

BOOK REVIEW SECTION

Geels, F.W.: Advanced Introduction to Sustainability Transitions. Cheltenham–Northampton, Edward Elgar, 2024. 145 p.

Since the publication of *The Limits to Growth* (MEADOWS, D.H. *et al.* 1972) and its global impact, concerns over biodiversity loss, resource scarcity, natural disasters, and climate change have intensified. These challenges suggest that modern civilization is on an unsustainable trajectory in its pursuit of socioeconomic prosperity, a concern foreshadowed by MALTHUS, who emphasized the finite nature of resources relative to population growth (MALTHUS, T. 1798). Today, there is a broad consensus on the unprecedented impact of human activity. From resource exploitation and pollutant emissions to disruptions of climate and biogeochemical cycles, evidence increasingly underscores the unsustainability of current practices (RICHARDSON, K. *et al.* 2023).

Amid this growing unsustainability and the need for new socio-economic models, the field of sustainability transitions has emerged, focusing on pathways toward more resilient societal systems. This field ar-

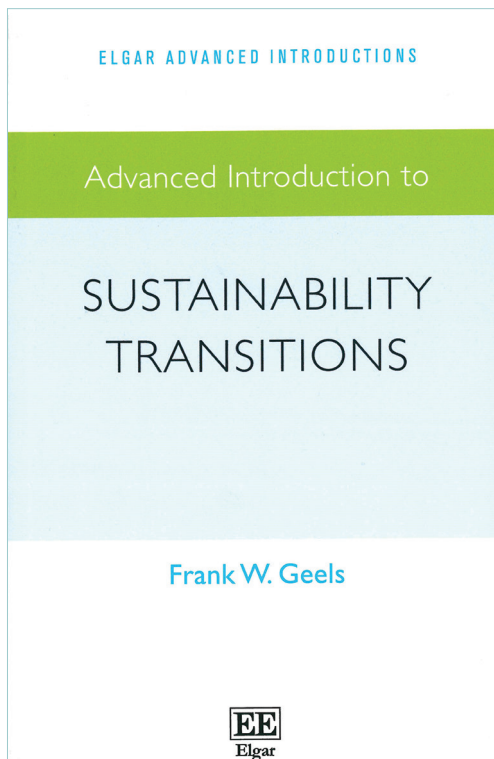
gues that sustainability cannot be achieved through incremental reforms to existing socio-technical structures. Instead, it explores how profound systemic transformations can be achieved in energy, mobility, food, and industrial sectors.

The book under review offers a rigorous yet accessible introduction to this field. The volume contains five regular chapters, while Chapter 6 provides concluding comments on the entire book. The book explores the evolution of sustainability transitions from early conceptual models through mid-2010s consolidation, to current debates about acceleration, destabilization, and justice. By doing so, it establishes important bridges between environmental studies, innovation studies, and political economy.

Authored by Frank W. GEELS, Professor of System Innovation and Sustainability at the University of Manchester and chairman of the International Sustainability Transitions Research Network, the volume reflects his two decades of experience shaping the field. Published in 2024 with Edward Elgar, it draws on insights from evolutionary economics, sociology, institutional theory, and political science to guide readers through the complex and expanding landscape of sustainability transitions.

This review situates the book within the wider field, summarizes its core arguments, and evaluates its contributions and limitations. It concludes that the book succeeds as an authoritative introduction, though its emphasis on middle-range frameworks and reconfiguration pathways risks underplaying the urgency of the radical alternatives advocated by many environmental movements.

To contextualize the volume, it is useful to review the origins and growth of sustainability transitions as a field of study. Sustainability transitions emerged in the early 2000s in response to increasing evidence that climate change, biodiversity loss, and resource scarcity could not be addressed through incremental adjustments to existing socio-technical systems. Instead, systemic shifts driven by radical innovations in energy, food, mobility, housing, and manufacturing were recognized to be central. The field expanded rapidly in the 2010s, stimulated by the escalating climate crisis, the diffusion of renewable technologies, and growing international collaboration. With the establishment of the Sustainability Transitions Research Network (STRN) in 2009, the field became institutionalized, and the volume of publications has ever since grown to the extent that newcomers may struggle to navigate its diverse and fragmented literature.



Sustainability transitions are defined by six key characteristics. First, they are *multi-dimensional*, involving the co-evolution of technological, social, economic, and institutional elements. Second, they are *multi-actor* processes shaped by interactions among firms, users, policymakers, and civil society. Third, they are *long-term*, often unfolding over decades due to the slow emergence of radical innovations and the resilience of incumbent systems. Fourth, they are *goal-oriented*, aiming to enhance environmental performance while ensuring social and economic sustainability. Fifth, they are *conflictual* because they disrupt established interests and face resistance from powerful actors. Finally, they are *non-linear and uncertain*, with multiple competing innovations making outcomes difficult to predict. Together, these features make sustainability transitions analytically complex and resistant to conventional short-term social science approaches. Given these defining characteristics, the volume has turned to theoretical frameworks to understand how transitions unfold.

The book foregrounds the Multi-Level Perspective (MLP), now the dominant framework in Sustainability Transitions. Originating in the early 2000s, the MLP synthesizes insights from innovation studies, evolutionary economics, and the sociology of innovation to explain transitions as interactions across three levels: *niches* (protected spaces for radical innovation), *regimes* (stabilized socio-technical configurations), and *landscapes* (broader exogenous contexts such as cultural norms, macroeconomic trends, and geopolitical shocks). Transitions occur when niche innovations gain momentum, regimes face internal tensions or external pressures, and landscape dynamics create windows of opportunity. MLP highlights lock-in mechanisms, economic sunk costs, social routines, and political networks that stabilize regimes and resist radical change. Furthermore, it rejects monocausal explanations while emphasizing conjunctural and configurational causality.

The book also discusses three other frameworks, *Strategic Niche Management* (SNM), *Technological Innovation Systems* (TIS), and *Transition Management* (TM). SNM emphasizes vision-building, learning, and social networks in early innovation phases. TIS focuses on system functions such as knowledge development and resource mobilization. Finally, TM looks at governance approaches by combining visioning, experimentation, and reflexive learning. While each has distinct emphases, the book demonstrates how they complement the MLP in analysing phases of transitions.

The volume provides three major contributions. The first one lies in its systematic analysis of transition phases. Building on earlier models, it makes the distinctions between four sequential stages, namely experimentation, stabilization, diffusion, and reconfiguration. *Experimentation* involves radical innovations that initially function as “hopeful monstrosities”, promising new functionalities but suffering from poor performance and high costs. Pilot projects and learning by doing are crucial at this stage, because they offer open-ended learning by doing and trial and error

processes in concrete settings. Frameworks like SNM and TIS illuminate these processes.

Stabilization occurs when innovations consolidate into dominant designs, supported by field-level knowledge, codification, and niche markets. Niche actors also often articulate positive cultural discourses in this phase to legitimate innovations and attract further support.

Diffusion represents the scaling up of innovations into mainstream markets, often requiring supportive policy interventions and favorable public discourses. Here, public perceptions and cultural meanings are crucial. While positive public debates and discourses help drive diffusion, negative ones can lead to controversies and thus hamper the diffusion process.

Reconfiguration denotes system-wide restructuring, involving changes in technologies, infrastructures, cultural norms, and institutions. This reconfiguration implies that, in addition to substitution, sustainability transitions can also change in a sequential or stepwise manner.

The book illustrates these phases with both historical and contemporary cases. The transition from horse-drawn carriages to automobiles in the United States (between the 1890s and the mid-20th century) demonstrates how innovations evolve from niches to mainstream systems, reshaping entire economies and cultures. Similarly, the transition to piped water in the Netherlands (between the 1870s and 1920s) shows how technological and institutional innovations co-evolved to transform public health. Contemporary cases, especially the German *Energiewende* (energy transition), highlight the interplay of technological advances, policy instruments, and external shocks. The diffusion of wind and solar power was accelerated by the Chernobyl and Fukushima nuclear accidents, supportive feed-in tariffs, and grassroots activism. Yet the case also illustrates vulnerabilities, such as the bankruptcy of domestic producers in the face of global competition (especially from China). These examples underscore the non-linear, contested, and contingent nature of transitions.

The second major contribution of the book remains its nuanced treatment of actors. If early research tended to focus mainly on structures, the volume puts emphasis on agency, power, and diversity by examining four main actor groups represented by firms, civil society, policymakers, and users.

Firms are conceptualized both as incumbents defending existing regimes and as new entrants pioneering radical innovations. Initially seen as power struggles between small-scale sustainability innovations and dominant social technical regimes, more recent scholarship emphasizes the reorientation of incumbent regimes under pressure from regulation, public opinion, and market opportunities. The Triple Embeddedness Framework (TEF) captures how firms face simultaneous pressures from economic and socio-political environments, leading to phases of denial, incremental adjustment, hedging, and eventual reorientation. Empirical studies of the automotive and electricity industries illustrate these dynamics.

Civil society actors, including grassroots innovators and social movements, contribute by pioneering alternative practices, shaping cultural meanings, and mobilizing for justice. While their initiatives often struggle to scale, they play important roles in challenging dominant discourses and introducing new imaginaries. Public debates and framing struggles play a major role in shaping legitimacy and social acceptance.

Policymakers and states have re-emerged as central actors, particularly after recent geopolitical crises. Early emphasis on governance suggested a diminished role for the nation-state, but events such as the COVID-19 pandemic, the war in Ukraine, and the gas price crisis (in 2021 and 2022) revealed the enduring power of state intervention. The resurgence of industrial policy in the European Union (the European Green Deal in 2019) and the United States (the Inflation Reduction Act in 2023) illustrates this shift. Policy mixes, combinations of Research and Development subsidies, feed-in tariffs, regulations, and just transition measures, are central to sustainability transitions.

Users, too often neglected in early research, are now recognized as crucial actors. They play multiple roles by representing experimenters, legitimators, citizens, intermediaries, and consumers. Adoption theories, social practice theories, and domestication studies reveal the complexity of user engagement. They shape transitions through consumption, routines, and cultural acceptance.

Finally, the book highlights how acceleration, multi-system interactions, finance, international supply chains, emerging economies, and cities are reshaping debates and practices in the field. It, thus, demonstrates that sustainability transitions are not merely technical challenges but deeply socio-political and global in scope. This reflects both the complexity and urgency of global transitions.

The discussion of *acceleration* is particularly strong. It frames the paradox of needing faster transitions while recognizing the barriers in early phases when costs are high and technologies immature. The socio-technical feedback loop framework provides a nuanced lens for understanding why electric vehicle (EV) diffusion shifted from scepticism to strategic commitment within a decade. This effectively illustrates how technical improvements, policy pressures, and public debates reinforce each other to produce tipping dynamics.

Taken together, these dynamics reveal that the acceleration of sustainability transitions is marked not only by opportunities for rapid diffusion, as in the case of electric vehicles, but also by significant risks, exemplified by Spain's recent power outage. Occurring on 28 April 2025 and lasting several hours (from midday until approximately 7 a.m. the following day), this outage, now understood to have stemmed from a combination of technical deficiencies and coordination failures, including inadequate voltage control, frequency oscillations, and improper generator disconnections (Red Eléctrica de España, 2025) raised significant concerns about grid stability and system resilience in a country where 59 percent of electricity is generated from renew-

able sources. Although official reports did not single out the role of renewables (Red Eléctrica de España, 2025), the complexity of grid operations and the extremely high reliability standards they require (99.97 per cent for modern reliability targets) (DUNSMORE, J. *et al.* 2025) keep this hypothesis in play. Given the inherent variability of solar and wind generation, Spain's substantial reliance on these renewable sources heightens the vulnerability of its electrical system to potential disruptions.

The argument on *multi-system interactions and deep transitions* adds historical and theoretical depth. By drawing parallels with past industrial revolutions, the author convincingly argues that today's net-zero pathways are characterized by cascading innovations across electricity, transport, and industrial systems. The concept of "deep transitions" raises the stakes by connecting system change to broader societal meta-rules. However, the critique that this approach risks being overly abstract and detached from contemporary socio-economic dynamics is well taken.

The treatment of *finance* is timely and insightful. By situating finance as its own regime with distinctive lock-ins, the author underscores why redirecting capital flows remains so challenging even though global financial assets were estimated at USD 461.6 trillion in 2022, of which the USD 6 trillion needed for the SDGs represents only 1.3 percent. Financial actors remain bound by established routines, short-term horizons, and risk-averse practices, which limit large-scale reorientation. Banks and institutional investors often regard emerging green innovations as too risky, favour large projects over smaller, fragmented ones, and lack the expertise to assess novel technologies. Consequently, investments concentrate in de-risked sectors such as solar, wind, and electric vehicles, while areas like building efficiency, hydrogen, and carbon capture remain underfunded. Broader structural constraints, including speculative financial logics, high transaction costs, and limited central bank engagement, further reinforce these barriers, rendering finance both indispensable and highly problematic for sustainability transitions.

The sections on emerging economies and cities highlight the need to adapt transition frameworks to local contexts. In the Global South, transitions are shaped by several key factors, of which the volume draws attention to four. First, fragmented and unstable socio-technical regimes create uncertainties that hinder planning and niche development. Second, firms and policymakers face limited resources and capabilities, with weak learning processes. Third, elite capture, corruption, and undemocratic governance constrain systemic change, even where natural conditions favour innovations such as solar or wind. Fourth, high poverty and inequality necessitate linking transitions to broader socio-economic development, while transnational actors often support niche innovations. These factors indicate that, although frameworks like the MLP remain useful, they require careful adaptation to the complex realities of emerging economies.

Regarding the processes in cities, the volume highlights significant limitations. Most early-phase initiatives (Latin America, South Korea, and Europe) are temporary, fail to scale, and have limited transformative impact. At the same time, implementation tends to be incremental, it involves weak social learning, limited citizen engagement, and a focus on reformist rather than systemic change. These patterns reveal a persistent gap between policy ambitions and practice, cautioning against wishful thinking and emphasizing the need for critical reflection on implementation challenges.

Having considered these three contributions, it is important to acknowledge the book's considerable merits, which make it a valuable reference for transition studies. In my view, the book has five major strengths. First, its synthetic overview makes it invaluable as a teaching and reference text. It consolidates an expansive body of literature into a coherent narrative without oversimplifying complexity. Second, its emphasis on the Multi-Level Perspective as a middle-range framework establishes an effective balance between theoretical abstraction and empirical relevance. Third, the integration of historical and contemporary cases enriches the conceptual discussion and grounds it in concrete examples. Fourth, its attention to actors reflects the field's maturation and responsiveness to mainstream social science debates. Finally, the reference to cross-cutting topics is a testament to the continuous expansion of the field.

That said, the volume also has some limitations that deserve attention. One limitation remains its heavy reliance on the Multi-Level Perspective. While the MLP is a well-established framework, this orientation risks narrowing theoretical innovation by overlooking alternative approaches. Its emphasis on technological efficiency and resource management, though valuable, does little to address the persistent inequalities that shape sustainability transitions, particularly in relation to energy access. A glance at global energy consumption underscores this issue. Of the 592 exajoules (EJ) consumed worldwide in 2024, Europe and North America accounted for 184 EJ, while Africa consumed only 21 EJ (Energy Institute, 2025).

This unequal distribution reflects a "law of thirds," whereby the wealthiest one-third of the global population uses roughly two-thirds of the world's energy (LAWRENCE, S. *et al.* 2013). Given the close relationship between energy access and economic productivity, such disparities constrain the capacity of societies to pursue long-term development and environmental stewardship. Incorporating more critical political economy perspectives that foreground these inequalities would significantly strengthen the volume's analysis.

Similarly, while the book convincingly demonstrates that incremental measures such as technological upgrades, efficiency improvements, and policy tweaks can yield benefits, recent climate data suggest they are insufficient to limit warming to 1.5 °C. In 2024, global emissions reached 40.8 GtCO₂e, a 1 percent increase above the target (Energy Institute, 2025). This trend suggests that continuous reliance on gradual transitions

risks locking in high-carbon infrastructure, amplifying climate feedbacks, and reducing adaptive capacity. Therefore, while incremental steps are politically feasible, they must be complemented by bold systemic interventions, including local-led poverty eradication, renewable energy expansion, transport electrification, and broad behavioural and institutional shifts, to achieve the scale and pace required for the 1.5 °C target.

Furthermore, the volume treats grassroots and social innovations somewhat sceptically, emphasizing their diffusion challenges rather than their transformative potential. This risks underestimating the cultural and normative shifts they generate. Emerging from local needs and experimenting with alternative practices of energy use, mobility, or food provision (SEYFANG, G. and SMITH, A. 2007), such initiatives may indeed not scale quickly in market terms but nonetheless reshape expectations, values, and social norms. Over time, these local experiments can accumulate into broader cultural shifts, influencing discourse, policy, and imaginaries of sustainable futures. By privileging diffusion barriers, the analysis reinforces attraction toward large-scale, technology-driven solutions at the expense of bottom-up approaches. Attending to the political and cultural dimensions of grassroots innovation would substantially enrich the analysis.

This point becomes particularly salient when considering Global South contexts. As a Malian researcher, I find the volume's findings uneven in their applicability. Developed largely from Western European cases, the book assumes strong institutions, abundant resources, and stable governance, conditions that do not always hold in Mali or much of the Global South. For example, in Sub-Saharan Africa, where large segments of the population live in poverty (ABDULHAKHEEM, A.K. *et al.* 2023), sustainable futures must begin with eradicating deprivation, and reliable access to energy is a crucial starting point. Evidence shows that while poor people may exist in rich countries, there are no rich countries without secure energy (IEA, IRENA, UNSD, World Bank, WHO, 2025). In this context, in addition to considering energy density for policy design, grassroots solutions (such as solar kiosks, community farming, and small-scale energy projects) are central drivers of change, even if the book dismisses them as fragile or non-scalable. The volume employs useful frameworks, but these require adaptation to contexts shaped by informal economies, weaker state capacity, and dependence on international donors.

Finally, in Central and Eastern Europe, the situation is different but also uneven. These countries are not part of the Global South, yet they remain outside the Western European core. Post-socialist legacies, dependence on coal and imported energy, and vulnerability to energy poverty (which manifests as inadequate heating or high housing costs) mean transitions face distinct barriers (BOUZAROVSKI, S. *et al.* 2017). The book's insights can illuminate these processes, but its solutions often feel distant. Overall, while the volume provides powerful analytical tools, it does not fully address the specific

challenges of regions beyond the global core, leaving much of the adaptation work to local researchers.

Despite these limitations, the book makes significant contributions to ongoing debates in socio-technical transitions research. It affirms the importance of multi-level and co-evolutionary perspectives while responding to critiques about agency, power, and justice. Its emphasis on acceleration resonates with recent reports from the International Energy Agency and the United Nations warning about closing windows of opportunity (International Energy Agency, 2021; United Nations Environment Programme, 2022). By documenting how transitions unfold through stepwise reconfiguration rather than sudden system overthrow, it highlights the role of unintended consequences in history while still acknowledging the potential for transformative change.

The book also connects with policy-oriented literatures on industrial strategy, innovation policy, and mission-oriented governance. Its discussion of state interventions situates sustainability transitions research within broader debates on post-neoliberal political economy, while its cautious treatment of de-growth and radical alternatives reflects the ongoing tension between reformist and transformative visions of sustainability. In summary, the book offers an authoritative, accessible, and critical overview of sustainability transitions research. It succeeds both in synthesizing the field for newcomers and in stimulating reflection among established scholars. By tracing the interplay of niches, regimes, and landscapes, analysing sequential phases of experimentation, stabilization, diffusion, and reconfiguration, examining the roles of diverse actors, and underscoring the importance of cross-cutting topics, it provides a robust framework for understanding socio-technical change. While its prioritization of the MLP and reconfiguration pathways limits engagement with more radical alternatives, it nonetheless equips graduate students and scholars, educators, practitioners, policymakers, and activists with valuable conceptual tools for addressing pressing sustainability challenges. In the context of escalating climate emergencies, these resources are particularly relevant for advancing clean, accessible, and affordable energy.

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