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## Article

# A 'return of the state' in energy transitions? The making of a hydrogen economy in the European Union

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# A “return of the state” in energy transitions? The making of a hydrogen economy in the European Union

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**Abstract:** A shifting paradigm in economic policy is re-asserting the centrality of the state for the transformative overhaul of global energy systems. Amid a burgeoning interest in state policy, however, contemporary scholarly discussions often lack a comprehensive examination of the state itself. We address this gap in economic geography and international political economy by investigating the nuanced role of the state in structuring global industries, with a focus on the emerging hydrogen economy in the European Union (EU). Further elaborating Horner’s typology of state roles in global production networks (GPN) with Jessop’s strategic-relational approach, this article replaces the states-markets dualism with concrete accounts of the co-constitutive relationships binding together the evolution of the “actually existing” State-GPN Nexus. Accordingly, we identify three underdeveloped analytical entry points, concerning (1) the conjoint interrogation of state roles, (2) finance, and (3) the historical regulatory form of the state. This conceptualization is then applied to three case studies on the developing hydrogen economy in Europe. Despite the prominent role of state capital, initiatives such as EU state aid schemes, the European Hydrogen Bank, and the spatialized industrial policy of Hydrogen Valleys reveal the prioritization of de-risking strategies through public-private partnerships more or less directly designed by democratically unaccountable industry groups.

**Keywords:** state; energy transition; hydrogen; European Union; global production network; strategic-relational approach

## 1 Introduction

On June 29th, 2023, the last newsletter by Derek Brower for the widely read *Energy Source* of the Financial Times delivered a rattling message: “Capitalism won’t deliver the energy transition fast enough ... and nor will Big Oil”. Contrary to popular belief, it contended that governments – not investment funds or oil majors – will have the upper hand in spearheading the radical overhaul of global energy systems. In recent years, initiatives like the Green New Deal, Build Back Better, and a plethora of net-zero-by-X pledges have contributed to a progressive departure from the triad of privatization, liberalization, and fiscal discipline distinctive of the Washington consensus. State capital is expanding, as evidenced by the proliferation of sovereign wealth funds (SWFs) from less than 50 at the turn of the century to almost 200 in 2023, managing over \$11.5 trillion in assets. For comparison, BlackRock, the largest asset manager, totals less than \$9.5 trillion. Similarly, state-owned enterprises (SOEs) and states’ participation as shareholders of publicly listed companies has tripled over the last two decades, now accounting for almost 11 % of global equity (\$11.7 trillion) (OECD 2024).

These trends have sparked a renewed interest in industrial policy (Chang and Andreoni 2020; Rodrik 2014), critical state theory (Jessop 2016; Johnstone and Newell 2018), new forms of developmental state (Dafermos et al. 2021; Gabor and Sylla 2023), as well as state capitalism (Alami et al. 2022; Babić and Dixon 2022). Consequently, the growing prominence of the state in economic policy has resulted in an extensive but fragmented academic literature.

Scholarly discussions often hinge on functionalist characterizations, ideal state types and roles, or comparative historical case studies – whereas the notion of the state itself oddly fades into the background. These have fostered lively and pertinent (albeit necessarily partial) debates over successful or failing strategies, state retreat versus market expansion, Washington Consensus versus variants of post-Washington Consensus, and so forth. Alternatively, we argue that neither an ideal typology of state roles

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vis-à-vis market forces nor a structuralist reading of state capitalism (that is, subjecting the unfolding of history to the diktat of capital accumulation) adequately explains *how* and understand *why* the state institutional ensemble intervenes in the world market economy. As a case study, this article addresses the under-theorization of the state in energy transition research by investigating the processes and logics through which the European Union (EU) and its member states engage in the making of a hydrogen economy.

Similar questions have recently inspired a new wave of research in international political economy scholarship (Alami and Dixon 2023; Alami et al. 2022; Babić et al. 2020; Dafermos et al. 2021) and in economic geography calling for a “more robust theorizing of state roles in GVC/GPN literature”<sup>1</sup> (De Marchi and Alford 2022, p. 89) (see also, Alford and Phillips 2018; Arnold and Hess 2017; Coe and Yeung 2019; Hess 2021; Horner 2017; Horner and Alford 2019; Mayer and Phillips 2017; Smith 2015; Werner 2021a). Moving beyond accounts that essentialize the state as an independent variable of political economic analysis (Jessop 2007, 2016), this article builds on Horner’s (2017) typology of state roles (i.e., as a facilitator, regulator, buyer, and producer) in GVC/GPN to analyze the many hats that governments wear when partaking in the threading of industrial production processes, referred to in this Special Issue as the “State-GPN Nexus”. This contributes to the ongoing debate on the State-GPN Nexus by carving out a space for the analysis of multi-layered state strategies and the social relations underlying them. Therefore, how do states “do what they do”, and why?

Section 2 reviews the resurgence of state policy in political economy debates. It also assesses the main scholarly discussions on state roles in GPN research, with a focus on the energy sector. In light of this, Section 3 introduces Jessop’s strategic-relation approach (SRA) to the “actually existing” state. Turning then to hydrogen developments in the European Union (EU), Section 4 summarizes the methodology followed in building the case study, while Section 5 presents an analysis of the hydrogen Important Projects of Common European Interest (IPCEI), the European Hydrogen Bank, and the Hydrogen Valleys, which are then discussed in Section 6.

## 2 The state in global production networks of low-carbon energy

Recently, GPN/GVC scholarship has begun to address the role of the state in industry formation more explicitly, drawing both praise and criticism. This section offers, first, an overview of the current surge of interest around state capital and its relevance for the GPN approach. Second, it summarizes the main approaches to state policy and shortcomings found in the GPN literature, with a particular focus on state roles in low-carbon energy transitions.

### 2.1 The never-ending “return of the state”

The concept of the “retreat of the state” emerged in the 1970s–80s, marking a shift from government to governance, and from centralized coercion to networked management. This was followed by incremental waves of privatization moving large chunks of public assets into private portfolios. In the current conjuncture, these trends appear to be reversing. However, whilst the “return of the state” narrative presents the state “as an independent, atomised rational actor” (Johnstone and Newell 2018, p. 79), it trims down the exercise of state power to mere imperative force (Jessop 2016, pp. 183–184). But neoliberal globalization did not lead to a disappearance of the state’s economic power, nor a retreat of regulatory institutions. Instead, it reconfigured nation-state strategies in favor of transnational capital, multilateral institutions, and international actors.

Following almost half a century of neoliberal praxis, critics argue that the “new” macro-economic paradigm promotes the valorization of private capital by mobilizing public finance. Gabor (2021) gave this phenomenon a catchy title: the “Wall Street Consensus”. As a result, the state apparatus is summoned to de-risk economic development by providing a safety net for institutional investors and private developers. De-risking does not eliminate investment risks, but it rather transfers them “from the private to the public sector” (Hunt and Tilsted 2024, p. 3). This incipient economic regime is evident in the proliferation of private-public partnerships (PPPs) to leverage private capital flows. PPPs are thus sealed between private actors – who are called to finance, manage, and profit from the development of social infrastructure and public services – and state agencies – who become risk-bearing partners via long-term agreements, production subsidies, financial buffers, first-loss payment schemes, and similar guarantees (Bayliss and Van Waeyenberge 2018; Bayliss et al. 2020). These trends are observed not only in the Global South, as seen in hydrogen

<sup>1</sup> Where GVC stands for global value chain, and GPN for global production network. In the remainder of this article, we will mostly refer to GPN, unless otherwise necessary.

developments in Namibia (Gabor and Sylla 2023) or solar energy projects in Zambia (Elsner et al. 2022), but also in high-income countries, such as the EU’s focus on hydrogen industrial policy (Kalvelage and Tups 2024; Vezzoni 2024).

Arguably, the PPP-led de-risking state “lacks an autonomous strategic vision” and is subservient to transnational financial capital (Gabor 2021, p. 422). Nevertheless, without neglecting the growing influence of financialization on development policy, it would be equally reductive to overlook the existence of multiple, conjunctural, regional state strategies. Schindler et al. (2023), for instance, suggest that the recent surge in large-scale infrastructural developments, the (re)nationalization of key industries, the expansion of state’s shareholder positions, and other spatialized industrial strategies reflect a distinctly strategic vision of the state. More precisely, despite acquiring new market-based organizational forms (such as the public listing of SOEs), governments strive to accommodate global investors while mobilizing state capital in line with domestic and regional (hence, “spatial”) accumulation strategies (Bridge and Faigen 2023; Rutherford and Holmes 2008; Schindler et al. 2023) – including industrial hubs, electricity generation facilities, transmission lines, and other large infrastructural projects aimed at strategic coupling with global production networks as well as fostering the formation of a consumptive middle-class. This is precisely what O’Sullivan and Rethel (2023, p. 325) find in the case of Malaysia and Indonesia, where domestic political considerations favor “domestic strategies of accumulation and middle-class preferences” over international investor demands.

Alami et al. (2022, p. 259) identify the study of these empirically observed economic processes as state capitalism research: “a flexible set of critical interrogations concerning the changing role of the state”, rather than rigid sets of concepts or models. Given the unprecedented scale of investments required for the (so far, only tentative) shift away from fossil fuels, the upgrade to low-carbon sources has become a primary catalyst for renewed interest in state policy (Babić and Sharma 2023; Gabor and Sylla 2023; Johnstone and Newell 2018). These concerns have been central to GPN scholarship since its inception as a heuristic to investigate “the material world in which people struggle to make their lives [...] [and] the fundamental structural and relational nature of how production, distribution and consumption of goods and services are – indeed always have been – organized” (Coe et al. 2008, pp. 271–272).

The GPN approach emphasizes the multilayered economic relationships that weave the tapestry of global industries beyond essentialized agents like “the firm” or “the

state” (Bridge and Bradshaw 2017; Coe and Yeung 2019; Coe et al. 2008). As a conceptual framework, the GPN also emphasizes the extra-firm sets of “competing agendas and asymmetric power relations through which” global production takes place (Bridge and Bradshaw 2017, 222). In sum, the GPN provides “a powerful heuristic device to grasp the complex determinations of an increasingly integrated and structured global economy” (Werner 2016, 458). It thus offers a privileged entry point into investigating how the global transformation of energy industries is affecting state strategies, and vice versa.

Notably, however, state institutions, capacity, and strategies have long remained undertheorized in GPN and GVC research (Grumiller 2021; Horner 2017; Mayer and Phillips 2017; Smith 2015). This is an undue lacuna in the literature, especially concerning the energy sector, where the state can take a predominant role in directly constructing production networks via SOEs, SWFs, and private firms with strong ties to the government (Yeung 2021, p. 433). While several GPN studies have examined low-carbon energy industries (among others, Curran 2015; Galan 2022; Vezzoni 2024), despite a few exceptions (cf. Bridge and Faigen 2022, 2023), the integration of the state into global energy systems warrants further scrutiny.

## 2.2 State roles in low-carbon energy systems: Analytical merits and conceptual limits

Horner (2017) advances a seminal typology of state roles, expanded upon also in Horner and Alford (2019), serving as a heuristic tool for classifying state powers within GPN/GVC in four archetypal roles:

1. *facilitator* (promoting and enabling firms’ activities)
2. *regulator* (restricting and defining the economic activity)
3. *producer* (through various forms of state ownership)
4. *buyer* (via public procurement)

This typology builds upon previous frameworks from developmental state theory (Coe and Yeung 2019), such as Evans’ (1995) state roles as custodian (i.e., regulator), demiurge (i.e., producer), midwifery, and husbandry (i.e., facilitator). It also draws on state governance types in GVC literature, including facilitative, regulatory, and distributive roles (Alford and Phillips 2018; Mayer and Phillips 2017). To evaluate Horner’s typology and cognate state functions taxonomies, we will briefly review their usage and address conceptual shortcomings and criticisms also put forth by other scholars.

### 2.2.1 The four-fold typology of state roles

In GVC/GPN literature, the state is generally framed as a *facilitator* of business operations, export-oriented development, and regional coupling. Thus conceived, the state engages in trade agreements to attract foreign investors, subsidizes domestic production, enhances infrastructure (e.g., roads, airports, ports, telecommunication), and introduces favorable taxation measures to attract global lead firms (De Marchi and Alford 2022; Horner and Alford 2019). Evans (1995, p. 13) identified this set of facilitating actions as the erection of a “greenhouse” of tariffs and incentives shielding infant industries from the competition – a role he calls “midwifery”. For example, in global environmental governance, levies are often imposed on polluting activities (e.g., carbon tax), as in the EU Carbon Border Adjustment Mechanism enforced in October 2023. Furthermore, the *facilitator* role has been broadened to include the steering of new industries (close to Evans’ “husbandry” role), encompassing workforce training, signaling investment opportunities, production processes assistance, and “securing a positive image of a conflict-free – and thus risk-free – investment environment” (Ehrnström-Fuentes and Kröger 2018, p. 199). Since the Paris Agreement of 2015, Nationally Determined Contributions and similar climate policy initiatives like the National Energy and Climate Plans of EU countries serve precisely to direct investments to strategic sectors, identify action plans to train and repurpose the workforce, and signal development priorities to market actors.

Secondly, the state acts as a *regulator* of GPNs by enforcing environmental and labor standards, quality controls, and price mechanisms, as well as regulating international flows of materials, technologies, and financial capital. This regulatory role is observable in measures like the domestic content requirements introduced by the US Inflation

Reduction Act (IRA) of 2022, which favor the manufacturing of industrial components within the US or, in limited cases (e.g., recycling of electrical batteries), in countries with free-trade agreements. In their literature review of states’ roles, De Marchi and Alford (2022, p. 97) find that states act as *regulators* when introducing protective measures against foreign firms, in “the form of tariffs applied to imports, local content requirements, or restrictions on foreign investment”. Interestingly, this empirically observed *regulator* seems rather overlapping with the state’s midwifery role as a *facilitator*.

Thirdly, the state can also be a *producer* of global commodities. As discussed above, the recent growth of SOEs, SWFs, development banks, and other forms of state capital is particularly prominent in energy markets, where states control roughly half of the oil and gas industry in terms of ownership structures, investments, and production volumes (Babić and Dixon 2022).

Finally, the fourth role in the typology identifies the state as a *buyer* through public procurement. Public authorities purchase goods or services for sectors like education, healthcare, housing, and infrastructural development, constituting a substantial volume of consumption. Public procurement accounts for 15–20 % of (macro)regional GDP – e.g., 14 % in the EU, currently the largest market for public procurement (Hughes et al. 2019; Raj-Reichert et al. 2022). Table 1 provides a thematic overview of these roles and functions, focusing specifically on the energy transition.

### 2.2.2 Two shortcomings of state role typologies

Despite the merits of this four-fold typology and the ensuing debate, scholars have offered sympathetic criticisms to overcome its conceptual rigidities. For instance, Werner (2021a) wages a particularly insightful critique of the

**Table 1:** The four-fold typology of state roles in the energy transition.

| Facilitator                                                                                                                                                                                 | Regulator                                                                                                                                                             | Producer                                                                                                                                                  | Buyer                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Assistance of firms in establishing production networks, signal future developments, and reduce risks                                                                                       | Control and regulate flows of financial capital, labor, energy, materials                                                                                             | Partial or full ownership of SOEs, SWFs, and development banks                                                                                            | Creation of energy demand and leadership in collective energy provisioning                                                         |
| <i>Examples</i><br>Nationally determined contributions; trade agreements (border carbon levies); industrial hubs; attraction of FDIs; subsidize labor transition from fossil sectors; RandD | <i>Examples</i><br>Production standards (greenhouse gas life cycle assessment measures); trade agreements; limits on foreign investments; preferential tax exemptions | <i>Examples</i><br>State-owned multiutilities divestment and/or phase-out fossil fuels; SWFs green mandates; energy supply and infrastructural investment | <i>Examples</i><br>Targeted public procurement, like the EU’s green public procurement and socially responsible public procurement |

Source: adapted from De Marchi and Alford (2022), Hess (2021), Horner (2017), and Horner and Alford (2019).

foundational state-market divide in most GVC/GPN studies, contending that also Horner’s typology struggles to eschew this neo-Weberian canon. Conversely, only a few GPN studies have advanced more nuanced understandings of the state as a terrain of social struggle and competitive accumulation strategies (among others, Bridge and Faigen 2022, 2023; Rutherford et al. 2018; Smith 2015). These approaches not only elucidate “what states do” in GPN, but also explore “why states act in the ways that they do, and how do social forces” shape their institutional arrangements (Werner 2021a, p. 183). Similarly, while acknowledging states also as producers and buyers is an important analytical step forward, Martin Hess argues that “state regulatory policies – rather than sitting alongside other roles – permeate them in fundamental ways, and therefore need to be seen as an overarching element” of the state within GPNs (Hess 2021, p. 20). This implies replacing the essentialist states-markets dualism with concrete accounts of the co-constitutive relationships binding together the evolution of the state institutional apparatus with more or less organized citizens, corporations, and other relevant social actors. In neo-Gramscian terms, it means viewing the state as integral to civil society, i.e., as a polity-cum-civil-society within GPNs (Arnold and Hess 2017; Hess 2021).

In this paper, we argue that this strategic-relational perspective is better equipped to address two major shortcomings in the approach outlined in Table 1. The first limitation concerns the inherent lack of standardization of state roles and its consistent application across the board. For instance, as discussed in Section 2.2.1, it is unclear whether trade agreements should be considered regulation or facilitation. Tellingly, also in the original formulation of the four-fold typology, trade policy seems to straddle both the *regulator* and the *facilitator* role (Horner 2017, p. 6; Horner and Alford 2019, p. 557). Similar ambiguities apply to financial capital flows. The promotion of outward and inward FDI is categorized as a facilitating action, whereas controlling capital flows is labeled as a regulatory role. Likewise, it is unclear whether protection measures for infant industries (i.e., Evan’s “greenhouse” of tariffs and incentives) should be viewed as facilitating or regulating – for instance, where do the domestic content requirements of the US Inflation Reduction Act (IRA) fit into these categories?

Moreover, SOEs are not only producers, but can also generate demand in line with state strategies, besides participating in public procurement tenders themselves (an activity partially regulated and liberalized by WTO agreements). Public procurement has played a strategic role in nurturing national industry champions of the likes of Nokia

and the Finnish electronics industry (Chang and Andreoni 2020), Hyundai in South Korea (via US military procurement) (Glassman 2011), and the growth of the solar industry in China (Rodrik 2014). As a result, the boundaries between state roles are often elusive. While functional categorizations of state roles can help in developing prolific analytical frameworks, such an approach could rest on more fertile conceptual grounds. This relates to the second limitation of empirically induced typologies.

Scholars have criticized the rigidity of neo-Weberian accounts (e.g., Glassman 2011; Hess 2021; Werner 2021a), leading to classificatory exercises that poorly represent the plasticity of real economic processes. These accounts rely on the ontological split between state and markets, which falls short in capturing the co-constitutive processes driving the renewed prominence of state capitalism in the 21st century. In the case of SOEs, most prominently, the conventional division between states and markets as separate entities with distinctive logics quite evidently falls apart (Babić et al. 2020). Therefore, it appears more fruitful to interrelate the various instances of state participation in specific segments of GPNs, following a strategic-relational approach (SRA) as expounded upon in the next sub-section.

### 3 Analyzing the “actually existing” state: The strategic-relational approach

Taking the regulatory essence of the state as the pre-analytical condition for understanding its participation in global production networks, state institutions can wear the facilitator, producer, buyer, and other hats at different times and geographies – hence the importance of discerning the reasons and methods by which state agencies enter (and leave) these networks. Jessop (2016, p. 115) suggests that analyzing “actually existing states in societies that are dominated by capitalist relations of production” requires the following:

- i. A focus on the functional adequacy (e.g., how are state powers mobilized, for what, and by whom?) and material possibilities (e.g., what can be done?) of concrete state activities,
- ii. by adopting a processual approach to the particular historical formation and articulation of concrete state strategies (or “projects”, in Gramscian terms),
- iii. which select those social groups, factions, networks, and coalitions of actors that are practically adequate to pursue the interests of both general and specific types of capital accumulation strategies.

The study of the state in capitalist societies should consider the concrete strategies, and structural selectivities of the state institutional ensemble in modern capitalist societies, by privileging a reading of the state as a social relation and a contested terrain of social struggle. Jessop’s SRA (for an overview, Jessop 2005; 2007, Ch. 1–2; 2016, Ch. 3) builds on these intuitions to develop an account of the state as the contingent crystallization of specific principles of societal organization which, in a defined historical conjuncture, dominate but do not exclude other potentially dominant strategies.

Therefore, although “profit-oriented market-mediated accumulation” is the contemporary primary logic of socialization on a world scale (Jessop 2007, 2016, *passim*) – expressed for example by a generalized subordination to global financial capital (Gabor 2021, 2023) – state projects can also be momentarily driven by other and competing principles of social organization (Hess 2021; Jessop 2016, pp. 42–45). These may include geopolitical security, environmental stewardship, welfare provisioning, ethnic cleansing, or theocratic rule. Moreover, the state’s strategic selectivities may privilege certain locations and some “market-mediated accumulation” strategies over others. For example, Rutherford and Holmes (2008) show how the Canadian automotive industry, concentrated in southern Ontario, largely favors Detroit-based transnational corporations, particularly smaller and localized enterprises. In a more recent paper, Rutherford et al. (2018) reveal how, in Quebec and Ontario, the intra-national dimension of state accumulation projects shapes the “strategic coupling” of regions and multinational actors from the metal transformation and automotive industry, respectively.

According to the SRA, despite the dominance of “profit-oriented market-mediated accumulation” strategies, contingent elements, such as path-dependent networks of actors, define the state project and the steering logic of the state apparatus. This is evident in those few studies applying SRA-inspired state theory to dissect the “actually existing” forms of state intervention in GPNs. Examples include the multi-scalar institutional interactions required to develop low-carbon energy in Northern England (Dawley et al. 2019), the contradictory relationships between the nation-state and transnational agri-food corporations in the Dominican Republic (Werner 2021b), the interrelationships between industrial policy and different capital fractions within the Ethiopian leather industry (Grumiller 2021), or the post-Brexit onshoring of lithium-ion battery production networks to safeguard the UK’s automotive industry (Bridge and Faigen 2023).

In summary, the SRA offers an analytical proposition distinct from both the state-market ontological split of neo-Weberian accounts and functionalist ex-post explanations of the embedded autonomy of the state. This article builds on previous theoretical discussions of the SRA in GPN literature (e.g., Hess 2021; Smith 2015; Werner 2021a) to strike a balance between the analytical benefits of characterizing state roles and the more nuanced reflections on the social relations guiding state action. Accordingly, the State-GPN Nexus could also be approached from three underdeveloped analytical angles:

1. The conjoint interrogation of state roles, “as contingent outcomes of political interests and struggles at different scales” and time horizons (Werner 2021a, p. 185). Indeed, scholars within the GPN/GVC tradition have already developed case studies combining the analysis of various state roles “for understanding of how their functions can bring about change in GPNs” (Raj-Reichert et al. 2022, p. 767) (see also, Bridge and Faigen 2022; Hughes et al. 2019). Consistent with Hess (2021), we argue that regulation of some sort (including liberalization processes as de-regulation) is a constant and pervasive feature of state engagement in GPNs. By combining non-regulatory state functions within concrete cases, scholars can better grasp the relations and feedback mechanism between institutional forms, as well as critically examine the interconnectedness and interdependency of institutional configurations (Werner 2021a). For instance, this combined analysis helps to identify how states as producers can influence consumption patterns, or how regulatory measures controlling outward capital flows can pave the way for enhancing domestic industrial capacity.
2. The more explicit analysis of additional forms of state intervention, chiefly finance. State finance extends beyond regulatory or facilitating measures, consisting of both individual funding schemes and their relationship with the macro-economic and financial environment (Dafermos et al. 2021; Gabor 2023). On one hand, financing mechanisms are orchestrated by various parastatal financial institutions, such as SWFs, development banks, or commercial banks (Alami and Dixon 2023, p. 90). On the other hand, state finance must also adapt to the prevailing macro-financial regime, for instance, influencing the interaction of fiscal and monetary policy. The “pressures of financial discipline” have been often underplayed in GPN scholarship (Coe and Yeung 2019). Perhaps due to a pervasive commitment to central bank independence, monetary policy

often remains an overlooked side of state functions (Alami et al. 2022), despite its consequential influence on shaping market conditions – as in the case of Quantitative Easing and other unconventional measures during the 2010s. Currently, the financial State-GPN Nexus responds to the turn toward risk mitigation, represented by the recent proliferation of PPPs to ease investment opportunities (Bayliss and Van Waeyenberge 2018; Gabor 2021). Blended finance, for instance, “is used to adjust the risk-return profile to facilitate investment in projects that would not have otherwise received finance” (Bayliss et al. 2020, p. 1). Ostensibly, by leveraging public funds, state-owned development banks contribute financial resources while also supporting strategic state projects. A case in point is the European Fund for Sustainable Development (ex-EFSD, now EFSD+). With a budget of up to €135 billion (including guarantees and other leveraging instruments), the EFSD+ 2021–2027 term is meant to promote the EU Global Gateway, the bloc’s alternative to the Chinese Belt and Road Initiative (Bayliss et al. 2020).

3. The structuring of state agency within upper (i.e., historical regulatory form) and lower (i.e., foundational integration in society) conjunctural constraints. State strategies develop according to “relations between structurally-inscribed strategic selectivities and (differentially reflexive) structurally-oriented strategic calculation” (Jessop 2005, p. 48). In simpler terms, actors’ competing strategies and agendas – whether from industry groups, public bodies, or the transversal interests of PPPs – are both molded by and shaping the environmental conditions, i.e., the social, political, economic, ecological, or cultural contexts. Teixeira (2022, p. 13), for example, reveals how corporate capture can occur at the expense of labor standards, local communities, and the environment when “the strategic selectivity of states at multiple scales privileges and empowers different actors” which, in turn, “influence state accumulation strategies, including the rules for regions to pursue investments”. In capital-intensive industries, such as energy, the state regulatory apparatus must also respond to environmental disturbances (that is, external or exogenous), beyond the agentic powers of individual (groups of) actors. These disturbances – such as production bottlenecks, price dynamics, market sentiment, technological maturity, or geopolitical conflicts – are first elaborated within the institutionalized regulatory sphere, before permeating lower instances of state intervention. Similarly, everyday practices also influence higher

levels of social organization. In other words, habits and historically formed preferences – like the choice of energy sources for domestic heating or commuting methods – demarcate a certain range of intervention for state institutions.

To illustrate how these theoretical contributions can practically contribute to the analysis of the State-GPN Nexus, the next sections introduce and discuss a case study reviewing the emergence of a low-carbon hydrogen economy structured around European transnational corporations, parastatal entities, public-private partnerships, and spatialized industrial policy.

## 4 Case study and data collection

Clean hydrogen is a widely discussed fuel in the context of the green transition, commonly presented as a prospective energy carrier complementary to electrification. Yet, virtually all hydrogen is currently produced using fossil fuels, although energy transition pundits foresee a staggering 60-fold expansion of “green hydrogen” production – that is, hydrogen produced with minimal greenhouse gas emissions (Griffiths et al. 2021; IEA 2023). While China currently dominates hydrogen production (30 %, followed by the US, Russia, and MENA countries), the EU and its member states seem strategically positioned to ride the forthcoming hydrogen wave. Factors such as investment outlooks, regulatory frameworks, patent holding, corporate networks, and industrial policy interventions contribute to this advantage (IEA 2023; Vezzoni 2024; Weichenhain et al. 2024). Hydrogen is thus emerging as a strategic industrial commodity for the energy transition in Europe.

Following the three analytical entry points to the State-GPN Nexus presented in Section 3 – i.e., the conjoint interrogation of state roles, finance as an additional form of state intervention, and the strategic selectivities on state agency (imposed by its historical regulatory form and integration in society) – the next section analyzes three key EU hydrogen policy developments. The first one concerns the *ad hoc* derogation of State Aid rules and environmental standards in the Important Projects of Common European Interest (IPCEI) (Section 5.1). The IPCEI represent not only an instrument to *facilitate* investment by de-risking industrial policy, but it also provides critical *financing* for hydrogen *production* sites which, as we shall see, are often owned by SOEs. This is an exemplary case of the state “switching hats” along the organization of energy production. The second case concerns the leveraging of public *financing* capacity to buffer private risk for hydrogen domestic production

and global procurement through the European Hydrogen Bank (EHB) (Section 5.2). While the domestic pillar of the EHB *facilitates* European production via reverse auctions, its international strategy aims to *buy* hydrogen long-term to resell it short-term to domestic off-takers. The third case analyzes the spatialized industrial policy pursued by the European Hydrogen Valleys (Section 5.3). This shows the orchestration of local *consumption* following the development of *production* capacity on site. To minimize supply risk and integrate European energy markets, Hydrogen Valleys include the *facilitation* of regional clusters connected by transnational infrastructure. Each of these case studies responds to conjoint state roles, all of them underpinned by the regulatory form of the state. For instance, SOEs are not only at the receiving end of IPCEI funding or EHB mechanisms, but they also participate in the ideation of state policies such as the European Hydrogen Strategy. The same is true of private corporations and civil society actors, whose interests are mediated by the state apparatus, chiefly through PPPs and consulting firms. Moreover, the historical conjuncture defines the structural constraints – i.e., the “strategic selectivities” – in which these “actually existing” state projects are conceived. Thus, it is key to position the EU transition to low-carbon energy within competing pressures from the world economy (as in the case of the EHB import strategy or the EU Global Gateway) and the relations of production organizing the European economy from within (as in the development of Hydrogen Valleys along the European gas grid or the pivotal role of the Germany industry explored in the case studies).

The analysis draws on primary materials from expert interviews, policy documents, and corporate reports. It relies on 22 semi-structured interviews (four of which included two or more interviewees) with 27 interviewees lasting between 32 and 145 min. These were conducted online (except one, in person) in English, Spanish, Italian, and French between May 2023 and July 2024 (see Appendix, Table A). The interviewees are all based in Europe. Among them are consultants for major hydrogen projects, experts at intergovernmental energy organizations, specialists from advocacy or industry groups, and executives of Hydrogen Valleys or companies receiving hydrogen IPCEI funding. Initial contact was made via email or LinkedIn, targeting prominent organizations, advocacy groups, corporations, and project developers in Europe. In several cases in which no interview could eventually be conducted, this led nevertheless to additional email exchanges.

The interview materials have been partially transcribed with the help of Zoom-compatible AI tools and then refined manually. They have then been coded according

to the state roles illustrated in Section 2, as well as the three analytical angles presented in Section 3. The results have been complemented by participant observation in five industry events on hydrogen developments in Europe, between May and June 2023. Finally, the primary materials have been cross-referenced with the documentary analysis for the three case studies. In the following sections, references to interviews use the codes provided in the Appendix.

## 5 Hydrogen developments in the EU

### 5.1 Hydrogen IPCEI

Since the first IPCEI in 2018, four out of ten funding calls have been dedicated to hydrogen projects, as summarized in Table 2. In line with amendments to state aid rules in 2014 and 2021, the IPCEIs introduce substantial derogations to the allocation of public funding for projects in strategic value chains that “represent a concrete, clear and identifiable important contribution to the Union’s objectives or strategies” (European Commission 2021, section 3.2.1). The IPCEI provides up to 100 % of the funding gap – that is, the difference between the positive and negative discounted cash flows of the project – for investments that would otherwise not be realized (COR\_2; COR\_5). After approval by the Commission, the funds are directly granted by national member states and, since the COVID-19 pandemic, these have occasionally overlapped with stimulus funds such as the Recovery and Resilience Facility (ORG\_4; COR\_6).

Despite the over €37 billion granted so far, concerns have been raised regarding lack of transparency, appropriation of higher quotas by states with greater fiscal capacity, and neglect of standard environmental impact assessments (Joint Non-Paper 2021; Pichler et al. 2021; Schneider 2022) (ORG\_2; COR\_7). Moreover, the predominant focus on competitive technical innovation has been criticized for exacerbating “trends towards addition to rather than disruption of existing unsustainable industries” (Pichler et al. 2021, p. 144). These regulatory derogations to state aid rules and environmental standards not only address the need for financing new industrial clusters, but also facilitate hydrogen production and uptake by de-risking industrial policy for institutional investors (Gabor 2023).

Since 2022, four hydrogen IPCEI have been announced, totaling € 18.9 bn of public funding granted to European companies to develop a transnational hydrogen economy. Notably, many of these firms are either majority-owned or have equity stakes held by public entities (Table 3). This highlights the multiple and conjoint roles that states can

**Table 2:** Summary of the four waves of hydrogen IPCEI.

| c                                                                                                                                                       | Month, year | Amount  | Companies | Countries |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------|-----------|-----------|
| <b>Hy2Tech</b><br>Hydrogen generation technology<br>Fuel cell technology<br>Storage, transportation and distribution technology<br>End user technology  | July, 2022  | €5.4 bn | 35        | 15        |
| <b>Hy2Use</b><br>Hydrogen infrastructure<br>Hydrogen applications in industry                                                                           | Sept, 2022  | €5.2 bn | 29        | 13        |
| <b>Hy2Infra</b><br>Electrolyzers<br>Pipelines<br>Storage<br>LOHC handling terminals<br>Cross-workstream collaboration                                   | Feb, 2024   | €6.9 bn | 32        | 7         |
| <b>Hy2Move</b><br>Mobility and transport applications<br>Fuel cell technology<br>Hydrogen onboard storage solutions<br>Hydrogen production technologies | May, 2024   | €1.4 bn | 11        | 7         |

**Table 3:** Overview of state capital involved in-owned companies participating in the Hy2Use, Hy2Tech, Hy2Infra, and Hy2Move IPCEI of 2022.

| Company            | Funding state | Ownership structure                                                                                                                                  | IPCEI projects |
|--------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Borealis           | AT            | 75 % OMV (31.5 % Austrian State; 24.9 % UAE State); 25 % Abu Dhabi National Oil Company (ADNOC) (SOE, UAE)                                           | 1              |
| Verbund            | AT            | 51 % Austrian State                                                                                                                                  | 2              |
| Fluxys             | BE, DE        | 77.41 % Publigas (Belgian municipalities) + Belgian State golden share                                                                               | 3              |
| Airbus             | DE, FR, ES    | 10.8 % German government; 10.8 % French government; 4.1 % Spanish government                                                                         | 3              |
| Creos              | DE            | Luxembourg SOE (Luxembourg State, City of Luxembourg, and other governmental entities)                                                               | 1              |
| EWE AG             | DE            | 76 % German Municipalities (EWE-Verband)                                                                                                             | 3              |
| Gascade            | DE            | 100 % SEFE Group (SOE, German State)                                                                                                                 | 2              |
| Gasnetz            | DE            | 100 % City of Hamburg                                                                                                                                | 1              |
| RWE                | DE            | 9 % Qatar Investment Authority (SWF)                                                                                                                 | 2              |
| VNG                | DE            | 100 % German Municipalities (79.83 % EnBW)                                                                                                           | 1              |
| Ørsted             | DK, NL        | 50.10 % Danish State                                                                                                                                 | 2              |
| EDP                | ES            | 20.86 % China Three Gorges Corporation (SOE, Chinese State) (ex-Portuguese SOE privatised in 1996–2013)                                              | 3              |
| Iberdrola          | ES            | 8.71 % Qatar Investment Authority (SWF); 3.45 % Norges Bank (SWF)                                                                                    | 1              |
| Petronor           | ES            | 33 % Petromal (SOE, UAE State)                                                                                                                       | 1              |
| Neste              | FI            | 44.22 % Finnish State                                                                                                                                | 1              |
| Alstom             | FR, IT        | 17.4 % Quebec Deposit and Investment Fund (CDPQ); 7.5 % Public Investment Bank (BPI) France                                                          | 2              |
| Elogen             | FR            | Subsidiary of GTT: 5.4 % Engie (23.4 % French State; 3.63 % CDC); 5.2 % Deposits and Consignments Fund (CDC)                                         | 1              |
| ENGIE              | FR, BE, NL    | 23.4 % French State; 3.63 % Deposits and Consignments Fund (CDC)                                                                                     | 4              |
| Genvia             | FR            | Five shareholders, among which French State entities (% unspecified): French Alternative Energies and Atomic Energy Commission (CEA), AREC Occitanie | 1              |
| McPhy              | FR            | 13.61 % EDF (SOE, French State); 5.78 % Public Investment Bank (BPI) France                                                                          | 1              |
| Ansaldo Green Tech | IT            | 88 % Italian development bank (CDP)                                                                                                                  | 1              |

Table 3: (continued)

| Company                                           | Funding state | Ownership structure                                                                                                                           | IPCEI projects |
|---------------------------------------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Enel Green Power                                  | IT, ES        | Subsidiary of ENEL: 23.6 % Italian State                                                                                                      | 4              |
| Eni                                               | IT            | 30.5 % Italian State                                                                                                                          | 1              |
| Fincantieri                                       | IT            | 71.32 % Italian development bank (CDP)                                                                                                        | 1              |
| SAIPEM                                            | IT            | 21.19 % ENI (30.5 % Italian State); 12.82 % Italian development bank (CDP)                                                                    | 1              |
| SNAM                                              | IT            | 31.35 % Italian development bank (CDP); 1.4 % Bank of Italy                                                                                   | 2              |
| Uniper                                            | NL            | 99.12 % SOE, German State                                                                                                                     | 1              |
| PKN Orlen                                         | PL            | 49.90 % Polish State                                                                                                                          | 1              |
| Eurostream                                        | SK            | 100 % SPP Infrastructure (SOE, Slovak State)                                                                                                  | 1              |
| NAFTA                                             | SK            | 56.15 % SPP Infrastructure (SOE, Slovak State)                                                                                                | 1              |
| Norges Bank Investment Management (Norwegian SWF) |               | 6.5 % Arkema (FR), 2 % ENGIE (FR), 2.5 % Air Liquide (FR), 8.2 % Iveco Group (IT), 3.45 % Iberdrola (ES), 3.2 % Repsol (ES), 3.4 % Shell (UK) |                |

Source: own elaborations from 2023 shareholder data are from 2023.

take, not only as a funder but also as a producer and a consumer of industrial commodities. While European national state entities predominantly own SOE shares, substantial stakes are also held by overseas state capital in strategic corporations participating in the hydrogen IPCEI – e.g., the Portuguese EDP, partially controlled by Chinese state-owned power company CTG; or the Austrian Borealis, among whose largest shareholders are oil and gas SOEs controlled by the UAE government. The last row in Table 3 also highlights minority shares held by the Norwegian sovereign wealth fund. As argued in Section 3, European states do indeed “wear many hats” in the hydrogen industry, providing billions in state aid to companies that, simultaneously, are also (at least partially) owned by the very same state – e.g., ORLEN in Poland, or EWE, Gascade, Gasnetz and VNG in Germany.

State-owned companies are not only at the receiving end of funding schemes like the IPCEI; they actively contribute to the design and implementation of state policy and European industrial strategies through advocacy groups. The European Clean Hydrogen Alliance (ECHA) provides a prominent example of this dual role. Established in July 2020, the ECHA is an influential PPP engaging all the stakeholders in the European hydrogen value chain. However, a closer look at its membership reveals the overrepresentation of corporate actors, including in its 2020 Governing Board, composed of names familiar to the hydrogen IPCEI like Shell, Verbund, Snam, Daimler, Bosch, and energy SOEs like EDF, Gasunie and Vattenfall. Board members are selected by the Secretary General who, in turn, is appointed by Hydrogen Europe, another PPP with over 400 members representing industry interests (ORG\_4). Hydrogen Europe has played a pivotal role in shaping EU hydrogen strategies, not only for its steering of the ECHA, but also

thanks to its prominent participation in key policy milestones since the late 2010s. Between 2018 and 2020, Hydrogen Europe has been guiding hydrogen discussions at the Strategic Forum, an ad hoc body set up by the European Commission (EC) to identify the key value chains for the IPCEI (Hydrogen Europe 2020). Unsurprisingly, hydrogen has been identified as a strategic industry. These recommendations contributed to the European Hydrogen Strategy of July 2020, outlining an industrial roadmap and investment agenda for 2020–2030 (European Commission 2020). Remarkably, Hydrogen Europe is also the primary partner of another PPP initiative, the Clean Hydrogen Partnership, tasked with delivering the objectives of the EU Hydrogen Strategy with an endowment of €1 billion in public funding for the 2021–2027 term.

Summing up, industry groups, including those invested by national state capital (such as SOEs or SWFs), wield significant influence in both the design and implementation of hydrogen industrial policy at the EU level. Yet, how uniformly are these policies embraced among member states and across industries? The next sub-section explores the unfolding of state projects and industrial strategies in selected EU member countries by analyzing a novel financing mechanism: the European Hydrogen Bank.

## 5.2 The European Hydrogen Bank

In December 2022, the H2Global Foundation (an initiative of the German government) launched HINT.CO GmbH, a financial instrument designed to import hydrogen-based products to develop a market for low-carbon hydrogen and its derivatives. HINT.CO operates via commercial agreements akin to contracts for difference (CfD), thus committing to long-term contracts with suppliers while, concurrently,

reselling hydrogen through short-term contracts to German off-takers (Gabor and Sylla 2023). The German H2Global financial instrument served as a blueprint for designing the European Hydrogen Bank (EHB) (GOV\_4; COR\_8), as illustrated in Figure 1.

Officially established in March 2023, the EHB aims to close “the investment gap” and connect “future supply of renewable hydrogen with” the 20 Mt/year by 2030 targeted in the REPowerEU, by facilitating “both renewable hydrogen production within the EU and imports” (European Commission 2023, p. 2). The EHB was endowed with €3 billion from the EU Innovation Fund, a figure that the lobby group Hydrogen Europe suggests should be pledged annually (Hydrogen Europe 2023, p. 6). In part as a response to the US IRA subsidy scheme for hydrogen production, the Bank began operations by targeting the domestic market. In April 2024, a first pilot reverse auction allocated €720 million in subsidies on the production costs of low-carbon hydrogen in the EU as a fixed premium over 10 years. Additionally, member states can cover the remainder of the supply curve through the Auctions-as-a-Service mechanism (another exception to EU State Aid rules), although without overlapping with IPCEI funding (CORP\_6). Germany has been the only country to utilize this mechanism so far, financing German projects that did not receive EU-level support with an additional €350 million. Another round of reverse auctions is expected by the end of 2024.

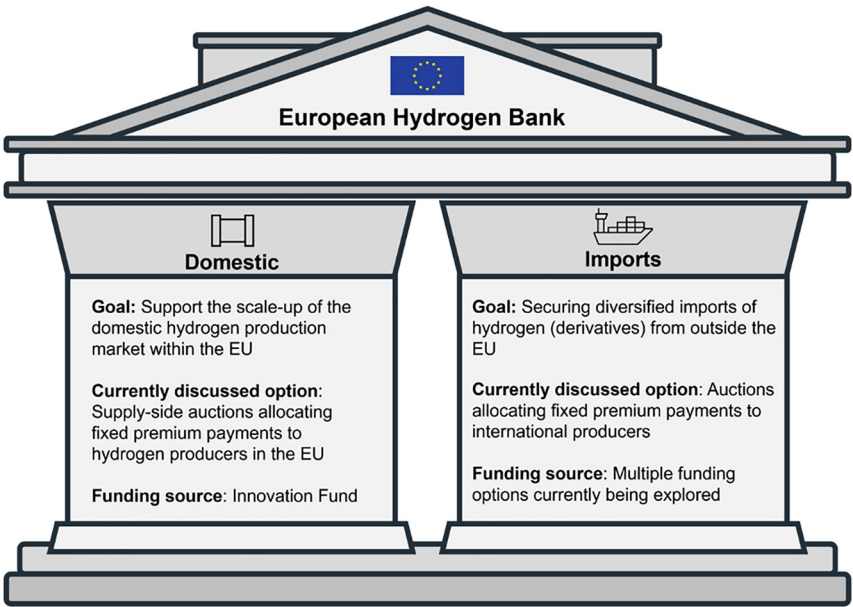
The EHB operates by stabilizing and lowering the operating expenses of producers and off-takers. According to

the EC, this targeted use of public resources is intended to hedge private risks by offering a buffer with public funds (European Commission 2023, p. 4) (COR\_9). Thus, the reverse auctions of the EHB facilitate and finance domestic producers. Complementary to that, the EHB’s import pillar secures hydrogen in bulk at a fixed premium from foreign producers through long-term contracts and then distributes it among European off-takers. Although the international scheme (right pillar in Figure 1) remains yet to be designed, it is expected to mirror the CfD-like structure of the German H2Global.

Prominent candidates for hydrogen imports to Europe include Latin American countries like Chile or Brazil, where the EU Global Gateway (funded through the EFSD+, as noted in Section 3) earmarked €2 billion in November 2023 for constructing a production facility to export green hydrogen to Europe (ORG\_3). Moreover, African countries like Algeria, Morocco, Mauritania, Egypt, Kenya, and Namibia have been scoped as potential trade partners by EU member states like Germany, the Netherlands, and Spain (Müller et al. 2022) (IND\_2; GOV\_4). The development of hydrogen commercial routes often requires complex infrastructure, such as pipelines or import terminals, begetting a turn to spatialized industrial policy, as explored in the next sub-section.

5.3 Hydrogen Valleys

Since the launch of the European Hydrogen Strategy (European Commission 2020), hydrogen “Valleys” or “Hubs” have



**Figure 1:** The architecture of the European Hydrogen Bank. A very similar figure already appeared in a position paper by Hydrogen Europe “based on information so far provided at various stakeholder meetings. January 2023” (Hydrogen Europe 2023, p. 4), and therefore before the official communication of the EC in March 2023. Source: “Competitive bidding” on European Commission portal, Hydrogen Europe (2023).

gained a foothold as a critical solution for building demand-side infrastructure for hydrogen, along with its supply. Hydrogen Valleys represent an explicitly spatialized form of industrial policy, aiming to “bring together – in a limited geographical area – all the elements of renewable hydrogen production, storage and end-use into an integrated ecosystem” (European Commission 2022, p. 26). As of 2023, approximately 100 Hydrogen Valleys exist globally, with over 70 % of them located in Europe (Weichenhain et al. 2024). Strategically positioned next to harbors, metropolitan areas, and end-users like oil refineries, fertilizer plants, and steelworks (Weichenhain et al. 2022) (IND\_3; COR\_9), these Valleys aim to pool demand and decrease final prices by integrating end-users and creating economies of scale (GOV\_3). The archetype developed by the Clean Hydrogen Partnership (the PPP in charge of the EU hydrogen strategy) in Table 4 shows how the installed capacity also determines the range of end-uses and market orientation. Most European Valleys fall into the intermediate category, serving as regional clusters of industrial players meant to revamp local manufacturing capacity – in other words, “to decarbonize not to de-industrialize” (GOV\_4). Of particular interest is the growing focus on export-led Hydrogen Valleys (over 300 MW), supported by parallel investments in import hubs, such as the developments at the port of Rotterdam (the Netherlands) for the provisioning of hydrogen to the North Rhine-Westphalia (Germany). To be sure, the archetypes in Table 4 are not mutually exclusive; rather, they represent an incremental approach to kick-start the European hydrogen economy by first establishing essential infrastructure locally in strategic hubs (GOV\_3) (Weichenhain et al. 2024).

Furthermore, Hydrogen Valleys favor the vertical integration of hydrogen value chains to minimize supply risks. End-use companies, such as refineries, are investing in

assets upstream, especially in the installed capacity of electrolyzers or carbon capture technologies. The backward integration of organizational and production processes is achieved by taking equity positions in upstream operators or by developing new production sites, either within the company or, more often, in partnership with other firms and public authorities (COR\_5). Indeed, most Hydrogen Valleys are coordinated by PPPs alongside consulting firms (GOV\_3; IND\_3; IND\_5). Additionally, long-term contractual agreements with other companies operating in the region are used to de-risk commercial investments and stabilize cash flows. Prospectively, when and if hydrogen becomes a globally traded commodity, long-term contracts will also mitigate exposure to market price volatility.

Interestingly, despite prioritizing production for consumption *in situ* (ORG\_2), Hydrogen Valleys are developing along the nodal points of the European gas grid identified by the European Hydrogen Backbone initiative (Weichenhain et al. 2024). This initiative is a plan to retrofit the existing natural gas infrastructure for hydrogen transport (Guidehouse 2021). It was drafted by the consulting firm Guidehouse – who has also laid out the strategy behind some European Valleys (IND\_5) – for a consortium of 31 transmission system operators, controlling over three-quarters of European natural gas consumption (IND\_1). The concept of a Hydrogen Backbone has since been endorsed in high-level EU policy circles (e.g., ECHA 2023; Hydrogen Europe 2022).

However, the emphasis on hydrogen transport highlights a peculiar tension in the spatialization of industrial policy in Europe. On the one hand, Hydrogen Valleys should develop local industrial ecosystems to avoid the costly and tricky transportation of hydrogen (Griffiths et al. 2021). Among others, this approach is favored by oil and gas companies that do not own nor operate pipelines and that

**Table 4:** Archetype of Hydrogen Valleys. The scale is identified by the equivalent electrolyzer capacity expressed in megawatts (MW).

| Local transport<br><20 MW                                                                                                                                                                           | Industry cluster<br>20–300 MW                                                                                                                                                                                                                  | Export-led<br>>300 MW                                                                                                                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Integration of fuel cell electric vehicles (FCEV) in the regional mobility fleet. Aiming to both establish the infrastructure (e.g., charging stations) with public support and pull private demand | Direct integration of supply with industrial applications on site, such as refineries, fertilizer production plants, and steel factories. These industries serve as “anchor load”, de-risking capital expenditure and securing a demand outlet | Export-oriented Hydrogen Valleys, connecting regions of high production capacity (e.g., large installed capacity of low-carbon energy) with end-users. Mostly run by energy supermajors and state authorities, often involving transnational alliances |
| Examples:<br>Zero Emission Valley Auvergne-Rhône-Alpes (FR); Hydrogen Valley South Tyrol (IT); HyBayern (DE)                                                                                        | Examples:<br>HEAVENN Groningen (NL); Basque Hydrogen Corridor (ES); HyNet North-West (UK)                                                                                                                                                      | Examples:<br>Andalusian Green Hydrogen Valley (ES); Green Hydrogen Magallanes (CL); Ceará Green Hydrogen Corridor (BR)                                                                                                                                 |

Source: adapted from Weichenhain et al. (2022, 2024).

require readily available hydrogen, such as the Italian Enel or the Finnish Neste (ORG\_2; IND\_3). Yet, these clusters often lack sufficient low-carbon electricity to power the energy-hungry electrolysis process. In a densely populated continent heavily reliant on energy imports like Europe, this is not a trivial issue. Therefore, Valleys must either rely on natural gas (with the dubious option of installing carbon capture technologies), transport electrons from other European regions with a relatively low-carbon electricity mix (such as the Nordics, France, or Portugal), import hydrogen from overseas, or a combination of these options.

On the other hand, industrial clusters could also lay the groundwork for an export-led hydrogen economy. This is certainly the approach favored by the gas grid operators behind the Hydrogen Backbone initiative, who also participate in some Hydrogen Valleys near major European logistics hotspots. Nevertheless, producing hydrogen via electrolysis requires substantially more energy inputs than direct electrification. Therefore, the larger land footprint required to install additional wind turbines and solar panels to produce green hydrogen severely limits the scope of Hydrogen Valleys in Europe (IND\_2; ORG\_1; ORG\_2).

## 6 The State-GPN Nexus of European hydrogen

The three instances of state participation in establishing a hydrogen economy presented in Sections 5.1–5.3 cannot be fully understood by zooming in on a specific state role. Instead, they represent a composite analysis of the “actually existing state”, viewed as a multi-faceted institutional complex responding to the interests of different actors at different times and administrative levels. Thus, in the case of the IPCEI, the EU transnational state facilitates the establishment of strategic new industries through derogations to State Aid rules, while nation-states directly fund these business undertakings, according to their own developmental projects. Most importantly, the firms at the receiving end of state aid are often (at least partially) owned by the very same government providing the funds. The interplay of public entities, state capital, and private firms is all the more evident in the organizational make-up of Hydrogen Valleys, typically managed by consortia of regional authorities, ministerial agencies, local firms, and transnational corporations. These PPPs are financed by dedicated public and private vehicles, such as national chambers of commerce, Horizon Europe, or industry associations. They coordinate the synergic integration of necessary infrastructural development to pool public/private demand

for public/private suppliers. It follows that Hydrogen Valleys emerge from the recursive interaction of not-so-clearly-demarcated “state roles” towards “the setup of regional ‘mini hydrogen economies’ [...] to de-risk and synchronise investments and avoid stranded assets” (Weichenhain et al. 2022, p. 8).

This points to the second underdeveloped analytical angle explored in Section 3: the role of finance in structuring the State-GPN Nexus. The logic of de-risking private investments is a pervasive feature of hydrogen industrial policy in Europe (Hunt and Tilsted 2024). The Hydrogen Bank is explicitly designed as a mechanism “to leverage private sector investments by de-risking renewable hydrogen production” (European Commission 2023, p. 5). Similarly, Hydrogen Valleys are “evolving into a de-risking platform for larger-scale, phased (giga) project development” (Weichenhain et al. 2024, p. 11). However, there is little accountability embedded in these public investment strategies. Several Valleys have fallen short of the promised investments and industrial upgrading for which they received funding (ORG\_1; IND\_2; IND\_3); whereas the IPCEI have been criticized for being lengthy and uncertain processes that are unlikely to deliver major transnational benefits by the end of the decade (COR\_1; COR\_5; COR\_6; COR\_8) (ECA 2024). Although windfall profits may be reclaimed by the Commission through a claw-back mechanism newly implemented in 2022, the IPCEI by definition can only fund projects that would not materialize if left to market forces alone.

This closely tallies the logic of blended finance behind the proliferation of PPP in public policy (Bayliss and Van Waeyenberge 2018; Bayliss et al. 2020; Gabor 2021). The hydrogen policy-making process in the EU is largely captured by a tight web of PPPs, notably: Hydrogen Europe, the ECHA, and the Clean Hydrogen Partnership. These PPPs are significantly influenced by industry groups outside the realm of democratic politics, like the Gas 4 Climate alliance behind the European Hydrogen Backbone (Guidehouse 2021). They not only directed the legislative process behind all the key measures analyzed in Section 5 – the IPCEI, the European Hydrogen Bank, and the Hydrogen Valleys – but, in the case of the Clean Hydrogen Partnership (within which Hydrogen Europe takes a steering role), they are also responsible for monitoring and implementing key policy milestones, such as the European Hydrogen Strategy of 2020 or the Hydrogen Valleys.

However, these PPPs, including those coordinating individual Hydrogen Valleys, represent diverse and, at times, contrasting economic interests and state projects. Sectors like automotive, oil and gas, and the chemical industry

wield significant, although contrasting, influence on hydrogen developments in the EU (Vezzoni 2024), as evidenced by the tension between export-led Hydrogen Valleys and those for localized consumption. Furthermore, corporations are not alone in influencing European policy-making, which is also subject to inter-state competition among member countries (GOV\_4; ORG\_3; IND\_5). Germany, for instance, has been attempting to coordinate the hydrogen IPCEI since its presidency of the Council of the EU in the second half of 2020<sup>2</sup> (COR\_8). As discussed in Section 5.1, smaller member countries have raised concerns regarding the potential cannibalization of IPCEI funding by larger states. Nevertheless, Germany retains a leading role in hydrogen policy, keeping a step ahead of other European players. Already in its 2020 national Hydrogen Strategy, Germany identified potential transnational joint ventures and collaborations with African countries (Kavelage and Tups 2024; Müller et al. 2022). To be sure, in line with the SRA arguments developed in this article, it is important not to take “Germany” or “German interests” as a unitary entity. Instead, they represent the articulation of diverse economic agendas, political strategies, and social struggles within the German state complex (Schneider 2022, pp. 11–13).

In conclusion, state action is decisively shaping the emergence of a European hydrogen industry, both at the EU transnational level and within member countries. The state system not only facilitates the uptake of hydrogen and its derivatives, but through SOEs and investment in SWFs, state capital actively participates in both the production process – as evidenced by the long list of suppliers in Table 3 – and the creation of demand through public procurement and pooling of end-users – as in the case of Hydrogen Valleys. These instances of state participation in the hydrogen economy are underpinned by its regulatory power over market relations. Measures like the Carbon Border Adjustment Mechanism, National Energy and Climate Plans, or industrial standards for “renewable hydrogen” production in the EU do more than merely shield nascent industries with a “greenhouse” of protective measures (as the *facilitator* role in Horner’s typology would imply), or limit undesirable outcomes of market forces (*regulator* role). These governmental interventions are instead tailored to suit the principles of societal organization which, in the current

historical conjuncture, define the historical regulatory form of the state. In our case study, all state actions – whether facilitating, producing, buying, or financing economic development – are subsumed under the historical peculiarities of the EU in the 21st century: a regional block stifled by import-dependence, scarce resource availability (in terms of transition materials and land), and several decades of de-industrialization, whilst retaining the centrality of economic growth at all costs. Moreover, as pointed out in several studies (Gabor 2023; Jessop 2007, pp. 212–217; Vezzoni 2023), the macro-financial regime prevailing in the EU severely limits the possibility of designing fiscal policies antithetical to market-mediated capital accumulation.

## 7 Conclusions

Amidst the recent surge in interest around state policy and energy transitions, concepts such as state capital, industrial policy, state strategies, and various “state returns” have increasingly become contentious topics also in mainstream policy discussions. However, scholarly debates often portray essentializing accounts of the state as an autonomous (somehow relative or embedded) entity, territorially defined by the borders of the nation, in wrestling contraposition with the market – wherein market expansion corresponds to state retreat, and vice versa.

Drawing on Jessop’s strategic-relational approach (SRA), this article has framed the “actually existing” state as a conjunctural crystallization of social relations, integrating diverse and overlapping strategies. Arguably, this points to at least three underdeveloped analytical angles to the State-GPN Nexus: (1) the conjoint interrogation of different state roles (as already explored in, e.g., Bridge and Faigen 2022; Hughes et al. 2019); (2) to the importance of financial instruments as well as the macro-financial regime, for how it shapes fiscal and monetary policy interactions (Alami et al. 2022; Gabor 2021); and (3) the structuring of state agency within the contingent contexts in which it takes place (Jessop 2005).

Through three case studies on hydrogen developments in the EU – the IPCEI, the EHB, and Hydrogen Valleys – we have sought to illustrate the value of combining the analysis of the multifaceted roles that state entities assume when partaking in GPNs. As discussed in Section 6, state aid is occasionally directed towards domestic SOEs, which may also be (partially) owned by foreign SWFs, to develop projects aligned with the strategies of the EU transnational state, which have been predominantly formulated by industry-led PPPs established by the EU that, in turn, lobby the EU itself on behalf of industry. This rather convoluted

<sup>2</sup> This is revealed also in non-confidential minutes of a video call between Hydrogen Europe and the EU DG Competition, accessible at: [https://www.asktheeu.org/en/request/9488/response/31953/attach/5/Minutes%20of%20a%20Videocall%20with%20Hydrogen%20Europe%2012%20Nov%202020%20non%20confidential%20version%2019012020.pdf?cookie\\_passthrough&tnqx3d;1](https://www.asktheeu.org/en/request/9488/response/31953/attach/5/Minutes%20of%20a%20Videocall%20with%20Hydrogen%20Europe%2012%20Nov%202020%20non%20confidential%20version%2019012020.pdf?cookie_passthrough&tnqx3d;1)

process underscores the many hats that the state wears at different junctures throughout its participation in industrial energy networks. Likewise, the relation with the macro-financial regime is also a crucial factor shaping the State-GPN Nexus, whether through the risk hedging strategies of the European Hydrogen Bank, the adaptation of State Aid rules of the IPCEIs, or the spatial integration of the European energy industry in Hydrogen Valleys.

This is particularly evident in the energy sector, and even more so in its conversion to low-carbon technologies. The development of a hydrogen economy, for instance, reveals how the state intervenes when market forces fail to mobilize investments, due to either lack of prospective profitability or widespread uncertainty. In such cases, the de-risking strategies prevalent in European industrial policy offer the private sector a way to hedge risks by effectively transferring potential losses from their balance sheets to the public budget. While the democratic accountability of these processes is questionable, the outcomes thus far have fallen short of expectations, as also reprimanded in a report of the European Court of Auditors on the EU’s hydrogen industrial policy (ECA 2024).

Overall, the state projects driving the transformation of European energy systems seem to hinge on increasing international competitiveness to spur green economic growth. Accordingly, as an integral part of the world capitalist economy, the historical regulatory form of the state in the EU constrains the type of energy transition fueled by hydrogen to a set of initiatives fostering a new economic cycle of capital accumulation in competition with other regional blocs. This

may lead to the paradoxical continuation of business-as-usual operations dominated by heavily polluting industries, such as oil refineries and fertilizer plants (Hunt and Tilsted 2024; Vezzoni 2024). So much for the alleged “return of the state” as a historical counterbalance to the short-sighted dynamics of profit-seeking market forces.

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## Appendix

**Table A:** Semi-structured interviews. Codes refer to the following: industry experts or advocacy groups (IND\_x), governmental entities (GOV\_x), civil society organizations (ORG\_x), corporations (COR\_x).

|    | Code  | Description                                                                                                | Date     | Duration |
|----|-------|------------------------------------------------------------------------------------------------------------|----------|----------|
| 1  | IND_1 | Consultant for European gas TSOs association                                                               | 05/05/23 | 69'      |
| 2  | IND_2 | CEO transnational hydrogen corridor in the EU                                                              | 25/05/23 | 79'      |
| 3  | GOV_1 | Energy technology expert at intergovernmental organisation and coordinator of intergovernmental initiative | 30/05/23 | 51'      |
| 4  | GOV_2 | Director of hydrogen at intergovernmental organisation                                                     | 02/06/23 | 62'      |
| 5  | ORG_1 | Senior energy and infrastructure campaigners (two interviewees)                                            | 19/06/23 | 66'      |
| 6  | GOV_3 | Coordinator of European hydrogen valley and Representative of European Port Authority (two interviewees)   | 22/06/23 | 64'      |
| 7  | IND_3 | CEO consultancy coordinating European hydrogen valley                                                      | 06/07/23 | 65'      |
| 8  | IND_4 | Unit Director at global hydrogen industry association                                                      | 07/07/23 | 70'      |
| 9  | GOV_4 | Senior corporate and government hydrogen advisor and vice-chair of leading intergovernmental partnership   | 17/07/23 | 72'      |
| 10 | ORG_2 | Academic member of a national science coalition, based in Italy                                            | 24/07/23 | 145'     |
| 11 | ORG_3 | Specialist in energy and climate, based in Spain                                                           | 26/07/23 | 60'      |
| 12 | ORG_4 | Specialist in energy transition, focus on Europe                                                           | 01/08/23 | 43'      |

Table A: (continued)

|    | Code   | Description                                                                                                          | Date     | Duration |
|----|--------|----------------------------------------------------------------------------------------------------------------------|----------|----------|
| 13 | IND_5  | Expert coordinating European hydrogen valley                                                                         | 08/08/23 | 45'      |
| 14 | COR_1  | Transnational corporation (SOE), energy industry, receiving IPCEI in Portugal and Spain                              | 06/11/23 | 32'      |
| 15 | COR_2  | Transnational corporation (SOE), energy industry, receiving IPCEI in Italy and Spain                                 | 07/11/23 | 43'      |
| 16 | COR_3  | Private company, industrial chemicals, receiving IPCEI in Italy (two interviewees)                                   | 04/12/23 | 48'      |
| 17 | COR_4  | Transnational corporation, maritime industry, headquartered in Finland, end-user                                     | 11/12/23 | 41'      |
| 18 | COR_5  | Transnational corporation (SOE), energy industry, receiving IPCEI in Spain                                           | 18/12/23 | 32'      |
| 19 | CORP_6 | Transnational corporation, automobile industry, receiving IPCEI in France, Germany, and Austria (three interviewees) | 20/12/23 | 62'      |
| 20 | COR_7  | Transnational corporation (SOE), energy industry, receiving IPCEI in Poland                                          | 19/02/24 | 34'      |
| 21 | COR_8  | Transnational corporation (SOE), energy industry, receiving IPCEI in Germany                                         | 02/04/24 | 55'      |
| 22 | COR_9  | Private company, energy industry, receiving IPCEI in France                                                          | 22/07/24 | 33'      |

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