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Understanding the Complexity of Governing Energy Transitions: Introducing an Integrated Approach of Policy and Transition Perspectives

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ABSTRACT

This article offers a comprehensive examination of integrating transition studies and policy studies in the context of energy transitions, highlighting the importance of participatory governance, reflexive policy frameworks, and innovation ecosystems. By combining insights from transition studies, such as niche innovations, multilevel governance, and socio-technical regime shifts, with policy studies' institutional analysis, the paper provides a holistic framework using Germany's *Energiewende* as a case study. It explores how participatory governance enhances legitimacy and how reflexive governance adapts to emerging challenges, sustaining long-term transitions. The *Energiewende* demonstrates the value of inclusive governance, where stakeholder engagement bolsters both policy legitimacy and social acceptance. This approach also shows that empowering local communities can lead to increased trust and cooperation in implementing policies. By leveraging frameworks that support innovation ecosystems, Germany has been able to integrate renewable technologies into existing infrastructures. Additionally, aligning local initiatives with national policies has proven critical in maintaining momentum in transitions. The integration of transition and policy studies reveals that leveraging multilevel frameworks is essential to accelerate sustainable technologies while ensuring equitable stakeholder participation. Further, adaptive measures in the *Energiewende* highlight how iterative feedback supports continuous learning and flexibility in transition pathways. This integration underscores the necessity of balancing technological innovation with social equity to ensure a just and sustainable transition. This paper argues that integrating these fields offers a better explanatory framework and practical strategies for overcoming transition obstacles. It concludes with recommendations for future research and policy development, emphasizing inclusivity, adaptability, and innovation in creating sustainable systems.

1 | Introduction: Integrating Transition and Policy Studies for a Deeper and Holistic Understanding of Energy Transitions

The transition from traditional fossil fuels to renewable energy sources is one of the most critical challenges facing contemporary societies. In this context, Germany's *Energiewende* stands out as a pioneering effort to achieve a sustainable energy system. One of the key takeaways from Germany's experience is that achieving a just energy transition requires balancing economic, social, and ecological priorities. This includes ensuring the participation of diverse stakeholders to enhance democratic legitimacy and social acceptance of transition initiatives (B. Lennon and Dunphy 2024). Despite initial

successes in this regard, the *Energiewende* has encountered significant obstacles in recent years, such as grid integration, market design, and public acceptance challenges (Faus Onbargi and Dombrowsky 2023). This raises questions about how the transition process can be sustained and even accelerated in future years.

This paper aims to contribute to the debate by integrating insights from two prominent fields: transition studies and policy studies. Transition studies focus on the processes and mechanisms that drive systemic changes in socio-technical systems, emphasizing the role of niche innovations, regime shifts, and multilevel governance (Geels et al. 2017). This makes it particularly well suited for the fields of energy, transport, and agriculture. Conversely, policy studies examine the political, institutional, and governance aspects that shape policy development and implementation (Jenkins-Smith et al. 2018).

First, we argue that the complexity of energy transitions necessitates an integrated approach of analysis that combines multiple disciplines and perspectives. Traditional approaches often fall short in addressing the multifaceted nature of transitions, which involve technological, economic, social, and political dimensions (A. Smith et al. 2005). Integrating insights from transition and policy studies can provide a more nuanced understanding of these processes, highlighting the interplay between technological innovation and institutional change. The concept of integration is not just theoretical but also practical, reflecting the need for comprehensive frameworks that consider the myriad factors influencing energy transitions. Previous research has already addressed the question of how public policy theories may be implemented in the context of energy transition research (Goyal et al. 2022). In such research, however, the policy itself is analyzed only occasionally, and theories on policy innovation are hardly used to explain transition dynamics. We therefore suggest a much stronger synthesis between policy theories and transition theories to create policy-relevant knowledge on energy transitions.

Second, we focus on the mechanisms and styles of participation as a key element of energy transitions in recent years, especially concerning the German *Energiewende*. Both transition and public policy communities recognize the importance of participation in energy transitions (Fischer 2017). Participation involves engaging a wide range of stakeholders, including citizens, industry representatives, and policymakers, in the decision-making process of energy transitions. Within the broad scope of policy studies, participation is considered a part of the decision-making process and can provide spaces for negotiation. Concerning sustainability issues, Eden (1996) stated that successful environmental policy depends largely on public participation. He argued that the classic, top-down process of public participation in the creation of policies is often expert-heavy, and that the further inclusion of citizens is not necessarily a solution here, as ideas presented could be dismissed as "nonscientific." Policies would therefore have to be redesigned in such a way that the modes of perception in which people 'understand' their environments through culture, morality, and social interaction become part of the design of policies. Regarding the creation of energy policies, Schroeter et al. (2016) refer to the view that participation can increase acceptance and legitimacy of energy transitions, contribute to improved efficiency of decisions, improve the quality of decisions, and promote knowledge generation. Following this viewpoint, participation can reduce friction in the energy transition, but it remains unclear how participation processes can be analyzed and evaluated in concrete terms.

Contrary to this understanding, within the context of transition studies, participation is primarily viewed as a means to empower communities and enable grassroots innovations (Seyfang and Smith 2007). By involving local actors in the design and implementation of transition initiatives, policymakers can ensure that these initiatives are socially relevant and contextually appropriate. Participation also facilitates the diffusion of innovations by creating networks of support and collaboration among stakeholders. By comparison, in policy studies, participation is seen as a mechanism for enhancing the legitimacy and accountability of decision-making processes (Fung 2015). Insights from recent interdisciplinary studies suggest that transformational responses to climate change need to move beyond incremental adjustments, embracing broader systemic changes that engage communities at multiple levels (Gillard et al. 2016). By focusing on the integration of these fields, we aim to develop a deeper understanding of how participatory and reflexive governance can accelerate future energy transitions while maintaining social equity and resilience.

In the following sections, we will first present insights from transition studies that are relevant for examining energy transitions and participation. The same will then be done with the subsequent section concerning policy studies. The insights from these two fields of study will then be integrated, with particular focus given to participatory and reflexive governance, policy frameworks, and innovation ecosystems. These results will then be related to the concept of democratic legitimacy, clarifying how an integrated approach can enhance governance opportunities for transition.

2 | Lessons From Germany's *Energiewende*: The Intertwining Pathways to Decarbonize Energy Systems

We will now explore the different perspectives exemplified by the case of Germany's *Energiewende*. This will allow for a deeper exploration of the entanglements of participation in relation to ambitious future climate policies. In its pursuit of climate neutrality by 2045, the *Energiewende* aims to drastically reduce carbon emissions and increase the share of renewables in Germany's mix of energy sources (F. Kern and Rogge 2018). However, the transition has faced numerous challenges, including technical, economic, and political barriers (Renn and Marshall 2020). By examining the *Energiewende* through the lens of transition and policy studies, we can derive insights that are applicable to other countries pursuing similar goals. These insights underscore the importance of not just technological innovation but also adaptive policy frameworks and participatory governance to drive long-term energy transitions (Radtke and Renn 2024; Ruffing and Brendler 2024).

One of the key challenges facing the *Energiewende* is the need to balance the interests of various stakeholders, including energy

producers, consumers, and environmental groups. This requires a participatory approach that involves stakeholders in the decision-making process and ensures that their interests and concerns are considered (Meadowcroft 2009). By integrating insights from transition and policy studies, we can offer a deeper understanding of the mechanisms of participation and their correlation with the most consequential future challenges of the *Energiewende*: pushing acceleration and expansion, ensuring democratic processes and co-ownership opportunities, as well as enhancing regulatory and economic conditions (cost pressure, approval procedures etc.). Germany's case underscores the importance of international cooperation and alignment. Given the interconnected nature of energy markets and environmental impacts, Germany's policies have implications beyond its borders, influencing European Union policies and international climate commitments.

The integration of transition and policy studies offers a comprehensive framework for addressing the multifaceted challenges of energy transitions. By combining these two perspectives, we gain a deeper understanding of the complex dynamics at play, particularly in the case of Germany's *Energiewende*. This ambitious initiative aims to achieve climate neutrality by 2045, targeting a renewable energy share of at least 80% by 2030. Germany's *Energiewende* has made notable strides toward this goal, with over 57% of its electricity consumption covered by renewables by mid-2024. Nevertheless, achieving a fully decarbonized energy system necessitates addressing persistent challenges. These include accelerating grid expansion, integrating decentralized renewable sources, and ensuring a stable energy supply while phasing out fossil fuels.

First, the successful integration of renewable energy sources into Germany's power grid requires substantial investments in infrastructure (Olbrich et al. 2024). The expansion of transmission and distribution networks is critical to transport wind energy from northern regions to the industrial south. To support this, Germany has initiated a comprehensive System Development Strategy, which focuses on modernizing grid infrastructure, enhancing digitalization through smart meters, and promoting grid flexibility (Büttner et al. 2024). Additionally, the development of a robust hydrogen infrastructure is essential for balancing energy supply, especially during periods of low wind and solar output (Nunez and Quitzow 2024).

Second, Germany's approach emphasizes sector coupling to optimize energy use across electricity, heating, and transport sectors (Gils et al. 2021). This includes deploying heat pumps, expanding district heating networks, and electrifying transport to reduce emissions. Enhancing energy efficiency remains a cornerstone of the strategy, with a focus on reducing overall energy demand through retrofitting and industrial process optimization.

Third, recent legislative reforms have been instrumental in accelerating the *Energiewende*. The implementation of the Renewable Energy Act of 2023 and the Onshore Wind Energy Act of 2023 has set ambitious targets for wind and solar expansion. By designating renewable energy projects as a matter of public interest, the government aims to expedite the approval process, thereby reducing project delays (Hielscher et al. 2025). This is particularly relevant, as engaging local communities remains vital to maintaining public support (Berle and Broekel 2025).

Fourth, to manage the intermittency of renewable energy sources, Germany is investing in flexibility mechanisms such as battery storage, demand response, and hydrogen storage. The integration of digital technologies, including smart grids and advanced metering, is expected to enhance the responsiveness of the energy system to fluctuations in supply and demand (Stute et al. 2024). The emphasis on resilience is also evident in efforts to diversify energy imports and build strategic reserves of green hydrogen.

Fifth, while the *Energiewende* has set ambitious targets, there are concerns regarding the economic impact on consumers and industries (Gerlach et al. 2024). Rising energy prices have sparked debates on the need for measures to protect vulnerable households and small businesses. To address this, the federal government has introduced subsidies, tax incentives, and funding programs aimed at easing the financial burden of the transition. Furthermore, ensuring a just transition is central to the *Energiewende*.

These economic and social considerations underscore the need for a more nuanced approach to managing the *Energiewende*, one that balances ambitious climate goals with equitable outcomes for all stakeholders. To gain a deeper understanding of how such transitions can be effectively navigated, it is essential to explore both the bottom-up dynamics of societal change and the top-down influence of policy frameworks.

3 | Insights From Transition Studies: Understanding Energy Transitions Bottom-Up

Transition studies provide a comprehensive framework for understanding how systemic changes occur within socio-technical systems. This field of research has developed several key concepts that are particularly relevant to participatory energy transitions, including the Multilevel Perspective (MLP), transition pathways, and the role of innovations and niches. These studies primarily focus on how participation serves as an enabler for transformative thinking and action, emphasizing that individuals and groups must be empowered to challenge ingrained routines and experiment with new practices.

First, analyzing energy transitions through the lens of transition studies means adopting a MLP. Essentially, the MLP is a central framework in transition studies, highlighting the interactions between different levels of a socio-technical system: niches, regimes, and landscapes (Geels 2005, 2011, 2012, 2020). Niches are spaces for radical innovations and experimentation, regimes represent the dominant structures and practices, and landscapes encompass broader socioeconomic and cultural factors. Transitions occur when niche innovations disrupt existing regimes, often driven by landscape pressures such as climate change or policy shifts (Geels and Schot 2007). The MLP provides a useful lens for analyzing the dynamics of energy transitions, highlighting the interactions between technological, economic, and social factors (Geels 2018, 2019, 2020; Roberts and Geels 2019a, 2019b).

The MLP also highlights the importance of aligning developments at different levels of the system. For example, successful energy transitions require not only technological innovations at the niche level but also changes in regulatory frameworks and market structures at the regime level. Additionally, landscape pressures such as international climate agreements and public demand for sustainable energy solutions create windows of opportunity for transitions (Rip and Kemp 1998). Furthermore, the MLP allows for the examination of how various factors at each level can either facilitate or hinder the transition process.

Derwort et al. (2022) have successfully combined the Multiple Streams Framework (MSF) as part of the classical analytical framework of policy studies and the MLP to provide a more detailed explanation of the German *Energiewende*. The MSF is used to explain how political changes occur when three "streams"—problems, policies, and politics—come together, creating a "policy window" for change. One example of such a policy window is the 1990 *Stromeinspeisegesetz*, or Electricity Feed-in Act, which involved policy entrepreneurs leveraging a convergence of these streams to push through legislation supporting renewable energy. This paper also explores how the MSF framework helps explain the 2011 decision to phase out nuclear power following the Fukushima disaster. Here, the MSF highlights how a policy window opened due to public concern over nuclear energy safety, and political entrepreneurs took advantage of this moment to accelerate the renewable energy transition. However, the MSF alone does not fully explain the technological and socio-technical dynamics that made such shifts possible. The MLP framework helps explain how renewable energy technologies like wind and solar power, which started as niche innovations supported by policies like the Feed-in Law, gradually matured and became viable alternatives to conventional energy sources (e.g., by the time of the Fukushima disaster in 2011).

As a result of combining the MSF and MLP, the author argues that Germany's energy transition cannot be understood solely through political events such as the passing of laws and other decisions by political actors. Instead, it was the interplay between political dynamics, technological innovation, and broader societal and environmental pressures that enabled the *Energiewende* to succeed.

In a similar way, Magnani and Cittati have applied two frameworks: the MLP and Socio-Technical Imaginaries to explore community renewable energy projects in Northern Italy to better understand the emergence of community renewable energy (CRE) projects and the collective ideas driving their development (Magnani and Cittati 2022). On the one hand, the MLP framework helps explain the structural conditions that allowed these CREs to emerge, such as the influence of regional and national policies. Additionally, it illustrates how external pressures, such as climate change and regulatory adjustments, opened windows for local actors to push for CREs. On the other hand, the STI framework focuses on the collective visions that local actors associate with their projects.

Beyond the MLP, the idea of discovering and analyzing transition pathways can be understood as the centerpiece of transition studies. Transition pathways describe the routes through which transitions unfold, encompassing different patterns of change and actor involvement (Geels and Schot 2007). Pathways can vary from technological substitution and reconfiguration to regime shifts and transformations.

In the case of the *Energiewende*, transition pathways can be observed in the gradual shift from centralized fossil fuel power plants to decentralized renewable energy systems. This shift involves not only technological changes but also shifts in market structures, regulatory frameworks, and social norms. Transition studies emphasize the importance of aligning these elements to support the desired pathways and ensure a smooth transition, including the following (Geels et al. 2016):

1. *Technological Substitution*: This pathway involves the replacement of existing technologies with new ones, often driven by technological breakthroughs and cost reductions. In the case of the *Energiewende*, technological substitution can be seen in the rapid expansion of solar and wind power, which have displaced traditional fossil fuel generation.
2. *Reconfiguration*: This pathway involves the reorganization of existing systems to incorporate new technologies and practices. In the *Energiewende*, reconfiguration can be observed in the integration of renewable energy into the existing grid infrastructure and the development of smart grid solutions.
3. *Regime Shift*: This pathway involves a fundamental transformation of the existing socio-technical regime, often driven by changes in policy and societal values. In the *Energiewende*, regime shifts can be seen in the phase-out of nuclear power and the shift toward a decentralized energy system.
4. *Transformation*: This pathway involves a radical change in the underlying structures and practices of the socio-technical system. In the *Energiewende*, transformation can be seen in the transition to a low-carbon economy and the development of new business models and market structures.

Each of these pathways presents unique challenges and opportunities for policymakers and stakeholders. By understanding the dynamics of transition pathways, policymakers can develop strategies to support the desired pathways and address potential barriers to change. Transition pathways also highlight the role of agency and strategic action by different actors. For example, entrepreneurs and innovators play a crucial role in developing and promoting niche technologies, while policymakers can create conducive environments for these innovations to thrive through supportive policies and regulations (A. Smith and Stirling 2010a, 2010b).

Based on the insights provided by transition studies, different types of energy transitions based on socio-technical dynamics can be characterized. Edomah et al. (2020) categorize energy transitions into three types: interim, deliberate, and transformative transitions. These types are defined by the combination of policy, citizen-driven changes, and the degree of acceptance or

enforcement of new energy behaviors and technologies. First, interim energy transitions are characterized by changes driven by policies without full public acceptance, often occurring in nondemocratic settings or due to political pressures. These transitions tend to be temporary, as users revert to previous behaviors when the external pressures are removed. One such example is the temporary changes in energy use patterns during the COVID-19 lockdowns. Second, deliberate energy transitions are initiated by citizens or energy users themselves, without supporting regulations. These transitions occur when individuals adopt new technologies, such as hybrid or electric cars, based on perceived benefits like cost savings or environmental impact. These changes may last for longer periods but are not necessarily backed by governmental policy. And third, transformative energy transitions combine both policy and citizen-driven changes.

As we have seen, transition studies can make multilevel dynamics visible and pathways explainable. However, as the way in which transitions are propelled forward is of primary concern, transition studies tend to place its research focus on the creation of innovations in relation to the emergence of niches. These play a critical role in driving transitions by providing spaces for experimentation and learning (A. Smith and Raven 2012). Niches can develop into powerful forces that challenge established regimes, particularly when they receive support from policy measures and societal actors. The *Energiewende* has benefited from a vibrant landscape of innovations, including advancements in solar and wind technologies, energy storage solutions, and smart grid systems.

To foster innovation, transition studies highlight the importance of creating protective spaces for niches, facilitating interactions between actors, and providing resources for experimentation. These insights underscore the need for policy frameworks that support innovation ecosystems and enable the scaling of successful solutions.

Moreover, innovations and niches often require active participation from diverse actors, including industry, academia, government, and civil society. Collaborative networks and partnerships can facilitate knowledge exchange, resource sharing, and joint problem-solving, thereby enhancing the capacity for innovation (Ali et al. 2023; Määttä 2021). Of course, this requires extensive participation in the sense of co-creation, cooperation, and collaboration by the actors involved in the process as well as the integration of new actors emerging from niches.

Transition studies have focused on the emancipatory potential of participation. This can be traced back to the process model of Transition Theory, which bears a certain similarity to the Policy Cycle (Geels and Schot 2007). According to this model, a socio-technical regime change is explained by the fact that a certain development path breaks open as triggered by external shocks. This generates a window of opportunity for niche actors who make novel discoveries and initiate learning processes via co-construction, thus facilitating a reconfiguration of the broken system.

According to the concepts of transition management, a transition arena, agenda, monitoring and evaluation, and experiments must be created and enabled in order for a transition regime change to take place (Silvestri et al. 2018). An input level, throughput level, the transition arena (framing the transition challenge, envisioning a shared future, exploring pathways and building an agenda), and an output level are also distinguished (Silvestri et al. 2018). This process also takes into account that citizens can have varying degrees of input depending on the structure in place (e.g., top-down authoritative hierarchical training, bottom-up participatory democratic social learning) (Aubert et al. 2019). Consequently, sustainability transition processes can be set in advance (closed, predetermined, prescribed) or set jointly (open, self-organized, co-created).

According to the theoretical assumptions of the transition model, emancipatory actors are necessary for a regime change as they are able to influence processes in a self-empowered way. Essentially, the emancipatory approach is distinguished from participatory principles, since here complete inclusion is attempted as opposed to modest inclusion and shared power (Swartz and Nyamnjoh 2018). In such an approach, participants choose their own agenda, initiate their own policy design process, and control their own outcomes.

Participatory approaches, on the other hand, focus on consultation, joint planning of design, shared responsibility, and outcomes that belong to participants collectively. Therefore, it is assumed that the transition path of a top-down transition can be achieved through re-constellation, whereas a bottom-up transition requires empowerment, which can generate a reconfiguration (substitution, backlash) of the regime (Boulanger et al. 2021; Cuppen 2018; Dall-Orsoletta et al. 2022; Longo et al. 2023). Despite this difference, both approaches are defined by structural and cultural tension, as well as stress and pressure on the dominant regime system (Kauffmann 2022; Oldenbroek et al. 2024).

Accordingly, abrupt and rapid social mobilizations can lead to the construction of novel political processes and structures. Since transition studies feature notions of free social spaces, a complexity thinking is enabled, which is essential for managing nonlinear dynamics. For transition studies, social movements are thus an important starting point for the creation of such open spaces, allowing foundations for a new agenda to emerge in which various actors and institutions can participate. They can be understood as door openers of transition, although they are in turn dependent on exogenous conditions on the one hand and on resonance in the overall social system (discursive space, publics) on the other. However, it is questionable how well emancipation works and what grassroots movements produce in turn (Forman 2017; Johansen and Emborg 2018; Kumar and Taylor Aiken 2021). Previous research on community energy projects has found that inequalities, undemocratic governance structures, and little de facto participation can often result (Łapniewska 2019; Mundaca et al. 2018; Radtke 2023; Radtke and Ohlhorst 2021; Ryder et al. 2023; Van Veelen 2018).

Geels et al. (2018) emphasize reducing energy demand as one crucial example of the transformative power of energy transitions, however, as one that requires more than just incremental technological improvements and calls for transformative changes in socio-technical systems more broadly.

These systems, which provide energy services like heating and transport, are complex and co-evolve with technologies, user behaviors, and policies. This makes reducing energy demand complex, requiring not just technological innovation but a reconfiguration of entire systems. However, low-carbon innovations often start in protected niches, where they can develop without the full pressures of market competition. These niches allow for experimentation and learning but fall short of the systemic changes required to enable broader diffusion of innovations. Furthermore, supportive policy frameworks are needed to address the interaction between emerging innovations and existing systems. Thus, inclusive participation plays a crucial role in transition studies, defined in an outcome-oriented manner.

This understanding of inclusive participation closely aligns with radical democracy theory, which emphasizes the role of grassroots activities and niche actors in driving change (Lummis 1996; Massey 1995). In the context of energy transitions, this theory focuses on bottom-up processes involving local communities, marginalized groups, and niche actors challenging existing power structures and driving transformative change (Krüger 2022). By prioritizing nonhierarchical, participatory models of governance, radical democratic approaches argue that legitimacy stems from the direct involvement of citizens in decision-making processes, rather than from institutionalized, top-down structures (Stephens 2019; Szulecki and Overland 2020). This can be seen as a departure from traditional liberal democratic frameworks, which tend to emphasize procedural fairness without necessarily ensuring broad-based participation (Popp-Madsen 2023). Furthermore, radical democratic theory posits that democracy is not merely a set of procedures or institutions but an ongoing process of contestation and participation (Massey 1995). This understanding of democracy emphasizes the continuous redefinition of social and political norms, where dissent and conflict are not seen as disruptive but as integral to the democratic process. In energy transitions, this theory provides a framework for viewing participation not just as a means to an end (i.e., successful policy implementation), but as a fundamental component of democracy itself (Krüger 2022; Müller et al. 2022). In this way, participation serves as both "resource feedback" by giving marginalized actors a seat at the table and "ideational feedback" by allowing them to inject new ideas and perspectives into the transition process (Wooten and Ulrich 2017). Radical democratic theory also challenges the notion of predetermined pathways in energy transitions. Instead, it supports the idea that transitions should remain open-ended and flexible, allowing for continuous input from diverse actors who may have competing visions for the future. Moreover, while grassroots activities are vital for generating adjustments in socio-technical regimes, the success of these initiatives often depends on how they align with broader societal and regulatory structures. By integrating frameworks such as the MLP, MSF, and STI, transition studies provide a comprehensive approach to understanding energy transitions.

To conclude, transition studies underscore the transformative power of participation. Through participatory processes, new socio-technical regimes can emerge, driven by grassroots actors and institutional support alike. However, further research is needed to explore how different forms of participation can be harmonized to foster more inclusive, equitable, and sustainable energy transitions. In summary, it is striking that participation plays a very specific role in transition studies, based on a purposeful understanding:

- In transition studies, participation is evaluated and defined in an outcome-oriented way: It serves as an enabler for transformative ways of thinking and acting and should empower individuals and actors to break through ingrained routines and experiment with new practices (emancipatory participation). Emancipation via empowerment, reconstellation, and adaptation is subordinated to participatory practices and the interaction of actors in order to achieve a reconfigurative bottom-up transition.
- The understanding of participation corresponds in large part to the approaches of radical democracy theory, which focuses on bottom-up activities by individuals and actors. It remains unclear how conflict-affirming or conflict-averse the practices should be and what joint decision-making with institutionalized actors should look like in concrete terms.
- Transition studies emphasize the importance of any grassroots activities of niche actors, which can generate adjustments in socio-technical regimes in the case of a window of opportunity. What remains open here is how these activities are mutually dependent, which are conducive or not conducive to change, and how visions of a shared future are actually to be developed when very diverse views and actions are present.

4 | Insights From Policy Studies: Understanding Energy Transitions Through Governance Processes

Policy studies offer critical insights into the governance structures, power dynamics, and institutional frameworks that shape policy development and implementation, especially in the context of large-scale energy transitions such as Germany's *Energiewende*. This transformative policy, which aims to transition Germany from fossil fuels and nuclear power to renewable energy sources like wind and solar, exemplifies the complexity of participatory governance and the balancing act between economic interests and environmental goals. The *Energiewende*, like many large-scale transitions, reflects the multifaceted challenges of simultaneously fostering innovation, ensuring inclusivity, and maintaining democratic legitimacy.

Energy transitions are inherently socio-political processes that require policies engaging a diverse range of stakeholders through democratic and inclusive approaches. Unlike purely technological changes, energy transitions must navigate complex socioeconomic landscapes, where policies must align with societal values while addressing practical aspects of renewable energy deployment (Krupnik, Wagner, and Vincent 2022).

The socio-technical perspective used to analyze energy transitions emphasizes the need for policy frameworks that align with broader sustainability goals, facilitating innovations such as renewable energy technologies. These frameworks must also account for the dynamics of entrenched interests, resistance from

incumbent industries, and the gradual societal shifts needed to embrace renewable energies (Sovacool et al. 2020). Political events, such as the Fukushima disaster, can create "policy windows" that allow for significant policy shifts, as demonstrated in Germany's post-Fukushima energy transition (Derwort et al. 2022).

Moreover, these transitions are not isolated to technical advancements; they encompass wider socio-political processes, requiring comprehensive governance approaches. The transition from nuclear and fossil fuel reliance to renewable energy is as much about transforming public attitudes, economic models, and institutional practices as it is about deploying wind turbines or solar panels. These shifts occur within the broader framework of energy justice, which requires policies to ensure fair distribution of both the benefits and burdens associated with transitions, particularly in socioeconomically disadvantaged communities (Harichandan et al. 2022). The concept of energy democracy emphasizes the need for a redistribution of power in decision-making and access to resources (Burke and Stephens 2017). In this context, energy justice involves addressing inequalities in energy access, mitigating the impact of rising energy costs on low-income households, and ensuring that the communities most affected by energy infrastructure projects have a say in decision-making processes (Heffron 2022).

Beyond that, effective energy transition governance requires a multi-faceted approach, where policy studies identify key points of engagement: the actions of public officials, the participation of citizens, and the involvement of civil society organizations. These actors collectively shape participatory governance structures, which must balance centralized and decentralized decision-making. Centralized governance, with its top-down approach, can expedite policy implementation, ensuring rapid deployment of large-scale infrastructure projects. However, this approach may limit the depth of stakeholder participation, particularly from marginalized groups whose interests might be overlooked in the pursuit of efficiency. Decentralized governance, by contrast, allows for more adaptable and inclusive decision-making, often through regional and local bodies, although it may present coordination challenges across different governance levels (Pierre and Peters 2005). Here, we can also find a link to energy democracy and justice, which advocate for a more radical decentralization of energy systems and greater community ownership and control over renewable energy resources (Finley-Brook and Holloman 2016).

The complexities of energy transitions are further illuminated by the MLP, which provides a theoretical framework for understanding how renewable energy technologies evolve in protected niches before gaining enough momentum to challenge established systems (Derwort et al. 2022). This perspective is particularly valuable in examining how technological innovations like solar and wind power can disrupt traditional energy markets and create new paradigms of energy production and consumption. The MLP suggests that successful transitions require not only technological innovation but also a supportive socio-political environment that encourages experimentation and nurtures emerging technologies. Policy frameworks and governance structures, therefore, play a critical role in creating these enabling environments by promoting investments in renewable energy technologies (Harichandan et al. 2022). At the same time, governance structures must ensure the equitable distribution of both the opportunities and challenges associated with energy transitions, addressing socioeconomic disparities in access to clean energy (Krupnik, Wagner, and Vincent 2022). The importance of assessing policy capacity, as noted by Khan and Hussain (2024), becomes crucial here, as the effectiveness of governance structures in managing transitions is often determined by their ability to mobilize resources, engage stakeholders, and adapt to changing conditions.

Public engagement is another crucial component of successful energy transitions, as demonstrated by recent movements such as climate strikes and grassroots activism. These movements highlight the growing role of public awareness and activism in shaping energy policy (Gatto 2022). Citizens' increasing demand for transparency, accountability, and participation in energy decision-making processes places pressure on policymakers to ensure that governance structures are responsive to public concerns. The decentralized structure of Germany's federal system, which allows regional and local governments to tailor energy policies to local conditions, also demonstrates the complexities of public engagement in multilevel governance (Jänicke 2012).

Lastly, governance structures influence how power and resources are distributed among stakeholders, affecting their capacity to shape policy outcomes (Wiget 2024). Understanding these dynamics is essential for identifying potential sources of resistance or support and for designing strategies to foster collaboration and build coalitions. Regulatory environments, defined as the rules, standards, and incentives that guide behavior and influence market dynamics, are equally essential in energy transitions. Regulatory frameworks can either support or hinder the deployment of renewable energy technologies, shaping investment decisions and consumer behavior (Doblinger et al. 2016). In Germany, regulatory measures such as feed-in tariffs and renewable energy targets have been central to the *Energiewende*'s success, offering financial incentives for renewable energy development (Jacobsson and Bergek 2004). However, these regulatory environments must remain flexible, allowing for adaptation in response to new challenges and technological advancements (Berkhout 2002). Policymakers must thus strike a balance between providing regulatory certainty—necessary to attract long-term investments—and fostering an environment that encourages innovation and experimentation.

In the broader framework of energy transition governance, participatory democracy is an essential approach. Participatory democracy, with its emphasis on citizen engagement in policy making through mechanisms such as deliberative forums, citizen assemblies, and participatory budgeting, adds legitimacy to energy transition policies (Machin 2023). While top-down institutional participation often dominates the governance of energy transitions, grassroots initiatives and bottom-up civic activities are equally vital in shaping these processes. Studies suggest that grassroots participation contributes to democratic legitimacy by promoting equal access to decision-making processes and ensuring that diverse voices are heard (Arnstein 1969). Policy studies typically focus on the design and evaluation of participatory governance structures, as well as assessing inclusivity, fairness, and effectiveness (Béland et al. 2022).

The interaction between governance structures, regulatory environments, and participatory democracy illustrates how multilevel governance can shape the pace and direction of energy transitions. Effective governance requires that regulatory frameworks provide clear signals and incentives for technological innovation, while also ensuring that new entrants to the energy market are not disadvantaged by prohibitive barriers (Kivimaa and Kern 2016). At the same time, inclusive participatory processes are critical in ensuring that marginalized communities are not excluded from decision-making processes and that their concerns are adequately addressed (Biegelbauer and Hansen 2011).

Looking forward, policy studies should emphasize the importance of interdisciplinary approaches that integrate renewable energy technologies into existing markets and develop comprehensive strategies for decarbonizing energy-intensive sectors (Harichandan et al. 2022). Additionally, equitable policy interventions are essential to addressing global disparities in energy systems and ensuring that technological innovation benefits all regions, particularly those in the Global South, which often face significant barriers to energy access (Sovacool et al. 2020).

In conclusion, the interplay between governance structures, regulatory environments, and participatory democracy is central to the success of energy transitions. Effective governance must balance the need for regulatory certainty with the flexibility to adapt to new challenges while fostering inclusive participation across all levels of decision-making. Ultimately, policy frameworks that align with sustainability goals, support innovation, and promote social justice will be critical for navigating the complex landscape of energy transitions. Governance structures influence how power and resources are distributed among stakeholders, affecting their capacity to shape policy outcomes. Understanding these dynamics is essential for identifying potential sources of support or resistance as well as designing strategies to foster collaboration and build coalitions (Rhodes 1996). Governance structures also impact the capacity for policy innovation and adaptation, determining how effectively new ideas can be integrated into existing systems (Sørensen and Torfing 2009).

What role exists for analyzing participation in policy studies? First, participation is theoretically understood as a complementary form of representative democracy that generates additional legitimizing power for political decision-making processes. Empirical-conceptual studies are based on examining how democratic surplus can be developed from different forms of participation. Participation is predominantly studied in an institutional context, with the predominant coverage of top-down formats of invited participation within the political system in the context of participatory governance structures and policy processes. Second, the understanding of participation is linked to functions, structures, and processes; the focus is on the modes of action of participation with regard to various factors (inclusivity, effectiveness, fairness, etc.).

Examples of conducting participation analysis studies in the context of environmental policies are approaches for explaining participation in collaborative governance networks. This is done by conducting a review of resource dependence, social exchange, and social identity theories in terms of measuring three participation attitudes (cognitive, affective, conative) (Barrutia and Echebarria 2019). In the context of participatory technology assessment, the principles of inclusion (equal weight to all citizens, inclusion of all affected groups), issue framing (adequate information provision, framing by the participants), and quality of decision-making (accountability of decision makers, attention to arguments) can be examined (Biegelbauer and Hansen 2011).

In summary, this chapter clarifies the policy analysis perspective on participation in energy transitions, such as:

- Participation is understood as a top-down process granted by institutions and organized interests. Other processes beyond these system contexts are not covered (e.g., grassroots initiatives).
- In the study and evaluation of participation, the focus is on the criteria of legitimacy and effectiveness. Both emancipation and contextual factors of participation procedures are largely ignored.
- Although participation can serve higher ideals of democratic theory, such as via deliberation, in addition to the typical influences within the decision-making process (policy cycle, which is the subject of policy analyses), these forms of participation are also assessed instrumentally—beyond deliberation, other, for instance, experimental and creative forms of will formation are not taken into account.

5 | Overlapping Perspectives: The Role of Power Dynamics and Policy Feedback

In the following sections, we identify and describe two overlapping perspectives of policy and transition studies, focusing first on power dynamics and political processes. This includes a strong emphasis on actor and governance settings analyzed primarily by policy studies, but also by transition research. Additionally, we highlight the role of policy feedback in policy and transition studies, which is a core feature of theories of public policy processes. Feedback loops are an essential mechanism of influencing the adaptations of actions by actors in transition processes.

Power dynamics and political processes play a crucial role in shaping energy transitions by influencing agenda-setting, policy formulation, and implementation (Betsill and Bulkeley 2007). These dynamics can either facilitate or hinder transitions, depending on the interests and strategies of key actors. In Germany's *Energiewende*, power dynamics are evident in debates over energy subsidies, grid expansion, and the phase-out of nuclear power. The transition has been shaped by a complex interplay of interests, including those of the government, industry, environmental organizations, and civil society groups (Haustein and Lorson 2023).

One critical aspect of power dynamics in the *Energiewende* is the shift in political power caused by the decentralized ownership of renewable energy projects. Decentralization has enabled citizens, municipalities, and cooperatives to participate in shaping the energy transition, disrupting traditional power

structures (Brisbois 2023). However, despite this shift, citizens' influence is often limited by their social and local positions, with landowners and officials holding more significant sway in local energy decisions (Schwarz 2020). This dynamic exemplifies how decentralization may empower certain groups while marginalizing others, a key consideration in designing equitable energy policies (Avelino and Wittmayer 2016). Moreover, understanding power in transitions requires examining how agency at the level of novel practices can influence structural change. Hoffmann argues that power is not only a destructive force but also a creative one, as new practices challenge and reconstruct existing structures, allowing agency to extend beyond the habitual (Hoffman 2013).

Policy studies highlight the importance of inclusive decision-making processes that engage diverse stakeholders, address power imbalances, and ensure that policies reflect the interests of affected communities. These processes should create spaces for dialogue, foster collaboration, and ensure marginalized voices are heard (Andersson and Ostrom 2008; E. Ostrom 1990, 2010, 2012; E. Ostrom et al. 1999; V. Ostrom and Ostrom 2019). This perspective aligns with the Multi-Actor Perspective, which distinguishes between state, market, community, and third-sector actors to analyze shifting power relations (Avelino and Wittmayer 2016).

Moreover, political processes significantly influence how the costs and benefits of energy transitions are distributed, affecting public support and acceptance. Policymakers must consider the equity implications of energy policies to avoid disproportionately burdening certain groups (Sovacool et al. 2019). Without addressing distributional concerns, policies risk reinforcing existing inequalities, as seen in cases where transnational energy corporations dominate new energy regimes, thus limiting the potential for transformative change (Haas 2019).

The role of political power in energy transitions is multifaceted, involving the capacity to influence policy agendas, shape public opinion, and mobilize resources. Tyfield (2014) emphasizes the productive aspect of power in transitions, arguing that power is not only about resistance or dominance but also about creating new possibilities for transitions, as seen in the case of e-mobility in China. Power is exercised through both formal mechanisms, such as legislation and regulation, and informal channels, like lobbying and advocacy (Lukes 2005).

Power dynamics are also closely linked to issues of legitimacy and accountability, as stakeholders must justify their actions and decisions. Transparent and accountable use of power is essential for maintaining legitimacy and fostering trust among stakeholders (Beetham 1991). In the context of energy transitions, these dynamics can either democratize or perpetuate existing hierarchies, depending on how power is distributed and exercised (Burke and Stephens 2018).

Energy transitions also present opportunities for empowerment and social innovation. Participatory agenda-setting in transdisciplinary research, for instance, offers a means of challenging traditional power dynamics by involving practitioners and citizens in decision-making (Fritz and Binder 2020). Rutting et al. (2023) further explore the role of power shifts in sustainability transformations, introducing the "Disruptive Seeds" approach to examine how niche practices challenge incumbent actors and systems. Energy transitions can be understood as deeply political processes shaped by power dynamics at multiple levels. Whether driven by top-down policies or bottom-up initiatives, understanding how power is distributed and exercised is critical for navigating the complexities of energy transitions.

Policy feedback mechanisms are crucial in shaping the evolution of policies over time, influencing both the design and implementation of future initiatives. In the context of energy transitions, such as Germany's *Energiewende*, policy feedback plays a significant role in determining whether policies are sustained, adapted, or dismantled. Feedback loops emerge when existing policies generate consequences—both intended and unintended—that impact future political processes.

Feedback effects are not limited to economic outcomes. Technological maturity and socio-technical fit, for example, create pressures for policy adaptation. These pressures arise as renewable energy technologies evolve and integrate with existing systems, leading to continuous learning and adjustments in policy design (I. D. Smith 2020). Another key concept in policy feedback is the idea of coalition cascades, in which feedback from one policy subsystem spills over into others, creating tipping points for broader systemic change. For example, early renewable energy policies in Germany not only impacted the grid system but also influenced policies related to energy storage and electric vehicle infrastructure, demonstrating the interconnected nature of feedback across multiple subsystems (Meckling and Goedeking 2023). Feedback mechanisms are particularly relevant in the co-evolution of policy mixes and socio-technical systems (Kern, Rogge, and Howlett 2019). In the context of sustainability transitions, policies do not exist in isolation; they interact with one another, creating feedback loops that shape both the socio-technical systems they aim to transform and the policy mixes themselves (Edmondson et al. 2019). Additionally, earlier experiences with renewable energy policies can reshape public opinion and influence future policy stances. In Norway, for example, shifts in municipal stances on wind power were influenced by feedback from earlier wind power policies, reflecting the role of local experiences in shaping broader policy positions (Eikeland et al. 2023).

Feedback mechanisms, combined with external socio-technical pressures, influence whether policies are durable or subject to change. Policy feedback also operates across national borders, driven by global interdependence. Domestic energy policies interact with global supply chains, creating feedback loops that influence the pace of clean energy adoption and the competitiveness of national industries (Meckling and Hughes 2018). Moreover, feedback processes are not always linear or self-reinforcing. The dynamics of policy feedback can also shift from self-reinforcing to self-undermining. For instance, in the case of EU biofuels policy, early positive feedback created momentum for the policy, but as knowledge about the environmental impacts of biofuels accumulated, negative feedback emerged, leading to a reversal of earlier policy gains (Skogstad 2017). Positive feedback mechanisms can also pave the way for more ambitious policy reforms. In South Africa, for instance, niche-support instruments in renewable energy programs generated positive

feedback that increased the political feasibility of more stringent energy policies, demonstrating how feedback can support policy ratcheting (Schmid and Lumsden 2023). Coalition building is another key factor in generating positive policy feedback. In Ireland's renewable energy transition, coalitions of support helped maintain and increase policy ambition, reinforcing feedback mechanisms that drive the long-term durability of transition policies (Fitzgerald 2020).

An updated research agenda for sustainability transitions highlights the role of power, agency, and feedback in shaping transition pathways. Feedback mechanisms play a crucial role in accelerating progress toward sustainability by influencing both the design and implementation of energy policies (Köhler et al. 2019). Thus, policy feedback is a vital mechanism in both policy and transition studies, shaping the persistence or change of policies over time. By leveraging positive feedback loops and addressing potential self-undermining dynamics, policymakers can accelerate energy transitions and ensure the durability of sustainability efforts. In summary, integrating the concept of policy feedback into both transition studies and policy sciences provides a more nuanced understanding of the dynamics that shape energy transitions over time. Policy feedback mechanisms, particularly in the context of participation, serve not only as a means of incorporating actors into decision-making processes but also as a critical enabler of systemic change. Participation in this case can be understood as both resource feedback and ideational feedback.

As ideational feedback, participation goes beyond mere presence and contributes new viewpoints, ideas, and innovative solutions to the conversation. This is particularly significant in energy transitions, where niche actors such as renewable energy entrepreneurs, local communities, and advocacy groups often hold alternative visions for the future that challenge dominant regimes (Lockwood et al. 2017). These actors introduce new perspectives that may disrupt entrenched socio-technical systems and offer pathways for more radical innovations.

Additionally, participatory feedback loops enhance policy adaptability. When participation is structured to incorporate continuous feedback, policymakers can more effectively monitor the socio-technical landscape, adjusting policies to respond to emerging challenges or shifting stakeholder preferences. This creates an iterative cycle in which feedback from one phase informs future decisions, fostering resilience and the capacity for learning within governance systems. Policy feedback also highlights the role of coalitions and power dynamics in shaping the success of participatory processes. While participation opens the door for new actors to influence policy, the real impact depends on how these actors form coalitions, leverage resources, and navigate existing power structures. Positive feedback from successful participatory models can reinforce coalition-building, driving long-term durability and increasing political feasibility for more ambitious energy transition policies. By situating participation within the framework of policy feedback, we can see how it serves as a critical enabler of both incremental and transformative change. Participation does not merely provide legitimacy to the policy process; it actively shapes the trajectory of energy transitions by bringing new voices into the fold, enabling innovation and fostering adaptability.

In conclusion, the interaction between policy feedback and participatory processes underscores the importance of an inclusive, multi-actor approach to energy transition governance. Future research should delve deeper into the ways in which participatory feedback loops operate, particularly in how they influence the scaling of grassroots innovations and the development of coalitions across different governance levels. This will allow policymakers to leverage feedback effectively, ensuring that energy transitions are not only sustainable but also socially just, with policies that reflect a diverse range of perspectives and priorities. Ultimately, by understanding participation as both resource and ideational feedback, we can unlock the transformative potential of inclusive governance, thus making energy transitions more resilient, adaptive, and equitable.

6 | Integrating Transition and Policy Studies for Democratic Energy Transitions

Integrating insights from transition studies and policy studies offers a robust framework for understanding and facilitating energy transitions. These joint insights allow us to address the complexities and uncertainties inherent in such processes while developing governance approaches that are both effective and democratically legitimate. In energy transitions like Germany's *Energiewende*, this integration is essential for balancing technological innovation, policy adaptation, and social acceptance.

In the following sections, we will first examine participatory governance, reflexive governance, and policy frameworks and innovation ecosystems. Afterward, we will explore the implications for democratic legitimacy, including discussions on input legitimacy, throughput legitimacy, output legitimacy, and legitimacy and participation. By taking this approach, we aim to showcase how integrating insights from transition studies and policy studies is crucial in shaping these governance models and ensuring their effectiveness. This exploration of governance models demonstrates how the combined perspectives of these fields can help create systems that are adaptable, inclusive, innovative, and responsive to the dynamic needs of energy transitions.

First, participatory governance plays a pivotal role in enhancing the democratic legitimacy of energy transitions by ensuring that a wide range of stakeholders—including citizens, industry representatives, and policymakers—are actively engaged in the decision-making process. This inclusivity fosters socially robust and adaptable policies, creating pathways for diverse stakeholders to co-create transition strategies and increasing the legitimacy of the overall process (Fung 2015).

Participatory elements, such as citizen assemblies and stakeholder consultations, provide opportunities for inclusive engagement and enhance both the legitimacy and effectiveness of transition strategies. By creating spaces for dialog and experimentation, these processes allow for social learning and adaptation. Policymakers can leverage the diverse expertise and knowledge of stakeholders, fostering trust, collaboration, and reducing the risks of conflict and opposition (Jaegersberg and Ure 2011; Ouhajjou et al. 2015). Moreover, participatory governance enables stakeholders to collectively explore new

approaches and solutions, supporting the development of innovative and adaptive transition strategies that can respond to evolving circumstances and societal needs (Fazey et al. 2014).

Reflexive governance emphasizes continuous learning and adaptation, acknowledging the dynamic and complex nature of energy transitions. This approach integrates iterative feedback loops, where policies are regularly evaluated and adjusted in response to new insights and changing conditions (Voß and Kemp 2006).

In the *Energiewende*, reflexive governance significantly enhances the capacity of governance systems to navigate uncertainties, incorporate stakeholder feedback, and address emerging challenges. By encouraging the exploration of alternative pathways and scenarios, reflexive governance allows stakeholders to consider various options and trade-offs when developing robust and flexible transition strategies (Leach et al. 2010). This approach also promotes anticipatory governance, where stakeholders engage in foresight and scenario planning to prepare for future challenges and opportunities (Renn 2011).

The integration of transition and policy studies underscores the critical importance of policy frameworks and innovation ecosystems in supporting energy transitions. Policy frameworks provide the institutional and regulatory structures that guide transitions, while innovation ecosystems facilitate the development, scaling, and diffusion of new technologies and solutions. For the *Energiewende*, policy frameworks must focus on creating enabling environments for innovation, supporting niche developments, and fostering collaboration between key actors (Raven et al. 2016). Innovation ecosystems play an essential role by offering resources for experimentation, knowledge exchange, and collaboration. These ecosystems support the development of new business models and market structures, fostering networks of support among stakeholders (Hekkert et al. 2007). By fostering a culture of innovation and experimentation, policymakers can enhance the energy system's capacity to meet new challenges and drive the transition toward a sustainable energy future (Fagerberg and Hutschenreiter 2020). However, while policy innovation—including the invention, diffusion, and success of new policies—is crucial for accelerating energy transitions, research shows that the policy innovation lens remains underexplored in the energy transitions literature.

We will now switch to some implications for democratic legitimacy as a link between the perspectives of policy and transition studies on energy transition. Through the lens of democratic legitimacy, we can understand how policies not only meet technical objectives but also gain social acceptance and support from a diverse range of stakeholders. This approach emphasizes the importance of aligning governance practices with principles of fairness, transparency, and effectiveness, thus ensuring that energy transitions are both resilient and equitable. Energy transitions, such as the *Energiewende*, have profound implications for democratic legitimacy due to the complex decision-making processes that affect a diverse array of stakeholders. Integrating insights from transition studies and policy studies can help enhance the legitimacy of transition strategies, ensuring that they are not only socially just and inclusive but also more effective in achieving their goals.

Input legitimacy refers to the mechanisms and processes through which stakeholders are engaged in decision-making. Ensuring that a diverse range of voices is heard is crucial for democratic governance (V. A. Schmidt 2013). In the *Energiewende*, enhancing input legitimacy involves establishing participatory forums, facilitating stakeholder engagement across governance levels, and providing citizens with the information and resources necessary to contribute meaningfully to transition pathways (Proedrou 2022).

Throughput legitimacy concerns the transparency, fairness, and accountability of the decision-making process itself. Ensuring that stakeholder input is incorporated and that decision-making processes are open, fair, and inclusive is crucial for democratic legitimacy (V. A. Schmidt 2013). In the *Energiewende*, throughput legitimacy can be enhanced by creating feedback mechanisms, ensuring transparency, and fostering equitable processes that allow all stakeholders to participate on equal terms (V. Schmidt and Wood 2019).

Output legitimacy assesses the effectiveness of policies in addressing stakeholder needs and achieving their intended outcomes (V. A. Schmidt 2013). It evaluates how well policies reflect the interests of affected communities and the extent to which they achieve their goals. For the *Energiewende*, output legitimacy can be strengthened by regularly evaluating the impacts and effectiveness of transition strategies.

As we have seen, democratic legitimacy in energy transitions is often viewed through a process model like Easton's input–output cycle (Easton 1965). According to this model, legitimacy is generated through input, throughput, and output (Renn and Schweizer 2020). These dimensions of legitimacy are crucial for maintaining the democratic claims of collective identity, liberal democratic rights, and shared norms and values. However, achieving legitimacy in energy transitions requires more than guaranteeing these principles on the levels of policy decision-making processes in a formal way of public participation procedures. Advanced democratic legitimacy in a wider and deep understanding means ensuring that participation is genuine, processes are transparent, and outcomes are just. This would fit in the perspective of transition studies and is based both on deliberative and radical democracy theory. Habermas' theory of deliberative legitimacy emphasizes communicative action, where legitimacy arises from seeking agreement through truthful discourse (Habermas 1990, 2023). In radical democratic theory, legitimacy goes beyond mere procedural fairness; it demands the active involvement of marginalized and noninstitutionalized actors in shaping decision-making processes. Participation must not only be an institutionalized, top-down process but also allow for bottom-up initiatives that challenge existing power structures and create new spaces for dialogue and contestation. Radical democracy emphasizes the transformative potential of conflict and dissent, seeing them as essential for a truly democratic process.

In contrast, Luhmann's systems theory views legitimacy as the acceptance of decisions based on legality, conformity to norms, and problem-solving ability (Pretorius et al. 2024; Rasmussen 2022; Thornhill 2021). The higher the perceived legality and conformity to normative principles, the more likely

the public is to accept and approve of the decisions (Höffe 1994). This perspective implies that legitimacy is often derived from the system's ability to demonstrate rationality, efficiency, and adherence to established legal frameworks, which can result in a more stable governance process (Shulman 2023). However, one limitation of Luhmann's systems theory is that it may overlook the importance of public engagement and emotional investment in decision-making processes (Machura 2019). By focusing on formal legality and systemic norms, the theory risks neglecting the value of participatory legitimacy, where citizens feel they have a stake in shaping policies that directly affect their lives.

Integrating analyses of policy and transition studies offers a comprehensive approach to bridging these diverse concepts of legitimacy, particularly in the context of energy transitions. By combining insights from policy studies—such as policy feedback mechanisms, institutional frameworks, and systems theory—with the participatory and transformative emphasis of transition studies, this integrated analysis ensures that both formal and informal channels of legitimacy are addressed. It acknowledges the need for legal conformity and systemic stability, as emphasized by Luhmann, while also embracing the participatory, bottom-up processes advocated by radical democratic theory.

In conclusion, by integrating insights from transition and policy studies, we can enhance both the effectiveness and democratic legitimacy of energy transitions. Participatory and reflexive governance practices ensure that energy transition strategies are socially inclusive, responsive to stakeholder needs, and adaptable to evolving circumstances. Moreover, supporting innovation ecosystems and developing adaptive policy frameworks allow for the creation of sustainable, long-term strategies that can drive the transition to a renewable energy future. A joint approach involving policy and transition studies provides significant advantages for managing energy transitions such as Germany's *Energiewende*. It ensures that governance processes are inclusive, adaptive, and resilient, thereby facilitating not only technological innovation but also social acceptance and legitimacy. By balancing input, throughput, and output legitimacy, policymakers can foster a more democratic and just energy transition, where diverse stakeholder perspectives are genuinely reflected in both the processes and outcomes of energy policy.

7 | Discussion and Limitations: Addressing Challenges in Participatory Energy Transitions

In this section, we will summarize and discuss the insights provided by Figure 1, which summarizes all the perspectives presented in this contribution. This particularly reflects the intersection of policy and transition studies within the framework of participatory energy transitions. It illustrates the complex challenges that accompany energy transitions, such as the need to accelerate the process, expand renewable energy, and incorporate democratic governance mechanisms. Additionally, the importance of co-ownership opportunities, favorable regulatory and economic conditions, and the integration of policy and transition insights to better understand

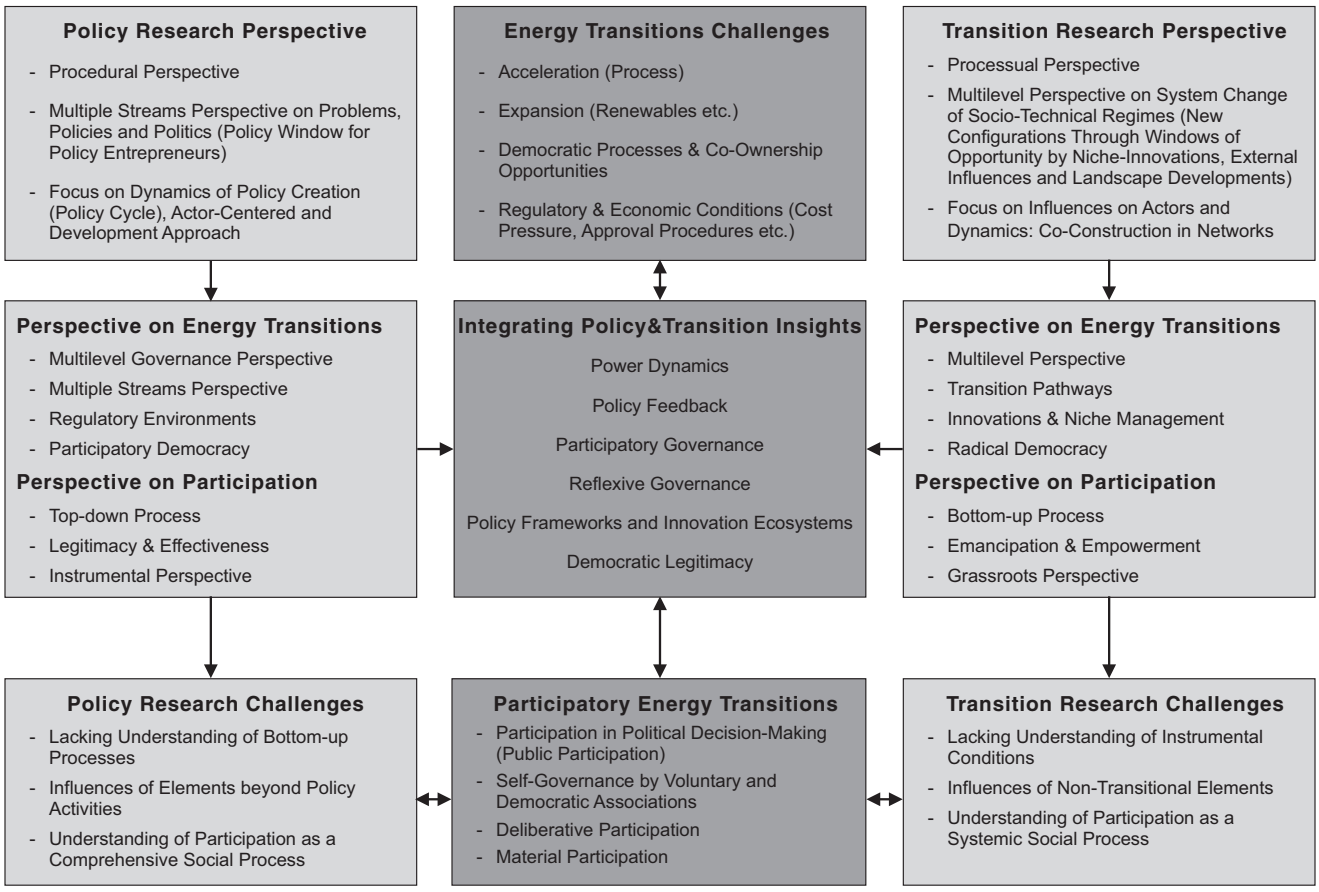

FIGURE 1 | Overview of policy and transition perspectives on energy transitions and participation.

power dynamics and policy feedback mechanisms is underscored by our findings.

First, we stress emphasis on the current and future energy transition challenges in general as well as regarding the German *Energiewende*. One of the most pressing challenges highlighted is the acceleration of energy transitions, particularly the shift toward renewable energy. This process involves overcoming numerous obstacles, including regulatory barriers, cost pressures, and the need for streamlined approval procedures. Furthermore, we highlight the importance of creating favorable regulatory and economic conditions to support the energy transition. These conditions include facilitating access to finance, reducing administrative hurdles, and fostering a supportive policy environment. Achieving this balance requires careful coordination between various levels of governance and an emphasis on both top-down and bottom-up approaches.

Turning back to the starting position of this paper, we have carved out the multiple perspectives on and interconnections between participatory pathways in energy transitions. Without a doubt, participation is central to explaining the dynamics of energy transitions all over the world, as underscored by the broad scope of research on participatory energy transitions. When studying energy transition in a multi-perspective way combining policy and transition studies, several dimensions of participation have to be considered, including public involvement in political decision-making, self-governance by voluntary associations, deliberative participation, and material participation.

The multi-level governance perspective emphasized is crucial for understanding the complex dynamics of energy transitions. It shows that participatory processes must be integrated across local, regional, and national levels to ensure inclusivity and effectiveness. The multiple streams framework, which highlights the role of policy entrepreneurs, is also key to navigating the complex interplay between problem identification, policy formulation, and political action.

The overview presented in Figure 1 further depicts the distinction between top-down and bottom-up participation approaches. Top-down processes are typically associated with the instrumental goals of legitimacy and effectiveness, while bottom-up approaches emphasize empowerment and social justice. Both approaches are necessary for successful energy transitions, but balancing these perspectives is critical. As one outstanding result of this synopsis and literature review, we highlight the importance of reflexive and participatory governance in managing energy transitions. Reflexive governance, with its focus on continuous learning, feedback loops, and adaptive policy-making, is essential for navigating the inherent uncertainties and complexities of energy transitions.

On the other hand, participatory governance ensures that stakeholders have a meaningful role in the decision-making process. This includes creating platforms for public participation, ensuring transparency, and addressing power imbalances that might otherwise limit equitable participation (Radtke 2025). Finally, building on the core theme of this paper, we assume that the integration of policy and transition insights is crucial for addressing the challenges of energy transitions. Policy research typically focuses on actor-centered approaches and the policy cycle, while transition research takes a broader, process-oriented view, focusing on the multilevel dynamics of system change. A key challenge in this integration is understanding how bottom-up processes interact with policy outcomes. Transition research must also account for nontransitional factors that can influence system change. Bridging these gaps will require more holistic frameworks that consider both the procedural and systemic dimensions of energy transitions.

While the integration of transition and policy studies offers valuable insights, several limitations must be addressed. First, there is a lack of empirical evidence on the effectiveness of participatory and reflexive governance practices in energy transitions. Another limitation is the geographic focus of much of the research. Studies on participatory energy transitions have predominantly focused on developed countries, especially Germany's *Energiewende*. While these insights are valuable, they may not fully apply to developing countries, where energy transitions face different challenges and opportunities (Newell and Bulkeley 2017). Additionally, much of the existing research has focused narrowly on the energy sector. Expanding the scope to include other sectors, such as transportation and agriculture, would provide a more comprehensive understanding of sustainability transitions.

Future research should focus on empirically assessing the effectiveness of participatory and reflexive governance practices. This includes exploring the role of intermediaries, evaluating the impact of participation on policy outcomes, and identifying mechanisms for scaling grassroots innovations (De Silva et al. 2018). Research should also investigate how policy feedback mechanisms influence the direction and pace of energy transitions. This includes examining how policies shape and are shaped by stakeholder preferences and behaviors, and how feedback loops contribute to policy learning and adaptation (Edmondson et al. 2019; F. Kern and Markard 2016).

In conclusion, this overview provides a larger picture of how to consider the perspectives of policy and transition studies together. Several starting points for new research on energy transitions can be derived. Additionally, some surprising overlaps, interconnections, and entanglements between selected issues may be built upon by widening the scope of concepts and unpacking the full toolbox of traditional policy and transition studies. This comprehensive depiction of the challenges and opportunities in participatory energy transitions is still an incomplete and porous framework, serving as an initial gateway for future studies. By integrating insights from both policy and transition studies, researchers and policymakers can develop governance frameworks that are not only effective but also democratically legitimate.

8 | Conclusion: Leveraging Integrated Approaches in Energy Transitions

The integration of transition and policy studies offers a powerful and comprehensive framework for understanding and navigating the complexities of energy transitions. These two fields, while distinct in their approaches and focuses,

complement each other in ways that are essential for addressing the multi-dimensional challenges associated with transitions like Germany's *Energiewende*.

First, we recapitulate the investigated perspectives of policy and transition studies. Policy studies traditionally focus on the role of actors, institutions, and the policy cycle. This includes examining how decisions are made within existing governance structures, how policies are implemented and evaluated, and how various stakeholders, from political actors to citizens, interact with and influence policy outcomes (Burke and Stephens 2017). On the other hand, transition studies take a broader, more systemic view, focusing on the processes of societal change, particularly the shift from one socio-technical system to another (e.g., from fossil-fuel–based energy systems to renewable energy systems) (Sovacool et al. 2021). Transition studies highlight the importance of long-term systemic change and emphasize the dynamic interactions between different actors, institutions, technologies, and societal factors. This field looks at the "navigable waters" of transitions, where complex interactions and feedback loops between different levels of governance, economic sectors, and social groups shape the trajectory of change.

Second, while policy studies and transition studies approach energy transitions from different angles, they have significant overlapping areas that can be leveraged to create a more holistic understanding of the governance challenges involved. Both fields recognize the importance of participation, reflexivity, and innovation in shaping the direction and success of transitions. For instance, policy studies' focus on actor-centered approaches can help illuminate how different stakeholders—governments, businesses, civil society, and citizens—can be engaged in decision-making processes. Transition studies, meanwhile, provide a broader understanding of how systemic change unfolds and how different socio-technical systems can be aligned or transformed to meet sustainability goals. Moreover, both fields emphasize the importance of participation and reflexivity in governance. Participatory governance, as emphasized in both policy and transition studies, ensures that a diverse range of stakeholders are involved in the decision-making process, contributing to the legitimacy and inclusiveness of transition strategies. Reflexive governance, meanwhile, underscores the need for continuous learning and adaptation, enabling governance systems to remain flexible and responsive in the face of uncertainty and change (Bornemann, Christen, and Burger 2025).

Third, we can make a strong point about the practice-relevant implications of integrating insights as the core of creating effective governance for participation in energy transitions. At the heart of this manuscript is the argument that integrating insights from transition and policy studies is essential for developing governance frameworks that are both effective and democratically legitimate. The integration of these insights allows policymakers to address the complexities and uncertainties of energy transitions more holistically, considering the dynamic interactions between different governance levels, economic sectors, and societal actors. Such an integration also opens up new opportunities for governance innovation. For example, participatory governance mechanisms, such as citizen assemblies and stakeholder consultations, can be enhanced by incorporating the reflexive governance principles of continuous feedback and learning (Radtke and Renn 2024). This allows for a more adaptive approach to policy making, enabling policies to be adjusted in response to new insights, changing circumstances, or emerging challenges.

Such joint insights ultimately open new transition governance opportunities. Opportunities emerge from broadening the scope of the relevant challenges, based on transition studies, and then tackling these through participation using policy research to address the emerging participation challenges. Most importantly, identifying joint insights and developing transition governance opportunities requires reflexivity, at the level of research and at the level of practice. Reflexive governance could provide a promising starting point. Reflexivity would prevent ignoring hurdles in goal attainment; at the same time, it challenges the concepts that are rigidly adhered to by continuously adapting them in a flexible and anticipatory way. In the context of the *Energiewende*, these integrated insights are particularly valuable. Germany's ambitious energy transition requires not only a shift to renewable energy sources but also a transformation of the entire socio-technical system that underpins the country's energy infrastructure. This transformation involves a wide range of stakeholders, from government agencies and energy companies to local communities and civil society organizations. The integration of transition and policy studies offers a robust framework for understanding the complex challenges of energy transitions. By combining insights from both fields, this approach allows for a more comprehensive analysis of how socio-technical changes can be managed effectively while ensuring democratic legitimacy and inclusivity (Hoffman et al. 2021; Hosan et al. 2024).

Germany's *Energiewende* exemplifies the need for adaptive governance structures that can balance the interests of diverse stakeholders, including industry, civil society, and local communities. Participatory governance has been crucial in enhancing public acceptance and fostering collaborative decision-making processes (Ahn and Baldwin 2024). Reflexive governance emphasizes the importance of feedback loops and iterative learning, which are vital in sustaining long-term transitions (Ferrari 2020). In the case of the *Energiewende*, adaptive policies have allowed Germany to adjust strategies based on evolving technological capabilities and public sentiment. The experience of the *Energiewende* demonstrates that achieving climate neutrality is not just a technological challenge but also a socio-political one that requires broad stakeholder engagement, continuous learning, and flexibility in governance. Future research should continue to explore how integrated approaches can optimize the transition process, focusing on areas such as policy innovation, stakeholder collaboration, and the socioeconomic impacts of decarbonization.

Moving forward, it is essential to address power dynamics and equity considerations within energy transitions (Avelino et al. 2023). Ensuring that marginalized communities are included in decision-making processes not only enhances democratic legitimacy but also contributes to more just and sustainable outcomes (Johnson et al. 2020). The lessons from Germany's experience underscore the need for multilevel governance approaches that are both flexible and inclusive, enabling the scaling of local innovations to the national level. Integrating

these analytical tools not only enriches our understanding of the *Energiewende* but also offers practical strategies for other countries facing similar challenges.

In the final considerations, we will condense some of the most promising and long-term oriented reflections and derivations for future research and real-world democratic policymaking in energy transitions. The discussion of participatory and reflexive governance in research, as well as the current challenges of energy transitions presented by politics and stakeholders all over the world, highlight the need for governance frameworks that are both flexible and inclusive. Energy transitions are inherently complex and involve a wide range of stakeholders, each with their own interests, perspectives, and capacities to influence the transition process. Reflexive governance, in this regard, provides a valuable framework for navigating the uncertainties and dynamic nature of energy transitions. By promoting continuous learning, feedback loops, and the adaptation of policies over time, reflexive governance enables policymakers to remain responsive to emerging challenges and opportunities (Duijnhoven and Neef 2016). The integration of policy and transition studies also highlights the importance of addressing power dynamics and ensuring that marginalized voices are included in the transition process (Jasanoff and Simmet 2021). This is due to the fact that both fields recognize the need to tackle power imbalances and ensure that the benefits and costs of transitions are distributed fairly among stakeholders (Siciliano et al. 2021).

While this manuscript provides a comprehensive framework for understanding the governance challenges of energy transitions, there are several areas that require further research. One of the primary limitations of current research is the lack of empirical evidence on the effectiveness of participatory and reflexive governance practices. Although theoretical frameworks and case studies offer valuable insights, there is a need for more systematic and comparative studies that assess the real-world impact of these practices on transition outcomes (Avelino and Wittmayer 2016).

Another important area for future research is the role of intermediaries in facilitating energy transitions. Intermediaries—such as NGOs, private sector organizations, and research institutions—play a critical role in bridging the gap between different levels of governance, facilitating communication and coordination between stakeholders, and promoting innovation. However, more research is needed to understand how these intermediaries operate and how they can be more effectively engaged in the transition process (Lepore 2024).

Exploring the role of power dynamics and political processes in shaping transition outcomes should be an additional focus of future research. This includes examining how different actors mobilize resources, influence policy agendas, and shape the direction of transition strategies (Avelino and Rotmans 2009). Understanding these dynamics is essential for developing governance frameworks that are not only effective but also equitable and socially just (Montañés et al. 2023).

Future research should examine the distributional impacts of energy transitions, particularly in terms of social justice and equity (C. E. Hoicka 2023). As energy transitions reshape societal structures, it is critical to ensure that the benefits and costs of these transitions are shared fairly among all stakeholders (Leonard et al. 2023). Research should focus on identifying mechanisms for ensuring that transition policies are inclusive and equitable, particularly for marginalized groups who may be disproportionately affected by the transition process (Sovacool et al. 2017, 2020, 2021, 2023; Sovacool 2021).

In conclusion, the integration of transition and policy studies provides a valuable framework for understanding and addressing the governance challenges of participatory energy transitions. By fostering inclusive and reflexive governance practices, supporting innovation ecosystems, and developing adaptive policy frameworks, policymakers can enhance the legitimacy, effectiveness, and adaptability of transition strategies. However, further research is needed to empirically assess the effectiveness of these governance approaches, explore the role of power dynamics and intermediaries, and ensure that transition strategies are socially just and inclusive (Sareen et al. 2023). By addressing these challenges, more robust and democratically legitimate governance strategies for navigating the complex and uncertain terrain of future energy transitions facing the overwhelming strains of climate change and mandatory climate adaptation measurements can be developed (Skjølsvold and Coenen 2021). These strategies can then be applied both in the case of the *Energiewende* and beyond in the context of sustainability transition strategies all over the world.

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Conflicts of Interest

The author declares no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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