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The environmental state: Analysing the 'creation' of renewable energy markets in the United Kingdom

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Abstract

Following work on the green state, the environmental state has become a prominent analytical concept in recent decades commonly applied to understand the expanded role the state has taken in decarbonizing the national economy. This article demonstrates that there is yet further empirical value to be gleaned from this subject acknowledging that the environmental state's recently more expanded role in securing the green transition is not without historical precedent. Specifically, we propose an additional function for the environmental state of 'market creation' – accepting the process by which environmental states operate *ex post facto* ownership positions in already-existing energy markets for fossil fuel commodities – but also identifying it can use its power and agency in an *ex ante* fashion to *create* entirely new markets for renewable energy. In historicizing the environmental state, we show that whilst ex ante actions to create markets for renewable energy are not necessarily new, it has yet to be identified conceptually, and through a case study of the United Kingdom (UK) and the creation of a new national market for renewable energy we seek to demonstrate the conceptual value of a proposed new function of market creation for the environmental state. Beginning in the 1989 Electricity Act, market creation by the UK environmental state has proceeded through various reforms such as the introduction of Renewable Obligation Certificates (RoC) in 2002 to Contracts for Difference (CfD) in 2013, continuing in efforts in the 2020s to create markets this time for low carbon hydrogen.

Keywords

Environmental state, decarbonization, renewable industries, industrial policy, industrial strategy, hydrogen

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Introduction

Impending environmental disaster was once only a future prediction largely found in the model of climate scientists. Now unfolding across the globe in extreme weather events, from record heat to extreme flooding, it is increasingly incontrovertible reality. Climate change has been a mainstay of the political agenda in the United Kingdom since the *Stern Review* in 2006, an important, if insufficient, moment in humanity's recognition that environmental sustainability required urgent political attention and action. It was followed by the 2008 Climate Change Act (CCA), the significance of which extended far beyond its environmental commitments as legislated for in a series of carbon budgets (presently entering the fourth 2023–2027), catapulting the United Kingdom in the eyes of many towards becoming a perceived leader on environmental politics in the global political economy (CCC, 2023). That the ecological situation has only gotten worse since the onset of the 21st century, as the United Kingdom itself became misaligned with its own carbon budgets established in the Climate Change Agreements (Environment Agency, 2023), is reflective of the broader failure of countries to enact a green transformation.

A conceptualization by which to understand the growing environmental functions embraced by nation-states throughout the world economy, such as those to combat climate change, is the environmental state (Duit, 2016a; Hauknost and Hammond, 2020). Receiving growing attention since the global financial crisis of 2008, the popularity of the environmental state is based around its ontological construction best able to yield robust empirical insights in contrast to the *green* (Eckersley, 2004) and *climate* (Christoff, 2022) state(s) themselves normatively abstracted from observable environment-economy relations. Current literature typically considers the environmental state to operate certain roles and functions (see Table 1), with recent scholarship has led to incremental evolution in our understanding of the roles and activities embraced by the environmental state (Craig, 2020; Duit et al., 2016). A prominent example in this literature is provided by Babić and Dixon (2023) who recently proposed the addition of a function of 'ownership' to our understanding of the environmental state, an argument based upon their empirical positioning of the environmental 'state as owner' in carbon markets.

To strengthen the ability of the environmental state to generate empirical comprehension even further, we propose an additional role for the environmental state which we term 'market creation'. An extra function revealed in archival and document analysis which shows the UK environmental state a key factor in the creation of a national market for renewable energy beginning in the 1989 Electricity Act proceeding to Renewable Obligation Certificates (RoC) in 2002 until more recently Contracts for Difference (CfD) in 2013. We then focus on more contemporary efforts by the environmental state to develop a national market for low carbon hydrogen in the 2020s. We believe the selection of the UK as a case study by which to propose alterations to the environmental state is justified precisely because of the dichotomous tensions the country brings to the fore. It is widely considered to be a worldwide leader on climate change (Burns and Carter, 2018) making it an excellent illustration of the actions taken by environmental states to mitigate climate change and yet is also routinely identified as weak (Christoff, 2005) and particularly ill-functioning variant of the neoliberal environmental state (Hauknost and Hammond, 2020). Others argue it can claim the mantle of climate leadership only because it successfully exports many of its environmental issues abroad (Jackman, 2022)[1]. This paradoxical view of the UK environmental state, to which we add further complexity in this paper by showing its willingness to engage in the very non-neoliberal activity of market creation (an intervention posited by those who aspire to an ideal green state (Bailey and Jackson, 2024; Beck and Larsen, 2024)), in our view justifies the greater exploration we seek to deliver in this paper. Indeed, whilst we accept that the bar for qualifying as an environmental

state has sometimes fallen so low to include those countries with even the most minimal ecological ambitions, we hope to show in this paper that the environmental state is nevertheless capable of taking actions in the realm of renewable energy that are significant and from which we might learn when designing environmental and green industrial policy in the future.

To clear the ground for our empirical contribution to both the literature on the environmental state and climate politics in the UK, we structure analysis as follows. The opening section begins by investigating the development of literature on the environmental state, particularly the evolution in understanding of its four main functions. We then, in the subsequent section, outline our conceptual contribution to the literature through the notion of the environmental state as 'creator'. To alight upon the empirical foundations of the market creation function, we identify the critical role played by the UK environmental state in the creation of a domestic renewable energy market from the 1989 electricity market onwards. Activity here by the environmental state aligns somewhat with the notion of 'weak derisking' in which the state 'tweaks the risk-return profiles of financial instrument's to crowd-in private sector investment into an industry. We then provide a discrete case study of efforts by the environmental state to create a fledgling market for low carbon hydrogen, separate analysis justified in our view because of the evolution of subsidy regime towards a 'robust derisking' strategy in which HM Treasury is currently 'directly subsidizing capital expenditure by non-financial firms' (Gabor and Braun, 2024). We conclude with the implications of this analysis for the political economy literature.

The environmental state: A four-dimensional construct

The nation-state has long been identified as an important environmental actor by scholars (Frank et al., 2000: 96) and international organizations (OECD, 2011) alike. Typologies of the relationship between nation-state and the environment has correspondingly abounded with the environmental state one of the most prevalent (Babić and Dixon, 2023; Craig, 2020; Dryzek and Hernes, 2002; Duit, 2016a; Duit et al., 2016; Goldman, 2001; Gough, 2016; Hauknost, 2020a; Hauknost and Hammond, 2020; Meadowcroft, 2005, 2012, 2022; Mol, 2016; Schnaiberg et al., 2002). Defined as when 'environmental management… become [s]… an essential component of state activity', the environmental state is considered one that also 'publicly recognize [s]' the enviro**n**ment 'as a fundamental part of what a civilized state should do' (Meadowcroft, 2006: 8). In contrast, alternative conceptualization of the nexus between state and ecology, such as the green (Bailey, 2020; Bailey and Jackson, 2024; Eckersley, 2004, 2020, 2021; Hildingsson et al., 2019) and climate (Christoff, 2022) state, are constructions generally considered more normative than empirical, the environmental state in contrast becoming something of an 'analytical-descriptor' of the state's environmental functions within a capitalist political economy (Eckersley, 2020). Therefore, as these concepts have come to establish varying degrees of analytical purchase, the environmental state has emerged as perhaps the primary conceptual vehicle for understanding of the nexus of state and ecology in the modern capitalist system.

Despite our attempts in the previous paragraph to outline the various differentiation in the state and ecology nexus, we acknowledge that the literature has become somewhat conceptually messy, and that in the attempt to forge a distinct agenda for the green state it has often become conflated with the environmental state (Beck and Larsen, 2024; Hildingsson et al., 2019). This conceptual messiness is typified by Newell (2019: 125) who argues that 'clear criteria about what constitutes a Green State are elusive' and the 'Environmental', 'eco' and 'ecological' prefixes to the state are often used interchangeably'. That the green and environmental state has conceptually converged might be the result of the latter been deployed to give meaning to the former. For example, in

identifying the importance of central banks in the green state transformation, Bailey and Jackson (2024) find that these institutions 'exemplify the intractability, incrementalism and limitations of actually existing green state transformations', with central banks operating only 'theoretically… [as] constituents of fully fledged green states'. Consequently, whilst we accept that conceptual distinctions of the state and ecology nexus have convoluted in recent years, we retain the separation of the environmental state in this paper purely because we find it a more empirically pliable concept to uncover what nation-states have actually done (or are doing) to combat environmental degradation. We nonetheless readily accept that some may some consider our paper an analysis of the green state.

An opening attempt at conceptualization of the environmental state was delivered by Christoff (2005) who sub-divided the concept into twin classification of welfare and neoliberal variants. Though a useful analytical concept, Christoff contends that the environmental state remains a relatively weak institution in the face of environmental issues (ibid). The environmental welfare state was considered to have moderate state capacity for intervention to protect the environment, its weak institutionalization of ecological values mitigated somewhat by its strong commitment to human social and environmental welfare and its moderate commitment to expend fiscal resources in pursuit of ecological issues. In contrast, the neoliberal variant has weak state capacity on environmental issues, with intervention that is expended towards the environment strongly market orientated. The neoliberal environmental state also said to have environmental values only weakly embedded within institutions, evident in their often weak to moderate budgetary commitment to social and environmental welfare. From its humble origins in protecting nature through a variety of regulatory instruments, the environmental state has come to be considered anything from the financier, orchestrator, even owner, of the industrial sectors that comprise the green energy transition (Babić and Dixon, 2023; Dryzek and Hernes, 2002; Jackson, 2024a).

Rejuvenated by a special issue in *Environmental Politics* (Duit et al., 2016), the environmental state has undergone further conceptual development since then (Craig, 2020; Hausknost, 2020a; Mol, 2016). The functions of the environmental state initially proposed across the four 'faces' of (i) regulation, (ii) redistribution, (iii) administrative and (iv) knowledge production (Duit, 2016a), and the environmental state defined more specifically as 'a state that possesses a significant set of institutions and practices dedicated to the management of the environmental and societal-environmental interactions' involving 'specialised administrative, regulatory, financial and knowledge structures that mark out a distinctive sphere of governmental activity' (Duit et al., 2016: 5–6). More recently, to fully understand the full extent of agency by environmental states throughout the world economy, it has been posited its functions should be redefined around those of (i) regulation, (ii) incentives, (iii) intervention and (iv) ownership (Babić and Dixon, 2023). These functions, whether delineated by Duit or Babic and Dixon, a series of actions taken by environmental states to overcome either market (e.g. negative externalities) and government failure (e.g. regulatory capture). This journey in conceptual refinement in the functions of the environmental state is delineated in Table 1.

More recent efforts to expand on original conceptualization of the environmental state by Babic and Dixon have delivered the concept with greater analytical precision, it been our belief that a process of rationalization in the functions of the environmental state was required to strengthen its ability to generate empirical insight. For example, in recognizing that regulation involves the environmental 'state in creat [ing] laws and provisions that rule our certain environmentally harmful practices and penalize offenders' and that this will likely involve 'setting up new state institutions' or 'instructing existing state apparatus to follow newly established rules', Babic and Dixon (2023: 610) implicitly acknowledge that 'regulation' requires an 'administrative' apparatus to establish,

monitor and enforce. This obfuscates the need for administration to be determined as a separate function of the environmental state, the analytical compression of administration with regulation supported by literature documenting the rise of the regulatory state, in which socio-economies around the world from the 1980s onwards were re-regulated in the exponential growth of a swathe of new quasi-public bodies tasked to enforce the competitive principle (Moran, 2003).

Similarly, there is every reason to consider, as Babic and Dixon have done, whether it is necessary to elevate 'knowledge production' as a distinctive function of the environmental state when it might realistically be considered an element of its other activities. This is explicitly acknowledged by Babic and Dixon when they assert that environmental state will 'actively nudge other societal agents to adapt and work towards environmental and climate goals' such as through 'incentives' that promote 'environmental values'. Again, support for the analytical merging of knowledge production with other functions can be found in literature, this time on political communication. McNair (2011: 11) states that 'political programmes, policy statements and electoral appeals' are all examples of how 'political actors… have their messages communicated to their desired audience'. This aligns with the understanding of political communication advanced by McNair (2011: 4) as 'purposeful communication about politics' that includes 'all forms of communication undertaken by politicians and other political actors for the purpose of achieving specific objectives', a definition of political communication itself based on the 'intentionality' of communicators to influence the wider political environment (Denton and Woodward, 1990: 11). Here, we can start to see how the environmental state engages in knowledge production as an element of its other functions.

The introduction of a new regulation, incentive or intervention in the market, for example, almost certainly accompanied by a justificatory discourse the intention of which is to disseminate knowledge about impending environmental crisis as the rationale for their introduction. For example, the announcement in October 2024 of £21.7 billion investment over 25 years in carbon capture, utilization and storage (CCUS) was accompanied by a press release from the Department of Energy Security and Net Zero (DESNZ, 2024) claiming investment marked 'a game-changing development in the mission to tackle climate change – protecting the environment from harmful emissions at a time when the UK has seen a year of record- breaking temperatures'. The press release also went to great efforts to stress the support for investment in CCUS of the Independent Climate Change Committee (ICCC), a key knowledge producer within the state, as well as global knowledge producers about climate change such as the International Energy Agency and the Intergovernmental Panel on Climate Change, all of which were claimed to view CCUS technology as 'critical' in the decarbonization of heavy industry, and a 'necessity for the UK to reach its legally binding target for net zero emissions by 2050'. That the UK environmental state went to such efforts to narratively justify investment in CCUS likely in no small part be due to the accusation that CCUS should play no meaningful part as a legitimate solution to climate change (Centre for Environmental Law, 2021). This proves to demonstrate that environmental state might produce knowledge as part of its activity that is disputed and contested, but we don't believe acknowledgement of such is enough to justify knowledge production as a singular analytical function of the environmental state.

Importantly, this journey of refinement travelled by Babic and Dixon opened up the conceptual space for them to elevate new functions that are critical in understanding the environmental state in the contemporary world economy. One such function proposed by Babic and Dixon is 'intervention', something that was previously only ever a subset of other functions in the original conceptualization by Duit (2016a: 74–75), receiving only passing mention within discussion of the 'regulatory' and 'knowledge production' purposes of the environmental state (see Table 1). However, in an age when scholars are increasingly identifying the number of states pursuing green

industrial policies (Kemp and Never, 2017; OECD, 2024; Schmitz et al., 2015; Tyeler and Schmidt 2019), and major participants within the world economy such as the United States, European Union and China are all now implementing their own green industrial strategies (European Commission, 2023; United Nations Conference on Trade and Development, 2023; White House, 2022), intervention by the environmental state should be considered a core function of its activities. Consequently, we consider a strength of Babic and Dixon's (2023: 611) definition of the interventionist function as the environmental state as 'directly influencing and engineer [ing] desired sustainable outcomes, for example, by manipulating or steering markets directly' is that it aligns nicely with definitions of green industrial policy, such as that provided by the World Bank, that identifies it as those 'with an environmental goal – or more precisely, as sector-targeted policies that affect the economic production structure with the aim of generating environmental benefits (Fay et al., 2013: 3).

Of arguably greater analytical importance however is the inclusion by Babic and Dixon (2023: 611) of 'ownership' as a core function of the environmental state, necessary because 'even the most interventionist characteristics of the environmental state still concern its governance-functions' hitherto the concept in its original form failing 'to capture the fact that states become market actors themselves'. Babic and Dixon (2023: 611) argue therefore that a new function of ownership was necessary to ensure that the intervention function was appropriately 'differentiated' from the 'role' of the environmental state 'as [the] owner of carbon assets itself' (Babić and Dixon, 2023: 611). The 'state as owner' of significant carbon-related industries and assets something pursued not only by environmental states in emerging economies but also by advanced industrial nations including Norway and France. In consequence, Babic and Dixon advanced the further function of the environmental state of 'ownership' (see Table 1) and it is towards this function of the environmental state that our paper now turns.

'States as market creators': An analytical extension of the concept of 'states as owners'

In this section, we articulate our own analytical expansion in the functions of the environmental state (see Table 2) during which we build upon the existing work by Babić and Dixon (2023) rather than seek to replace it. We accept the regulatory, incentive and interventionist functions are accepted as critical to understanding the scope of the environmental state in the contemporary era. The role of the environmental state as carbon owner is also undeniable and therefore retained within our new categorization of *market creation* as a function of the environmental state. The extent to which states have created markets has, to varying degrees, been alluded to elsewhere, particularly in Beck and Larsen's (2024) analysis of China and Larsen (2024) subsequent work on Vietnam. Following analysis therefore compliments this previous work, whilst also providing greater conceptualization as the meaning of market creation through a case study markedly different to the East Asian economies that have occupied the focus hitherto.

Why then do we propose the replacement of the ownership function with that of market creation? Ownership by the environmental state is posited by Babic and Dixon to occur *ex post facto*. By this, we mean the positions taken by the environmental state in domestic and world markets are with a view to shape, guide or restructure *already established* domestic and international markets for energy commodities, especially fossil fuels. Here, the view of 'ownership' has much similarity with literature on state capitalism variously defined as 'the state… using its sovereign authority to orient economic processes (domestic or international) to the political objectives of state actors (Silverwood and Berry, 2023: 124; see also Bremner, 2010: 43; Lee, 2020: 1; Wright et al., 2021: 2–3), in which it

Table 1. Conceptual refinement in the functions of the environmental state.

Duit's environmental state	Function	Babic and Dixon's environmental state	Function
Regulation	Regulation of use and access to natural resources, as well as impact of industrial production, intensive agriculture and urbanization	Regulation	Establishment of new laws, rules and administrative bodies to discipline those engaged in environmentally harmful practice
Redistribution	Taxation on fossil fuel goods to alter actor behaviour and generate resources to be redistributed towards low carbon alternatives	Incentives	Techniques to motivate actors to change their behaviour and work towards environmental targets set by the state
Administration	Institutional apparatus to address environmental problems, particularly government departments/ministries and other public agencies	Intervention	Policies (often temporary) that seek to guide and steer market outcomes towards desired environmental outcomes
Knowledge Production	Production and dissemination of knowledge and norms about the environmental crisis	Ownership	Direct and measurable impact on ecological crisis caused by investment (or disinvestment) decisions taken by the state, particularly in carbon industries

Source: (Babić and Dixon, 2023; Duit, 2016a).

potentially chooses to intervene in the capitalist system in multiple ways such as 'owning majority of minority equity positions in companies or by providing subsidized credit and/or other privileges to private companies' (Musacchio and Lazzarini, 2014: 2). State capitalism might also involve institutional creation, such as state-owned enterprises (Musacchio et al., 2015) or sovereign-wealth funds (Schwartz, 2012), which in the contemporary era are increasingly likely to engage in considerable cross-border foreign investment strategies (Babić et al., 2020). Consequently, Babic

Table 2. Further conceptual refinement of the environmental state.

The environmental state – Silverwood and Jackson	Functions
Regulation	Laws, administrative institutions and norms established to promote environmentally beneficial behaviours and discipline wrongdoers
Incentives	Techniques to incentivize individuals and businesses to work towards environmental targets set by the state
Intervention	Direct influence to guide and steer markets towards desired environmental outcomes
Market creation	Actions taken *ex post facto* to create new organizational or management structures within already established energy markets or *ex ante* in which the state directly create new markets for the generation and supply of energy

and Dixon (2023: 609, 611, 613) astutely identify that the environmental state attempts not only to 'regulate and govern markets' but also act 'crucially…. [as] owners, shareholders, investors and lenders'. The 'state ownership of carbon assets' by the environmental state is therefore clarified to mean 'all types of fully state-owned entities holding shares in firms that are located in carbon industries', such as state-owned enterprises and sovereign-wealth funds, through which environmental states might eventually come to pursue its own strategies for decarbonization.

It can subsequently be determined then that to execute ownership the environmental state must first *create* either through (i) the *development* of new institutional structures (e.g. a state-owned enterprise or sovereign-wealth fund) through which ownership over energy commodities (particularly fossil fuels) or economic benefits from them can be engineered or (ii) the *insertion* of new management structures within existing energy companies by which the environmental state can assert its influence (e.g. by becoming a majority shareholder). This is merely a supportive point however, our main reasoning of the need for conceptual extension is temporal, resting in the assertion that the environmental state is capable not only of acting *ex post facto* in already-existing markets for fossil fuels but also *ex ante* using its power and agency to directly create the modus operandi and structure by which markets for renewable energy operate and function. Consequently, we argue that to properly understand the activities environmental states have been taking we must go further than the current conceptualization of 'ownership' allows, which we propose to do through in the evolution of this function to one of *market creation*. For instance, as we will show in our ensuing case study, the UK environmental state engaged in the creation of a new national market for the generation and supply of renewable energy in the 1989 Electricity Act, with subsequent efforts by the UK environmental state to reshape the domestic market for renewables arriving in the twenty-first century. Indeed, the willingness of the environmental state to create new national markets for renewables ensures its actions align with the broader historical approach the UK state to industrial strategy, which has focussed much more on 'making markets' for international capital, than taking ownership positions through the creation of state-owned enterprises or sovereign-wealth funds (Berry, 2022; Silverwood and Berry, 2023). Our modest contribution to conceptual refinement of the functions of the environmental state offered in this paper is demarcated in Table 2.

The environmental state and market creation: Renewable energy

The 1989 electricity act and the Non-Fossil Fuel Obligation (NFFO), 1989–2001

The 1989 Electricity Act and its introduction of the NFFO has recently been identified (Silverwood and Jackson, 2025) as an important evolution by the UK environmental state establishing at the stroke of a legislative pen the structure and terms of a new national market for nuclear *and* renewable energy, and embroiling the Thatcher government in an expansive form of state intervention directly repudiated by her own rhetoric that favoured the formation of markets through reliance on entrepreneurial dynamism. Despite the claim of 'rolling back' the state therefore, the Thatcher government in fact used the power and agency of the state to create a market for renewables in the 1989 Electricity Act. Initial impetus for this legislation arose from privatization of the nuclear industry, the return of which to the private sector had failed to attract a sufficient influx of investment into the sector, largely because the nuclear industry had 'no assurance of a market for its costly electricity' (Gipe, 1995: 42). The rhetoric of the Thatcher government would have us believe that this barrier to investment in the nuclear industry would be left to the rectification of entrepreneurial forces. Instead, the 1989 Electricity Act placed a statutory requirement (the NFFO) on newly formed regional electricity companies (RECs) to purchase a certain amount of energy from nuclear and

renewable sources. Here, we can see how actions taken by the environmental state under Thatcher mirror somewhat the activity of 'weak derisking' identified by Gabor and Braun (2024) involving the state directly in 'tweaking risk-return profiles' of the cost of renewable energy to 'crowd-in' investment from the private sector.

Department of Trade and Industry and HM Treasury documentation produced during the Conservative government of Margaret Thatcher described the purpose of the 1989 Electricity Act and NFFO as the creation of 'a commercial market to be *established* within the UK in new and renewable energy', which 'concentrates resources on those technologies with good prospects of commercial application' (DTI & HM Treasury, 1995: 68) *(italics added)*. DTI & HM Treasury (1997: 75) would later make this point even more clearly explaining the 'purpose of the NFFO' was 'to *create* an initial market for the most promising renewables which have the prospect of competing in the liberalized market' *(italics added)*. At the same time, the actions of the environmental state have been noticed by scholars, with Mitchell (1995: 1077) describing the energy system it introduced to the UK by the 1989 Electricity Act as a 'market enablement programme' that 'accepted the principle that paying a premium price for near market technology is an efficient and appropriate means of transferring technologies to competitiveness'. A market for nuclear and renewable energy created in the 1989 Electricity Act in which RECs were compelled to purchase renewable energy with 'premium' paid on each unit (MwH), the premium calculated as the difference between the 'administrative strike price' (established by the DoE) and the average monthly purchasing price (established by the market). For example, the administrative strike price for generation of wind energy under the NFFO was 9pence (1990) and 11pence (1991) per kilowatt then the 'highest [strike price for wind energy] in the world' (Gipe, 1995: 43).

The NFFO has subsequently been described as providing a 'subsidy to the contractors' (meaning nuclear and renewable energy generators) (Mitchell, 1995: 1077). Whilst there is much to be said in deployment of the term subsidy to describe this policy, it should be noted that NFFO did not involve direct transfer of expenditure from central government to producer (or generator in this case), the commonly considered relational form of subsidy. Instead, the 1989 Electricity Act forced electricity suppliers (now statutorily obligated to purchase a portion of their energy from nuclear or renewable generators) pay a fossil fuel levy, which was passed onto the consumer via their energy bills, to OFGEM. The fossil fuel levy was then passed to the Non-Fossil Fuel Purchasing Agency (NFFPA), who operated as an intermediary between electricity suppliers and generators, with authority not only for the collection of the fossil fuel levy from electricity suppliers, but also the administration of renewable generation contracts awarded under NFFO. It was fossil fuel levy that financed the 'premium' paid on each unit of MwH energy produced by renewable energy generators under the NFFO.

Lipp (2007) consequently explains that it is more sensible to explain the renewable market created in the 1989 Electricity Act as a quota system than traditional subsidy regime. The intention of this system was to 'crowd-in' investment from electricity suppliers (or perhaps more accurately energy consumers) into the renewable and nuclear industries. This was achieved via a market that was created to establish three important mechanisms. First, the state directly established the value of renewable energy products (via the administrative strike price). Second, the state assured a market for renewable energy by dictating demand (by setting obligations on suppliers to purchase renewable energy). Third, ensure revenue support for the renewable energy industry by establishing a levy on electricity suppliers (paid for by consumers) to be passed to the generators of renewable energy. As documented in Table 3, these mechanisms achieved the 'crowding-in' of £418.5 million worth of investment into the renewable industries during the opening 7 years of its existence.

Table 3. Revenue support for renewables under NFFO (nominal), 1990–97.

Year	NFFO (£millions)
1990–91	6.1
1991–92	11.7
1992–93	28.9
1993–94	68.1
1994–95	96.4
1995–96	94.5
1996–97	112.8
Total	418.5

Source: (Pollitt, 2010: 23).

Renewable Obligation Certificates (ROC), 2002–2012

The UK environmental state continued to tamper with the market for renewable energy it had created in the 1989 Electricity Act, albeit not in a way that upended the established quota system involving the 'obligated demand' (Aparicio et al., 2012: 812) placed upon electricity suppliers to source a certain amount of energy from renewable sources (Lipp, 2007). In 2002, the NFFO was replaced by ROCs expanding the annual obligation of UK electricity suppliers to provide an even greater level of electricity from renewables. This 'new' market designed by the UK environmental state was built around the energy regulator, OFGEM, who issued ROCs to generators of renewable energy for distribution to electricity suppliers upon the purchase of renewable energy (or directly to the electricity supplier in those instances when they were also renewable energy producers). In turn, ROCs were given back to OFGEM by electricity suppliers as proof they had met their obligation to supply a portion of their electricity from renewable sources. Electricity suppliers were also allowed the option of 'buying out' there renewable obligation. Likewise, the introduction of ROCs provided renewable generators with twin incomes streams: (i) from the sale of renewable energy to wholesale markets and (ii) the sale of ROCs to energy suppliers (Grimwood and Ares, 2016; Higgins and Foley, 2014: 606).

The market for renewable energy then entered a brief period of stasis before the Renewable Obligation Order 2009 (ROO). Here, the obligation on electricity suppliers to purchase energy from renewable sources became whichever was the greater value of (i) the ROCs needed to meet the fixed target (the annual obligation) or (ii) the ROCs expected to be issued according to the amount of electricity generated uplifted by 10 percent. This alteration by the UK environmental state ensured 'guaranteed headroom' for renewable energy producers setting 'an effective floor for ROC prices' and ensuring the stage was set for future reform by graduating the domestic renewable energy market towards a feed-in-tariff structure (Aparicio et al., 2012: 812). The ROO also saw the demise of equality between renewable technologies in the provision of ROCs, with renewable energies becoming 'banded' according to their desirability. For instance, henceforth, OFGEM would provide one ROC for each unit of MWH energy generated by the onshore wind industry, whilst two ROCs would be delivered for each unit of MWH energy produced by the offshore wind industry (Grimwood and Ares, 2016; Higgins and Foley, 2014: 606).

Contracts for Difference (CfD), 2013-present

One element that has not altered throughout the various iterations of the domestic market for renewable energy created by the UK environmental state has been the principle that revenue support for renewable electricity generators would be levied from electricity suppliers with costs passed to consumers' energy bills (Watson and Bolton, 2024: 6). For instance, under the ROCs system, it was accepted that 'energy companies recover [ed.] the cost of renewable obligations through consumer bills' (Grimwood and Ares, 2016). Evolution of the UK renewable energy market towards CfD only saw this principle further embedded with the introduction of the Levy Control Framework in 2011, which applied a supplier obligation mechanism to 'meet the costs' of the new scheme and created a new counterparty, the Low Carbon Contracts Company (LCCC), authorized to escort payments from electricity supplier to renewable generators (BEIS, 2015). This ensured that electricity suppliers met their statutory obligation to fund CfD payments to generators entered by the LCCC (2016), a statutory obligation enshrined in the electricity market reforms introduced by the UK environmental state in the Energy Act 2013. The main substance of the electricity market reforms was to switch the domestic market for energy away from the quota system introduced in the 1989 Electricity Act, and reinforced by the ROC system, in which electricity suppliers were obligated to purchase renewable energy to a type of feed-in tariff (FIT) approach called CfD in which the UK environmental state guarantees for renewable suppliers a fixed price for their energy. In this new system, electricity supplier are levied to fund the contracts with renewable suppliers entered by the LCCC, the ultimate cost of CfD then exacted from consumer energy bills (DECC, 2011: 3; BEIS, 2022c).

The environmental state had once again therefore established a domestic market for renewable energy in which significant subsidies, levied from electricity suppliers, and in turn applied to consumer energy bills, would be provided to renewable energy generation. We might now safely use the term 'subsidies' because, as noted in documentation by the now defunct Department of Business, Energy, and Industrial Strategy (BEIS), renewable energy generators considered themselves to be in receipt of a subsidy (BEIS, 2019: 5), even if the system itself is not what we might consider a traditional subsidy regime (the provision of direct finance between government and producer). Furthermore, BEIS itself referred its latest efforts to restructure the domestic energy market through CFD to the UK's Subsidy Advice Unit (2023: 4) on the grounds that they might distort competition and investment into renewables, as well as securing approval of the European Commission for the delivery of 'state-aid' (Subsidy Advice Unit, 2023: 5) illustrating the subsidized-nature of the domestic renewable energy market created by the UK environmental state.

Subsidies to renewable energy generators would be delivered through CfDs, the essential re-structure to domestic energy markets introduced by the UK environmental state in its electricity market reforms in the 2013 Energy Act. CfDs is a type of FIT, the initial moves towards which began in April 2010 with the introduction of a new FIT scheme to the domestic UK energy market. Closed to new applicants in April 2019, the FIT saw accredited renewable generators receive payments from their FIT licensee (electricity supplier) on a quarterly basis for the renewable energy they generated receiving such support over contracts of anywhere between 10 and 25 years depending on certain criteria (such as technology type, generation capacity). The costs of the scheme were spread across all licenses electricity supplier in what was referred to as a 'levelization' process (OFGEM, n.d).

Transition towards a FIT structure for the domestic UK energy market was solidified in CfD (DECC, 2012, 2013). Introduced with the stated aim to 'provide increased revenue certainty to low carbon generation' such that investment into renewable energy would be enhanced, renewable

generators with a CfD sell their electricity into the wholesale electricity market, the CfD ensuring the generator receives a payment of the difference between the market price at which the energy is sold and the strike price, the latter been the cost established in the CfD to produce each MWH unit of energy for any given renewable technology. In other words, if the renewable generator sells its power at a market price lower than the strike price then the CfD ensures a payment of the difference as a reward to investment. In those instances where the market price is higher than the strike price the renewable generator is obligated to pay the difference in reverse. It consequently argued that CFD 'stabilise returns for generators at a fixed level, over the duration of the contract', which are typically 15 years in length, removing renewable electricity generators from 'long-term exposure to electricity price volatility, substantially reducing the commercial risks faced by these projects' (DECC, 2012: 14–15). Strike prices are established both by government (who establish the highest price they are willing to pay for each unit of power produced by each renewable technology – this is the administrative strike price) and competitive auction. Renewable energy generators then submit sealed bid at each auction round (at time of writing they have been seven) containing their strike price which are accepted sequentially from lowest to highest until the 'budget' set by the government for any given year has been spent (Watson and Bolton, 2024: 6).

The environmental state and market creation: Hydrogen in the 2020s

A potential evolution in the subsidy regime by the environmental state for renewable energy is more recently underway in the creation of a fledgling domestic market for low carbon hydrogen. Ultimately, as we have seen in the previous section, the subsidies provided to renewable energies through CfD are still levied from consumer bills (as they were under NFFO and ROCs) and not directly provided by the state. In the burgeoning market for hydrogen, however, the environmental state is providing subsidies directly from the taxpayer, the subsidy regime for hydrogen more closely aligned therefore with 'robust derisking' delineated by Gabor and Braun (2024) in which the 'state subsidizes capital expenditure in cleantech manufacturing directly'.

Presented to the House of Commons by BEIS in August 2021, the Hydrogen Strategy offers additional contemporaneous evidence of the willingness of the UK environmental state to create new markets for renewable energies. Indeed, BEIS began its Hydrogen Strategy by identifying that there currently existed 'no low carbon production of hydrogen in the UK or globally' (HM Government, 2021: 4), a somewhat problematic observation given its vision to establish the UK as a 'global leader' in low carbon hydrogen capable of producing 5 GW (the target was later increased to 10 GW) (BEIS, 2022) of energy by 2030 only 9 years after publication. This would support the UK environmental state in 'delivering decarbonization across the economy' accelerating the transition to 'net zero, supporting new jobs, and clean growth across the UK' (HM Government, 2021: 14). To remedy the disparity between reality and vision, BEIS argued it would adopt a 'whole-systems approach' not only engaging in intervention 'across the entire hydrogen value chain in the 2020s' from 'production, to networks and storage, to use across industry' in support of 'commercial, technical and user readiness for new technologies' (HM Government, 2021: 4, 21). In short, BEIS saw their role as nothing less than 'to *create* a thriving market for hydrogen and associated goods and services' (HM Government, 2021: 21) *(italics added)*.

It is in the efforts of the environmental state to structure production in the hydrogen industry that we most clearly see its willingness to create markets for the sector, just as it has for the wider renewable industry since the 1989 Electricity Act. Euphemistically pursued under the auspices of originating a 'hydrogen business model', the hydrogen strategy outlined how it would involve the UK environmental state in the provision of 'long-term revenue support to hydrogen producers to

overcome the cost challenge of producing low carbon hydrogen compared to cheaper high carbon alternatives' (HM Government, 2021: 37). How this was to be achieved however not properly established by BEIS until the publication of a consultative document April 2022 in which the preference for a hydrogen sector that had a 'contractual, producer focussed business model' which 'incentivise [d] the production and use low carbon hydrogen through the provision of ongoing revenue support' (BEIS, 2022a: 13) was determined.

As the consultative document progressed, it became clear that what BEIS meant by 'revenue support' was the provision of subsidies for hydrogen production distributed via annual allocation necessary to mitigate 'the risk… that the price the producer is able to achieve for selling hydrogen does not cover the costs of producing it' (BEIS, 2022a: 21). BEIS explicitly argued that subsidies were necessary for production of low carbon hydrogen to 'overcome one of the key barriers to deploying low carbon hydrogen; the higher cost of low carbon hydrogen compared to high carbon counterfactual fuels' (BEIS, 2022a: 7). BEIS continued to explain in the consultative document that subsidies would be paid via 'variable premium option support' meaning that subsidies were to be calculated as the difference between 'strike price' (cost to produce) and 'reference price' (price paid) for each unit of hydrogen, with the variable premium set to change as the value of hydrogen (the reference price) oscillates (BEIS, 2022a: 21–24). It was hoped the provision of subsidies would 'crowd-in' private sector investment to the hydrogen industry 'stimulat[ing] investment in new low carbon production capacity' especially in 'newly constructed facilities built for the specific purpose of producing hydrogen' (BEIS, 2022a: 14).

More information was not forthcoming until the publication of a swathe of documentation in late 2022 and the opening months of 2023 by BEIS (2022b), and then the newly rebranded DESNZ (2023), notably the Heads of Terms and Front-End agreements (see also Subsidy Advice Unit, 2023). Here, it was confirmed that the hydrogen business model would 'support producers of low carbon hydrogen by paying them a premium, calculated as the different between a strike price… and a reference price', the strike price determined as that 'reflective of the producer's unit cost of production and negotiated on a project-by-project basis', and the reference price that 'at which the producer sells their hydrogen, with a floor at the natural gas price'. Where the strike price exceeds the reference price, 'a premium will be payable' to the producer of the 'difference amount' to 'provide the producer with price certainty by enabling the producer to recover the costs of producing low carbon hydrogen and make an allowed return on investment'. Conversely, in circumstances where the reference price exceeds the strike price, then hydrogen producers then 'an amount is payable by the producer' such that the government can 'achieve value for money' (BEIS, 2022b: 15–16). Nevertheless, a price discovery incentive has been built into the hydrogen business model, a 'reward mechanism' to 'incentivise producers to achieve higher sales prices, which will reduce the size of the support payment' (BEIS, 2022b: 2) in which producers achieving a higher reference price than the floor price (indexed to natural gas) could retain 10% of the difference amount, itself calculated either as the difference between reference and (i) floor price or (ii) strike price (BEIS, 2022b: 22). Furthermore, the Head of Terms agreement include a sliding scale for volume support, which determined that 'if the producer is producing hydrogen and its offtake/sales volumes fall, the producer will receive an additional amount [of support] for each unit of hydrogen sold', 'equivalent' the document noted as 'paying the producer a higher level of strike price for the low volumes of hydrogen sold, even though the strike price itself will not be adjusted'. Certain 'qualifying events' might preclude payment of sliding support such as 'facility outage' or a 'breach of, or default under… any agreement' (BEIS, 2022b: 22–23).

The Head of Terms also established that producers entering into a Low Carbon Hydrogen Agreement (LCHA) would do so via a 'private law, commercial contract' administered by a newly

created counterparty, the Low Carbon Contracts Company Ltd (LCCC). LCHA's entered into by hydrogen producers and the LCCC would be over a period of 15 years reflective of 'the potential time for the nascent low carbon hydrogen market to develop' and because this was determined a 'long enough period for producers to secure private sector financing'. It was also noted that supporting renewable producers over such a length of contract was a 'precedent' set in CfD (BEIS, 2022b: 4). DESNZ (2023a: 18–19) later confirmed that hydrogen contracts would ultimately be managed by the LCCC, the counterparty also providing the 'conduit for subsidy funding' (DESNZ, 2023a: 18). At time of writing, subsidies to hydrogen producers, the first round of which were allocated in December 2023 to 11 different projects totalling 'over £2 billion of revenue support' (DESNZ, 2023b), are paid for directly by HM Treasury. The business model for hydrogen consequently involves a more traditional subsidy regime than the wider renewable market in which subsidies are paid (albeit through the counterparty of the LCCC) from government to producers. In no small part this was due to rebellious Conservative backbench politicians during the Prime Ministership of Rishi Sunak (Riley-Smith, 2023), initial proposals for hydrogen subsidies to be funded by a direct levy on consumer energy bills as per existing arrangements under CfD (and historically under the NFFO and ROCs) rejected by those political actors. The 2023 Energy Bill does however allow the environmental state to introduce a future hydrogen levy on gas shippers through secondary legislation 'to fund… payments and associated costs' of the hydrogen business model (DESNZ, 2023c: 16, 17 and 19). Doing so would bring the subsidy regime in the hydrogen market into alignment with the wider renewable sector.

Conclusion

Our key finding is that the UK environmental state has created, and continues to create, national markets for the production of low carbon energy, engaging in such activity even whilst regularly been identified as perhaps *the* archetypical case of neoliberalism when it comes to the interaction of state and ecology. We have articulated this occurrence via conceptual contribution to literature on the environmental state, the literature on which identifies the concept as having specified functions which we have sought to revise and expand by an additional role of market creation. The addition of market creation to the functions of the UK environmental state was shown by exploration of the actions it took to structuring the market for renewable energy across three phases of complex and dynamic development. The initial act of market creation took place in the 1989 Electricity Act introducing a quota system for production in which the UK environmental state sought to 'crowd-in' investment by dictating the value of renewable energy and dictating demand for renewable energy products. The market for renewable energy remained stable until the evolution of ROCs in 2002 designed to generate even greater levels of demand for renewable energy by increasing the annual obligation on UK electricity suppliers to source an even greater level of electricity from renewable sources. The UK environmental state then undertook further evolution of the market for renewables with the introduction of CfD in 2013, essentially moving the market in the direction of providing FIT. One continuity in the UK environmental states restructuring of the renewable energy was the principle that subsidies to renewable energy generators would come from consumers rather than directly from government, this principle appears to have lapsed when it comes to the creation of markets for low carbon hydrogen in the 2020s, with the UK environmental state accepting that subsidies would be provided directly to producers at least in the short-term.

We hope the paper reveals the worth in, and paves the way for, future research that seeks to historicize the green transition, even as we collectively engage in the worthy and necessary endeavour of seeking solutions to the Anthropocene. Here we hope our decision to choose the UK as a

case study goes someway to proving the importance of our point. The UK has been identified as a 'climate leader' that has made significant gains emissions reduction (Burns and Carter, 2018), but also a weak neoliberal environmental state (Christoff, 2005). Its claim of climate leadership resting largely on the reduction of carbon emissions claimed to have been driven by the private sector. Instead, we have sought to show that whatever successes the UK claims in renewable energy have been spurred though a process of creation on the part of the environmental state, in which market formation and price signals have arisen from the stroke of the bureaucratic legislative pen, rather than the ingenuity, innovation and dynamism of entrepreneurs. As scholars across several disciplines, from political economy to developmentalism and environmental politics to sport (Bailey, 2020; Craig, 2020; Jackson, 2024a, 2024b; Jackson and Silverwood, 2025; Silverwood and Ariza, 2021; Silverwood and Woodward, 2018a, 2018b, 2024; Woodward and Silverwood, 2023), identify a 'return' to the subject of the state, we demonstrate that it has been an ever-present feature of the green transition in the UK.

We make modest contributions to narrower literatures. Whilst we are primarily concerned with discussion of the environmental state, as we sought to articulate in the review of literature earlier in the paper, scholars might equally feel comfortable considering our evidence as an example of how green state can positively affect climate transformation. Taking the lead from the important contribution to the literature on the environmental state by Babić and Dixon (2023), we have sought to show that the environmental state might be conceptually refined even further through the function of market creation. Our proposal is not simply a normative or conceptual contention, but an empirical one, drawn from a littered history of the UK government intervening in the domestic energy market.

Given the growing confluence of the environmental state and green state (Bailey and Jackson, 2024; Beck and Larsen, 2024; Duit et al., 2016), we believe our conceptual proposal contributes to several frontiers attempting to conceive of the state's contemporary role in the global political economy. For example, by focussing on what is often deemed a climate leader, we hope that our paper provides some addition to the emerging green industrial policy literature (Allan et al., 2021; Allan and Nahm, 2024). However, we do believe that our identification of a market creation function goes beyond the typical sort of industrial interventions understood by the green industrial policy. It is an intensification of commonly ascribed green industrial policy involving the environmental state in the very act of market formation, not just seeking to alter and restructure already-existing renewable energy markets. As we consider the past and present the environmental state in the UK, we thereby outline the context in which future developments make understood, and the lineage from which they have emerged.

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Note

1. Although our focus is on the UK, and thus what is commonly understood as Scope 1 and Scope 2 emissions, the CCC points out that the UK has been 'exporting' much of its emissions by importing consumer goods whose Scope 3 emissions take place elsewhere. We thank our reviewer for reminding us of this point.

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