15

Transferring Technologies

The Polycentric Governance of Clean Energy Technology

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15.1 Introduction

Clean energy technology transfer is an important precondition for climate change mitigation and the transition to a low-carbon global economy, because clean energy technologies are costly and face a number of barriers to adoption, particularly in developing countries. Technology transfer is defined by the Intergovernmental Panel on Climate Change (IPCC) as 'a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organizations and research/education institutions' (IPCC, 2000: 3). International technology transfer can involve the transfer of technical knowledge, hardware, assets and manufacturing capability from firms in one country to firms in another country (Gallagher *et al.*, 2012). Under the United Nations Framework Convention on Climate Change (UNFCCC), this transfer occurs from developed to developing countries, and involves technology information, learning, enabling environments, capacity building and mechanisms for transfer to occur (UNFCCC, 2017a).

This chapter focuses on the governance of transferring clean energy technologies to developing countries, covering the technologies, services and processes that reduce energy consumption and enable a transition to a low-carbon economy. The polycentric approach (Ostrom, Tiebout and Warren, 1961; Ostrom, 2010) informs our analysis. Since energy and technology transfer involve multiple governing authorities and scales, polycentricity is worth exploring. While the regime complex is a concept frequently used to characterise climate and energy governance (Colgan, Keohane and Van de Graaf, 2011; Keohane and Victor, 2011), it tends to provide a snapshot of different governance arrangements and their relations. The notion of regime complexity does not fully allow for the examination of what Andonova and Mitchell (2010) describe as the 'rescaling' of politics, which is generating multiple nodes of governance authority both horizontally

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(through the proliferation of international and transnational institutions) and vertically (across local, national and regional jurisdictions). Rescaling is producing a more polycentric system of climate governance (see Chapter 1). This chapter thus questions to what extent, why and with what outcomes this governance system has become increasingly polycentric over time.

Multiple barriers stand in the way of the cleaner energy transition in developing countries – from knowledge access limitations, to market and institutional failures, weak financing institutions and limited technological adaptability to the developing country's absorptive capacity (Acemoglu *et al.*, 2012; Dechezleprêtre, Glachant and Ménière, 2012). Additionally, developing countries face trade barriers, intellectual property rights issues and credit access constraints (Worrell *et al.*, 2001; Keller, 2004). Specific mechanisms of technology transfer aimed to address these different barriers, such as financing through development aid or capacity building, are thus needed to achieve clean energy development (Popp, 2011).

The intergovernmental regime under the UNFCCC has included relatively limited provisions for clean technology transfer. As a result, the Kyoto Protocol's market-based mechanisms, in particular the Clean Development Mechanism (CDM), became the de facto instruments for diffusing clean energy technologies to developing countries. Consequently, governance instruments and financing for clean energy have also emerged across other scales of governance, including traditional players such as international development banks, but also new ones such as development banks from the global South, new intergovernmental organisations like the International Renewable Energy Agency (IRENA) and transnational governance initiatives. This all suggests a shift in the balance of clean energy governance towards a more decentralised and complex polycentric system (Jordan *et al.*, 2015).

This chapter examines what political processes shape the polycentric structure of clean technology transfer. It analyses the early role of the UNFCCC's technology-related and market-based mechanisms in promoting technology transfer to developing countries. It then investigates the horizontal rescaling of international institutions through the rise of initiatives in the multilateral, transnational and bilateral spheres, and the implications for polycentric governance. Finally, this chapter investigates to what extent we can observe some of the anticipated effects of polycentricity in shaping clean energy technology pathways.

15.2 Clean Technology Transfer under the UNFCCC

The first international effort to set up a governance structure to address the international transfer of clean energy technologies was made through the UNFCCC. The 1992 Convention commits all parties to 'promote and cooperate in the

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development, application and diffusion, including transfer' of technologies related to climate change mitigation, and requires developed countries to 'take all practicable steps to promote, facilitate and finance' technology transfer to developing countries (UN, 1992: Articles 4.1[c] and 4.5). Technology transfer was one of the three main means – along with financial support and capacity building – in which the regime intended to support developing countries in addressing climate change. A technology transfer framework and an expert group on technology transfer were created under the Convention in 2001. The main achievement of this framework was the technology needs assessment process, under which more than 85 developing countries received support in identifying the key technologies needed in combating climate change (UNFCCC, 2016).

While the technology needs assessment process was instrumental in helping developing-country governments devise a climate 'technology action plan', providing capacity building and information, funding for the implementation of such plans is lacking (Pueyo *et al.*, 2011). Nonetheless, the UNFCCC reports that since 1991, its financial mechanism – particularly through the Global Environment Facility (GEF) – has provided developing countries with more than $5 billion of funding for 800 projects with mitigation technology transfer objectives. Since 2009, an additional budget of $50 million for climate technology activities was launched under the Poznan strategic programme on technology transfer (UNFCCC, 2016).

In addition, a range of bilateral and multilateral initiatives were set up early in response to the UNFCCC's technology transfer provisions. Among them were the Technology Cooperation Agreement Pilot Project set up by the United States in 1997, as well as the Climate Technology Initiative (CTI) established in 1995 by some European and Organisation for Economic Co-operation and Development (OECD) countries. Both the Technology Cooperation Agreement Pilot Project and the CTI worked to demonstrate how developed countries could fulfil their technology transfer obligations under the Convention, while the CTI, together with the United Nations (UN) Development Programme, also directly engaged in providing assistance to developing countries in producing their technology needs assessments (Kline, Vimmerstedt and Benioff, 2004). Thus, from an initially monocentric governance structure centred on the UNFCCC, bilateral and multilateral initiatives quickly started to emerge, though mainly as a way to implement the obligations that had been centrally established.

The UNFCCC's engagement in technology transfer to developing countries goes well beyond those made through its technology framework and financial mechanism. Several studies have highlighted the important role that the 1997 Kyoto Protocol's market-based mechanisms – particularly the CDM – have played in promoting the adoption of clean energy technologies in developing countries (e.g.

Dechezleprêtre *et al.*, 2008; Schneider, Holzer and Hoffmann, 2008; Seres, Haites and Murphy, 2010). The CDM financially supports greenhouse gas emission reduction (or sequestration) projects in developing countries by allowing such projects to generate emission reduction credits that can be used by developed countries to meet their emission reduction obligations under the Kyoto Protocol. In terms of size, the CDM was very successful, with more than 7,750 projects and 300 multi-project programmes registered in 99 countries. These are expected to deliver more than one trillion tonnes of carbon dioxide–equivalent emission reductions per year. About 83 per cent of these projects (entailing 73 per cent of total emission reductions) involve investments related to energy generation or consumption, and can thus be regarded as potentially involving energy technology transfer.[1] Larger projects and projects developed with a foreign, industrialised country partner – or by a subsidiary of a foreign firm – are usually more strongly associated with technology transfer (Haites *et al.*, 2006; Dechezleprêtre *et al.*, 2008; Seres *et al.*, 2010). In financial terms, at its peak, the CDM provided significantly more resources to developing countries than the GEF (about $23 billion during 2002–2008, representing about $106 billion in primarily clean energy investment if all proposed projects are implemented), but its investments are still smaller than private foreign direct investment flows (Kossoy and Ambrosi, 2010: 42; Popp, 2011).

In part because funding was insufficient to implement the technology needs assessments, and partly due to the CDM's success, this mechanism eventually became the de facto UNFCCC channel to transfer new technologies to developing countries, even though this was beyond its actual remit. A 2010 UNFCCC Secretariat report on the CDM's contribution to technology transfer concluded that at least 30 per cent of projects and 48 per cent of estimated emission reductions involve some technology transfer to developing countries (Seres *et al.*, 2010).

Over time, technology transfer through CDM projects has become less frequent. This trend signals a weakening in the extent of clean technology promotion by the Kyoto mechanisms. However, it also reflects that technological learning takes place in the host developing countries so that 'local sources of knowledge and equipment become more established' (Seres *et al.*, 2010: 11; see also Dechezleprêtre *et al*., 2008). This learning process has taken place particularly in the three largest CDM project hosts – China, India and Brazil – while technology transfer still seems to be substantial in all other host countries.

Crucially, the host country context affects the extent to which the CDM promotes technology transfer. International technology transfer has been substantially more prevalent in CDM projects in China and Brazil than in India, at least partly because India does not set a requirement for such transfers. Also, the broader policy contexts of a country – including tariffs and barriers to technological imports,

protection of intellectual property rights and openness towards foreign investment – have affected whether the CDM contributes to technology transfer. More generally, the likelihood that CDM projects take place at all – particularly for those more innovative and costly technologies for which technology transfer is most needed – is related to the existence of domestic policies that either mandate or financially support those technologies (Castro, 2014). Policies such as feed-in tariffs or other subsidies for renewable electricity complement the CDM in making these technologies more affordable and thus creating a demand that can be supplied by technology transfer. Nevertheless, research does not support the idea that the CDM has meaningfully contributed to accelerating the diffusion of such supportive policies to developing countries (Stadelmann and Castro, 2014). Finally, the domestic private sector, including its business infrastructure and technical capacity, provides the market and technical opportunities to absorb new technologies (Dechezleprêtre *et al.*, 2008; Seres *et al.*, 2010, Schmid, 2012).

Because of both domestic contexts and investor interests, CDM projects have not been equitably distributed across developing countries, with only three of them (China, India and Brazil) hosting 74 per cent of registered projects. Such a skewed distribution clearly has an impact on the CDM's ability to transfer clean technology to poorer developing countries. Scholars have further critiqued the CDM for the limited extent to which it contributes additional incentives for clean technology transfer (Haščič and Johnstone, 2011; Lema and Lema, 2013, 2016). They find that in China and India, for instance, the build-up of domestic technological capacity related to wind energy preceded the CDM, and that the technology transfer channels used by the CDM already existed. They concluded that at least in these core beneficiaries, the CDM was not a major factor in creating new technology transfer mechanisms. Domestic technological capacity, policies and innovation from local firms significantly shape the broadening international technology supply channels.

To enhance the relevance of technology transfer in the climate regime, UNFCCC parties agreed in 2010 to establish a new Technology Mechanism. This mechanism comprises the Technology Executive Committee (TEC) in charge of identifying policies to accelerate technology transfer, and the Climate Technology Centre and Network (CTCN) responsible for implementation, including the provision of information, knowledge and technical assistance, and the promotion of collaboration between countries seeking assistance and technology experts (UNFCCC, 2017b). As is elaborated in Section 15.3, this new governance structure relies much more strongly on partnerships with other technology-related organisations to deliver its services.

Overall, the UNFCCC initially provided a rather monocentric impulse for technology transfer, first through the technology transfer framework and later

through the CDM (even though the CDM already had substantial tasks given to private hands; see Chapter 13). Nonetheless, these instruments already had to interact with bilateral and multilateral implementation-related initiatives, and more crucially with national-level policy systems and business environments, which shaped the way in which they were able to contribute to technology transfer. By contrast, the Technology Mechanism clearly reflected the evolving polycentric nature of technology governance by directly engaging with the relevant international and national-level partners.

15.3 Horizontal Rescaling of International Institutions

In parallel with the UNFCCC, the governance of technology transfer has undergone a horizontal rescaling, with a growing number of agencies taking on mandates or programmes for clean energy (Andonova and Mitchell, 2010; Andonova and Chelminski, 2016). This institutional development has created new nodes of governance at the international level, shaping a more polycentric system. Multiple factors have contributed to such developments, including the dissatisfaction of state actors with the existing UNFCCC mechanisms and the subsequent incentivisation for the proliferation of new institutions to address the limits on the renewable energy portfolio of the International Energy Agency (IEA), as well as innovative initiatives within developing agencies (Colgan *et al.*, 2011; Van de Graaf, 2013; Andonova, 2017). In addition, bilateral aid and regional institutions have played an increasing role; countries interested in promoting clean energy technology use them as another means to exert political influence.

The major intergovernmental actors that have played historical roles in governing clean energy technology transfer include the IEA's Renewable Energy Unit and the United Nations Environment Programme (UNEP), with the Group of 8 (G8) and the newly created IRENA emerging subsequently. Multilateral development banks such as the World Bank and the Asian Development Bank have similarly become key players in clean energy technology transfer, and bilateral development banks, such as KfW, the European Investment Bank and the China Development Bank, are playing an increasingly central role in financing technology transfer. Altogether, these are representative of major emerging and historical players in governing clean technology transfer, whose contributions include financial and technical assistance, policy advice, capacity building and knowledge sharing.

The first avenue through which an alternative platform for clean energy was created within the IEA was through the 2008 G8 Energy Ministerial in Aomori. The G8 and China, India, South Korea and the European Union decided to establish the International Partnership for Energy Efficiency Cooperation (IPEEC) to further promote energy efficiency policies and practices. IPEEC was created as

a cooperation platform hosted by the IEA, to facilitate collaboration with emerging market economies that are not IEA members, which is envisioned as a way to integrate non-OECD members into the IEA for future energy cooperation (Lesage, Van de Graaf and Westphal, 2010). The IEA hosts IPEEC, but the partnership remains legally distinct from the IEA, with a separate legal agreement.

Donor countries such as Germany – and to a lesser extent Denmark and Spain – actively promoted the creation of an international organisation dedicated to renewable energy technology and technology transfer through international conferences and by political support. In response, many international organisations and transnational initiatives have mutually adjusted to the growing proliferation of institutions. In some cases, the horizontal rescaling has led to greater synergies as a type of mutual adjustment, where overlapping institutions form partnerships such as the creation of the CTCN, detailed further in what follows. In other cases, institutional overlap has created competition and turf wars, such as between the IEA and IRENA. While there was an admitted programming overlap, the initial contention between these two organisations eventually has led to synergies and partnerships on clean energy. Thus, the specific impetus towards greater polycentricity at the international level was political on the part of certain states and international organisations, as well as institutional. The processes of mutual adjustment among development banks and international organisations to respond to the changing incentives and political interests of donor countries thus developed a more polycentric organisational landscape (Andonova and Chelminski, 2016).

Since its creation in 2009, IRENA now has 154 member states and 26 states in accession (180 total), and a budget that rivals the IEA (IRENA, 2017). Unlike the IEA, which has OECD countries as its core members, IRENA is located in the United Arab Emirates, a developing country under the UNFCCC categorisation. Its location signals how governance authority needs to encompass a geographical shift to engage particularly emerging and developing markets. IRENA's contribution to technology transfer lies in its capacity-building programmes, policy and technical expertise, training, knowledge sharing and financing for renewable energy pilot projects. The IRENA/Abu Dhabi Fund for Development Project Facility is a $350 million concessional loan to finance 'innovative, replicable renewable energy projects in developing countries', which embodies the aims of technology transfer. Since 2012, $144 million in loans (and $189 million leveraged through co-financing) have already been allocated to 19 renewable energy projects recommended by IRENA, including wind, solar, geothermal, hydro, biomass and bioenergy and hybrid technology. Questions remain as to whether IRENA will accomplish its goals to reduce information asymmetries, facilitate technology transfer in developing countries and build political consensus for renewable energy (Van de Graaf, 2013).

More than 10 years prior to IRENA's creation, UNEP acted with considerable governance entrepreneurship in promoting renewable energy technology transfer through knowledge management, policy advising and partnerships. In 1997, UNEP's technical Division of Technology, Industry and Economics created a new Energy Branch, which has since developed a substantial portfolio on renewable energy and energy efficiency, in anticipation of a growing interest among industry and policy circles in diverse mechanisms to support clean energy transfer after the adoption of the Kyoto Protocol (Andonova, 2017). UNEP was subsequently selected as the host of the CTCN, which was created under the UNFCCC. The networked structure of the CTCN – with authority under the UNFCCC, managed by UNEP, and including both intergovernmental and transnational organisations – represents a political recognition of the polycentric nature of clean energy governance and the need for greater coordination across its various horizontal nodes internationally, and vertically to domestic policies. The United Nations Industrial Development Organisation and 11 Centres of Excellence across developed and developing countries collaborate with UNEP to stimulate technology cooperation and enhance technology transfer through technical assistance, information and knowledge sharing and networks of collaboration (CTCN, 2017).

Development banks have similarly become important actors in clean energy transfer, creating another set of nodes in the horizontal rescaling of clean energy governance. UNEP and Bloomberg New Energy Finance found that financing from development banks was approximately $84 billion in 2014. The largest funders of clean energy were KfW ($28.3 billion), the European Investment Bank ($11.7 billion), the World Bank Group ($9.4 billion), Brazil's Brazilian Development Bank ($6.3 billion) and the China Development Bank ($6 billion), in addition to funding from the Asian Development Bank, the European Bank for Reconstruction and Development, the African Development Bank, the Japan Bank for International Cooperation and the Export-Import Bank of China ranging from $1.6 billion to 3 billion (UNEP and BNEF, 2016; BNEF 2016).

The World Bank entered the business of climate financing shortly after the adoption of the Kyoto Protocol, largely on its own initiative and with the financial support of donors with proactive climate policies and of private actors (Andonova, 2010). By 2008, the expansion of climate finance and the greater consensus among all major donors of the Bank resulted in the creation of the Climate Investment Funds (CIFs), whose programmes were subsequently extended to the regional development banks (Andonova, 2017; Newell 2011). The CIFs play a significant role in technology transfer by financing mitigation and adaptation activities, including renewable energy development and forest management in developing countries. The major funds related to technology transfer include the Clean

Technology Fund ($5.6 billion) and the Scaling Up Renewable Energy in Low Income Countries Programme ($780 million) fund (World Bank, 2017). The $8.3 billion in CIF pledges are expected to attract an additional $58 billion in co-financing for the more than 300 projects. Equally importantly, the CIFs are to work with developing country governments in developing strategies for low-carbon development and technology investment.

Studies of polycentric systems rarely ask how the layers of such systems became established, and instead focus on the functions and effects of polycentricity. Our discussion reveals how both political incentives and governance entrepreneurship can provide a strong impetus for the horizontal rescaling of authority 2010. The emergence of multiple institutional nodes working on clean technology transfer in the multilateral system was created by institutions reacting to donor countries incentivising new institutions and institutional expansion into the clean energy domain, coupled with organisational entrepreneurship of the creation of new programming or partnerships related to clean energy. Donor countries incentivised institutional change to promote their respective agendas related to energy governance, which in the case of Germany was to support multilateral solutions to technology transfer, and in the case of the United States was to pursue a unilateral agenda or club governance. Governance entrepreneurs within organisations such as UNEP or the World Bank similarly saw windows of opportunities to propose new financing mechanisms for climate and clean energy that supported their mandates and expanded their resources (Andonova, 2017). We observe mutual adjustment amongst governing units, but also competition and contention. The significant role of the World Bank and other development banks has raised concern about the role of the more broadly representative UNFCCC framework, creating in turn a stimulus to new institutional developments such as the CTCN and the Green Climate Fund (Nakhooda, 2011; Newell, 2011; Andonova, 2017). The polycentric landscape of clean technology governance is therefore best understood as an evolving one.

15.4 Transnational Governance and Clean Technology Transfer

Transnational initiatives for clean energy, which link subnational and non-state actors across borders for the purpose of advancing a set of common governance objectives, represent a third layer in the rescaling of clean technology governance towards greater polycentricity (Bulkeley *et al.*, 2014; Andonova, Hale and Roger, 2017; see also Chapter 4). Several drivers have, in turn, contributed to the rise of such initiatives. First, several transnational climate governance initiatives that involve local actors such as cities or regions depend on the realisation of local and global co-benefits. An example is the optimisation of energy resource use or

efficiency enhancement in buildings and transportation, which achieves global sustainability objectives of emissions reduction while serving the needs of local communities. A number of cities initiatives for climate change, such as ICLEI – Local Governments for Sustainability (originally called the International Council for Local Environmental Initiatives), Energy Cities and the Covenant of Mayors, have major energy optimisation components (Betsill and Bulkeley, 2004; Bulkeley *et al.*, 2014; Dolšak and Prakash, 2017). Second, the emphasis on clean energy of many transnational initiatives has reflected the initially weak intergovernmental mechanisms for technology transfer beyond the project-based CDM. For example, the private Gold Standard for voluntary certification of project-based carbon offsets was created with the explicit purpose of rewarding projects that emphasise sustainable development co-benefits, such as investment in renewable energy technologies. For countries interested in advancing clean energy cooperation, transnational clean energy partnerships have provided informal but useful vehicles of influence. After the exit of the United States from the Kyoto Protocol in 2001 and the unsuccessful effort of European countries to promote an intergovernmental agreement in 2002 on clean energy sources due to limited interest by both developing and major industrialised countries, transnational initiatives such as REN21 and the Renewable Energy and Energy Efficiency Partnership created an alternative vehicle to promote collaborative effort by interested parties (Andonova, 2010; Pattberg *et al.*, 2012). The peaks of transnational clean energy initiatives, first in 2001–2005 and subsequently in the 2006–2010 period, reflect these political drivers (Figure 15.1).

Unsurprisingly, many of the early transnational clean energy initiatives reflect specific interests pursued by their members. The United Kingdom initiated the Renewable Energy and Energy Efficiency Partnership in 2002 to advance investment in renewable energy by tackling (through capacity building and project-based investment) specific barriers to technology diffusion (Pattberg, 2010). The United States launched the (now-defunct) Asia-Pacific Partnership on Clean Development and Climate. It promoted a technology-oriented approach, albeit with a different conception of clean technology, which included clean coal. In the run-up to the 2015 Paris Agreement, India – together with France – initiated the International Solar Alliance (Government of India, 2017), a new transnational partnership reflecting the growing role of emerging markets and greater recognitions of the synergies between the UNFCCC and transnational governance (Hale, 2016; Andonova *et al.*, 2017).

Public-private partnerships have thus tended to dominate transnational governance for clean energy since 2000 (Andonova and Chelminski, 2016). Very few transnational initiatives involve solely private or non-state actors. The influence of private actors on clean energy diffusion and transfer has materialised primarily

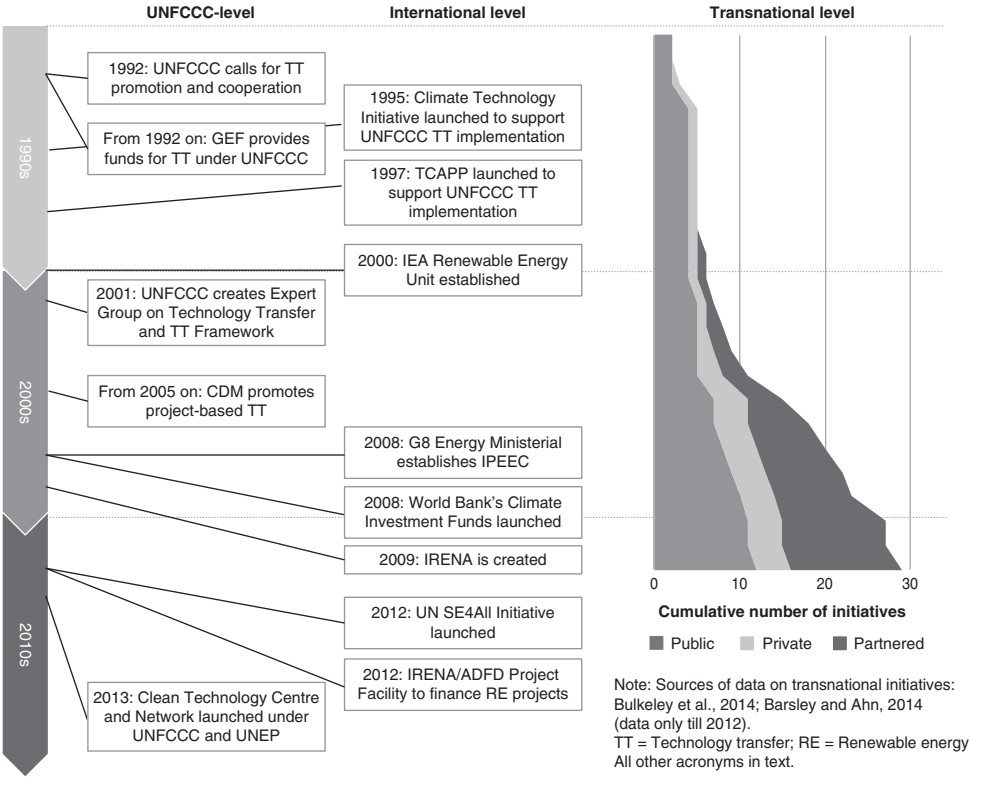

Figure 15.1 Emergence of the polycentric governance system for clean energy technology transfer. Sources: Bulkeley *et al*. (2014) and Barnsley and Ahn (2014).

through market mechanisms and foreign direct investment, encouraged importantly by the recent upsurge of national policies related to clean energy technologies in large emerging economies such as China and India (Lewis, 2007; Wang, Qin and Lewis, 2012).

The domain of transnational governance for clean technology transfer has thus created space for experimentation with innovative mechanisms of governance when intergovernmental cooperation stagnated (Hoffmann, 2011; see also Chapter 4). It also subsequently triggered linkages between local, national and transnational initiatives (Andonova *et al.*, 2017). These initiatives have performed specific functions in the larger polycentric system. Figure 15.2 reflects our coding of transnational clean energy initiatives that advance instruments specifically for technology implementation and transfer, compared to those that focus largely on knowledge barriers and policy diffusion and do not incorporate instruments such as financing of technology investment or project-based mechanisms. The sample of 34 clean energy initiatives was derived by extracting from the database on

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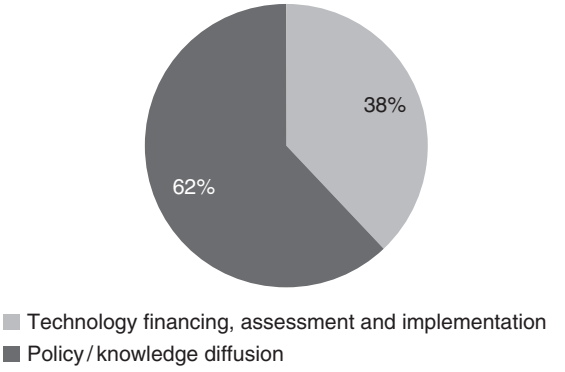

Figure 15.2 Transnational initiatives: technology implementation and policy diffusion.

transnational climate governance (Bulkeley *et al.*, 2014) only those initiatives with an explicit focus on clean energy, complemented with transnational networks listed in the IEA survey on clean energy cooperation (Barnsley and Ahn, 2014). Since almost all initiatives tend to involve capacity-building components (Bulkeley *et al.*, 2014), Figure 15.2 does not include separate coding for capacity support, but examines the extent to which transnational governance promotes more direct measures of technology transfer versus policy and knowledge diffusion.

Figure 15.2 shows that about 38 per cent of the transnational governance initiatives have promoted direct mechanisms of technology transfer, typically through project-based financing and the diffusion of technologies. They have developed in parallel with the CDM to promote a set of technologies, often reflecting the specific agenda of funding and recipient countries (Pattberg, 2010; Taplin and McGee, 2010). The larger share of clean energy initiatives (62 per cent) has placed a strong focus on policy learning, diffusion and reducing knowledge barriers. The REN21 network, for instance, was created in 2002 to address multiple information gaps by providing a platform embedded in UNEP to involve both policymakers and non-state actors, such as renewable industry associations and NGOs. During the 2000s, REN21 became a premier source of information on renewable energy technology and public policies, coordinating with institutional players such as the IEA, IRENA, UNEP and the World Bank, as well as national administrations, NGOs and researchers. Transnational initiatives have provided an important vehicle to create linkages and foster a degree of mutual adjustment in the polycentric system that has emerged – vertically across subnational and international objectives, as well as horizontally across formal and informal international institutions. The creation of Sustainable Energy for All (SE4All) in 2012 and the adoption of Affordable and Clean Energy as one of the Sustainable Development

Goals in 2015 have codified at the level of the UN General Assembly the relevance of polycentric governance for a clean energy transition, including – as anticipated by the work of Ostrom (2010) – the need to recognise the role of multiple authorities at different scales. SE4All became possible through the leadership of Ban Ki-moon, then the UN Secretary-General, supported by other international organisations, transnational initiatives and negotiations of UN member states for the adoption of the UN General Assembly Resolution 65/151 in 2011 declaring 2012 the International Year of SE4All (UN, 2011; SE4All, 2017). The network structure of these universal commitments on clean energy under UN frameworks creates a loosely coordinated system of the multiple levels and instruments of clean energy governance that have developed over the past two decades.

15.5 Polycentric Governance and Mechanisms of Technology Transfer

The governance of clean energy technology has evolved considerably towards a polycentric system since the adoption of the UNFCCC, as shown in Figure 15.1. Multiple governance structures operate at the international and transnational levels, connecting actors engaged in the diffusion and implementation of cleaner energy technologies. What instruments and mechanisms has established this polycentric system to advance the objective of clean technology transfer?

Project-based deployment of cleaner technology appears in our analysis as the dominant mechanism of technology transfer. Supported substantially by the flexibility mechanisms of the Kyoto Protocol, a large share of the resulting projects have stimulated the deployment of cleaner energy technologies. The verdict is still out, however, if the glass is half full or half empty. As we discussed earlier, about 80 per cent of all CDM projects have a strong clean energy component. However, less than half of all projects reported involve some technology transfer to developing countries, with the rate of technology transfer varying strongly across project types and host countries and decreasing over time. Nonetheless, the CDM has also had a catalytic effect (Hoffmann, 2011) in terms of stimulating private project-based schemes for carbon offsets, many of which target either forestry projects or the advancement of a higher share of clean energy technologies. Several transnational public-private partnerships and cities networks, such as the Renewable Energy and Energy Efficiency Partnership, the UN Fund for International Partnerships and ICLEI, facilitate project-based climate actions that include the advancement of renewable energy and energy efficiency technologies.

Financial support has become another important instrument to reduce some of the financial barriers and capital risks for the development of clean energy technology in developing countries. Unlike the original centralised design of the GEF as the first international funding mechanism for climate mitigation, finance for clean

energy technology developed laterally through expanding programmes of international organisations and donor governments. The World Bank was first to experiment with climate funds to support the development of carbon offset projects in line with CDM requirements. After the G8 Gleneagles Summit of 2005, and the greater – albeit soft – agreement among major economies to encourage clean energy diffusion, there was a substantial increase in bilateral donor funding and the creation of a new financial facility, the CIFs. The proliferation of financial mechanisms and the engagement of development banks may have created overlaps and raised concerns about the role of the UNFCCC. The creation of climate funds and donor programmes to support technology transfer in developing contexts also fostered experimentation and demonstrated that multiple mechanisms can be used to generate financial support. There is still limited systematic assessment of the impact of these multiple streams of international and transnational finance on clean energy projects; recent studies suggest that international assistance has been a key driver of reducing financial barriers to investment in sectors such as geothermal development (Chelminski, 2017). However, the polycentric structuring of governance has frequently failed to overcome the limited coordination among institutions working on the ground in developing countries. Therefore, gaps often remain between developing country needs and limited domestic capacity for project implementation, despite continued flows of international finance.

The *pooling of credible knowledge* on renewable energy technologies and on policy instruments for clean technology and energy efficiency was initially the driving mechanism of clean technology governance. The comparative advantage of organisations such as the IEA and UNEP was precisely in developing programmes for technical support and information on specific sectors or areas of low-carbon technology development. UNEP developed sector-specific strategies with member states and non-state actors, focusing on energy and agriculture, efficient lighting, sustainable biofuels and efficiency in buildings (Andonova and Chelminski, 2016). The IEA has been the main source of credible information on technology trends, but also on country- and sector-specific technologies. Before the creation of IRENA, REN21 developed as a platform for knowledge-sharing across countries, industry and development organisations. It quickly became a premier source of up-to-date information on renewable technologies and policies, drawing on governmental sources as well as on credible non-governmental and academic information (Andonova, 2017).

The structure and functions of the polycentric system governing clean technology transfer reveals *relatively limited emphasis on capacity building* as a mechanism to unblock barriers to clean technology uptake and implementation. For instance, the early climate finance mechanisms of the World Bank were criticised for predominantly funding projects in large emerging markets and

transition countries, a pattern that replicated rather than corrected the uneven distribution of CDM projects (Michaelowa and Michaelowa, 2011). Indeed, the capacity of states to attract project-based technology transfer and financing has been an important factor shaping these flows. At the same time, targeted capacity building under the CDM or climate finance instruments remained limited and unevenly applied. The IEA provides energy statistics training for non-IEA member states (aimed at developing countries) to build institutional capacity by developing tools for governments to maintain accurate energy datasets and national energy balances. Institutional capacity building to implement reforms and new policies is an important step in technology transfer, but it has represented only a fraction of overall finance, such as in geothermal development in Indonesia and the Philippines, for example, representing a major gap in technology transfer governance (Chelminski, 2017).

Regulatory mechanisms are almost entirely lacking in international and transnational governance initiatives, reflecting the unwillingness of states to organise clean energy technology cooperation around a specific binding agreement (see Chapter 14). Instead, since the creation of IRENA and the expansion of transnational and international programmes, several coordinating mechanisms were established across levels of polycentric governance. Importantly, these coordinating structures have been enabled by institutions with broad and quasi-universal membership, including the UN General Assembly, with the endorsement of SE4All and Sustainable Development Goal 17 and the UNFCCC. For instance, under the UNFCCC, the CTCN was established to facilitate technology transfer by providing technical assistance when this is requested by developing countries, improving access to information and knowledge on climate technologies and fostering collaboration among climate technology stakeholders (UNFCCC, 2017b).

Despite this lack of emphasis on regulation at the international and transnational level, *domestic regulation still plays a crucial role* in support of such technologies, either through 'technology push' mechanisms such as the promotion of research, development and deployment programmes, or through 'demand pull' mechanisms that financially support upscaled deployment. Particularly in the more advanced and technologically proficient developing countries, it has been shown that it is mostly appropriate domestic structures – including both regulation *and an active private sector* that sees the business opportunity in deploying new technologies – that are needed to achieve technology transfer and development. This point supports the need for increased institutional capacity building at the national and subnational levels of government to support technology transfer. More research is needed to find out whether the purported catalysing role of international and transnational initiatives is stronger in less developed countries. Given the importance of the private sector, it

may well be that transnational initiatives, which more directly involve private actors including businesses, will further gain prominence in the future.

15.6 Conclusions

The governance of clean energy technology transfer has evolved towards a polycentric system due to diverging state interests, mutual adjustment and experimentation. As state actors – from both the global North and the global South – were dissatisfied with the existing regimes, their interests to pursue other forums through forum-shopping and institutional creation led to the development of a polycentric system. The rise in multiple nodes of authority – including the UNFCCC, UNEP, SE4All and IRENA – combined with the growing actors at multiple levels of governance – including the international, regional, bilateral, national, transnational and local levels – can be conceptualised as a form of polycentric governance. The polycentric system has become more authoritative and legitimate over time, with high-level recognition of its structure at the UN level. Nonetheless, there are still questions about the extent to which a polycentric system promotes international equity, particularly for the least developed countries. This chapter shows that countries with proactive policies and financial capacity have often driven institutional development towards a more flexible and innovative polycentric system. Large emerging countries and other developing countries with relatively strong domestic policies have been, at least initially, the main beneficiaries of its various components. The increasingly polycentric structure of the governance of clean technology opens new avenues for research on its effectiveness and equity implications across jurisdictions and evolution of the system over time.

Note

1. Data provided by UNEP DTU Partnership (2017).

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