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Landscape for change? International climate policy and energy transitions: evidence from sub-Saharan Africa

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What is the role of the climate regime in facilitating rapid decarbonization of the world's energy systems? We examine how core assumptions concerning the roles of the nation state, carbon markets and finance and technology in international climate policy are being challenged by the realities of how transitions in the energy systems are unfolding. Drawing on the critical region of sub-Saharan Africa, we examine the potential for international climate policy to foster new trajectories towards decarbonization.

Policy relevance

The international regime for climate policy has been in place for some twenty years. Despite significant changes in the landscape of energy systems and drivers of global GHG emissions over this time, the core principles and tools remain relatively stable – national governments, carbon markets, project-based climate finance and the transfer of technological hardware. Given the diversity of actors and drivers and the limited direct reach and influence of international climate policy, however, there is an urgent need to consider how the climate regime can best support the embryonic transitions that are slowly taking form around the world. To do this effectively requires a more nuanced understanding of the role of the state in governing these transitions beyond the notion of a cohesive state serving as rule-enforcer and transition manager. It also requires a broader view of technology, not just as hardware that is transferred, but as a set of practices and networks of expertise and enabling actors. Likewise, though markets have an important role to play as vehicles for achieving broader ends, they are not an end in themselves. Finally on finance, while acknowledging the important role of climate aid, often as a multiplier or facilitator of more ambitious private flows, it is critical to differentiate between the types of finance required for different transitions, many of which will not be counted under, or directed by, the climate regime. In sum, the (low-) carbon economy is being built in ways and in numerous sites that the climate regime needs to be cognizant of and engage with productively, and this may require fundamental reconsideration of the building blocks of the international climate regime.

Keywords: Africa; carbon finance; climate change mitigation; climate policy frameworks; energy policy

1. Introduction

In June 2015 the G7 declared its intention to phase out the use of fossil fuels by the end of the century, affirming the need for radical decarbonization in order to respond to climate change. Now entering

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their 25th year, the international climate change negotiations continue to be at the heart of this global response. Yet this landscape is changing. Once dominated by the pursuit of global targets and timetables, national governments now declare Intended Nationally Determined Contributions (INDCs) for reducing GHG emissions. At the same time a host of other actors – from cities to corporations, regional governments to civil society organizations – are being heralded as central to achieving progress and their actions tracked within the Non State Actor Zone for Climate Action. The importance of engaging a range of actors and sites in the transition to a low-carbon economy is now making its presence felt in the international climate policy regime. The extent to which this shift from megamultilateralism, which has dominated international environmental policy for the past two decades, raises challenges for the fundamental principles and measures on which global responses are being sought has yet to be scrutinized.

In this article we seek to open up this question. At the heart of the climate negotiations are the fundamental issues of securing national level action, developing carbon markets and other sources of finance and facilitating the development and transfer of technology. We suggest that in each case the realities of how the energy system transitions that are so vital to delivering international goals are unfolding raise significant challenges to the assumptions on which such frameworks are being built. In short, it is not only that new actors are needed, but also that the means through which low-carbon transitions are (and are not) being pursued need to be rethought.

Research focusing on the development and contestation of climate policy has tended to neglect the ways in which sociotechnical systems both structure and open up the possibilities for decarbonization. In contrast, research on sociotechnical transitions has concentrated on how existing incumbent systems might come under pressure or be reshaped through processes of innovation. Transitions studies have examined how both social and technical innovations come to be incorporated in or challenge dominant systems and how change occurs, with less explicit interest in the dynamics of power and politics through which such transitions are forged and resisted. In this sense, questions of climate policy and politics have been relegated to a general landscape pressure on existing sociotechnical systems and are largely absent from the study of the intricacies of transition processes in particular sectors or places.

In this article, we seek to bring the changing nature of international climate policy and the realities of energy transition into conversation with one another. We explore this interface through recent research on energy system transformations in sub-Saharan Africa (SSA), particularly in Kenya, South Africa and Mozambique. These countries are experiencing competing energy trajectories supported by different actors, along more or less carbon-intensive lines. Rather than being confined to the work of national governments or international development agencies, in each case the role of foreign investment and transnational corporations – including those of the so-called rising powers like China, India and Brazil, whose industrializing economies have experienced significant economic expansion over the past decade – is fundamental in shaping carbon trajectories. Although attention paid to the domestic politics of climate change and low-carbon transitions in these countries in the climate policy literature has been growing (Dubash, Raghunandan, Sant, & Sreenivas, 2013; Pegels, 2014), we argue that further attention to their international role is needed in order to understand the possibilities and limitations for climate action. Moreover, across Kenya, Mozambique and South Africa there are different levels of connection to the market, finance and technology mechanisms that are associated with the climate regime, allowing for further comparison of the extent to

which the regime can support 'local' decarbonization strategies across diverse institutional settings and uneven levels of economic development. This raises questions as to whether and how the global climate regime can support and enable low-carbon transitions.

The research underpinning this analysis is informed by two parallel projects in which 178 interviews were undertaken in Mozambique, South Africa, China, India and Brazil during 2012–2014 together with the creation of a database of low-carbon energy projects in South Africa and Mozambique. The data were gathered using energy finance datasets (such as Bloomberg Energy Finance), policy reports, press releases and web-based sources and then triangulated with findings from interviews and project site visits. The research in Kenya involved a further 29 interviews with government officials, donors and businesses conducted during 2013 and reflections gleaned from a dissemination event on the research held in Nairobi in 2014. For reasons of space the evidence from these cases is necessarily used to illustrate the broader schisms between international climate policy and the practice of transitions in these settings, rather than to provide a more systematically comparative account of energy transitions across the three countries (Table 1).

2. International climate policy and low-carbon transitions

The global landscape of carbon emissions that confronted policy makers in the early days of seeking to negotiate an international agreement was relatively straightforward. Countries could be divided into those whose economies had contributed to current levels of GHG emissions and those who had not yet made a significant imprint. A quarter of a century later the picture is rather different. Economic development and the changing nature of production and consumption have reshaped this landscape in fundamental ways, such that the lines between the North and the South have become blurred. Furthermore, while international policy has remained focused on the language of pollution control and the protection of the atmospheric commons, in other arenas the mantra is one of developing pathways to low-carbon economies or enabling deep decarbonization (The Institute for Sustainable Development and International Relations, 2014). Ostensibly of course, one requires the other. Despite this mutual interdependence, the premises on which policy design is based to forge international agreement and the conditions in which low-carbon transitions are emerging diverge in ways that potentially undermine the potential for international climate policy to deliver effective emissions reductions, especially beyond Annex 1 countries.

Under the international climate regime, the route towards mitigation for countries beyond the Organisation for Economic Co-operation and Development (OECD) is seen to lie in three key areas: the development of national policy responses, the emergence of carbon markets and other forms of climate finance, and mechanisms for technology transfer (UNFCCC, 2014; Technology Executive Committee, 2015). The focus on the nation state as the primary actor that can leverage the policy and investment changes required is fundamental to the architecture of the climate change regime. Establishing effective carbon markets and forms of finance has been a long-standing tenet of the international policy regime. Negotiations in Paris at COP21 placed a large emphasis on new market mechanisms and around the world a range of emissions trading systems are being established in places as diverse as California, China, Mexico and Kazakhstan. Furthermore, over the past five years emphasis has been placed on the need to release the level and kinds of financing required to invest in low-carbon

Table 1. Comparing South Africa and Mozambique.

Indicators	South Africa	Mozambique
Percentage of population without access to electricity	15%	80% ^a
Reliance on fossil fuels	Coal accounts for 96% of electricity generation 16,383 MW of new coal will be constructed as part of the new Integrated Resource Plan	One of the largest untapped coal regions in the world, with estimated coal resources of 25 Gt Coal became the second largest export earner in Mozambique during the first six months of 2012 A 110 MW gas-fired power plant and two coal-fired projects amounting to 900 MW are being developed by independent power producers. ^b
Percentage of renewable energy in the mix	Currently 1% Renewable energy will account for approximately 9 percent of electricity supply (17.8 GW) by 2030 Top 10 globally for clean energy investment and accounted for almost 90% of investment in SSA during this period. ^c	3% renewable share overall The 2.1 GW Cahora Bassa large hydro plant represents more than 85% of Mozambique's total power capacity. In 2013, the country saw just US\$ 2 million of investment in renewable energy (other than large hydro). This was a small fraction of the US\$ 50 million committed since 2006, more than 95% of which was directed at biofuel production. 80% of the country's energy consumption is met by biomass
Targets for decarbonization	Pledge to reduce the country's GHG emissions by 34% by 2020 and 44% by 2025	National Climate Change Strategy 2013–2015 In 2011, the government introduced a renewable energy strategy that set targets for 100 MW of onshore wind and 125 MW of small hydro power by 2025. Aims to introduce feed-in tariffs and other renewable energy funding mechanisms

^a<http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS>.^b<http://global-climatescope.org/en/country/mozambique/#/details>.^c<http://global-climatescope.org/en/country/south-africa/#/details>.

technologies and infrastructure. The Green Climate Fund has been central to these discussions, resulting from the Copenhagen Accord whereby developed countries committed to jointly mobilizing US\$ 100 billion per year by 2020 to address the needs of developing countries – including both public and private funds for climate change mitigation and adaptation. This is alongside the launch of new regionally relevant initiatives in Paris for financing low-carbon energy such as the Africa Renewable Energy Initiative (AREI), which aims to build at least 100 GW of new and additional renewable energy

generation capacity by 2020, and 300 GW by 2030. Technology transfer has similarly been central to the development of the international climate policy regime over the past two decades and since Conference of the Parties 13 (COP 13) in Bali, technology transfer and the principle that less economically developed countries should benefit from low-cost, clean technologies as they seek to reduce their emissions has also become one of the pillars of the climate change regime.

Over the past two decades, international climate policy has emphasized a state-led, finance-driven model of technology deployment, where it is assumed establishing the appropriate costs of carbon and making these costs visible together with providing specific support for alternative energy sources (and other industrial processes) can induce a market-led transition to a new low-carbon economy (OECD, 2013; World Bank, 2012). Yet this model has been troubled both by the empirical realities of how, where and by whom low-carbon transitions are emerging, but also by critiques of their underlying assumptions. The ongoing emphasis on markets as a means of realizing low-carbon transitions continues in spite of the poor performance of carbon trading to date, the very low price of carbon worldwide and the low levels of activity in the Clean Development Mechanism (CDM), once thought to be the success story of the Kyoto Protocol. This experience suggests, at the very least, that policy design and delivery in this area has not adequately accounted for the relationship between establishing market mechanisms and the political economies and practices of decarbonization.

Equally fundamentally, it has been argued that current approaches to technology transfer are constrained by a lack of engagement with the role of the private sector, an assumption that technology primarily flows from countries in the North to those in the South and a limited evaluation of the impacts of the transfer of technology as hardware rather than software (Ockwell & Mallett, 2012; Pueyo, Mendiluce, Sanchez Naranjo, & Lumbreras, 2012) where there has been a lack of attention to the institutional and social dimensions of innovation (de Coninck and Sagar 2015, p. 2–3). Counter to the dominant narrative within international climate policy, transition studies suggest that innovation is an ongoing processes and that although finance and technology are necessary conditions for transition, they are far from sufficient (Kern, 2011).

With the emergence within the Intergovernmental Panel on Climate Change (IPCC) and the Green Climate Fund (GCF) of the language of transformative change, in which paradigmatic shifts towards low-carbon and climate-resilient forms of development are regarded as the goal of interventions, there is increasing engagement with the notion of transition within the climate policy field (Winkler & Dubash, 2015). We suggest that understanding how and why transitions to low-carbon economies are unfolding in different national contexts can provide further insight into how and why the international climate policy regime may or may not be effective in furthering its own goals.

3. The case of SSA

The trajectories of energy transitions in SSA are both little understood and increasingly in focus. From economic powerhouses such as South Africa to countries like Mozambique, Rwanda and Kenya – where national action plans on climate change are being developed as part of a donor drive to promote ‘climate-compatible development’ (Mitchell & Maxwell, 2010) – the energy trajectories of African countries are complex and highly differentiated, providing useful insights into whether and how international climate policy can support transitions to low-carbon economies.

In SSA, a multiplicity of energy systems concurrently provide energy services, including those based on fuelwood, kerosene, small-scale renewables, large-scale hydro and coal-fired generation (particularly in South Africa), while there is significant investment in the development and export of fossil fuel resources including gas and oil. Despite this, access to energy services is the lowest in SSA of any world region, with significant implications for reaching the new Sustainable Development Goal to 'Ensure access to affordable, reliable, sustainable and modern energy for all'. Furthermore, with the population expected to both grow and urbanize over the coming century, the International Energy Agency predicts that energy demand will grow by around 80% by 2040 in SSA (IEA, 2014), much of which will be met by the expanded use of fossil fuels unless incentives are put in place to pursue alternative pathways.

In this context, there has been growing interest in how to support the development of low-carbon energy transitions where measures 'to address energy poverty can also be those that would set countries on the much-sought alternative path to low-carbon development' (Christian Aid, 2011). There is also a strong donor discourse about 'climate-compatible' development, which advocates interventions that deliver the triple win of poverty alleviation, climate adaptation and climate mitigation (Mitchell & Maxwell, 2010), mirrored in the concept of transformative change for low-carbon transitions (Winkler & Dubash, 2015). As this narrative gathers pace, significant hope is being invested in international climate policy as a means through which to contribute to such forms of development. Indeed the preamble to the Paris Agreement states the 'need to promote universal access to sustainable energy in developing countries, in particular in Africa, through the enhanced deployment of renewable energy' (UNFCCC, 2015). At the same time, the growing interest in Africa's fossil fuel resources suggests that any low-carbon transition is far from a foregone conclusion. In the rest of this section, we draw on recently completed research in South Africa, Kenya and Mozambique to examine the ways in which low-carbon transitions are (and are not) being fostered.

3.1. Governing energy system transitions

Under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC), states are the key actors that are expected to negotiate and implement international agreements. According to transition theory they are expected to perform key steering and convening functions among disparate social actors with competing interests in order to achieve transformative change (Meadowcroft, 2005). However, conceptually and empirically such state-led models of climate policy and energy transitions have been found wanting. Research has demonstrated the ever more significant role of transnational forms of climate governance and the multiplicity of actors and forms of authority involved in governing climate change at different scales alongside, through and with state-based organizations (Bulkeley et al., 2014). Moreover, in many settings it is clear the state is not in a position to perform key roles in relation to innovation, lacks convening power and resources to deliver targets and goals and often also has only limited autonomy to assert policy preferences that diverge from those of transnational businesses, donors and other powerful states. Especially where they are heavily aid-dependent (such as Mozambique) or through processes of power sector reform have relinquished a degree of control over the energy system to private providers (Bayliss & Fine, 2007; Tellam, 2000), many states find it hard to set the terms of energy sector reforms aimed at decarbonization – even if they have the political will to undertake them. In the case of Kenya, for example,

donors funded and coordinated the conclusion of the country's National Action Plan on Climate Change (Newell, Phillips, & Pueyo, 2014).

The key point is not that states in such settings are powerless as they still control large parts of systems of electricity generation and transmission. It is rather that state capacity and autonomy to chart and pursue lower-carbon pathways is shaped by their relations with various other actors and is unevenly distributed. With regard to renewable investments powerful countries such as South Africa can induce investors through its Renewable Energy Independent Power Producers Procurement Agreement (RE-IPPP) programme. For example, the involvement of Chinese companies (such as Yingli Green Energy, Suntech, Jinko Solar and Powerway) in the supply of solar photovoltaic technologies has been facilitated by the South African government's RE-IPPP. But in most cases investments result from commercial and geopolitical interest in new energy resources rather than because of state-led climate policy, responding to the saturation of domestic markets or attempts to build up global supply chains – as is the case with the high levels of interest shown by Chinese solar firms in investing in SSA. More problematically still from the point of view of decarbonization is the fact that states often seek to manage the pace of change on terms that protect key incumbent (often fossil fuel) interests, even allowing them to determine levels of market access for new independent power producers as has occurred in South Africa. This cautions against underestimating the degree of incumbency power and the close links between the state and key energy providers that often have major interests in fossil fuels, or what in the South African context is referred to as the minerals–energy complex with key parastatals such as Eskom at its heart (Baker, Newell, & Phillips, 2014).

Rather than it being a matter of a national energy regime being subject to singular transition pathways co-ordinated by the nation state, in the context of SSA multiple forms of energy transition are being orchestrated by a range of actors within and beyond the nation state. What we see in practice are competing energy pathways being supported and financed by different combinations of business actors, non-governmental organizations (NGOs), donors and parts of the state. Within the Mozambique, for example, Fundo de Energia (FUNAE) has been addressing energy access in areas located further from the grid and has developed a focus on renewable energy and rural (off-grid) electrification funded largely by donors, whereas other elements of the state apparatus such as the Ministry of Mineral Resources and Energy are working together with foreign mining and infrastructure companies to pursue hydrocarbon revenue streams and fossil fuel-based power generation. The transnational governance of transitions therefore requires attention (Truffer, 2012) as the UNFCCC process seeks to catch up with these new realities of energy transition, together with a more nuanced, realistic and desegregated understanding of which states are able to deliver which types of transition. This will need to be informed by the degree of policy autonomy the state has from investors and donors, as well as consideration of the uneven capacity within the state to advance transitions in the face of powerful incumbent interests.

3.2. Levering change through carbon markets and climate finance?

The role of market mechanisms in climate policy and enabling decarbonization continues to be undisputed in the international regime. Thus far the focus has been on the CDM even though the role of a broader set of market mechanisms featured in the negotiations in Paris. Since 2001, almost 8000 projects have been registered under the CDM, making it the main vehicle for transferring private finance into mitigation projects in developing world. Over 2001–2012, it is claimed that the CDM spurred US\$

215 billion in investment and issued 1.46 trillion Certified Emissions Reductions (CERs) (<http://www.cdmpipeline.org>). Although the CDM continues to be hailed a pioneer in international environmental policy (UNFCCC, 2012), the performance of carbon markets has dwindled significantly over the past few years, bringing into question their role as drivers of deep decarbonization. CDM investment has shrunk and many projects are stranded and may remain that way until the Paris Agreement creates sufficient demand for them. Prices for the credits, which currently stand at EU€ 0.09 per tonne of CO₂ equivalent, are at all-time lows and have curtailed the inflow of new projects. The CDM has also been rocked by scandals around corruption, fraud, double-counting and problems over additionality, meaning that claimed emissions reductions have not been taking place (Subbarao & Lloyd, 2011). In addition, co-benefits and developmental gains expected from CDM projects have not been widely delivered – in relation to jobs, technology transfer and health outcomes (Das, Phillips, & Newell, 2013; Sutter & Parreño, 2007).

The impact of carbon markets has also been highly uneven geographically. It has long been apparent that investor interest sparked by carbon trading did not lead to extensive investments in SSA, where CDM projects make up less than 2% of registered projects (<http://www.cdmpipeline.org>). As powerful blocs such as the EU have sought to address this by buying larger volumes of credits from the least developed countries, there should be potential for countries like Mozambique to benefit from carbon finance. Yet structural problems around infrastructure, access to finance, the low price of electricity and weak regulatory systems continue to inhibit market-based mechanisms such as the CDM in SSA. This is in spite of the efforts of international institutions such as the World Bank (though its Carbon Finance Assist and market-readiness programmes for example) and many regional and bilateral donor efforts to boost developing country capacity to effectively screen, host and capture benefits from such projects. Evidence suggests that in South Africa CDM projects have further entrenched the power of elite industrial actors central to the country's minerals–energy complex such as Eskom and Sasol by providing support for large-scale industrial or chemical processes (Baker et al., 2014). These actors have the financial resources to afford the transaction costs associated with registering and managing a CDM project and high levels of institutional access to secure government support and approval for their projects. Understandably the challenges are even greater in Mozambique, which has just one CDM project at the validation stage, recently approved by the Designated National Authority (DNA). This project involves switching from coal to natural gas in the rotary kiln of a clinker manufacturing plant outside of Maputo. In this context, key barriers to the further development of carbon markets include a low capacity to develop CDM projects and the lack of upfront financing for pre-investment studies of the CDM component of projects.¹

Whether future climate finance for clean energy comes from carbon markets or other sources, the issue will be same: whether it is at a scale and level of certainty that will shift the calculus of powerful state and private actors rather than be seen as something that merely reduces risk and adds value to existing projects. Securing carbon financing is more often than not an afterthought once the viability of a project is already established, but does not in and of itself have sufficient financial weight to support more substantial change in energy policy. It is telling that in South Africa's 2010 Integrated Resource Plan 40% of the new electricity generation anticipated from renewable energy envisaged feed-in-tariffs as the driver of investment, not the CDM or other forms of external finance.² As one project developer put it: 'if there's one thing I've learned it's don't base your business on carbon revenue ... basing it on carbon increases risk'.³

Given the limited scope for carbon markets to finance transitions to lower-carbon energy systems, alternative sources of climate finance are being sought. Climate aid is clearly an important part of the story. Leading donors such as the World Bank have been actively (re)positioning themselves to manage the financial flows directed through and beyond the Green Climate Fund (GCF), as well as owning their own portfolio of Climate Investment Funds – some \$3.75 billion of which was spent controversially co-financing the Medupi coal-fired power plant in South Africa. Similarly, the African Development Bank made an overt bid to manage a large portion of the funding pledged as part of the Copenhagen Accord and follow-on agreements in 2011. Yet given the sums of money required it is increasingly clear that a key role for the climate regime, donors and governments is to try to leverage private finance as public funding alone falls short of the mark. It is estimated that the energy sector in non-OECD countries would need around US\$ 200 billion of additional investment in clean energy and energy efficiency by 2020 (IEA, 2010). Mitigation costs in developing countries could reach US\$ 140–175 billion per year by 2030. Yet the current flows of all climate finance from developed to developing countries range from US\$ 40 to US\$ 175 billion per year. This includes annual flows of up to US\$ 50 billion through public institutions and up to US\$ 125 billion of private finance (UNFCCC, 2014). Large proportions of climate finance can be classified, therefore, as investment.

Problematically, commentators suggest that the ‘crucial assumption – that donor financing can be used to catalyse private investment in clean energy – remains largely untested’ (Buntaine & Pizer, 2014, p. 2). In SSA, the potential indirect catalytic effects of climate finance are not being achieved for the most part. In Mozambique much investment from rising powers is going into business-as-usual carbon-intensive energy trajectories, whereas aid-donor funding is too small in scale and remains focused on individual projects. Hence although donor funding is catalysing different kinds of socio-technical configurations around everyday energy use, this has crucially not yet had an impact in relation to wider energy systems. In South Africa, public aid is less important but donors have been supporting their own renewable energy firms seeking to gain commercial footholds in the market.⁴ Finance and technical assistance from European bilateral donors, particularly Denmark and Germany, has been influential in the early stages of South Africa’s burgeoning renewable energy industry and has played a considerable role in project development, shaping policy, directing research and developing the RE-IPPPP program.

This highlights the need to desegregate different types of finance in order to appreciate what role it is realistically able to play in supporting lower-carbon energy transitions. There is a need to distinguish the assets, instruments and return timeframes of commercial institutions such as commercial and investment banks from pension and private-equity investors, as well as those among non-commercial financial institutions, public development banks from MDBs and sovereign wealth funds. There are clearly important regional differences to take into account here too, as firms with strong relations to Chinese financial institutions such as the China Development Bank have secured significant lines of credit for the purpose of expanding sales outside China. Each of these financial actors have critical, but different, roles to play in financing competing energy trajectories through financing infrastructures, projects, and investments in carbon markets such that ‘different transformations need different types of finance’ (Spratt, 2015, p. 159).

Levering private finance to address energy poverty, energy security and climate change also needs to be balanced with significant disincentives for business-as-usual investments in energy. This implies a substantial shift of subsidies and support from the fossil fuel-based economy to a low-carbon

economy. This is sensitive terrain for donors, concerned about being seen to be pushing a low-carbon energy agenda in countries where tackling energy access remains the priority, and where governments often request funds for fossil fuel-based development accordingly. Although donors are investing in off-grid, pro-poor affordable energy, many governments remain wedded to high-carbon pathways. For example an International Finance Corporation (IFC) official in Kenya suggested: ‘with the discovery of oil in Turkana and coal in Kitui areas, the government is becoming more assertive. The government offered a 1000 MW opportunity on coal, but donors and investors are reluctant in investing in it because of the GHG effects’.⁵

For some commentators, achieving transformational change requires greater levels of national ownership over the agenda for low-carbon development and a move away from metrics that are too tightly coupled to emissions reductions (Winkler & Dubash, 2015). Yet a focus on national ownership is no panacea, for it neglects what transitions scholars refer to as landscape pressures, which are critical in order to realign the incentives and shift regimes away from fossil fuels. Climate change and carbon market finance under the UNFCCC can help to make lower-carbon pathways more attractive by reducing the risks for investors, offering lines of otherwise unavailable credit and funding projects that are ‘additional’. But the CDM – and even organizations such as the GCF – are too small in scale, too weak amid low carbon prices or insufficiently advanced to drive a shift at the landscape or regime level. Transitions studies suggests that unless there is alignment between the regime and niche, niches will remain just that (Geels, 2002). There is a real need for donors and Multilateral Development Banks (MDBs) to help tackle incumbent power through shifts in lending practices as well as support to initiatives to reduce fossil fuel subsidies and to apply pressure on private financial actors to divest their investments in fossil fuels. This of course is where ambitious global climate policy could play a significant role.

3.3. Technology transfer

Negotiations about the funding and prioritization of technology needs have been central to international climate debates, featuring in the 1992 UNFCCC discussions and subsequently taken up by the Global Environment Facility. They have gained renewed emphasis in the context of recent discussions about the technology mechanism and the climate innovation centres that are currently being established. Questions have been asked, however, about what kinds of technology and what kinds of transfer can best be supported and whether assumptions inscribed in policy bear much resemblance to the practice of design, innovation and diffusion on the ground (Ockwell & Bryne, 2015). As Ockwell, Watson, MacKerron, Pal, and Yamin (2008, p. 4104) have argued, ‘technology transfer needs to be seen as part of a broader process of sustained, low-carbon technological capacity development in recipient countries and both national and international policy interventions are necessary for low-carbon technology transfer’.

As with the other areas of climate policy, there has been a proliferation in the number and types of actors involved in technology transfer: over the past few decades, several larger developing countries have taken significant steps to strengthen their innovation capabilities, alongside which an increasing number of actors – private, public, domestic and international – are involved in technology transfer (de Coninck and Sagar 2015, p. 1). Emphasizing the plurality of actors is not to downplay the role of the state – quite the contrary. As Rennkamp and Boyd (2015) note: ‘technology transfer can be sales-driven or capability-driven. Capability-driven technology transfer can benefit local industry

development, job creation, and poverty reduction in the longer term. These benefits reflect the government's priorities in its development goals, which appear in various policy strategies and plans' (Rennkamp & Boyd, 2015, p. 12). This is vital because South Africa, for example, needs cleaner technologies in order to achieve its emissions reduction targets, yet very few of these technologies are manufactured locally.

Rather than being orchestrated through direct transfers of hardware, energy transitions are taking place through complex assemblages of technology manufacture, supply and distribution involving a dense network of suppliers, contractors and distributors in supply chains that span several countries. Our analysis – based on a database of trends in investments by type of actor (e.g. developer, owner, construction, operation or maintenance), energy source and service, technology type and provider, project scale and location, levels of grid connectivity and type of financing – finds that a broad range of actors is involved in new renewable energy projects constituting approximately 4000 MW of approved generation capacity under South Africa's RE-IPPPP. Spain (21%), Italy (16%) and France (14%) are the major players in terms of project ownership while Spain (22%) is also the major project developer followed by the US (15%) and France (11%). Germany (24%) and Spain (22%) lead project construction with Denmark third (14%). Finance and investment in clean energy in South Africa is led by Spain (14%) but closely followed by France (7%) and the UK (5%). Following the nature of global trends in innovation and manufacturing in renewable energy technologies Germany has a clear lead in terms of the origin of clean energy technologies followed by Denmark (17%) and Spain (10%). These loose assemblages of technology developers and providers are organized around competing higher- and lower-energy pathways. Some focus on investments in larger-scale renewable projects that are attractive to bigger investors and foreign renewable energy firms supported by state policies that are aimed at diversifying the energy mix to supply the grid, such as South Africa's RE-IPPPP or recent interest in geothermal energy in Kenya supported by the Geothermal Development Corporation (CDKN, 2013). The preference is often for pathways that deliver a higher return and provide energy for industry given the pressure to prioritize growth.

Then there are the carbon-intensive pathways being pursued by ministries of power and energy in SSA aimed at luring multinational resource conglomerates such as Vale from Brazil, Tata and Oil India and the China National Petroleum Company to invest in new discoveries of gas and coal, as is the case in Mozambique and Kenya. Finally there are off-grid renewable energy pathways being developed. These are often supported by NGOs and by small-scale financing such as 'sunny money', a social enterprise set up by the NGO Solar Aid, as well as by European donor support but – the rising powers are also becoming increasingly interested in these pathways. For example, FUNAE in Mozambique received a US\$ 13 million credit line from the Export–Import Bank of India to oversee the construction of Mozambique's first solar panel assembly plant. In this regard, as the New Climate Economy report notes, decentralized options are becoming more attractive where the costs of grid expansion are high and where new business models for energy provision are emerging, but 'care should be taken to ensure that the technologies employed do not imply a lock-in to perpetually low-power electricity consumption' (NCE, 2014, p. 20).

Building the infrastructures and networks to support, finance and sustain such innovations is critical and often not amendable to one-off, donor-driven projects. Effective technology transfer has to shift from the transfer of individual hardware to establishing new sociotechnical systems if it is to enable low-carbon transitions. The terms on which, and by whom, these systems are established is of

course critical to their transformative potential. We need to take into account the informal networks and the role of innovation system builders that enable innovation in more organic ways, although there is a key role for donors as work in Kenya shows (Ockwell & Byrne, 2014). This is not then a matter of getting the business model or price right, but is about assembling new systems, and that requires all kinds of social, cultural and political work alongside creating markets – in particular developing domestic capability for technology. This challenges the increasingly popular but uncritical narrative that reduces the role of technology to questions of scaling-up and of de-risking private finance rather than paying sufficient attention to the range of actors that have to be enrolled in technology development and diffusion if it is to be both socially and environmentally beneficial.

4. Conclusions: implications for climate policy

The challenge of decarbonization entails multiple requirements, drivers and dimensions. Addressing climate change is central to this challenge and the policy architecture built up around the UNFCCC is critical to its achievement. Yet given the diversity of actors and drivers and the limited direct reach and influence of international climate policy there is an urgent need to consider how the climate regime can best support the transitions to low-carbon economies that are slowly taking shape around the world in ways that the international climate regime has failed to do thus far. To do this effectively, we have argued, requires moving beyond notions of a cohesive state serving as rule-enforcer and transition manager. It also requires that technology be viewed more broadly, as not just as hardware that is transferred, but a set of practices and networks of expertise and enabling actors. And while markets have an important role to play as vehicles for achieving broader ends, they are not an end in themselves but rather one (and not the only) tool capable of shifting sociotechnical systems in lower-carbon directions. Furthermore, while acknowledging the important role of climate aid, often as a multiplier or facilitator of more ambitious private flows, it is critical to discriminate between the types of finance that are required for different transitions – some of which will be counted under the climate regime and directed by it, but the majority of which will not.

In sum, the climate regime needs to be cognizant of and productively engage with the both the ways in which the transition to a low-carbon economy is being built and the numerous sites at which this transition is taking place. Critical decisions about constructing, financing and politically embedding (low-) carbon pathways are being made by a vast range of actors in numerous arenas in ways that are not directly shaped by the climate regime, but where a greater appreciation of them can improve the effectiveness of global climate policy and the assumptions it makes about the drivers of change.

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Data access statement

Transcripts of the interviews undertaken for this research can be found at 'ReShare data collection' <https://discover.ukdataservice.ac.uk/catalogue/?sn=851967&type=Data%20catalogue>

Notes

1. http://www.undp.org/content/undp/en/home/ourwork/environmentandenergy/strategic_themes/climate_change/carbon_finance/CDM/mozambique_opportunities.html.
2. Interview with head of South Africa's DNA, Department of Energy, May 2011.
3. Interview with hydropower developer May 2011.
4. Interview with senior staff, Danish embassy, Pretoria May 2011.
5. Interview with senior energy sector specialist, World Bank, Nairobi, 21 August 2013.

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