capita, transparent and independent governments and lower coal share in the electricity mix (Jewell et al., 2019).

Although we search for effective transitioning away from fossil fuels, including oil and gas, we only find effective national examples for coal. We could identify three distinct regional groups with common entry points (see Figure 3 and Table 1). The first regional group, **Coal Dependent & Climate Leaders**, includes Canada and Germany that both have committed to phase-out coal. They have established an international standing as leading nations in their efforts to fight climate change. At the same time, their coal represents a noticeable fraction in their energy mix which increases the challenge of stranded assets and structural change. Motivated by their proactive international standing and exposure to environmental impacts, such as air pollution and flooding, they established a stakeholder commission, and thus enhanced the required institutional capacity. Furthermore, health gain framing in climate policy is a central element for public support and strengthening of pro-policy coalitions (Millar et al., 2020). In Canada, a narrow mandate of the stakeholder commission contributes to specific and ambitious results in climate mitigation and public involvement (Gürtler et al., 2021). On the contrary, the broader mandate of the German stakeholder commission slowed down ambition (Gürtler et al., 2021) but is recognized as key to ease lobby resistance accompanied by large compensation payments and removal of fossil fuel subsidies (Furnaro, 2023; Markard et al., 2021; Oei et al., 2020). The German case further illustrates that auctioning with a declining ceiling price is superior to pre-determined or negotiated compensations in terms of efficient retirements (Tiedemann & Müller-Hansen, 2023).

The case of the UK is rather unique as the coal share has been declining due to a liberalized market, rise of renewables as well as substitutability with nuclear and abundant natural gas reserves(Brauers et al., 2020; Isoaho & Markard, 2020). In addition, no new coal-fired power plants were constructed in the UK during the 2000s and 2010s (Walk & Stognief, 2022). Therefore, vested interests and coal phaseout oppositions were comparably weak and the case of the UK can be considered **Liberalized & Coal Independent**. Furthermore, rising environmental concerns and supportive social activism combined with pressure from the EU, as well as national climate policies, enabled the phaseout pledge in 2019 (Isoaho & Markard, 2020).

Finally, the regional group referred to as **Internationally Supported** includes Vietnam, which has also pledged to phase-out coal. Do and Burke (2023) emphasize that the key factors enabling the coal phase-out commitment are the political motivation to secure international support for domestic green growth and the limited availability of financing for new coal power plants. Moreover, participating in international efforts to address climate change is a central political priority.

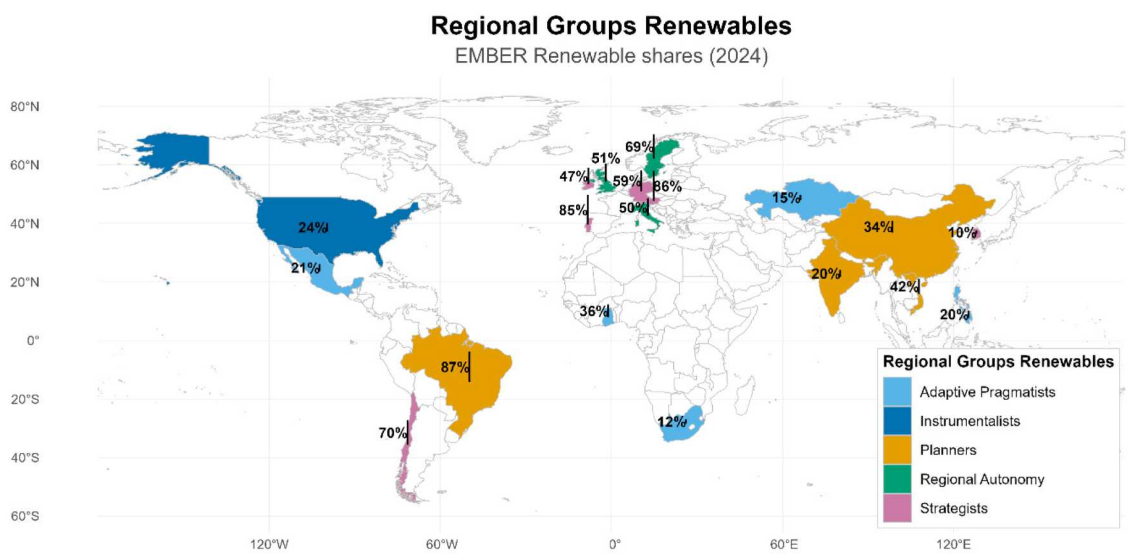

Figure 4. Regional distribution among renewable groups. The renewable shares are based on EMBER (Ember, 2024).

4 . Discussion

Despite successful renewable deployment cases in advanced economies, significant challenges persist. Notably, large disparities exist between subregions, such as the differences observed between state and federal policies in the USA (Narassimhan et al., 2022). Similarly, considerable differences exist across member state performance within the EU stemming from differences in public support as well as fossil fuel dependencies (Musiał et al., 2021). FiTs – a key policy mechanism employed in advanced economies – face challenges related to cost-sustainability and competitive dynamics. For instance, the reduction in level of remuneration around 2013 is linked to a slowdown of RE growth (Shivakumar et al., 2019). Concurrently, a number of European countries has been undergoing a transition towards more market-based instruments (Hadjipanayi et al., 2016).

For emerging and middle-income economies, concerns about policy stability and consistency are paramount (Vakulchuk et al., 2023). Cases like China show remarkable speed and scale of renewable energy deployments. However, these advancements raise challenges in policy coordination. In addition to electricity curtailment; managing conflicts among policy-induced interest groups presents another challenge. While interest groups can contribute to policy stability, they may also act as obstacles to necessary policy change and adjustment (Do et al., 2020; Gao & Yuan, 2020; Karltorp et al., 2017).

Countries like Brazil, India, and South Africa adapt instruments to local objectives and capacities. Auctions are an effective way to achieve diverse requirements while scaling across institutional contexts, capacities, and technologies. They show strategic state support without major financial strains and different ways to tackle knowledge and skill gaps. However, challenges remain in the scale of deployment and to meet energy security concerns as well as increasing energy demand.

Comparing the regional distribution of renewable energy groups (see Figure 4) with the high-impact countries identified in the Policy Database (NewClimate Institute et al., 2024) reveals substantial overlap, suggesting that the entry point grouping approach captures the most policy-active economies well. However, some countries present in the Policy Database are not represented in the regional grouping, most notably Thailand and Indonesia, two rapidly growing economies in Southeast Asia where renewable energy policy is increasingly central to national policy instruments.

While the involved parties agreed on a coal phase-out in Germany, it is expected that an earlier phase-out would have been cheaper, reduced environmental damage, and would have led to accelerated regional recovery (Oei et al., 2020). Further, Gürtler et al. (2021) point out that the overburdening mandate assigned to the German commission resulted in a hesitant compromise. Specifically, bilateral compensation schemes have been criticized for lacking transparency and being too generous (Furnaro, 2023). The abrupt transitioning away from coal and simultaneous scaling of renewables in Vietnam raise challenges to the electricity grid and concerns about power shortages (Do et al., 2020; Do & Burke, 2023). Therefore, the development of the electricity grid and storage capacity should belong to the central elements in climate policy strategies and international financial support.

Furthermore, the pace of policy interventions is an important component. Countries that implemented a gradual transition appear to rely on more policy support than those that enacted abrupt transitions in a short time frame (Brauers et al., 2020; Do et al., 2020; Do & Burke, 2023). While this insight did not influence the regional grouping, it has been highlighted in several studies as influencing policy outcomes.

This review is subject to several limitations. First, the Policy Database indicates that some regions that effectively reduced emissions with high-impact policies are not represented in our sample. Consequently, future climate policy research should prioritize the examination of effective policy cases in less studied regions, such as Indonesia, Thailand, Russia, Turkey, Saudi Arabia and others, as they can offer valuable insights for countries within comparable regional contexts. Second, the majority of extracted articles are case studies lacking statistical measures of causality or effect size for the policy intervention's impact on deployment. As a result, the observed deployment effect may be correlational, and the identified entry points could be idiosyncratic, potentially failing to produce comparable outcomes in another comparable region. Finally, this review is limited to the provision of an overview of entry points without quantifiable ranking criteria regarding the effect size of deployment. Moreover, some studies assess the effectiveness of a policy intervention based on a limited time frame, which may not accurately capture its most recent or long-term outcomes.

5 . Conclusion and policy implications

In this systematic literature review, we identify co-occurrences of effective empirical policy interventions and contextual factors in the energy sector, thereby providing an overview of regional groups of similar entry points.

We group entry points to establish a classification of regional groups with common effective policy interventions, and key enablers and other contextual factors. These regional groups can serve as illustrative examples for countries sharing similar contextual conditions for their energy transition. For each group, we present concrete empirical examples to support practical application and learnings.[7]

Overall, the majority of enablers identified relate to economic feasibility. The three enablers cited with the highest frequency in the literature are institutional capacity (institutional feasibility), interest group support (social feasibility), and market structure (economic feasibility).

Regarding the deployment of renewables, five different regional groups are identified. Three of them primarily capture advanced economies. **Instrumentalists** rely on liberal market structure and mature financial markets for economic and regulatory instruments. In contrast, **Strategists** build on a long-term central policy strategy and strong institutional capacity to incentivize distributed power producers. Within the regional group of **Regional Autonomy**, local authorities with a high degree of power and competencies effectively utilize their local engagement and influence.

The next two regional groups reflect middle-income and emerging economies. **Planners** rely on a medium- to long-term top-down approach with a high degree of public involvement in the energy sector. Within the regional group of **Adaptive Pragmatism**, regions adapt policy instruments to context-specific needs, whereby renewable deployment is considered as additional capacity for rising energy demand and security concerns rather than as a substitute for fossil energy.

The regional distribution of renewable entry point groups indicates a remaining gap in the literature: rapidly growing Southeast Asian economies, where renewable energy policy is becoming increasingly central, remain partly under-represented in the literature, particularly in qualitative case studies that examine policy effectiveness and contextual factors. Addressing this gap would improve the geographical balance and explanatory depth of research on effective climate policies.

We identified three distinct regional groups for transitioning away from coal. In the special case of decreasing coal energy shares and reserves of available energy substitutes, national climate policies and rising environmental concerns can be sufficient to support a coal phase-out pledge (**Liberalized & Coal Independent**). However, the presence of high coal energy shares is likely to be accompanied by a strong opposition that requires the establishment of a stakeholder commission **(Coal Dependent & Climate Leaders)**. Canada is a convincing example that a narrow mandate of the stakeholder commission can lead to more efficient and ambitious results. The German case illustrates that auctioning with a declining ceiling price can be an effective approach for retirement programmes. Finally, for financially constrained or developing economies, international financial support for green growth can be a motivation for transitioning away from coal **(Internationally Supported)**, as demonstrated by the effective policy example of Vietnam.

This research presents an overview of entry points to deployment of mitigation technologies and transitioning away from coal in the energy supply sector. Future research could apply the proposed review approach to discover entry points in further sectors central to climate neutrality, such as transport, industry, or buildings. Furthermore, future climate policy research and case studies should examine effective policy cases in less studied regions with high impact policies in the energy sector, closing a shown research gap. In addition, more quantitative research is needed to explore and compare effect sizes of technology deployment resulting from policy incentives and contextual factors. This could help energy system modellers to refine good policy practice scenarios. Quantifiable outcome indicators could also support policy makers in policy goal formulation and evaluation.

Notes

1. Only 69 out of around 1,500 policies evaluated by Stechemesser et al. (2024) are effective in terms of causing emission breaks.
2. Steg et al. (2022) also use a sixth dimension of environmental feasibility, while Brutschin et al. (2021) argue that environmental contextual factors describe a desirability dimension rather than a feasibility dimension.

3. The list is continuously updated and can be filtered, i.e., by high impact policies. The webpage also provides deeper policy analysis for G20 countries (https://climatepolicydatabase.org/).
4. In the literature it is clearly stated that the policy intervention induced a technology deployment change, supported either by statistical analysis or by insights from expert judgements or interviews.
5. See, https://huggingface.co/distilroberta-base.
6. With a confidence of 97.7 percent, we identify at least 90 percent of relevant articles.
7. The regional group of entry points are presented on the webpage: https://www.elevate-climate.org/context-factors-enabling-effective-sectoral-climate-policies with links to exemplary effective policies.

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Author contributions

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