ORIGINAL ARTICLE OPEN ACCESS

The Comparative Political Economy of the Green Transition: Economic Specializations and Skills Regimes in Europe

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Received: 15 January 2025 | **Revised:** 1 September 2025 | **Accepted:** 8 September 2025

Funding: The authors received no specific funding for this work.

Keywords: comparative political economy | global value chains | green transition | growth regimes | skill formation

ABSTRACT

The green transition is fundamentally transforming contemporary economies and societies. This article investigates how European models of capitalism perform and specialize across the green value chain—conceptualized as innovation, manufacturing, services, and deployment—and how national skill formation systems underpin these specializations. Integrating insights from comparative capitalism literatures with descriptive statistics and principal component analysis (PCA), we develop and test expectations about growth regime-specific patterns of green specialization and skill profiles. Our findings reveal marked cross-national variation between green leaders and laggards: Nordic economies characterized by dynamic services and continental manufacturing-based models are frontrunners in the green transition, while Eastern Europe's FDI-led regimes and Southern Europe's demand-led regimes emerge as laggards. Furthermore, PCA results uncover two distinct decarbonization pathways among European green leaders: one group of countries (Austria, Finland, Germany) specializes in green manufacturing, supported by high shares of STEM graduates; another (Denmark, Switzerland, and to a lesser extent Norway and Sweden) focuses on green innovation and dynamic services, sustained by a strong supply of STEM doctorates. This article contributes to political economy debates on the green transition by identifying distinct green specializations and decarbonization pathways across European models of capitalism and by underscoring the growing centrality of high-level STEM skills in the green transition.

1 | Introduction

The green transition constitutes one of the most profound socio-economic transformations of the 21st century, fundamentally altering global systems of production, consumption, and innovation (Anzolin and Lebdioui 2021). Since the 1990s, governments have debated strategies to combat climate change while making commitments to mitigation policies. Yet, despite growing global consensus on the urgency of decarbonization, countries continue to exhibit significant variation in their capacities, strategies, and policies to advance the transition (Guarascio et al. 2024; Lachapelle et al. 2017; Lebdioui 2024; Liefferink et al. 2009; Nahm 2022).

Extant literature has explored how environmental ideas, norms, and values inform the behavior of citizens and political elites (Armingeon and Bürgisser 2021; Béland and Cox 2016; Cigna et al. 2023; Kammermann and Dermont 2018; Thomas et al. 2022); how power dynamics between governments, parties, and interest groups influence green policies (Aklin and Urpelainen 2018; Allan and Nahm 2025; Kupzok and Nahm 2024; Mandelli 2024; Meckling and Nahm 2022); and

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to what extent political and socioeconomic institutions shape incentives, constraints, and capacities for policy actors in the green transition (Ćetković and Buzogány 2016; Finnegan 2022; Lachapelle et al. 2017; May and Schedelik 2021; Meckling and Nahm 2018; Mikler and Harrison 2012). Despite these important contributions to the debate, few studies have so far systematically examined cross-country variation in green transition pathways through the lens of the comparative capitalism literature.

With the exception of Guarascio et al. (2024), existing comparative political economy (CPE) scholarship has either focused on a limited set of countries—such as Germany, China, and the United States (US) (Nahm 2021)—or narrowed its scope to specific sub-domains of the green transition, such as research and development (R&D) or innovation capabilities in green technologies (Ćetković and Buzogány 2016; Driscoll 2024; May and Schedelik 2021; Mikler and Harrison 2012). This article contributes to ongoing debates in the political economy of the green transition by analyzing how different European models of capitalism perform in the green transition and which skill regimes shape and enable distinct patterns of economic specialization along the various segments of the green value chain. To investigate these issues, the article combines insights from CPE scholarship on Varieties of Capitalism (VoC) (Hall and Soskice 2001), growth models (Baccaro and Pontusson 2016), and growth regimes (Hassel and Palier 2021) to develop and test theoretical expectations on different models of capitalism's likely economic specializations in distinct segments of the green value chain and the associated skill profiles.

Building on the work by Lachapelle et al. (2017) and Nahm (2022), we conceptualize the green transition as a global "division of labor." From this perspective, firms embedded in distinct models of capitalism leverage the institutional resources of their domestic political economies to specialize in particular segments of the green transition. In line with the special issue's introduction, we conceive of the green transition as a set of interrelated economic activities—innovation, manufacturing, services, and deployment—that together constitute a global green value chain. We combine descriptive statistics with principal component analysis (PCA) to address two key questions: first, how do different European models of capitalism perform in the green transition, and to what extent do different models of capitalism specialize in distinct segments of the green value chain? Second, how are such green specializations associated with, and enabled by, distinct cross-national skill profiles?

Our findings reveal substantial cross-national variation in the extent and nature of the green transition across different European models of capitalism. Notably, not all countries display equal capabilities to embrace the green transition, pointing to a stark divide between "green leaders" and "green laggards" (see also Guarascio et al. 2024; Liefferink et al. 2009). Green leaders include economies identified by Hassel and Palier (2021) as the Nordic regimes based on dynamic services and Continental export-led manufacturing-based regimes, which consistently outperform Eastern European regimes financed by Foreign Direct Investment (FDI) and Southern European publicly financed, demand-led regimes. Among the leaders, however, two distinct decarbonization pathways emerge (Figure 3). Nordic dynamic-services economies such as Denmark, Norway, and Sweden—joined by Switzerland—combine strong performance in green innovation and dynamic services, reflecting advanced research systems and developed high-end service sectors. By contrast, Continental export-led manufacturing-based regimes such as Austria and Germany, together with Finland, display robust industrial ecosystems that underpin their leadership in green manufacturing. These differences point to an emerging division of labor in the European green transition, with countries embedding themselves in specific and interdependent segments of the green value chain.

On the skills dimension, we find a consistent complementarity between advanced Science, Technology, Engineering, and Mathematics (STEM) training and national specialization in green sectors. Bivariate analysis and PCA loadings show that STEM doctorates are tightly linked to innovation capacity, while STEM graduates align closely with green manufacturing. These results align with recent CPE scholarship highlighting higher education as an emerging instrument of industrial policy for the twin transition and the proactive role of governments in channeling students into strategically vital fields such as STEM (Durazzi et al. 2025).

This article makes three contributions. Theoretically, it bridges CPE scholarship on models of capitalism with the literature on the political economy of the green transition. By developing theoretical expectations on countries' likely economic specializations within the green value chain, it highlights how domestic supply- and demand-side conditions may shape the trajectories of different economic models. Empirically, it offers, to the best of our knowledge, the first comprehensive empirical-descriptive investigation of cross-country variation in green transition pathways. Drawing on the concept of growth regimes (Hassel and Palier 2021), it maps how different models of capitalism perform across four key segments of the green value chain at the nexus of demand- and supply-side dynamics. Finally, the article zooms into a specific component of countries' broader set of institutional resources, i.e., their skill formation systems, to illustrate how distinct national skill ecosystems may support countries' specialization along the green value chain (Di Carlo and Durazzi 2023).

The remainder of the article is structured as follows. Section 2 situates our study within broader debates on the political economy of the green transition, emphasizing our contribution to institutional comparative analyses. Section 3 introduces our analytical framework in two steps: first, it elaborates on the four segments of the green value chain; second, it theorizes how four ideal-typical growth regimes derived from the CPE literature may be expected to specialize across different segments of the green value chain and how distinct skill profiles could be expected to underpin such green specializations. Section 4 details the data sources and methodology of our analysis, while Section 5 presents and discusses the empirical findings. The concluding section summarizes the argument and findings, acknowledges limitations, and outlines avenues for future research.

2 | The Comparative Political Economy of the Green Transition: A Literature Review

Reducing greenhouse gas (GHG) emissions requires a far-reaching transformation of contemporary economies and societies (IPCC 2015). Since the 1990s, governments have engaged in sustained debates on climate change mitigation, leading to a series of international agreements and national commitments. However, despite broad consensus on the urgency of climate action, significant cross-national variation persists in the objectives pursued and policy instruments deployed to advance the green transition (Lebdioui 2024). CPE offers valuable analytical tools to examine such variation by investigating how domestic *ideas*, *interests*, and *institutions* mediate external pressures for reform, thereby shaping divergent national trajectories (Hall 1997). The burgeoning literature on the green transition can thus be reviewed through this tripartite heuristic (see also Schmid et al. 2021).

Scholars examining the ideational foundations of the green transition have explored how beliefs, norms, and values shape political support for decarbonization policies (Kammermann and Dermont 2018). This literature investigates both the normative orientations of voters and political parties, analyzing public preferences for green policies (Armingeon and Bürgisser 2021; Thomas et al. 2022) as well as partisan positioning on environmental issues (Farstad 2018; Fraune and Knodt 2018; Lockwood 2018). In addition, recent work has highlighted the role of normative frames—such as 'just transition' and 'sustainable development'—in informing policy discourses and practices at both national and international levels (Cigna et al. 2023; Mandelli 2022).

Interest-based approaches highlight the material stakes of key actors and their capacity to promote or obstruct the adoption of green policies. This literature typically focuses on three main categories of actors. First, state actors are portrayed as pivotal agents of structural change and decarbonization, either by confronting entrenched vested interests (Allan and Nahm 2025; Meckling and Nahm 2022; Mildenberger 2020) or by assembling "winning coalitions" for climate action through green industrial policy (Ergen 2017; Meckling et al. 2015). Second, green and mainstream political parties have emerged as influential drivers of climate legislation, responding to voters' growing environmental concerns and strategically leveraging ecological and eco-social platforms for electoral gains (Abou-Chadi 2016; Mandelli 2024). Third, producer groups exert significant influence over policy outcomes, particularly when transition costs and benefits are highly concentrated. Research shows that fossil fuel incumbents often mobilize to block transition policies (Aklin and Urpelainen 2018; Green et al. 2022), while the presence of a sizable "decarbonizable sector" can enable the formation of supportive coalitions for ambitious climate policy (Kupzok and Nahm 2024).

Finally, institutionalist approaches underscore how distinct national institutional configurations shape the incentives and constraints confronting policy actors and economic stakeholders in the green transition (Dubash et al. 2021). This literature spans a range of institutional domains—at both macro and firm levels—to account for cross-national variation in decarbonization trajectories (Lockwood et al. 2017). First, state capacity (Collington 2024; Driscoll and Blyth 2025; Singh 2023) and bureaucratic structures (Meckling and Nahm 2018) are identified as critical enablers of policy design, coordination, and implementation. Second, electoral rules and systems of interest intermediation condition the political feasibility of climate investment, particularly where redistributive outcomes stretch across time and social groups (Finnegan 2022). Third, supply-side institutions underpin national capacities for green innovation, technological upgrading, and manufacturing production. These include national business systems and innovation regimes supporting the invention and production of clean technologies (Ćetković and Buzogány 2016; Driscoll 2024; Ergen 2017; Lachapelle et al. 2017; May and Schedelik 2021; Mikler and Harrison 2012; Nahm 2022) as well as skill formation systems increasingly repurposed to meet emerging occupational demands in the green economy (Busemeyer et al. 2025; Carstensen et al. 2024; Durazzi et al. 2024). Finally, recent work has examined how corporate governance institutions shape firms' capacities and incentives to pursue green restructuring (Ferguson-Cradler 2024).

In sum, while existing research has yielded valuable insights into how institutional configurations shape decarbonization trajectories, it remains limited in both comparative scope and conceptual breadth. With the exception of Guarascio et al. (2024), most comparative studies concentrate on a narrow set of countries—e.g., Germany, China, and the US (Nahm 2021)—or examine only discrete policy sub-domains of the green transition in isolation. This article seeks to advance institutionalist accounts of the green transition by providing a systematic, theory-informed, and empirically grounded analysis of cross-national variation across different European models of capitalism. To this end, we integrate insights from the VoC framework (Hall and Soskice 2001) and the more recent literature on growth models (Baccaro et al. 2022; Baccaro and Pontusson 2016) and growth regimes (Hassel and Palier 2021).

3 | Worlds of Green Capitalism: Models of Capitalism and Skills Along the Green Value Chain

In developing our theoretical framework, we build on Lachapelle et al. (2017) and Nahm (2022), who emphasize the collaborative and interdependent character of the green transition. Rather than conceiving it primarily as a geopolitical competition for technological dominance, these authors conceptualize the green transition as a *global division of labor*. Whereas academic and policy debates often frame the process as a "green tech race" (Kleimann et al. 2023), the division-of-labor perspective offers a more nuanced account by emphasizing the cross-country collaborative dimension of the green transition. From this vantage point, firms embedded in distinct models of capitalism tend to specialize in specific segments of the green value chain, drawing on the institutional resources provided by their domestic political economies (Nahm 2021). Because no country or firm can be self-sufficient in today's complex innovation and production systems, economies tend to specialize in different segments of the green tech supply chain, resulting in strategic (inter-)dependencies with foreign partners (Caravella et al. 2024). This behooves us to analyze how different European models of capitalism perform across different segments of the green value chain. Following the categories outlined in this special issue's introduction, we conceptualize the green value chain as a transnational process composed of four distinct segments: *innovation*, *manufacturing*, *services*, and *deployment*.

The innovation stage constitutes the foundational phase of technological development, bridging laboratory research and prototyping to enable commercial application (Nahm 2021, 36). It is pivotal to the green transition and brings together diverse actors and capabilities—including public and private research laboratories, venture capital firms, and state R&D funding mechanisms—necessary to generate the intellectual property underpinning green technologies (Lachapelle et al. 2017, 320; see also Ćetković and Buzogány 2016; May and Schedelik 2021; Mikler and Harrison 2012). The manufacturing stage builds on these innovations, focusing on the production and scaling of technologies such as solar photovoltaic systems and wind turbines (Anzolin and Lebdioui 2021; Nahm 2021). As the intermediate step between technological breakthroughs and market deployment, this stage relies on precision engineering and incremental innovation to ensure the reliability and scalability of green technologies in global markets (Allan et al. 2021; Anadon et al. 2016; Mikler and Harrison 2012). Green services encompass specialized activities that facilitate innovation, manufacturing, and deployment. Following the category of so-called "dynamic services" (Ansell and Gingrich 2013; Driscoll 2024; Jones et al. 2016; Wren 2020), these include, for example, environmental protection and resource-efficiency measures, hazard mitigation, regulation and certification, green finance, sustainability consultancy, technical and architectural services, and environmental training and education (European Commission 2018). Finally, the deployment stage involves the integration of green technologies into economic and social systems. This includes, for instance, installing solar panels, constructing wind farms, deploying geothermal systems, and retrofitting buildings to enhance energy efficiency (Anzolin and Lebdioui 2021; IRENA 2024).

How do different models of capitalism specialize in distinct segments of the global green value chain, and what types of skills are mobilized to support these specializations? Guided by established theories in the comparative capitalism literature, we now turn to these core questions. A central premise in CPE holds that different VoCs exhibit distinct innovation capacities and economic specializations, shaped by the institutional features of their supply-side configurations (Hall and Soskice 2001). Complementing this perspective, the growth model approach emphasizes cross-national differences in the demand-side drivers of growth (Baccaro and Pontusson 2016). Integrating these supply- and demand-side dimensions allows us to deductively derive expectations about national specializations within the green value chain. In particular, the four segments of the value chain can be systematically mapped onto the characteristics of distinct growth regimes, as identified by Hassel and Palier (2021), whose framework provides a heuristic synthesis of the VoC and growth model approaches (see Table 1 for an overview).

Three segments of the green value chain—innovation, manufacturing, and dynamic services—are primarily supply-side production activities shaped by the institutional resources of national models of capitalism (Nahm 2022).[1] By contrast, the deployment of clean energy sits at the intersection of supply and demand: the domestic installation of low-carbon technologies stimulates demand through consumption and investment (Anzolin and Lebdioui 2021), particularly in sectors such as housing and utilities (Lachapelle et al. 2017). This process is typically supported by generous public incentives that increase the affordability and uptake of green technologies (IEA 2022). Yet, effective deployment also hinges on supply-side capacity, notably a workforce equipped with the skills required to install and maintain green technologies. Scaling up energy-efficient building retrofits, for instance, presupposes not only household consumption but also an adequate supply of (vocationally-) skilled labor.

While supply-side institutions, therefore, largely determine national capabilities in innovation, manufacturing, and services, the deployment stage necessitates also the incorporation of demand-side dynamics. The growth regimes framework is particularly useful in this regard, as it integrates analysis of supply-side institutional arrangements that structure production (Hall and Soskice 2001) with demand-side drivers of growth (Baccaro and Pontusson 2016). Given data constraints, our analysis focuses solely on four of the five regimes identified by Hassel and Palier (2021): high-quality manufacturing export-led regimes, dynamic services export-led regimes, FDI-financed export-led regimes, and publicly financed domestic demand-led regimes.[2] In the remainder of this section, we develop expectations about the segments of the green value chain in which each regime could be expected to specialize and identify the types of skills that are likely to be mobilized in support of these economic functions.

In high-quality manufacturing export-led regimes—exemplified by Germany as the archetypal coordinated market economy (CME)—net exports serve as the primary driver of growth, while domestic demand remains structurally subdued to preserve international competitiveness (Baccaro and Höpner 2022). These economies sustain persistent current account surpluses through technologically advanced, large manufacturing sectors specialized in the export of high-quality goods (Storm and Naastepad 2015). By contrast, financialization and high-end services remain comparatively underdeveloped, reinforcing the centrality of manufacturing in the productive system (Wren 2020). Supply-side institutions and economic policies are correspondingly organized to safeguard the competitiveness and resilience of the export sector (Hassel 2014; Di Carlo et al. 2024). In the context of the green transition, such regimes are well positioned to capture significant market shares in green manufacturing, while likely maintaining only moderate levels of green deployment to avoid stimulating domestic demand. A defining feature of green manufacturing is its reliance on high-quality technical skills, enabling firms to apply advanced green technologies in the production of low-carbon goods. Two institutional sites are central to producing these skills: vocational education and training (VET) systems and higher education. Collective skill formation in VET—based on close coordination between firms, unions, and the state—has proven effective in supplying technical skills aligned with the evolving demands of high-tech manufacturing (Durazzi and Tonelli 2025; Emmenegger et al. 2023; Thelen 2019). Recent research suggests that such systems may be particularly well suited to foster green skills,

TABLE 1 | Growth regimes' expected specialization across the green value chain and corresponding skill system.

Growth regime	Green innovation	Green manufacturing	Green dynamic services	Green deployment	Skills profiles and systems
High-quality manufacturing, export-led	Medium—applied R&D and incremental innovation	High—precision engineering, incremental upgrading	Medium—engineering and technical services linked to manufacturing	Low–Medium—export orientation limits domestic deployment	Strong collective VET producing high-quality technical skills; targeted expansion of STEM graduates
Dynamic services, export-led	High—disruptive innovation and R&D in green services	Medium—specialized production supported by dynamic services	High—expertise in green dynamic services	High—balanced growth model supports domestic demand and deployment	High-quality dual VET plus open-ended higher education expansion; significant STEM doctorates for advanced R&D
FDI-financed, export-led	Low—limited domestic R&D and innovation capacity, reliance on foreign technology transfer	Medium–high—cost-efficient production within (green) global value chains	Low—minimal specialization in green dynamic services	Low—constrained by fiscal austerity and low domestic demand	Medium-level vocational skills from underdeveloped VET; dependence on skills and technology transfer from foreign firms
Publicly financed, domestic demand-led	Low—limited domestic R&D and innovation capacity, reliance on external technologies	Medium—simple assembly and processing activities	Low—minimal specialization in green dynamic services	Medium—deployment driven by public investment, but hampered by fiscal constraints and weak VET	Weak VET systems limit green skill supply; reliance on constrained public funding for skill development

Source: authors' elaboration.

provided consensus emerges among stakeholders on the urgency of the transition and the system remains open to new actors from the green economy (Busemeyer et al. 2025, 2). Higher education has likewise been strategically leveraged to support green manufacturing through targeted state-led expansion of STEM enrollments—fields crucial for green technological upgrading (Diessner et al. 2022; Durazzi et al. 2025). Evidence from Germany underscores the effectiveness of this strategy: between 2005 and 2017, the number of engineering graduates employed in green-related sectors increased by 187%, highlighting their growing importance as a source of highly skilled green labor (Anger et al. 2020, 39).

In contrast, dynamic services export-led growth regimes—the Nordic service-oriented CMEs—pursue a more balanced growth model that combines strong export performance with sustained domestic demand (Baccaro and Pontusson 2016; Erixon and Pontusson 2022). These economies have gradually shifted from manufacturing-based growth to one driven by high-value-added service sectors (Hassel et al. 2020, 65), a transformation facilitated by financialization and the expansion of ICT-intensive activities characteristic of the knowledge economy (Anzolin and Benassi 2024; Haskel and Westlake 2018). Their institutional architecture rests on advanced innovation ecosystems and digital infrastructures (Thelen 2019), reinforced by significant public and private investments in environmentally oriented R&D (Driscoll 2024; Guarascio et al. 2024). This configuration positions Nordic countries such as Denmark, Finland, Norway, and Sweden as likely frontrunners in both green innovation and dynamic services. The balanced growth strategy of these regimes—combining strong export performance with robust domestic demand—also positions them to excel in deployment, where proactive government policies promote renewable energy use and mobilize service-sector expertise to stimulate domestic consumption and accelerate the adoption of low-carbon technologies (Anzolin and Lebdioui 2021; Lebdioui 2024). At the core of their innovation capacity lie advanced R&D activities—spanning basic and applied research (Ornston 2013)—which hinge on highly specialized skills, often associated with doctoral-level training in STEM disciplines (Durazzi et al. 2024). By contrast, dynamic green services rely on more general and transferable competencies, typically cultivated through the broad-based expansion of higher education (Durazzi et al. 2025). Support for green deployment is further reinforced by high-quality VET systems, comparable to those of manufacturing-led regimes. These play a vital role in "greening" occupational profiles at the lower end of the skill distribution and enhancing their attractiveness to younger cohorts. A notable example is the revitalization of Denmark's VET system, where training programs for electricians and plumbers have been strategically updated to meet the demands of the green transition, explicitly linking these roles to the broader societal goal of creating "green jobs" (Carstensen et al. 2024).

FDI-financed export-led growth regimes, prevalent in Eastern European countries, are characterized by comparatively large manufacturing sectors (Hassel et al. 2020, 66). These economies rely heavily on FDI and are deeply integrated into global production networks, often functioning as hubs for cost-efficient manufacturing and assembly (Nölke and Vliegenthart 2009). Domestic demand is structurally constrained by low wage levels and fiscal austerity, both strategically maintained to preserve competitiveness and retain foreign producers (Ban and Adascalitei 2022; Bohle and Greskovits 2012, 2019). Financialization, ICT development, and dynamic service sectors remain underdeveloped, limiting opportunities for the diversification of their growth strategies. FDI-led economies, such as Czechia, Hungary, and Poland, are likely to achieve moderate specialization in green manufacturing while maintaining low levels of green technology deployment to keep domestic demand subdued. Their specialization is supported by medium-level vocational skills, produced through relatively weak VET systems (Hassel et al. 2020). Although integration into global supply chains may facilitate the manufacturing of renewable energy components, their innovation capacity remains constrained by reliance on technology transfer from multinational corporations and underdeveloped dynamic services. Green technology deployment is likewise expected to remain modest, as fiscal austerity and low wage levels restrict both household consumption and governments' fiscal capacity to support large-scale renewable energy adoption.

Finally, publicly financed, demand-led economies—most notably in Southern Europe—pursue state-led growth strategies in which public resources are often directed toward consumption-enhancing social policies (Di Carlo et al. 2024; Hassel et al. 2020, 69). These economies have been marked by the substantial expansion of low-end service sectors, particularly tourism and hospitality (Bürgisser and Di Carlo 2023), alongside relatively limited high-end services (Baccaro 2022, 29) that are crucial for the development of a knowledge-based economy. Within the green value chain, these economies could be expected to specialize in the deployment segment, relying on demand-side policies to stimulate the adoption of low-carbon technologies and to foster domestic economic activity. Yet the effectiveness of such deployment is constrained by high levels of public indebtedness and the fiscal strictures of the European Monetary Union (Scharpf 2016), as well as by VET systems that lack the dynamism and attractiveness of the Nordic and Continental European dual models. This latter institutional weakness risks generating bottlenecks in the supply of green technical skills, particularly at the lower end of the occupational structure (CEDEFOP 2023).

4 | Data and Methods

We proceed to test the theoretical expectations outlined in Section 3 and summarized in Table 1 using descriptive methods, including comparative country-mapping, correlational evidence, and PCA. Our aim is to conduct a theory-guided inductive analysis to explore variation across countries, consistent with the typological tradition of CPE (Emmenegger et al. 2015; Hassel and Palier 2021). Given the hard constraints posed by data availability and reliability, our empirical scope is limited to 25 European countries and focuses on the year 2021 or the latest available data.[3]

We compile an original dataset drawing on multiple sources, including the International Renewable Energy Agency (IRENA), the Organization for Economic Co-operation and Development (OECD), Eurostat, and UNESCO. Our empirical mapping

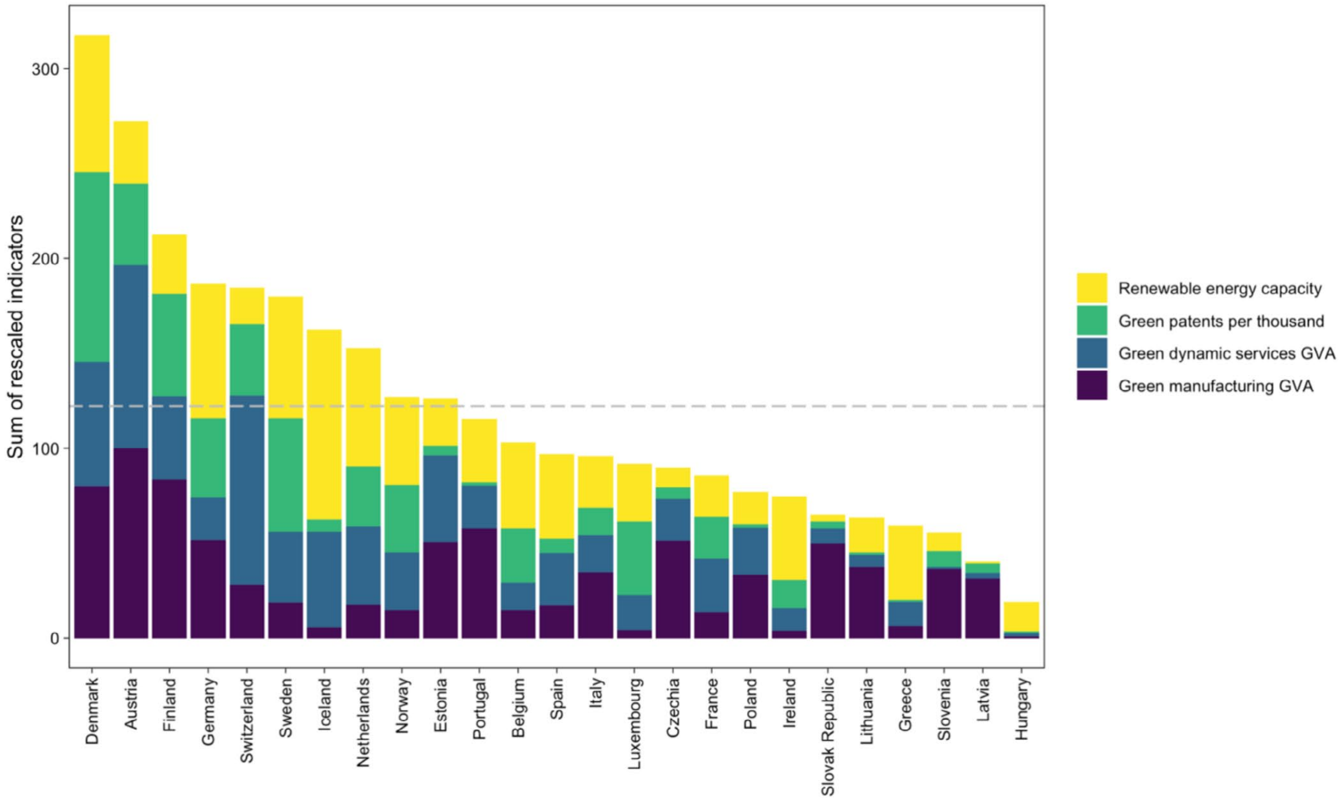

FIGURE 1 | Green capitalism ranking index, European countries (2021). Note: Each variable is rescaled to a 1–100 scale and combined to generate the stacked bars: Renewable energy capacity (MW per 1000 inhabitants, excluding hydropower and biomass), green patents per 1000 inhabitants, green dynamic services GVA (% of total GVA), and green manufacturing GVA (% of total GVA). All data refer to 2021 or the latest available year. The gray dashed line denotes the sample mean.

follows the four segments of the green value chain—innovation, manufacturing, dynamic services, and deployment—through which we conceptualized the green transition. We match these segments as closely as possible to available data and employ the resulting indicators (detailed in Online Appendices 1 and 2) to construct a multidimensional indicator of green capitalism development, comparable across countries (see Figure 1).

Green innovation is proxied by the number of environment-related patents per thousand inhabitants, using OECD data (OECD 2024a). The OECD identifies green patents through the "ENV-TECH" methodology, which classifies technologies into categories such as environmental management, energy-related inventions, GHG capture and storage, green ICT applications, climate mitigation technologies for buildings, transport, and waste management (Favot et al. 2023). Typical examples include innovations in batteries, smart grids, electric vehicles, and energy efficiency technologies.

Green manufacturing is measured by the gross value added (GVA) of industries classified as "green manufacturing" as a share of total GVA (see Online Appendix 5 for details), using Eurostat data (Eurostat 2024a). This category includes the production of renewable energy technologies—such as solar panels, turbines, and biomass boilers—as well as processes designed to improve energy efficiency and reduce energy losses.

Green dynamic services are measured using Eurostat's environmental economy dataset (Eurostat 2024a). We calculate the share of green dynamic services—defined as service activities aimed at environmental protection, resource efficiency, and mitigation of environmental harm—in total GVA. This category includes activities such as environmental consulting, green architecture and engineering, sustainability certification, green finance, and environmental education. Informed by Wren's (2013) typology of dynamic services, we approximate dynamic green services by including five sectors as defined by NACE Rev. 2 classifications: transportation and storage; information and communication; financial and insurance activities; real estate activities; and professional, scientific, and technical activities. The combined GVA of these sectors is expressed as a share of total GVA to produce a cross-country comparable indicator.

Green deployment is proxied by the installed renewable energy capacity, expressed in megawatts (MW) per thousand inhabitants, using IRENA data (IRENA 2025). This indicator covers solar (thermal and photovoltaic), onshore and offshore wind, and geothermal energy. To capture contemporary pathways to decarbonization, we exclude biomass and hydropower, as these sources predate the recent decarbonization turn and have been widely used in some countries since the 1970s (e.g., the Nordics; see Online Appendix 6 for further discussion).[4] For robustness, however, we replicate the analysis including biomass and hydropower; results remain largely consistent (see Online Appendices 7 and 8).

To examine countries' education and training systems, along with their associated skills profiles, we employ four indicators that build on the classic distinction between specific and general skills—created respectively via vocational training and higher education (Hall and Soskice 2001; Thelen and Culpepper 2007). These indicators are also informed by recent contributions to the literature on skill formation in the context of the green transition (Busemeyer et al. 2025; Durazzi et al. 2024, 2025; see also the Introduction to the Special Issue).

STEM doctorates, based on Eurostat (2024b), are measured as the number of doctoral-level graduates in STEM disciplines per thousand inhabitants aged 25–34. This indicator captures highly specialized skills at the upper end of the education spectrum, which are essential for R&D-driven technological breakthroughs (Swift 2018; Thune and Børing 2015).

STEM graduates are measured as the proportion of tertiary graduates in STEM fields and are based on UNESCO (2024) data. This indicator reflects the extent to which governments have pursued a *targeted expansion* of higher education—prioritizing STEM disciplines that are particularly relevant for advanced manufacturing (Diessner et al. 2022; Durazzi 2023; Durazzi et al. 2025).

Higher education graduates, based on Eurostat (2024b), are measured as the share of people aged 25–34 with a tertiary degree. This serves as a proxy for the *open-ended expansion* of higher education, a strategy often pursued by governments to supply high-level skills for dynamic service sectors (Durazzi et al. 2025). In a complementary analysis, we also use the share of non-STEM graduates as an alternative measure of open-ended expansion, which yields similar results (see Online Appendix 9).

Finally, *Dual VET shares*, based on OECD (OECD 2024b), are measured as the share of VET students in secondary education enrolled in 'dual' programs combining classroom- and firm-based training. Due to data gaps, we use the latest available observation for each country, with some series ending at the year 2011. Although this constitutes a limitation, dual VET shares are typically time-invariant, which increases our confidence in the reliability of this variable for the analysis. High dual VET participation serves as a proxy for high-quality VET systems, which have been shown to adapt more effectively to socio-economic and technological shifts, including those related to the green transition (Carstensen et al. 2024; Durazzi and Tonelli 2025).

Our empirical strategy combines descriptive statistics with PCA to uncover cross-country patterns (Ferragina and Filetti 2022; Jolliffe and Cadima 2016). PCA is well suited to reduce complexity in multi-dimensional data, as it summarizes variation across many indicators into a smaller number of components. Rather than examining variables in isolation, PCA generates new composite indicators—principal components (PCs)—that capture the main sources of variance. The first two PCs usually explain the largest share of variation and provide a parsimonious visualization of how countries differ across multiple dimensions.

The advantage of PCA lies in its ability to map multi-dimensional variation onto a two-dimensional space. Countries are positioned according to their scores on the first two PCs, which can be readily interpreted through scatterplots. The method calculates how variables co-vary across the dataset and constructs uncorrelated PCs that maximize explained variance. These PCs are ranked by the amount of variation they explain and are uncorrelated with one another. Each variable contributes with distinct weights, or *loadings*, that indicate their influence on each PC. Countries located near the Cartesian axes' origin approximate the sample average across all dimensions, whereas those farther from the axes score higher or lower on specific sets of variables.

We apply the PCA to eight indicators: four capturing performance along the green value chain (green innovation, green manufacturing, green dynamic services, and renewable energy deployment) and four proxying education and training systems (STEM doctorates, STEM graduates, higher education attainment, and dual VET shares). This allows us to examine how national economies combine different forms of green specialization with distinct skills regimes. To further probe patterns, we apply K-means clustering to the PCA results and visualize the clusters with ellipses, grouping countries around centroids that represent the average position of similar cases. This inductive procedure enables us to assess whether distinctive green growth regimes emerge from the interaction of production structures and skills regimes. Finally, we complement the PCA with bivariate analyses between green economy indicators and skills variables.

5 | Findings

The empirical analysis proceeds in two steps. First, we construct a composite *green capitalism index* (Figure 1) to evaluate countries' cumulative performance across the four dimensions of the green value chain, as well as their relative position within each individual segment.[5] Second, we conduct a PCA that integrates green capitalism and skill-related variables, enabling us to examine how distinct national decarbonization trajectories align with different skills regimes.

5.1 | Green Leaders and Laggards in the European Green Value Chain

Our green capitalism index (Figure 1) reveals marked variation in green transition capacities both across and within European countries. At the cross-national level, sharp asymmetries emerge in countries' green capabilities. Nordic countries (Denmark, Finland, and Sweden) and core Continental economies (Austria, Germany, and Switzerland) consistently achieve above-average scores, positioning themselves as clear frontrunners. By contrast, countries at the lower end of the distribution—predominantly Eastern Europe's FDI-financed growth regimes and Southern Europe's publicly financed, demand-led models—appear as systematic laggards. This polarization underscores the uneven distribution of decarbonization capacity across the continent and signals the likely emergence of structural winners and losers in Europe's green transition.

Countries also diverge in their economic specialization across the segments of the green value chain. Even among the leading performers on the composite green capitalism index, distinct national profiles emerge, reflecting differentiated strengths in innovation, manufacturing, dynamic services, and deployment.

Denmark, Austria, and Finland—the top three performers—display relatively balanced capacities across the four segments of the green value chain. By contrast, other high-scoring countries reveal more pronounced specializations. Switzerland is strongly oriented toward green dynamic services (see Appendix 2), while Sweden's comparative advantage lies in green innovation. Iceland, in turn, stands out for its exceptional renewable energy capacity. Among export-led manufacturing regimes, Austria and Germany both exhibit particularly strong green manufacturing sectors, accounting for 1.8% and 0.9% of total GVA, respectively (see Appendix 4). Yet these two countries diverge markedly in the scale of their green dynamic services, which remain comparatively small in Germany but substantial in Austria.

Interestingly, the group of green laggards—despite low overall scores—exhibits notable levels of green manufacturing specialization. Within the FDI-financed growth regimes (Czechia, Slovak Republic, Slovenia, and Poland), performance is weak across three core dimensions of the green transition—innovation, dynamic services, and deployment—yet comparatively stronger in green manufacturing. Among Southern European economies characterized by publicly financed demand-led growth regimes, Portugal and Italy host relatively large green manufacturing sectors, whereas France and Spain display stronger specialization in green dynamic services. Spain, Greece, and Portugal also perform relatively well on renewable energy deployment, consistent with expectations for publicly financed, demand-led growth.

Overall, the empirical patterns partly align with theoretical expectations from the comparative capitalism literature, while also refining them in important respects. First, significant cross-national asymmetries emerge in the extent of green transition capabilities: Nordic and Continental European economies appear as leaders, while Southern and Eastern European economies remain laggards. Second, important intra-cluster variation characterizes the group of leaders. Nordic service-based regimes combine strong specialization in green services and innovation with medium-to-high deployment capacity and some manufacturing strength, whereas Continental manufacturing-based regimes display robust green manufacturing capabilities, with Austria and Switzerland also hosting large dynamic services. By contrast, FDI-financed and publicly financed demand-led regimes are generally weaker performers. Even so, Central Eastern European countries and Italy display notable green manufacturing capacities, while Greece and Spain perform relatively strongly on deployment.

5.2 | Varieties of Green Capitalism: Economic Specializations and Skills Regimes in Europe

In this section, we integrate the analysis of green capitalism indicators with skills-related variables to examine how distinct economic specializations across growth regimes are associated with—and underpinned by—differentiated national skills profiles. Before turning to the PCA results, we begin with bivariate relationships between key segments of the green value chain and various skill indicators (Figure 2).

The results provide preliminary support for two theoretical expectations outlined in Section 3. First, we find a strong positive correlation between STEM doctorates and green patent intensity ($r = 0.551$). Second, we observe a similarly strong association between the share of STEM graduates and green manufacturing GVA ($r = 0.515$). Taken together, these findings suggest a systemic alignment across Europe between advanced STEM skills and strategic segments of the green value chain—namely, innovation and manufacturing.

Other relationships, though weaker, are nonetheless noteworthy. The share of dual VET is positively, albeit modestly, correlated with both green manufacturing and deployment. This does not contradict expectations; rather, it highlights the broader economic role of dual VET systems, which extend beyond green sectors narrowly defined. Unlike the targeted application of advanced STEM skills in innovation and manufacturing, dual VET appears to support a wider spectrum of industrial and service activities. A similar logic applies to the weak association between higher education graduates and green dynamic services: because green services account for only a fraction of a larger and more diverse service sector, broad-based expansion of higher education is likely to feed into a wide array of service activities, diluting any specific link to green services alone.

After examining countries' green capitalism "performance" along the green value chain (Figure 1) and its correlations with skill variables (Figure 2), we proceed with a PCA that integrates green capitalism and skill-related indicators (Table 2). As expected, PC1 (x-axis in Figure 3) loads positively on all green capitalism variables, with particularly strong associations for green innovation, dynamic services, and manufacturing, and a more moderate—but still positive—association with renewable energy deployment (Table 2). Among the skills indicators, STEM doctorates, STEM graduates, and dual VET all load positively, while higher education graduates also load positively but to a lesser extent. Consistent with the composite index constructed above (Figure 1), we interpret PC1 as an overall measure of green capitalism capacity, capturing the extent to which countries align innovation, production, and skill formation with the green transition.

PC2 reveals a more nuanced pattern of cross-country differentiation. Green manufacturing and STEM graduates load positively, while higher education graduates, renewable energy capacity, STEM doctorates, and dual VET shares load negatively. This axis therefore distinguishes between two alternative green growth configurations. At the positive pole are manufacturing-centered regimes, sustained by a targeted expansion of STEM graduates. At the negative pole are economies oriented toward innovation, dynamic services, and renewable deployment—underpinned by stronger supplies of STEM doctorates, vocational training, and broad higher-education expansion. PC2 captures therefore structural divergence in how national economies specialize within the green transition, reflecting distinct skill regimes and industrial orientation.

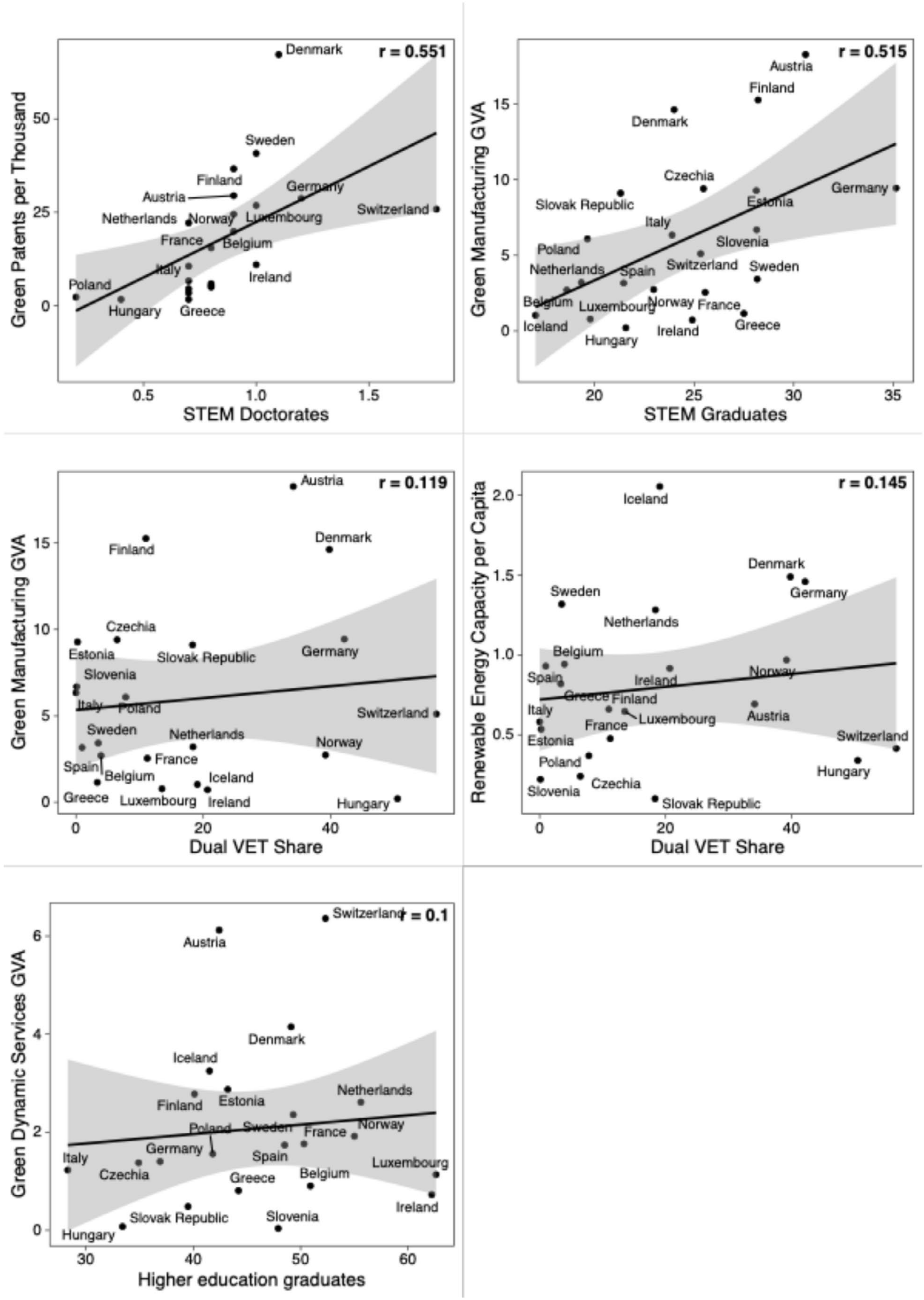

FIGURE 2 | Bivariate analyses of green capitalism and skill variables. Note: Solid black lines denote the ordinary least squares (OLS) line of best fit. All variables refer to 2021 or the latest available year.

TABLE 2 | PCA loadings per indicator and cumulative variance across the first two components.

Green capitalism indicators	PC1	PC2
Green patents per thousand inhabitants	**0.48**	−0.08
Green dynamic services GVA, share of total GVA	**0.46**	0.04
Green manufacturing GVA, share of total GVA	0.30	**0.54**
Renewable energy capacity (MW per thousand inhabitants)	0.23	−0.36
Skills indicators		
STEM doctorates per thousand aged 25–34	**0.46**	−0.17
Dual VET shares on all secondary VET students	0.35	−0.07
STEM graduates (share of total graduates)	0.25	**0.45**
Higher education graduates (% of people aged 25–34)	0.12	**−0.57**
Standard deviation	1.73	1.34
Cumulative variance	0.37	0.60

Note: Following Ferragina and Filetti (2022), coefficients in bold indicate variables more strongly correlated (positively or negatively) with the principal components.

Figure 3 situates countries along these two PCs. The horizontal axis (PC1) reflects overall green capitalism capacity, with higher values denoting stronger performance across the value chain. The vertical axis (PC2) separates manufacturing-centered profiles (upper half) from innovation- and deployment-oriented ones (lower half), with dynamic services occupying an intermediate position but leaning toward the innovation pole.

The PCA reveals a dual divide: first, between green leaders and laggards along the horizontal axis (PC1), and second, among the leaders, between manufacturing-centered and innovation/services-oriented specialization along the vertical axis (PC2). In the top-right quadrant, Austria and Germany—both Continental, export-led regimes characterized by high-quality manufacturing—together with Finland, a Nordic dynamic-services regime, emerge as green industrial leaders. Their profile combines strong green manufacturing capacity with a comparatively high share of STEM graduates. By contrast, in the bottom-right quadrant, Denmark (Nordic dynamic-services, export-led) and Switzerland (Continental, export-led) exemplify a second decarbonization pathway, one oriented toward green innovation and dynamic services. This specialization rests on intense patenting activity, significant cohorts of STEM doctorates, and robust dual VET systems. Sweden and Norway (both Nordic dynamic-services regimes) occupy an intermediate position: they perform well above the European average on PC1, but fall short of the five frontrunners.

By contrast, the bottom-left quadrant brings together economies such as Iceland, Ireland, Belgium, and the Netherlands, alongside Southern European demand-led regimes like Spain and France. These countries register relatively low overall green capitalism scores. Their profiles are shaped above all by broad higher-education expansion, reflected in generalist skill profiles and high tertiary graduation rates, but weaker green innovation and manufacturing capacity.[6] Finally, the top-left quadrant is populated by Eastern European (FDI-financed) regimes (Hungary, Poland, Czechia, Slovakia, Slovenia) and Italy. Although situated at the lower end of the green capitalism index, these economies follow a manufacturing-oriented pathway, displaying moderate specialization in green manufacturing and relatively higher shares of STEM graduates, but enduring weaknesses in green dynamic services and innovation capacity.[7]

The results highlight the emergence of two distinct leading decarbonization pathways. The first is a Continental/Nordic manufacturing-centered trajectory (Austria, Germany, and Finland), underpinned by strong industrial ecosystems and a steady supply of STEM graduates. The second is a Nordic/Continental innovation- and services-oriented trajectory (Denmark and Switzerland, with Sweden and Norway in intermediate positions), driven by advanced research and patenting activity, a strong presence of STEM doctorates, and dynamic service sectors.

These leaders stand in contrast to two laggard configurations. The first, found in parts of Southern and Western Europe, reflects a higher-education–driven model (France, Spain, Belgium, Ireland, the Netherlands, Luxembourg, and Iceland), characterized by extensive tertiary expansion but limited innovation and manufacturing capabilities. The second laggard trajectory is a structurally constrained manufacturing-oriented pathway in Eastern Europe and Italy. While comparatively more specialized in manufacturing activities and supported by some STEM graduate supply, these countries remain hampered by weak innovation systems and underdeveloped dynamic services, limiting their ability to upgrade green industrial strategies.

6 | Conclusions

This article constitutes, to the best of our knowledge, the first systematic effort to theorize and empirically assess how different models of capitalism across Europe are performing and positioning themselves in the green transition. By conceptualizing the green transition as a value chain encompassing four core segments—innovation, manufacturing, services, and deployment—we developed theoretically grounded expectations about likely patterns of specialization across distinct growth regimes. We then examined how national education and training systems underpin these patterns by generating the skill profiles required to sustain specialization in each segment. These expectations were empirically evaluated through a combination of descriptive statistics and PCA.

Our findings broadly confirm several core theoretical expectations while also qualifying them in important respects. As shown by the Green Capitalism Index (Figure 1), European countries display pronounced variation in their capacity to engage with the green transition, suggesting—consistent with recent contributions (e.g., Guarascio et al. 2024)—the emergence of clear green leaders and laggards. Among the leaders, Nordic

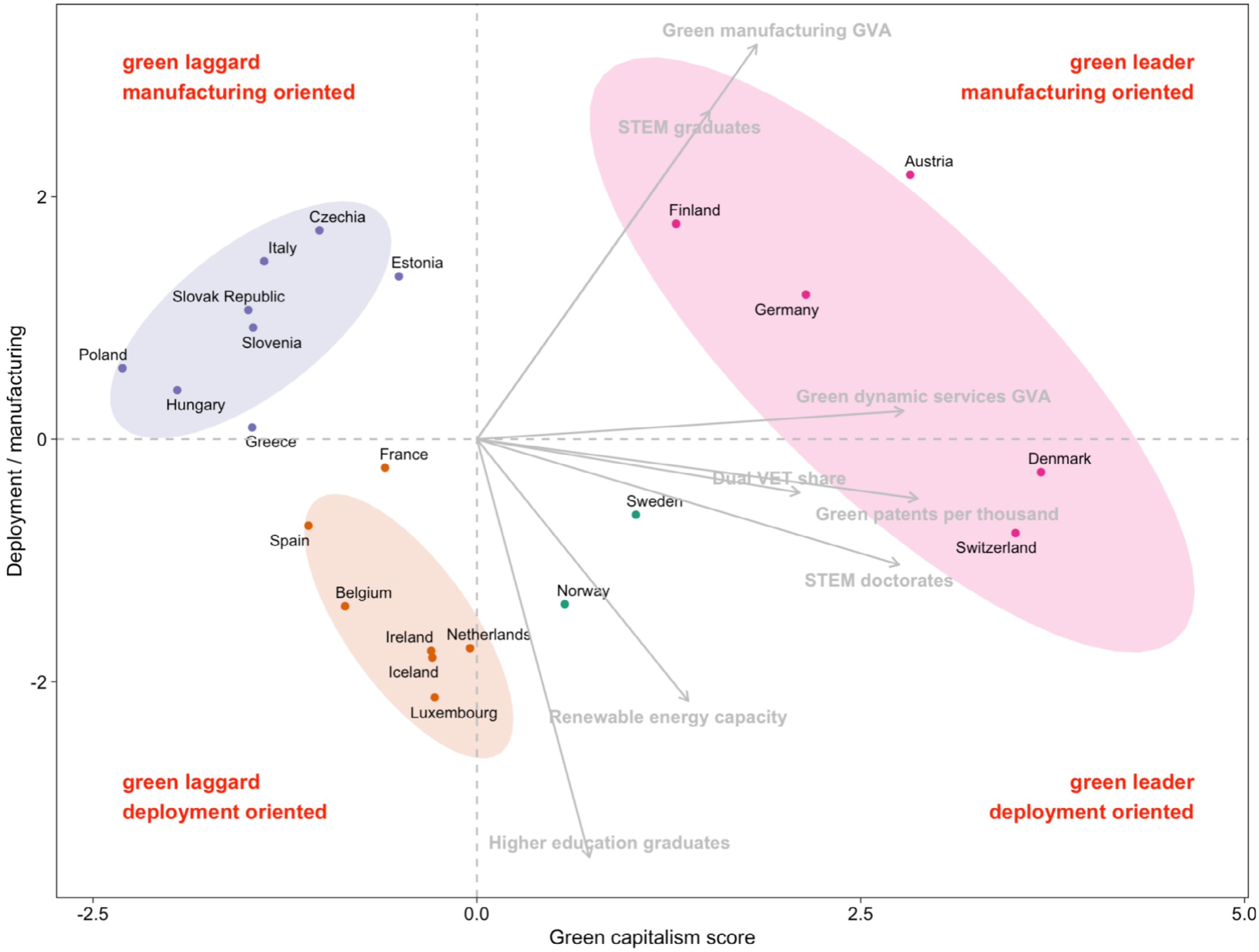

FIGURE 3 | PCA of 'green capitalism' and skill variables. Note: Variables included are green patents per 1000 inhabitants; green manufacturing GVA as a share of total GVA; green dynamic services GVA as a share of total GVA; renewable energy capacity per 1000 inhabitants (MW, excluding hydro and biomass); STEM doctorates per 1000 aged 25–34; dual VET shares (% of secondary VET students); STEM graduates (% of tertiary graduates); and higher education graduates (% of population aged 25–34). All data refer to 2021 or the latest available year. Some country observations are omitted due to missing data. Gray dashed lines denote sample averages. K-means clusters are based on countries' proximity.

dynamic-services regimes such as Denmark and Sweden—together with Switzerland, a Continental manufacturing-based economy—excel in green innovation and dynamic services, supported by strong research systems and advanced service sectors. By contrast, Continental manufacturing-based export-led regimes such as Austria and Germany, as well as Finland (a Nordic dynamic-services regime), dominate in green industrial production, reflecting the strength of their advanced export-oriented manufacturing ecosystems.

At the other end of the spectrum, Southern European publicly financed demand-led regimes (e.g., Spain, France and Italy) and Eastern European FDI-financed regimes (e.g., Hungary, Poland, Czechia, and Slovakia) largely emerge as laggards. While their overall green capitalism scores remain low, Eastern European economies and Italy exhibit modest specialization in green manufacturing, pointing to production capabilities but also weaknesses in green innovation and dynamic services. By contrast, Spain performs better on renewable energy deployment, consistent with publicly financed, demand-driven strategies. Taken together, these patterns point to a deepening stratification of green capabilities across the European political economy, with the consolidation of likely winners and the entrenchment of structurally disadvantaged latecomers in the unfolding transition.

Turning to the skills dimension, our analysis reveals that advanced STEM skills—acquired through tertiary education and doctoral training—are strongly associated with the strategic segments of the green value chain. Specifically, STEM doctorates are closely associated with green innovation (patent intensity), while the share of STEM graduates aligns with green manufacturing specialization. This suggests that the green transition is being sustained by a targeted reorientation of higher-level STEM training toward sectors requiring advanced technical expertise. In this sense, Europe's green leaders—Austria, Germany, Finland, Denmark, Sweden, and Switzerland—have reinforced complementarities between high-level STEM skills and innovation- or manufacturing-centered decarbonization pathways. This evidence reinforces recent contributions to the skill-formation literature (e.g., Durazzi 2023; Durazzi et al. 2024), which emphasize the centrality of higher education alongside the traditional focus on VET. Crucially, our results also suggest that higher education cannot be understood as a monolithic category: its contribution to the green transition depends on how governments steer students into specific disciplines, such as STEM, that directly support strategic green sectors.

While this article has provided a first cross-country empirical exploration of how different models of capitalism are engaging with the green transition, several limitations should be acknowledged. First, owing to the lack of reliable comparative data, our analysis omits key countries whose role in global green value chains is pivotal—most notably China, but also other East Asian economies such as Japan and Korea, as well as the UK and the US (Nahm 2021, 2022). Their exclusion necessarily constrains the generalizability of our findings, which remain primarily confined to European models of capitalism. Second, our analysis of the demand side of the green transition is limited by the absence of comparable cross-national data on government support for clean energy deployment.

Despite these constraints, the focus on Europe remains highly relevant. While China has emerged as the global green tech superpower (IEA 2023), the EU continues to excel in high-end climate R&D (Driscoll 2024, 189) and in manufacturing green technologies such as electric vehicles and hydro-turbines (Bontadini et al. 2023). Today, the manufacturing sector remains a key driver of green innovation, accounting for six out of every 10 global patent applications for climate change mitigation technologies (UNIDO 2023). Europe's resilience in both R&D and manufacturing thus positions it as a critical actor in shaping the global division of labor in the green transition. Conceptualizing the transition in these terms and examining how it unfolds across Europe's diverse models of capitalism is essential for evaluating the EU's capacity to shape global sustainability trajectories. It also underscores the importance of how Europe manages its relationship with China. Striking the right balance between competition and collaboration in the invention, production, servicing, and deployment of green technologies will be central to the EU's long-term strategic positioning.

Future research could address the gaps identified here by assembling comparable datasets which include China and other key players, including Japan, Korea, the UK, and the US, thereby enabling broader cross-regional analyses. Explaining cross-country variation in renewable energy deployment likewise warrants closer attention, particularly given the enduring role of historical energy legacies in shaping contemporary pathways. Small-N, process-oriented case studies could further illuminate how political agency—especially governments, political parties, and producer groups—shapes the green transition through the design and management of supply- and demand-side interventions. More broadly, while this article has linked growth regimes to specialization in different segments of the green transition, growth regimes themselves are not exogenously given. They are the product of political struggles and public policy choices that crystallize into institutional configurations enabling the pursuit of specific socio-economic goals. Future research could therefore adopt a meso-level perspective to investigate which policy choices enabled countries to specialize in particular segments of the green transition and what political processes underpinned these decisions.

By conceptualizing the green transition as a differentiated value chain and linking it to the institutional foundations and demand-side drivers of national growth regimes, this article has sought to open a new research agenda. Our findings suggest that while existing CPE frameworks offer valuable tools for theorizing national pathways in the green transition, they also reveal clear limits: growth regimes and related typologies *do not* consistently map onto distinct trajectories of green specialization, and thus cannot be applied off the shelf to explain the dynamics of green capitalism. This calls for a more refined theoretical apparatus attuned to the complementarities, trade-offs, and institutional innovations underpinning the green transition. Future research should advance this framework and systematically analyze how countries across regime types deploy public policies to restructure their economies and societies in the pursuit of decarbonization. Ultimately, approaching the green transition through the lens of CPE not only illuminates how capitalism adapts to climate imperatives, but also raises the broader question of whether—and how—capitalist institutions can be reconfigured to confront the 21st century challenges of sustainability and systemic transformation.

Acknowledgments

Previous versions of this paper were presented in internal seminars at the London School of Economics and Political Science, the University of Konstanz, the University of Milan, the University of Padova, and the University of St. Gallen, as well as at conferences including SASE 2025 and SISEC 2025. We are grateful to the colleagues who invited us to present earlier versions of this manuscript and to all participants for their feedback and suggestions, which have greatly improved the final text. Among these, we are particularly thankful to Michael Scherwin Bajka, Marius Busemeyer, Lisa Dorigatti, Patrick Emmenegger, Igor Guardiancich, Cecilia Ivardi, Marcello Natili, and Stefano Ronchi. Open access publishing facilitated by European University Institute, as part of the Wiley - CRUI-CARE agreement.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Endnotes

[1] This is not to deny that green innovation, manufacturing and service activities have implications for the demand side of the economy. However, our interest here lies predominantly in the study of the institutional ecosystem within which these production activities are embedded.

[2] The authors identify a fifth growth regime defined as *finance-based domestic demand-led*. However, data availability (which is restricted to EU countries, as detailed in section four) does not allow a meaningful investigation of finance-based growth regimes, as their ideal-types, e.g., the UK and US, are not covered in our sample.

[3] We take 2021 as the most recent year with the highest number of country-observations. Computing means across whole periods could be distortive, due to significant data availability gaps across countries.

[4] We are grateful to an anonymous reviewer and to Igor Guardiancich for urging us to make this clarification explicit.

[5] To further assess how countries position themselves across the four segments of the green value chain, we conduct a PCA on the innovation, manufacturing, services, and deployment indicators. Results (Appendix 7) broadly confirm the patterns visible in Figure 1: a clear demarcation between green "leaders" and "laggards," alongside some specialization among top performers. While the first component (PC1) closely resembles the composite green capitalism index, the second component (PC2) captures a potential trade-off between deployment capacity and manufacturing specialization, positioning countries along a vertical axis in the PCA space. These results are robust to alternative measures of renewable energy capacity (Tables 9–10 and Figures 11–12 in Appendix).

[6] Using a different proxy for higher education expansion (non-STEM graduates) yields similar results (Appendix 9).

[7] Appendix 3 reports a robustness test for the PCA, using hierarchical cluster analysis on the same set of variables. The resulting country groupings closely mirror those obtained through the PCA. Appendix 4 details each country's scores across all variables employed in the analysis.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Data S1:** Supporting Information