

## Accountability and sustainability transitions

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### Abstract

What constitutes a sustainability transition? This question is important for analyzing energy transitions and in the broader realm of socio-material systems. We identify sustainability transitions as premised on shifts in accountability relations and associated changes in flows of legitimacy. Contestation and adaptation of accountability mechanisms lend themselves to empirical observation. Analysis of accountability relations allows us to characterize sectoral dynamics. Beyond evaluating ostensible sustainability transitions, this analytic strategy can identify mechanisms to institutionalize accountability relations that integrate ecological limits and justice considerations into socioeconomic dynamics. To operationalize our conceptual scheme we analyse solar energy uptake in Portugal, a purported case of sustainability transitions. This empirical analysis juxtaposes the promise of movement to a more equitable, low-carbon energy future with institutional and material inertia. We draw on expert interviews, field observation and secondary research to apply accountability analysis to this energy transition case. Assessment and sanctions serve as markers of the changing accountability regime that characterises sectoral transition and stability.

### 1. Introduction

Scholarship on sustainability transitions is burgeoning and splintering, which can be a strength as well as a weakness. Within the “evaluative” stream in the literature (Loorbach et al 2017), a range of seemingly distinct questions structure the field: what constitutes transitions, when is a claim of transition valid, and how to recognize ‘success’? The domains assessed and targeted for sustainability transitions can be characterised as socio-material systems, such as energy systems that introduce greenhouse gases such as carbon dioxide into the atmosphere and cause climate change, thereby triggering reflexive assessment of risk, rights and responsibilities. Informed by contrasting theories of change, varied research streams feature different methods and data types, philosophies of science, and ambitions. These vary from densely analytical and theoretical, historical and descriptive, to action-oriented and prescriptive.

Despite this diversity, the common problem framing hinges on the establishment – or institutionalization - of a disruptive innovation trajectory. In reviewing the sociotechnical transitions literature a decade ago, Smith and Stirling (2010) commented:

*Acknowledged to be the most important element, institutionalization is considered least in the transition management literature (Smith and Kern 2009). This is the point at which serious commitments are needed, to such an extent that the incumbent regime suffers and is undermined if they are not made (Smith et al. 2005, Shove and Walker 2007). Politically and economically, institutionalization is very difficult. It involves mobilizing serious selection pressures against the incumbent regime and redirecting vast institutional, economic, and political commitments into promising niches along desired pathways.*

As highlighted here, system transformation involves shifting resources away from a set of powerful actors and practices (Stirling 2019). We identify accountability as a concept and set of practices with potential to advance sustainability transitions. As recent scholarship suggests (cf. Biermann and

Gupta 2011; Kraft and Wolf 2018; Sareen and Haarstad 2020), accountability analysis can take us beyond analysis of socioecological imperatives, shifting values, and idealized conceptions of mechanism design that dominate sustainability debates.

For us, accountability is a process of assessment through which some actor or action is evaluated in relation to contextual norms or institutional logics. Moreover, accountability demands that these evaluations are linked to rewards and sanctions that reshape competitive dynamics and the demography of relevant populations (e.g., firms, technologies, routines). We identify an opportunity to advance an analytical and potentially practical programme of research focused on accountability. Drawing on neo-institutional theory (Suchman 1995), we define accountability as *a process of social regulation premised on grants of legitimacy to actors that conform to institutionalized norms*.

In this article, we derive an accountability analysis methodology, and apply it to solar energy uptake in Portugal, a growing niche (Pinho and Hunter 2019). Our analytic focus interprets shifts in accountability in relation to the institutionalization of a sustainability transition. Extending work by Kraft and Wolf (2018), we argue that attention to accountability relations – and the associated legitimacy flows – can support empirical assessments of sociotechnical transitions. We develop an approach to identify changes in environmental governance that shape behaviours, technical practices and, over time, the composition of populations of economic actors (*i.e.*, organisational ecology or demography). The institutional shifts that we identify as driving socio-material change represent selection pressures in environments characterised by competition. For example, new regulations, taxes, prices, and social norms reward some set of actors/actions and disadvantage those that fail to read or actively disregard these signals. These shifts in social regulation stem from, and inform, new understanding of risks and emergent social norms (cf. Lund 2016; Mitchell 2011). To some extent, this reference to a shifting competitive landscape can be understood through reference to Schumpeterian dynamics and organisational ecology (Hannan and Freeman 1984). More generally, we refer to multi-scalar socio-material systems in which population dynamics – and the behaviours of individuals in the population – are mediated by changes in material, structural and relational domains. This perspective has strong parallels to Kallis and Norgaard's treatment of co-evolutionary ecological economics (Kallis and Norgaard 2010).

In short, behaviours that have implications for sustainability (e.g., investments in energy infrastructure and changes in relevant public policies) are subject to varied assessments that condition prospects for actors within diverse populations. The standards of assessment and the implications of these 'accountability tests' – *i.e.*, redistribution of privileges and duties – are continuously subject to contestation and change. Thus, a sustainability transition is a change in accountability regime (*i.e.*, the full range of assessments and selection mechanisms at work in and on some specified domain). Study of changes in accountability assessments, mechanisms, and procedures can be a means of evaluating progress (such as the growth and consolidation of a low-carbon niche), lack of progress (such as persistence and reaffirmation of commitments to fossil fuel energy sources), and twists and turns in sustainability transitions.

We structure our argument as follows: Section 2 contextualises accountability and legitimacy within environmental governance scholarship. Section 3 presents our accountability analysis framework. Section 4 applies our framework to dynamics of solar energy uptake in Portugal. The empirics emphasize the ambiguity of the sociotechnical dynamics, and the analysis demonstrates how an accounting of accountability allows us to make sense of the dynamics. In the concluding discussion in Section 5, we reflect on our approach to characterising sustainability transitions and articulate programmatic implications.

## **2. The accounting of accountability and legitimacy under transition**

This section first introduces and links sociotechnical and institutional dimensions of transitions, and then argues for the need to focus on accountability relations to characterise sectoral transitions.

### 2.1 Sociotechnical and institutional dimensions of transitions

Within the social sciences, the significance of social dimensions of technology and processes of technological change is now well-established (Healy and Barry 2017; Rip and Kemp, 1998). Within engineering and the biophysical sciences, there is increasing awareness of the relevance of the social dimensions of technology and knowledge generation (Palmer 2012; Kates et al 2001). This socio-technical understanding is central to tremendous investments in research in the past 15 years (e.g., within the European Union (EU) Framework Programme for Research and Innovation) regarding the conditions under which technological innovations could drive low-carbon, sustainability transitions.

The research on sustainability transitions can be disaggregated into at least four specific strands (Markard et al 2012). These are *transition management* and *strategic niche management*, which are oriented towards understanding how transitions can be purposely engendered, and the *multilevel perspective on sustainability transitions* and *technological innovation systems*, which both take a systems approach to understanding transitions. The ontology that underlies most research on sustainability transitions is that (1) technological innovation defines transitions, and (2) transition dynamics are structured by a relatively coherent system (Sareen and Haarstad 2018). The perspective has been criticised for both lacking a sense of geographical complexity (Bridge et al 2013; Hansen and Coenen 2015) and for favouring path dependence and stability over disruption and emergence (Haarstad and Wanvik 2016). Systems of innovation thinking similarly risks structural determinism (Mostafavi et al 2011). Analysis of sustainability dynamics including growth in renewable energy production, shifts in automobile usage, and changes in diet must include analysis of agency and localised politics.

Neo-institutional theory has produced a great deal of knowledge regarding localised access rules and processes for making and revising such rules (Vatn 2009; Epstein et al 2015). Yet, conceptualizing transitions as a challenge that hinges on adaptation of design principles to local contexts is reductive (Epstein et al 2015). Despite early preemptive cautioning (Cleaver 2000; Giddens 1989) and ecological economics' focus on "getting the (plural) values right" (Spash 2012), environmental governance work has approached transition as a matter of "getting institutions right" (Rodrik 2004). Yet there is mounting evidence that existing socio-material trajectories are not responsive to efforts to define and promote "good governance". For example, GHG emissions in 2017 increased globally at a rate above 3%, despite new scientific evidence of environmental change (IPCC 2018), the Paris Accord, and various mitigation initiatives.

In this context, we perceive a need to advance empirical analysis of the enabling and constraining effects of institutional change. We argue for more investment in analysis of *de facto* processes of social regulation that have the potential to restructure practices, populations, and socioecological relations. We identify *accountability* – social relations of discipline that shape socio-material development – as an essential aspect of environmental governance.

### 2.2 Why focus on accountability relations under sustainability transitions?

In calling for attention to shifts in the disciplining effects of institutions, we aim to advance a symmetrical analysis in which the likelihood of discipline contributing positively to shared ecological security and social equality is equal to the likelihood of advancing crony capitalism, distributional inequities, and authoritarianism. Analytical treatment of accountability should address questions regarding the relationships between more or different accountability and a range of normative aims (e.g., the 17 Sustainable Development Goals) in varied contexts and scales. A programme of research

organised around this theme must address critical questions including how accountability relations implied by monitoring programmes, eco-labeling, environmental management systems, and offsetting schemes, for example, are implicated in our capacity to satisfy ourselves with gestures that legitimate existing socio-material relations and “sustain the unsustainable” (Blühdorn 2007). We engage critically with representations of who holds whom to account, based on what standards, and in support of whose objectives. Beyond mapping individual accountors and accountees, we seek to address institutional dynamics that structure demography and sociotechnical practice. Accountability has potential to change the distribution of actors and behaviours that modulate sustainability concerns (e.g., pollution, over-consumption of fossil fuels). A sustainability transition implies a population-level change. This would typically involve a mixture of demographic churn (entry and exit) and adaptation (new technical practices and/or new organisational strategies) (Smith et al 2005).

Sustainability transitions can be defined as pathways through which socio-material changes reduce environmental risks. Sustainability transitions scholars are currently trying to integrate power, politics and culture into their systems thinking approaches (cf. Turnheim et al 2015; Cherp et al 2018; Sareen and Haarstad 2020). Accountability analysis approaches complex systems in a way that respects the multiple layers and players involved, and attends to power relations as constituted by actors' capacity to change formal and informal standards and codes of legitimacy, and the potential to distribute sanctions and rewards that can drive population or even systems change. For example, consider how scientific and popular understanding of risks of climate change might trigger redistribution of government subsidies, strategies of institutional investors, and cultural codes that shape the social license to operate of firms in the energy sector.

We see accountability as *a set of relational practices that mediate flows of legitimacy to organisations* (Kraft and Wolf 2018). Legitimacy is defined as a critical resource organisations need in order to function and reproduce their status in competitive contexts. It is the means through which organisations derive authority and reproduce access to resources. This follows from Suchman (1995, p. 574) who views legitimacy as “a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions”. Legitimacy flows to organisations when they are regarded as having internalised institutional norms derived from foundational aspects (i.e., deep structures) of society (e.g., family, community, market, government). As expressed by Kraft and Wolf (2018, p. 7-8):

*Within the organizational literature, specifically neo-institutional theory, all organizations require legitimacy (Meyer and Rowan, 1977; Suchman, 1995). Without legitimacy, organizations cannot gain necessary resources and, therefore, struggle. Organizations objectively possess legitimacy, but create it subjectively (Suchman, 1995). Organizations strategically engage in practices and deploy symbols to acquire legitimacy as an operational resource (Dowling and Pfeffer, 1975). Legitimizing actors perceive organizations as legitimate when organizations incorporate institutions into their structures (Meyer and Rowan, 1977).*

Kraft and Wolf (2018) focused on formal accountability relations as represented by material artefacts such as contracts, laws, and annual reports. Yet accountability relations are expressed in informal ways. As represented by the sociological concept of embeddedness (Granovetter 1985), action is situated. Normative and cognitive elements of institutions structure interactions and discipline behaviour, hence the need to address informal aspects of accountability and changes in accountability relations and procedures. That said, it is not clear how the various disciplinary traditions of case study methodology (cf. Yin 2017) can support commitments to address both formal and informal aspects of accountability regimes. Whereas Sareen (2019) proposes empirical attention to practices of legitimation; here we build on Kraft and Wolf (2018) to argue for an emphasis on assessment and sanctions as the two core relational practices that constitute accountability.

The first element centers on information flows that support assessment, and the second on the willingness and ability to sanction. At base, accountability refers to accountors obtaining information (accounts) of behaviours of accountees. This information is assessed in relation to a set of standards or norms (i.e., institutions), and a judgement is made. This judgement is focused on the extent to which an accountee has *successfully incorporated institutions into their structures. Institutions are the values, formal and informal rules, beliefs, and assumptions that define a field of social interaction* (Meyer and Rowan 1977). In our treatment, this process of assessment constitutes an accountability 'test'.

Sanctioning is the second element of accountability relations. Accountees found to have successfully internalised relevant institutions receive grants of legitimacy from accountors. This legitimacy positions them to compete in the next period of a recurrent process of assessment. Those who fail an accountability test confront the risk of having flows of legitimacy withdrawn. When the implications of loss of legitimacy constitute a significant risk to the organisation – e.g., jeopardising their solvency, legal and social right to operate – we can say they have been sanctioned. The prospect of interruptions in flows of legitimacy pose risks that structure thought, deed and strategy. Reciprocally, when emerging actors garner legitimacy by opening up new pathways, positive rewards reinforce these behaviours and corresponding socio-material changes, potentially reconstituting the field.

In our view, treatment of accountability within the environmental governance literature has emphasized the information question without equal investment in the question of sanctions and selection pressure. Mol's (2006) work on informational governance is important in this context. Information flows are seen as being endowed with capacity to coordinate people and material so as to achieve social regulation. This line of thinking can be linked to neoliberalism and faith in self-organizing systems (Bonanno and Busch 2015). We critically engage such conceptions of social regulation. Attention to information and assessment tools and routines must be accompanied by probing their translation into socio-material change. Accordingly, we focus on the *mechanisms through which accountability is linked to discipline (i.e., selection pressure), changes in the population of actors and behaviours and, ultimately, to socio-material relations.*

Our position is both *normative* (i.e., focused on a particular problem that we specify) and *analytical* (i.e., focused on evaluating a theory-based proposition). We identify a need for changes in social and material dynamics to avoid serious (i.e., practically irreversible) consequences of existing trajectories. Sustainability transitions is a broad reference to programmes of change along these lines. As part of an effort to support sustainability transitions, we identify an urgent need for concepts and empirical tools to make sense of opportunities and challenges. By making an accounting of accountability mechanisms and changes in accountability environments, we identify a potentially promising means of analyzing changes in socio-material systems. Our thesis is that accountability and selection pressure are critical elements of sustainability transitions.

### **3. An accountability analysis framework**

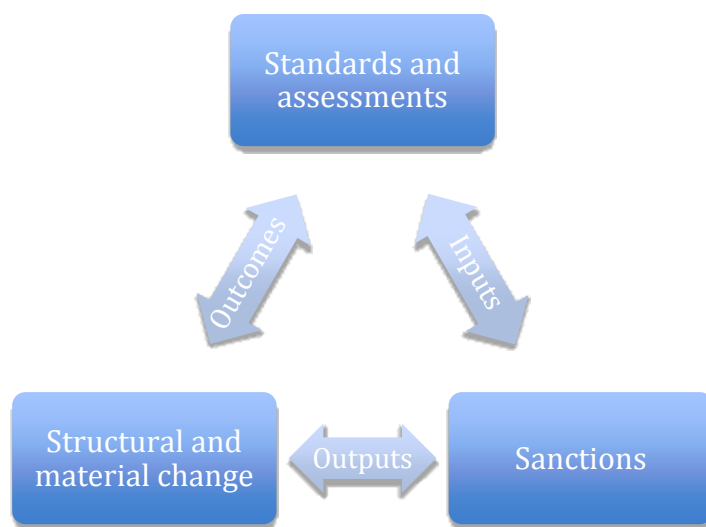
We have organised this section in two parts: 3.1 introduces a three-step cycle of inputs, outputs and outcomes through which to map changing accountability regimes during sectoral transitions, then 3.2 introduces a 2x2 'LASH' matrix that structures empirical representations of relations of accountability.

#### *3.1 Changing accountability regimes and the reflexive cycle of sectoral transition*

Advancing an analysis of accountability dynamics requires the following data: **(1a – standards)** an account of existing accountability standards or norms and current debates regarding potential

changes to those standards; **(1b – assessments)** an account of accounts given and accounts taken; **(2 – sanctions)** an account of sanctions imposed and rewards distributed, as justified through reference to accountability tests; **(3a – structural change)** an account of shifts in relevant behaviours and actions (e.g., solar energy deployment and acts that enable solar deployment) attributable to shifts in standards, assessments and sanctions (i.e., an assessment relative to a counterfactual); and **(3b – material change)** an account of institutionalization of new material practices (e.g., reductions of greenhouse gas emissions) that can be attributed to specific accountability mechanisms. We note that points **(1a)** and **(1b)** are inputs within an accountability regime; **(2)** is the output of an accountability regime; and **(3a)** and **(3b)** are, respectively, proximate and ultimate outcomes of an accountability regime.

Thus, we have conceptualised sectoral transitions as a three-step cycle: standards and assessment as *inputs*, followed by sanctions as *outputs*, followed by structural and material changes as *outcomes*. Figure 1 depicts these elements and dynamics.



**Figure 1** Changing accountability regimes and the reflexive cycle of sectoral transition

The *inputs* include the population of actors and the range of production, consumption and investment behaviours that can be observed empirically. Attention to these inputs can make accountability mechanisms – and changes in those mechanisms – visible. For example, when a firm makes a major acquisition, analysis of the press release can identify connections between competitive strategies and changing institutional context. When regulations require an electricity supplier to report greenhouse gas emissions, this record can be scrutinized. Thus, we can observe how the inputs of an accountability regime, (1a) standards and (1b) assessments, are shaped, emerge and play out in symbolic and discursive ways. Such cognitive and cultural shifts are precursors to actions that reshape sectoral practices.

The *outputs* include concrete actions in the form of sanctions, both positive (incentives, rewards) and negative (penalties, surcharges), that impact the field of actors and actions. They feature the operational aspects of accountability in practice, both formal (laws and administrative rules) and informal (the interpretation of applicability and extent of sanctions to cases). Attention to these dynamics can provide insights on political, cultural and ontological shifts that follow from expert and popular assessments of socioecological risks and what constitutes prudence, justice, and appropriate behavior. For example, when a ministry introduces new permitting procedures or new oversight routines, there is potential for restructuring commercial strategies. The emergence of carbon liability as a central concern of investors may drive changes in taxes, subsidies, and trade in carbon certificates – concrete manifestations of a change in thinking as a new social and economic calculus.

This calculus reflects the linkage between climate risks and the expectations of economic actors. It constitutes accountability relationships between greenhouse gas emitters and a range of actors who evaluate their conformance with evolving standards of probity.

The *outcomes* include multi-scalar budgetary priorities and industrial reorganisation in response to the selection pressure exerted by sanctions. They capture the reshaping of competitive dynamics through both new institutional structures and new physical infrastructures. Attention to such restructuring can provide direct observations of changes due to new relations of accountability. It is in this domain that the outcomes of an accountability regime, (3.1) emergent change and (3.2) structural change, can be examined and characterised as institutionalization of a sustainability transition.

In sum, within any given sector, claims that characterise change as sustainable are situated within the cycle represented in Figure 1: from inputs to outputs to outcomes. These changes interact reflexively (as depicted by the two-way arrows), hence in actuality these relationships flow both ways, but our input-output-outcome ordering has heuristic value for accountability analysis. Generally speaking, standards determine the data we have on a sector, such as energy, and assessments draw on such data to debate and enact decisions. These inputs inform the articulation and enforcement of sanctions. New sanctions in turn lead to changes in the population of actors, the governance practices and structures of institutions, and the physical infrastructure that comprises the sector.

We identify changes in accountability mechanisms as the single most important element of an analysis of sustainability transitions focused around accountability. New laws, new administrative rules, redirection of subsidies, judicial rulings, as well as new professional practices, new social practices, and new justifications (*i.e.*, references to alternative bases of legitimacy) are the most important kinds of empirical evidence for the restructuring of a given sociotechnical domain. Accountability relations are dynamic, and these changes have potentially important consequences for people and planet.

As we are primarily interested in analysing changes in an accountability regime during sectoral transition, the main results of accountability analysis focus on (part 1) standards and assessment and (part 2) sanctions. In 3.2 below, we present a 2x2 matrix that considers and characterises their intersections.

### 3.2 The 2x2 'LASH' matrix for case results of accountability analysis

Our treatment of accountability within sustainability transitions is closely linked to concerns about authority and discipline (Wolf 2020). Such a framing demands that we critically analyse how discipline is exercised – by whom, on whom, for what purposes, subject to what controls. Our conception of accountability as a social process predicated on interplay between assessment and sanctioning positions us to identify four ideal-type 'worlds' of accountability (Table 1). As discussed above, our approach is symmetrical in that we aim to account for the full spectrum of socioecological relations, not just some normative conception of what is needed to progress toward a specific conception of sustainability.

Assessment of organisations or actions can be informed by deliberative processes (Hajer et al 2003), or not. In other words, in working to make sense of relations of accountability, on one axis we must assess the extent to which the criteria of assessment, accountability tests, reporting and data collection protocols, and determinations of conformity with standards are transparent and premised on deliberative and inclusive processes. On the other axis, we must assess the extent to which accountability assessments are backed by sanctions and whether such sanctions can bring about

structural and material change. Integrated reflection on these two axes gives rise to four possible states (Table 1). In a given social context, we may observe i) radical liberalism or *laissez-faire* tendencies (L), authoritarianism or private interest governance (A), strongly substantiated accountability (S), and hollow accountability (H). In this respect, we view accountability as a thoroughly ambiguous resource in relation to social justice, good governance, and sustainability transitions.

**Table 1.** The LASH matrix for accountability analysis: Assessment and sanctions

	Ability and willingness to sanction	No ability and willingness to sanction
Deliberative assessment	(S) Strong accountability	(H) Hollow accountability
No deliberative assessment	(A) Authoritarianism	(L) <i>Laissez-faire</i>

The LASH matrix provides a basis to characterise the accountability regime for a given sector in relation to the four ideal-types. It is a tool to aggregate the multiple and contradictory elements of an accountability regime. In what instances is accountability substantive, and where is it hollow? Where it is substantive (i.e., sanctioning based on assessments premised on standards derived from deliberative process), the sector will directly reflect the values that structure the accountability tests. Applied to a sustainability transition, substantive accountability takes the form of institutionalizing new selection pressures that can ostensibly restructure material dynamics (from dependence on fossil fuels to low-carbon energy, for instance). Where it is hollow, accountability mechanisms function to document and transmit accounts of gaps between standards of socially acceptable behaviors and real-world practices, but sanctions are inadequate to produce change. Hollow accountability mechanisms have a performative aspect whereby they produce legitimacy without corresponding changes in the material system. Applied to sustainability transitions, hollow accountability is the principle vehicle for maintenance of cognitive dissonance and business-as-usual (Wolf 2020).

Under conditions of authoritarianism and *laissez-faire*, there is no deliberative assessment, hence the conditions for strong accountability are not in place. Under authoritarianism, legitimation is monopolised by an administration that can level sanctions on any basis of their choosing, whereas under conditions of radical liberalism there are no standards and no central authority. The rise of authoritarian populism (McCarthy 2019), on the one hand, and deregulation ushered in by the turn ‘from government to governance’ (Capano et al. 2015), on the other, highlights the contemporary relevance of these quadrants of the LASH matrix. By addressing all four types of (un)accountability, the matrix can capture a broad range of relationships, some of which are contradictory, that constitutes an accountability regime.

To demonstrate the explanatory power of our approach, we conduct an empirical accountability analysis of a case focused on energy transition – one of the most important and urgent sectoral transitions. We are concerned with solar energy uptake in Portugal as the growth of a technological niche that *prima facie* constitutes a sustainability transition towards a national and regional low-carbon emission energy profile (cf. Pinho and Hunter 2019).

**4. Accountability analysis of sectoral change: Solar energy uptake in Portugal**

We conducted an accountability analysis of solar energy uptake in Portugal during 2017-2018. Our attention is focused on changes, debates about potential changes, and lack of changes. The



assessment is based on 80 interviews conducted during five months of fieldwork (two in 2017, one in 2018, two in 2019) with various experts and sectoral stakeholders, in-depth field observations including site visits to solar projects, and desk research. We focus on assessments and sanctions – enacted or absent. Sanctions can also be positive, in support of strategies for transitions to sustainability – e.g., regulatory changes that enable rapid uptake of renewables. We focus on demonstrating the value of accountability analysis for assessing prospects for a sustainability transition. After a case summary in 4.1, we conduct accountability analysis in 4.2, which highlights specific accounting mechanisms, and how they were distributed and interacted. The results populate the LASH matrix in 4.3.

#### **4.1 The accountability regime of solar energy uptake in Portugal**

Portugal is a long-standing leader in renewable energy in Europe, a region that set globally ambitious targets for mitigation and specifically energy transition during the 2017-2018 study period. Long dependent on fossil fuel imports, Portugal developed large hydro (since the 1980s) and wind power (since the 2000s), with emerging solar capacity (since 2008) and Europe's best solar irradiation conditions. During 2017-2018, Portugal went from seeing renewable energy as a burden on taxpayers that had to be subsidised, to embracing ambitious policies premised on rapid unsubsidised growth in renewable energy. Within European targets, Portugal aimed to attain 31% total energy supply from renewable sources by 2020, with an increase to 47% by 2030. This included the growth of solar energy from 0.4% in 2015 to 1.9% in 2020 and 9.9% by 2030 within its energy mix, a target set by end-2018 in its Carbon Neutrality Roadmap 2050 and National Energy and Climate Plan 2030.

Portugal's energy sector is formally steered by national regulatory, executive and political bodies, who set standards following a corporatist model common of significant state involvement even under privatisation of sectoral components. A vertically integrated incumbent, Energias de Portugal (EDP), controls the lion's share of energy generation and electricity distribution. In recent decades, EDP has been privatised. The sector is also populated by a handful of retailers, associations and consultancies, including many solar developers who constitute population churn.

Notable solar capacity first appeared in 2008 with what was briefly the world's largest solar park, Amareleja, drawing on subsidised tariffs – positive sanctions to encourage early growth of a niche. Small-scale solar uptake was also subsidised, and capacity gradually grew during the 2010s, but limited to a small role as well below 1% of total electricity generation. Allegations of political corruption on wind power contracts surfaced during the late 2000s, politicizing renewable energy during the 2011 elections; financial support for renewables dried up, exacerbated by a recession during 2009-2015. By 2015, when Portugal steered clear of financial jeopardy and the generally pro-renewables Socialist minority government replaced the Social Democrats, it faced a context where subsidised renewable energy were politically untenable. Small-scale solar uptake slowed to a trickle as incentives for selling power back to the grid shrank. A few pre-committed subsidised utility-scale solar plants came up till 2017. But remarkable cost decreases in photovoltaic solar technology – more than eight-fold within a decade – made solar developers queue to install over 2.2 Giga Watts (GW) of *unsubsidised* solar capacity, nearly thrice the commissioned solar capacity of 800 Mega Watts (MW) in 2017. New selection criteria were developed to allocate limited grid capacity to these competing actors. Portugal's first unsubsidised solar plant was grid-connected in 2018.

Our accountability analysis examines sectoral changes during this period of high uncertainty and dynamism for solar uptake. Structurally, a new Ministry of Environment and Energy Transition was created in October 2018 and articulated an ambitious national vision for solar energy uptake involving new grid capacity allocation mechanisms. Materially, by 2018, Portugal's electricity mix featured 1.5% solar energy, a promising increase from 0.4% in 2015 and on course to the 1.9% target by 2020. Table 2 presents an overview of the initial and final status of inputs, outputs and outcomes.

Sub-section 4.2 analyses the uneven and indeterminate processes through which existing sociotechnical arrangements were critiqued and new knowledge and values were established to shape processes of selection; in other words, a change in accountability regime.

**Table 2.** Changes in inputs, outputs and outcomes in Portuguese solar energy uptake (2017-2018)

	<b>Initial status (2017)</b>	<b>New status (2018)</b>
<b>Inputs:</b> <b>1. Grid geography</b> <b>2. Small-scale solar</b>	1. Grid infrastructure transmitted wind and hydro power up north, favoured coal (base load) and gas (flexibility), and had limited capacity free in solar-rich Southern Portugal	1. Grid investment plans fell short of enabling solar uptake in accordance with its economic competitiveness, constraining developers to target areas with available grid capacity
	2. Smaller distributed solar capacity was limited to self-consumption or low feed-in tariffs, thus upholding entrenched grid operation logics with no scope for local aggregation	2. Energy retail was bureaucratically restricted to large players, which held back citizen prosumers and community energy initiatives from revenue sharing from solar uptake
<b>Outputs:</b> <b>1. Conventional governance</b> <b>2. Public resistance</b> <b>3. Solar finance</b>	1. The usual experts from large-scale, entrenched organisations decided solar uptake protocols and pathways, although a change was signalled	1. Public engagement was limited to marginal consultation; criteria for the siting and extent of solar uptake were translucent during 2017-2018
	2. Despite strong public resistance, the government was ambivalent on offshore oil efforts until a statement for energy transition in late 2018	2. Substantive cuts to fossil fuel use remained anathema to powerful sectoral decision-makers at the expense of holding up solar uptake
	3. Banks and investors worked out power purchase agreements (PPAs) to finance solar parks without tariffs or subsidies, and solar developers began to see wholesale energy market trade as a viable option	3. A wholesale electricity market with payments for 'flexibility' meant recognizing big earnings (€24 million during 2017) from renewable energy export and halting reserve capacity payments to gas (€20 million p.a.)
<b>Outcomes:</b> <b>1. Solar licensing</b> <b>2. Institutional reconfiguration</b>	1. Solar park developers submitted expressions of interest, an ad hoc committee evaluated them based on a vaguely specified set of factors, then issued licenses thrice a year with a 2-year timeline for installation	1. Approved developers built plants, asked for and got extensions, or traded licenses, while those without licenses continued to queue, leading to speculation over solar licenses and delays in installing solar capacity
	2. Energy portfolio relocated from the Ministry of Finance to the new Ministry of Environment and Energy Transition, and National Energy and Climate Plan 2030 and Carbon Neutrality Plan 2050 launched	2. Old license system dismantled to increase transparency, and solar auctions of 1.75 GW capacity declared for mid-2019 with options of competitive tariffs or grid access payments with PPAs or market trade

#### **4.2 Accountability analysis: Inputs, outputs and outcomes**

##### **4.2.1 Inputs: Standards and assessments**

In terms of inputs, the two key factors examined below are transmission grid geography, and the integration of small-scale solar power generation. This is informed by empirical observation of how the population of actors used specific metrics and information about energy infrastructure to shape

sectoral change; the application of standards and assessment in practice. These ontologies and cognitive processes supported normative reflections around solar uptake, to inform and catalyse the adaptive evolution of accountability mechanisms.

*Grid geography:* Portugal is weakly integrated into the European transmission grid due to its isolated geography, geopolitics, and investment requirements. Historically, Portugal's transmission grid has been weak in the solar-rich southern regions. Other renewables are concentrated up north with better grid infrastructure, high tariff industrial consumers, and Portugal's two major cities. Two coal thermal plants take up 1.9 GW grid capacity and gas sources help adjust supply levels to balance variable renewable energy sources and demand fluctuations; national demand peaks at about 9 GW. Decadal grid investments planned in 2017 included expanding southern transmission capacity, but only promised 800 MW additional capacity for solar PV uptake by 2024-26, an amount already exceeded by licensed solar projects in 2018. The basis for justifying particular grid infrastructure logics thus exhibited path dependency. This put the onus on solar developers to battle against odds that favoured existing players and constrained the former to target areas where grid capacity remained available based on existing practices, rather than on techno-economic competitiveness. In mid-2018, the European Commission committed €578 million to expand interconnectivity between Portugal, Spain and France. This included some southern Portugal grid strengthening, creating scope to add more solar capacity even as standards of assessment for electric grid use persisted.

*Small-scale solar:* Incentive schemes promoted small-scale solar uptake for self-consumption and prosuming to the grid, which grew in the early 2010s. But before it reached 200 MW nationally, these schemes were removed; during 2017-2018, small-scale solar registered negligible growth relative to large-scale plants. Household and community solar generation could no longer benefit from prosuming as regulations mainly supported self-consumption, instead of sale to neighbours, use by multiple households or sale to the grid at an attractive rate. These standards constrained small-scale solar energy, while small-scale storage costs were not yet competitive. Legislation held back changes that could encourage growth, e.g., local aggregation of solar capacity and revenue sharing between prosumers and energy retailers. Notably, financial benefits of distributed solar uptake through avoided transmission infrastructure investments were marginal in public discourse on solar uptake, despite the efforts of the solar energy cooperative Coopérnico and environmental organisations like Zero. Some initiatives, including by Lisbon municipality, did get off the ground, but legislative change came later, in 2020.

Overall, the studied period saw little substantive change in standards and modes of assessment in relation to solar uptake. Established criteria and sensibilities dominated governance and investment decision-making, exhibiting the path dependence typical of energy infrastructure and its governance. At the same time, we observed contestation and movement applied to the electric grid and prospects for integrating small-scale solar power. New values, opportunities and arguments were championed, and new actors made inroads into debates and decision-making fora. These dynamics pointed to plausible pathways for new standards and modes of assessment that could create space for a technological niche to grow.

#### 4.2.2 Outputs: Sanctions

*In terms of outputs,* we examine conventional governance modes, public resistance against fossil fuel expansion, and the emergence of financing mechanisms for solar energy. In determining the nature of sanctioning, we attended to legal, political and financial changes that exerted pushes and pulls on various actors and actions in Portugal's energy sector to create conditions for material change.

*Conventional governance:* During 2017 and 2018, solar energy received modest political support, and techno-economic competitiveness was represented as mediating Portuguese solar uptake. This was

tempered by bureaucracy, policy lacunae, and perverse incentives (e.g., to stall solar uptake, or to speculate on licenses). Power differences among stakeholders proved problematic, with partial interests being represented via associations, and preferential access to information and to decision-making forums for traditionally influential, networked actors, e.g., when nominating members to committees to make decisions concerning the electric grid. This raises questions of democratic process and splintered representation. Despite the country's high irradiation potential and complementarity between solar and more extensive renewable energy sources, the state stalled on favourable legislation for small-scale solar prosumers. The status quo favoured the incumbent while blocking sectoral democratisation. For instance, the incumbent prominently sponsored a solar festival in Lisbon in 2018 to popularise solar energy, while issues like legislative barriers for community projects remained marginal. Numerous taxes were lumped into the fixed component of electricity bills, rather than being recovered through direct means. So citizens were treated as consumers and price-takers, not co-participants in the energy sector, while conventional authorities decided how energy companies should conduct themselves. This lack of state support limited debates around solar energy to technocratic issues without substantive public engagement. Such conventional, top-down governance prevented rapid multi-scalar growth of the niche.

*Public resistance:* Controversy on prospecting for oil off Portugal's western shore reigned from 2017 till mid-2018. Public protests highlighted threats to the environment and the prosperous coastal tourism sector, and the financial and moral folly of being a late entrant to a fossil fuel sector. Informed citizens, when interviewed, expressed frustration at regressive state policies that did not take a clear stance to exit fossil fuels and enable solar energy uptake. One consortium that sought an offshore oil prospecting license was dismissed. Then, with the new ministry's formation in late 2018, came a clarifying statement barring future consortia. Portugal's renewable energy leader credentials were accompanied by strong public political emphasis on financial benefit. Recovery from recession and the politicisation of renewables made solar subsidies infeasible, even as citizens paid historical sectoral debt from other sources as fixed electric charges. Energy transition with solar uptake was contested in multiple domains, including the socio-cultural. Wildfires during 2017 and 2018 led to significant loss of life and property. The fires influenced popular perceptions on the urgency and necessity of energy transition, by framing them as being not only an economic but also an environmental and personal security issue. The quarterly ECO123 from the affected Monchique region explicated links between environmentally responsible choices and wellbeing, encouraging just energy transitions and profiling leaders. By adding public legitimacy to assessments that favoured rapid solar uptake and sanctions against fossil fuel persistence, environmental movements in response to such phenomena (including a massive flood that affected the capital Lisbon) strongly swung political stakes towards climate action ahead of the 2019 national election.

*Solar finance:* Solar energy is an intermittent source with predictable energy production, whose financial viability depends on being able to sell energy to the wholesale electricity market during specific times of day. With a significant volume of variable energy sources, including wind energy, in the supply mix, the Iberian electricity market moved towards valuing flexibility in its wholesale trade (IEA 2016). In 2017, the Portuguese government announced discontinuation of longstanding annual €20 million payments for strategic reserve capacity to gas, which can be quickly ramped up. Meanwhile, renewable energy exports through grid interconnections generated €24 million in revenue during 2017. This convinced solar developers that investments could be recovered, especially with energy prices in France expected to stay high for several years due to nuclear plant maintenance operations. Solar developers, foreign banks and investors developed financial instruments for power purchase agreements (PPAs, where businesses contract large-scale solar power, giving developers an assured source of revenue) and Portugal's first unsubsidised solar park was grid connected by summer 2018. Those interviewed estimated 7-8 year payoff periods for 25-year solar plants. Investment capital to build solar plants that would trade on the wholesale electricity market became available during 2018 as well. This marked a remarkable shift from 2017,

when national discourse framed renewable energy projects as creating a debt burden for citizens and unlikely without publicly subsidised tariffs.

Overall, the period saw Portugal manage a crisis of public accountability on energy transitions and gradually move to a more reasoned discourse on solar uptake (cf. Sareen 2019). More transparent energy governance emerged and ways to secure public benefits were considered. Yet representation of stakeholder interests remained uneven. Entrenched historical patterns of incentives, constraints and authoritative decision-making continued to structure thought and deed in a top-down sector.

#### 4.2.3 Outcomes: Structural and material change

*In terms of outcomes*, we profile two key arenas that shape prospects for solar power: energy production licensing processes and stuttering growth, and the emergence of a new ministry and selection mechanisms for solar uptake. The former were structural changes that exerted selection pressure to modulate competitive dynamics. They manifested as social controls and institutions, or mechanisms for accountability. The latter were material changes. They moved the ecological impact of Portugal's electricity sector towards lower greenhouse gas emissions.

*Solar licensing:* The Directorate General for Energy and Geology (DGEG), a national executive agency, allocated licenses for solar parks. During 2017 and 2018, it operated three annual windows for license applicants. Solar developers submitted expressions of interest that far exceeded available grid capacity. Queues went over 2.2 GW while DGEG commissioned a few projects, which would have brought installed solar capacity near 1 GW. But not all were installed within a two-year timeline, and one-year extensions were granted. Thus, targeted increases were achieved as represented by a formal licensing process, yet this energy supply was not fully realised. Perceptions arose that some developers had curried favours to gain licenses. Moreover, a translucent allocation process that featured an ad hoc selection committee and rough guidelines did little to assuage doubts. Interviewed solar developers and ministry officials voiced a concern that a speculative market was emerging around solar licenses, with buyers profiting by selling licenses to foreign investors. This risked driving up costs to developers and, eventually, consumers, through rent-seeking practices around greenfield development activities (e.g., land acquisition, environmental impact assessments, license procurements). Despite these problems, a number of grid-scale solar parks did come up during this period, and national solar installed capacity surpassed 650 MW.

*Institutional reconfiguration:* The national regulator Entidade Reguladora dos Serviços Energéticos (ERSE), executive agency DGEG, the political office of the Secretary of State of Energy (SSE), and numerous sectoral actors and associations sought to further their interests during sectoral change. In late 2018, there was a cabinet reshuffle a year ahead of national elections. This relocated the energy portfolio from the finance ministry to the environment ministry, which was later renamed the Ministry of Environment and Energy Transition and a new SSE took office. By the end of 2018, the ministry had launched a draft National Energy and Climate Plan 2030 in line with EU mandates for member states, a Carbon Neutrality Roadmap 2050, and scheduled 1.35 GW of solar auctions for July 2019. Interviewed ministry representatives explained that the aim was to clear up the messy backlog of licenses, and presented the reliance on auctions as a means to ensure transparency and mitigate speculation.<sup>1</sup> A market mechanism such as auctions was popular amongst solar developers as it would offer a level playing field and facilitate their access to project finance.

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<sup>1</sup> This was borne out by a successful auction for 1.35 GW of solar energy in July 2019, where one of the lots set a world record tariff of just over €15 per Mega Watt hour (MWh), and the average tariff was a shade above €20 per MWh, which compares very favourably with an average annual price of over €55 per MWh on the wholesale electricity market across all sources. This period is, however, not the focus of this article.

Overall, the studied period featured a transition from a period in which the status of solar power in the spheres of administration, markets, and politics was unclear and weak to a more favourable, better coordinated institutional environment. Subsidy shifting, the effort to systematise licensing procedures and allocate solar capacity through auctions, the articulation of a policy vision, and robust political representation, together served to relax structural constraints. They positioned large-scale solar projects favourably within both commercial and political contexts. While limited material change took place during 2017-2018 (large-scale solar plants typically take 12-18 months to build), conditions for the future rapid growth of solar energy were institutionalised.

**4.3 The LASH matrix for solar uptake in Portugal**

Table 3 summarizes how our accountability analysis characterizes the changing accountability regime in Portuguese solar uptake.

**Table 3.** Characterisation of accountability in solar energy uptake in Portugal (2017-2018)

	<b>Ability and willingness to sanction</b>	<b>No ability and willingness to sanction</b>
<b>Deliberative assessment</b>	(S) Strong accountability - EU and national energy targets - Solar auction mechanism	(H) Hollow accountability - Transmission capacity allocation - Ad hoc solar license procedures
<b>No deliberative assessment</b>	(A) Authoritarianism - Limitations on rooftop solar - Barriers for community solar	(L) Laissez-faire - Offshore oil prospecting licenses - Speculation on solar licenses

As shown in Table 3, our analysis identifies accountability relations in Portugal’s energy sector in the period 2017-2018 within all four quadrants of the LASH matrix. Outcomes that displayed elements of both deliberative assessment and an ability and willingness to sanction include European Commission targets for renewable energy uptake in Portugal, in line with regional efforts for a transition to low-carbon energy. This drove Portugal’s efforts to enable solar energy uptake to an ambitious extent (from less than 1 GW to nearly 10 GW by 2027), observable in its launch of national plans in late 2018. It also announced a new structural market mechanism to allocate grid capacity for solar projects. Earlier solar licensing and transmission grid capacity allocation measures during the study period, however, suggest a hollow form of accountability. The basis for allocation was publicly contested, with limited deliberative assessment among policymakers. The selection procedure for licensing solar developers introduced confusion and criticism, and wider stakeholder involvement in developing a national solar strategy was under-utilised. Most important, the assessment routines of the policy process were not backed up by sanctions. Solar developers who received licenses did not necessarily install solar capacity.

Turning to authoritarian forms of accountability, we emphasize treatment of small-scale solar energy projects. Limitations were imposed without deliberative assessment. These sanctions stifled actors positioned to take solar projects forward, namely households and community-based energy cooperatives. Such models exist in Europe, hence their restriction is best explained as the incumbent modulating sectoral development in its self-interest (Sareen and Haarstad 2018).<sup>2</sup> In terms of radical liberalism, two tendencies surfaced and were quashed during this period. Offshore oil prospecting licenses were pursued by an industrial consortium; public protest highlighted a lack of deliberative

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<sup>2</sup> This contestation evolved beyond the studied period of 2017-2018. With the new ministry in place and the Socialist party reelected in 2019, community energy legislation did emerge in January 2020.

assessment and that such developments would reveal the state's utter lack of ability or willingness to sanction, given Portugal's stated commitment to mitigation. The state's eventual legal rejection of this possibility lacked a direct ecological basis. The new ministry in late 2018 proposed a strategy to address solar license speculation through solar auctions with rules to tailor these to state priorities. Hence, while liberalization characterised the sector for most of 2017-2018, shifts in assessment routines and in policy highlight potential for social regulation.

Overall, outcomes under Portuguese solar uptake during 2017-2018 were evidently determined largely by market opportunism and regional and national political economies. We observe indications of shifts towards stronger accountability relations, with the emergence of a new ministry, national energy decarbonisation plans, and mechanisms such as solar auctions. Our accountability analysis finds evidence of an emerging appetite for deliberative assessment and sanctions in the rollout of solar energy in Portugal. To realise sustainability, we identify arenas for intervention, in terms of both inputs and outputs. Inputs include: clear selection criteria and timelines for large-scale solar plants; more ambitious targets for small- and medium-scale solar energy; the institutionalization of participatory procedures that involve stakeholders more inclusively and on an even footing; and ongoing public debate on how solar energy uptake can contribute to sustainable socio-material change in the energy sector. Outputs include: revised logics for grid infrastructure use to enable greater solar energy uptake over time; legislation that supports energy cooperatives; and formal commitments to invest in future energy infrastructure in ways that prioritise a move away from fossil fuel sources and toward rapid uptake of renewable sources like solar energy in line with emerging ambitious energy transition targets.

## **5. Characterising sectoral change in terms of accountability relations**

This concluding section abstracts from our case analysis to reflect on how accountability analysis can contribute to research and realization of sustainability transitions. We have defined accountability in terms of social regulation, and we have developed an accountability analysis framework that we hope researchers, policy actors, and practitioners will take forward. Mitchell (2011: 1882) refers to "an instrumental logic of consequences but also ... a normative logic of appropriateness". We foreground both of these considerations as vital elements of analysis of accountability and sustainability transitions. Specifically, accountability and a planned shift to just, low carbon futures is premised on both assessment *and* sanctions.

A focus on accountability and legitimation pathways simultaneously *speaks to a conceptual understanding of institutionalization within sustainability transitions and a set of empirical research strategies*. Such a theoretical framing and analytical approach can support critical and constructive analyses. We have been able to characterize specific measures that can secure public benefits at a specific juncture of a specific sustainability transition, but the implications of accountability analysis extend beyond this. The analytical characterisation of interplay between understanding, values, standards of assessment, sanctions, selection pressure, and material change can help make sense of dynamics of social regulation and environmental governance. Specifically, we offer a means to assess claims of sectoral transition by examining how practices of restructuring relate to the institutionalization of new values and new modes of competition. We view these two considerations and their interaction as core to ecological economics, as both an analytical and normative project.

Our ambition with this article is primarily conceptual and programmatic. We argue that accountability analysis can move beyond contemporary emphasis on institutional design and informational governance premised on social inclusion and transparency. Research focused on accountability tests as a form of selection pressure can help us understand socio-material change and stability. The concepts we introduced and the analytical strategies we demonstrated in this article have potential, but further development, methodological specification and strategies for

scalable mobilization remain necessary. As Biermann and Gupta (2011) noted nearly a decade ago in a collection in this journal, accountability and legitimacy matter for the effectiveness and outcomes of environmental governance, yet remain relatively unexamined. The ideal dataset we specified to support a comprehensive accountability analysis is an aspiration. We encourage the Intergovernmental Panel on Climate Change and national and sub-national initiatives committed to compiling sustainability indicators to invest in systematically and reflexively tracking accountability relations – with an emphasis on not only assessment but also on sanctions – as a complement to existing monitoring strategies.

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