6

LEARNING FROM THE KENYAN SOLAR PV INNOVATION HISTORY

The detailed historical analysis in Chapter 4 and Chapter 5 demonstrates the ways in which the development of the off-grid solar PV market in Kenya resembles processes of Socio-Technical Innovation System Building. In this penultimate chapter we focus specifically on the implications of these observations for policy and practice. We begin by revisiting the dominant policy framings introduced in Chapter 1, namely Hardware Financing and Private Sector Entrepreneurship. We then discuss how approaches based on these framings contrast with a Socio-Technical Innovation System Building approach and how the latter holds more promise in terms of supporting transformative policy interventions with greater potential to address the sustainable energy access problematic.

In relation to each framing, we provide an empirical example. We begin by contrasting the Hardware Financing framing of the Photovoltaic Market Transformation Initiative (PVMTI) with Lighting Africa's more Socio-Technical Innovation System Building-oriented approach. We then introduce a new policy intervention that was not covered in the innovation history in Chapter 4 and Chapter 5, as it is too new to be able to chart tangible results. This is the example, mentioned in Chapter 1, of Kenya's new Climate Innovation Centre (CIC) – an infoDev/World Bank initiative with support from the UK's Department for International Development (DFID) and its Danish equivalent, Danida. The CICs represent a good example of a Private Sector Entrepreneurship framing to the problem of sustainable energy access and technology transfer more broadly. While it is too early to provide any detailed empirical evidence, we present what evidence is currently available in the public realm on the Kenyan CIC and discuss the potential implications of the framing it adopts in terms of its likely impact in transforming sustainable energy access, or supporting low carbon development more broadly in Kenya or beyond. This *ex-ante* analysis of the transformative potential of the CIC approach builds on the insights from the historical analysis of the solar PV market given in Chapter 4 and Chapter 5, and the Socio-Technical Innovation System Building perspective these insights support.

Then, having presented quite a critical perspective on the two policy approaches that exemplify the framings we have argued are inadequate (PVMTI and CICs), we end the chapter by putting forward some recommendations for how policy might operationalise a Socio-Technical Innovation System Building approach in order to maximise chances of creating the conditions within which transformations in sustainable energy access are more likely to occur. This draws on lessons from the Lighting Africa example as well as generic insights from our detailed innovation history of solar PV in Kenya. In doing so, we articulate a vision for a new kind of institution with the potential to better support the development, transfer and adoption of sustainable energy technologies in developing countries, especially among lower-income countries where socio-technical innovation systems are less well developed, but where significant opportunities exist to build such systems around sustainable, pro-poor technologies across the board (energy-related or otherwise). We have, elsewhere, introduced this idea in the form of institutions that we have called 'Climate Relevant Innovation-system Builders' (CRIBs) (see Ockwell and Byrne 2015), but we believe it is applicable to other sustainability issues.

Hardware Financing and Private Sector Entrepreneurship versus Socio-Technical Innovation System Building

In Chapter 1, we introduced three alternative framings through which the issue of sustainable energy access – as well as linked concerns such as low carbon technology transfer and low carbon development or green growth – can be understood. Two of these, Hardware Financing and Private Sector Entrepreneurship, tend to dominate current international policy narratives. To recap briefly, these two framings and their associated narratives can be summarised as follows:

- *Hardware Financing*: A Hardware Financing framing of the problem of sustainable energy access is based on a standard Environmental Economics argument. This argument acknowledges, for example, that low carbon energy technologies are not competitive with fossil fuel-based energy technologies because their prices fail to reflect the positive externalities to society of mitigating future greenhouse gas emissions. This leads to the assumption that introducing market-based mechanisms, like the Clean Development Mechanism (CDM), which allow technology hardware suppliers to be paid for these positive externalities (i.e. subsidised), will provide incentives for investment in low carbon energy technologies in developing countries. This argument carries the additional assumption that such investment in low carbon energy hardware will be extensive enough to reorient technological change and economic development in developing countries towards more sustainable directions.
- *Private Sector Entrepreneurship*: A Private Sector Entrepreneurship framing of the sustainable energy access problem focuses at a more micro-economic level. It argues, for example, that low carbon technological change will be driven by

innovation in the private sector and therefore emphasises the need to provide venture capital to entrepreneurial private sector initiatives in developing countries. Again, this argument carries a similar assumption to the Hardware Financing framing, namely that such venture capital provision for sustainable private sector entrepreneurship will reorient countries' development trajectories towards more sustainable directions.

Our central aim in this book has been to demonstrate the limitations of the above two framings for the problem of sustainable energy access, and to provide an alternative. In turn, the alternative should be a framing that is equally relevant to broader issues such as low carbon technology transfer, low carbon development, green growth, etc. The alternative we have been promoting is what we have called Socio-Technical Innovation System Building.

- *Socio-Technical Innovation System Building*: This framing significantly broadens the focus of potential policy interventions, emphasising the need for a systemic understanding of how innovation and technological change can be nurtured through policy. It also emphasises the importance of attending to the social practices with which sustainable energy (and other) technologies intersect, the co-evolutionary nature of innovation and socio-technical change and the existing socio-technical regimes with which sustainable energy technologies must compete.

One potential criticism of this systemic framing of the problem is that the policy prescriptions it generates risk being too context-specific to be practical – that they are not generic enough to be widely-applicable and so are unworkable as policy interventions. Indeed, the attraction of the other two framings, particularly Hardware Financing and market-based mechanisms in general, is that they can be explained with simple narratives and that they come with policy prescriptions that are entirely generic. That is, context-specific issues are irrelevant to the applicability of such policy interventions.

We would dispute these arguments, and so, in this penultimate chapter, our concern is two-fold. First, we provide some comparative examples and more detailed discussion of specific policy interventions that characterise all three of the framings summarised above. This serves both to re-emphasise the limitations of interventions based on Hardware Financing or Private Sector Entrepreneurship and to provide a worked example of Socio-Technical Innovation System Building in practice. Second, we provide a concrete proposal for how Socio-Technical Innovation System Building could be achieved using generic policy approaches, while achieving results that respond to the context specificities that are critical determinants of the impacts of policy interventions across the richly variegated characteristics of different countries (see Chapter 1 for a more detailed discussion of context specificities in relation to sustainable energy access).

Hardware Financing: The Photovoltaic Market Transformation Initiative (PVMTI)

Let us begin with an example from our innovation history of solar PV in Kenya, which fits well with a Hardware Financing approach. In 1998, the International Finance Corporation (IFC) began implementing a project in Kenya that was intended to transform the market by addressing a perceived finance constraint. The Photovoltaic Market Transformation Initiative (PVMTI) made USD 5 million finance available on both the demand and supply sides of the Kenyan PV market, which would be disbursed in loans to consumers and suppliers over the ten-year life of the project (Gunning 2003, p. 81). Finance for customers, it was assumed, would enable them to overcome the high initial cost of PV systems and therefore release pent-up demand. Finance for companies would allow them to purchase in bulk and so reduce their costs, hence lowering prices to consumers. In this way, the initiative clearly adopted the kinds of narratives that characterise the Hardware Financing framing of how sustainable energy access might be increased in Kenya, in this case, by financing the purchase of solar PV modules and solar home systems (SHSs). The project was to be implemented in three countries simultaneously: Kenya, Morocco and India. Kenya was 'viewed as a true free market for PV products' (IFC 1998, p. 12), presumably therefore making it the ideal context for a market-based intervention (although this clearly begs the question as to why, if the Kenyan market was truly free, would any market-correcting policy intervention be necessary?). With a total investment across the three countries of USD 25 million, the project was expected to have a discernible impact on sales in the world market; specifically, the impact was expected to be about a 5 per cent increase in world PV sales within five years (IFC 1998, p. 14).

A request for proposals was issued in September 1998 (Gunning 2003, p. 85). As the terms of lending were a leverage of 1:1 and a minimum PVMTI investment of USD 0.5 million, companies in Kenya were forced to come together as consortiums because no single company could risk such an amount of money (Bresson 2001, p. 5; Ngigi 2008, interview). One of the first consortiums to submit a proposal involved the Cooperative Bank of Kenya (CBK) together with battery manufacturer Chloride Exide and EAA. This received 'first-track' status, meaning that it was acceptable in principle and ready for implementation (Ngigi 2008, interview). However, the IFC had issues with investing in CBK because of their non-performing assets and decided the proposal was not bankable. Soon after this, according to Ngigi (2008, interview), disparaging articles began appearing in the local media and EAA became one of PVMTI's biggest critics. Certainly by 2001, there was evident disquiet and impatience expressed in the SolarNet[1] newsletter by some actors (de Bakker 2001, pp. 4–5; Bresson 2001, pp. 5–6; Muchiri 2001, p. 4).

Other proposals were received (Hankins and van der Plas 2000; Ngigi 2008, interview), and a long process of negotiations ensued – negotiations between the consortiums and the IFC and, when these failed to produce deals, local financial institutions were persuaded to engage with the project, these deals collapsing after more protracted negotiations (Ngigi 2008, interview). Eventually, it appeared that most of the available finance would finally be disbursed. Three deals were agreed: one with Barclays Bank Kenya, one with Equity Building Society and one with Muramati Tea Growers Savings and Credit Cooperative (SACCO) (Hankins and van der Plas 2000, p. 29). But these fell apart for various reasons, and the disquiet among stakeholders mentioned above turned to resentment.

Byrne (2011) identifies a range of factors that contributed to the failure to broker finance deals for SHSs through PVMTI. These include the following:

1. The minimum deal size was too large for the Kenyan market. Minimum investment was USD 0.5 million from a local consortium, to be matched by PVMTI. No local suppliers were able to mobilise this level of investment on their own.
2. There was misalignment between the IFC and local banking rules, making it impossible for either party to finalise deals.
3. The transaction costs were too high for mainstream banks, despite some interest in bundling deals for on-lending to micro-finance institutions (MFIs). The deal flows were too small compared with the costs of managing them.

This failure stimulated some actors to begin discussing ways in which PVMTI might be changed in order to provide some tangible benefit to the market (van der Vleuten 2008, interview). These actors approached PVMTI in 2003 requesting help with capacity-building (Magambo 2006, p. 1). In 2004, PVMTI went through a restructuring (IFC 2007b, p. 42). As a result of meetings with PV actors in Kenya and the frustrations felt within the PVMTI hierarchy itself (Ngigi 2008, interview), together with the evidence for training and quality needs (Jacobson 2002a; Jacobson 2002b) and the availability of some technical assistance[2] grant money, PVMTI began a capacity-building project in Kenya in 2006 (IFC 2007b, p. 42; PVMTI 2009). A grant of USD 350,000, together with 'in-kind contributions and co-financing' of USD 115,000, was used to support the Kenya Renewable Energy Association (KEREA), the development of a PV curriculum, PV training courses, the production of three manuals (user, vendor and installer manuals) and a quality assurance programme (Magambo 2006; IFC 2007b, p. 42; Nyaga 2007, interview; PVMTI 2009). PVMTI was then extended to 2011, and local actors began to take a more favourable view of the project (Ngigi 2008, interview).

These latter activities closely resemble various aspects of the capability-building activities noted in previous chapters as being critical to building well-functioning socio-technical innovation systems. Eventually, then, this adjustment of PVMTI's approach resulted in what looked like valuable contributions to fostering the systemic capabilities that provided the bedrock upon which the Kenyan solar PV market developed. But, in terms of the project's main goal – to make a discernible impact on the Kenyan PV market by financing hardware purchases – it was a failure, having helped to finance only 170 SHSs (IFC 2007b, p. 42) in a country that is estimated to have had around 200,000 installed SHSs in 2005, rising to an estimated

320,000 in 2010 (Ondraczek 2013). Similar critiques have been levelled at PVMTI's Hardware Financing-based approach in other countries, such as India (Haum 2012). Hardly a market transformation then.

Socio-Technical Innovation System Building: Lighting Africa

Let us now compare the case of PVMTI to the approach of Lighting Africa, an approach that we have already argued looks like a policy intervention resembling Socio-Technical Innovation System Building. Curiously, this initiative, as with PVMTI, was also funded by the IFC. As already described in Chapter 5, Lighting Africa was launched in September 2007 with a global call for project proposals aimed at developing new lighting products and delivery models for Africa's large, unelectrified, rural off-grid lighting market. The hope was that recent advances in performance of key technologies – especially light-emitting diodes (LEDs) – could be harnessed to provide cheaper and better lighting for the so-called bottom of the pyramid (BOP). Grants of up to USD 200,000 were available for each successful proposal, and 16 were selected from the more than 400 proposals received, four of them to be implemented in Kenya (Lighting Africa 2008c, p. 7). Since then, Lighting Africa conferences have been held in 2010 (Nairobi) and 2012 (Dakar), during which awards were given for a selection of 'outstanding' lighting products on the market. The most recent conference took place in Dubai in October 2015, although it is unclear whether any awards were given this time.

Soon after its launch in 2007, the Lighting Africa programme began implementing a wider range of activities than the call for project proposals. These activities included market research in several countries, product testing and the development of quality assurance methodologies, identification of financing needs throughout the value chain, knowledge-sharing and self-evaluation and moves to identify policy constraints by researching the policy environments in several countries (Lighting Africa 2009). For Kenya, by the end of 2008, the programme had already provided highly detailed qualitative and quantitative market assessments (Lighting Africa 2008a; Lighting Africa 2008b). And much more research followed, including on products available in Kenya, product-testing and a review of the policy environment and policy actors (see the Lighting Africa website[3] for these reports).

Active interventions in Kenya began in 2009 and, over the next few years – up to the official completion of its pilot phase in mid-2013 – the programme engaged in a number of other activities. These interventions included an aggressive and roaming awareness-raising campaign, quality assurance labelling of products, the setting-up of a product quality testing facility, training of technicians, capacity-building for business development and for finance institutions, lobbying of policy-makers on regulations and building networks of actors to encourage the flow of information. The systemic nature of these capability-building activities undertaken by Lighting Africa, together with their direct engagement with potential technology users and attention to the kinds of technologies that might best suit local needs, is much closer to a Socio-Technical Innovation System Building approach than to either Hardware Financing or Private Sector Entrepreneurship interventions. While it is difficult to determine the extent to which outcomes can be attributed directly to these efforts, the programme does make a series of claims about its impact across Africa (see Table 6.1). And a recent updated survey in three towns in Kenya tends to support the notion that the market for pico-solar off-grid lighting products has expanded rapidly since 2009. Specifically, the survey report claims that cumulative sales of quality-assured pico-solar products since 2009 had reached about 2.3 million in Kenya by June 2015 (Turman-Bryant *et al.* 2015, p. 6). This suggests that the Lighting Africa approach has been far more transformative than PVMTI could ever claim to have been.

PVMTI versus Lighting Africa

The SHS market in Kenya is now worth about USD 6 million annually, and more than 320,000 SHSs have been installed (Ondraczek 2013). We do not have figures for the value of the pico-solar market but, as reported above, the number of products sold is significant. This is still a relatively small fraction of the population with access to small quantities of electricity from PV. Nevertheless, as argued in Chapter 5, the case does represent one of the best examples in Africa of anything resembling a transformation in relation to sustainable energy access.

Little – if any – of the success can be attributed to the Hardware Financing intervention PVMTI. But the IFC may have learned important lessons from the PVMTI experience that informed the design of the Lighting Africa programme – whether or not this is the case is an empirical question in need of further research.

TABLE 6.1 Lighting Africa claimed impacts as of December 2014

Quantity	*Impact*
35,000,000	People across Africa with improved energy access due to modern solar lighting products
14,380,000	People in Africa whose basic lighting needs are being met by modern solar lighting products
7,500,000	Quality solar lighting products sold through local distributorships in Africa
700,000	Tons of GHGs avoided in Africa
31	% growth in sales of quality-assured solar lights between July and December 2014
4.8	% of Africa's un-electrified now using solar lights up from less than 1% in 2009
41	Manufacturers whose products have passed the Lighting Global Quality Standards
25	Countries where quality-verified products are on sale in Africa

Source: Selected impacts reported in Lighting Africa (2014).

The Lighting Africa programme has taken a more systemic approach to developing the market, albeit a different segment of the market than the target of PVMTI. It has focussed more on building capabilities throughout the value chain, building actor networks and influencing policy and other institutions. These are all supply-side activities. However, crucially, from the perspective of this book, Lighting Africa also built a detailed understanding of the electricity needs and desires of poor people, using this to inform its awareness-raising efforts and, thereby, helping to create demand for solar lighting alternatives to kerosene.

So, one clear lesson from the evolution of the Kenya PV market is that its success – whether for SHSs or pico-solar lighting products – is explained by a combination of interventions that has addressed several dimensions of a nascent socio-technical innovation system. An interesting aspect of these interventions has been the attempt to understand the detail of consumer preferences and constraints. This has enabled much better designs of SHSs and lighting products that address the context-specific nature of electricity services in rural areas. And the results suggest that governance of inclusive energy transitions would be improved by taking a systemic approach and that, in this approach, working more closely with consumers of energy services to understand their needs more deeply would raise the chances of providing more appropriate solutions.

Private Sector Entrepreneurship: Climate Innovation Centres (CICs)

Having explored the relative success of Lighting Africa's Socio-Technical Innovation System Building approach next to PVMTI's Hardware Financing approach, we now spend some time examining a current policy intervention that typifies the Private Sector Entrepreneurship framing. This is the example of the CICs introduced briefly in Chapter 1. Although, as the analysis below reveals, the CICs are to some extent already engaged in activities that could move them beyond their predominant focus on private sector entrepreneurship, there is significant potential to do much more. While it is too early to judge the success of the Kenyan CIC and, furthermore, we lack the empirical evidence to do so (another area warranting further research), it is possible from publicly available documentation to examine the way in which the CIC approach is framed. It is also possible to look at the outcomes reported to date. It is on the basis of such *ex-ante* analysis, building on the lessons from the comparison of Lighting Africa and PVMTI above and the theoretical insights from this book, that we analyse the CIC approach below.

CIC framing and approach

The CICs are being implemented as the 'flagship initiative' (infoDev 2015, p. 4) of infoDev's (the World Bank's innovation arm) Climate Technology Programme (CTP), in collaboration with DFID and Danida (the UK and Danish overseas development agencies). At the time of writing, CICs have been launched – or have business plans and are in the process of being launched – in seven locations: Kenya, India, Ethiopia, South Africa, Morocco, Vietnam and the Caribbean. The CICs' focus is very much on financing local entrepreneurship around climate technologies via 'a tailored suite of financing and services that support domestic SMEs' (infoDev 2015, p. 8).

The overall framing and associated narratives with which the CTP operates are well captured by the following statements taken from the CTP brochure (infoDev 2015, pp. 4, 8):

> The CTP supports the private sector in developing countries – targeting SMEs and entrepreneurs – to innovate novel technologies and business models to address local climate challenges.
>
> The CICs build local capacity and address barriers to innovation by offering a tailored suite of financing and services that support domestic SMEs. With the CIC's assistance, innovative enterprises become more competitively and profitably involved in booming local and international cleantech markets – creating jobs and leading to economic growth.

The document goes on to describe how knowledge bridging is also being attempted across different countries' CICs, providing a means of sharing and accessing knowledge internationally, including policy insights.

The quotes above demonstrate how the CTP and CICs frame small and medium-sized enterprises (SMEs) and entrepreneurs as the key actors in addressing local climate challenges, including energy access, an issue mentioned several times in the document as something the CICs will positively impact. The CTP website claims one of its impacts will be to 'provide energy access to over 28 million people …',[4] and the brochure claims that the programme will provide 'clean energy to an additional 35,000 homes in South Africa' and '1,400MW of off-grid renewable energy access' (infoDev 2015, p. 5). It should be noted that energy access is just one planned impact of the programme among a range of others, including:

- tapping into, in unspecified ways, the 'vast untapped resource' of women and girls' contribution to 'climate sectors' (infoDev 2015, p. 7);
- 'allowing 3,000,000 people including women and girls to be less vulnerable to the effects of climate change' (infoDev 2015, p. 5);
- 'allowing access to clean water for 90,000 Ethiopian households' (infoDev 2015, p. 5).

This casts the claimed benefits of funding private sector entrepreneurship in relation to climate technologies very widely, intersecting with multiple other development priorities, including gender, climate adaptation and resilience, clean water and sanitation, as well as sustainable energy access. These claims are then followed with a narrative that depicts supporting these actors with venture financing as the key to plugging both local innovators and developing countries 'more profitably' into 'booming local and international cleantech markets' with resulting benefits in terms of jobs and economic growth (infoDev 2015).

The implication is that this kind of financial and other business support to private sector entrepreneurs is the means through which transformative impacts can be achieved in sustainable energy access as well as a raft of other climate-related areas. Bearing in mind the much broader suite of both actors and activities that previous chapters have demonstrated are necessary for well-functioning socio-technical innovation systems, we might readily conclude that this kind of Private Sector Entrepreneurship approach is likely to meet with limited success. It certainly does not look like the kind of systemic intervention that we have so far argued is necessary to transform sustainable energy access. When we look at the list of activities that the CICs are meant to conduct, however, it becomes clear that the CICs' activities are, in fact, intended to be broader than a single focus on financing private sector entrepreneurs.

The Kenyan CIC from a Socio-Technical Innovation System perspective

Each of the national-level CICs is launched with its own business plan developed from a consultative process that engages with a range of private, NGO and public sector stakeholders. The Kenyan CIC's business plan (summarised on its website) states the following mission, intended impact and goals:[5]

> Our Mission
>
> Our Mission is to provide an integrated set of financing, venture acceleration services, market development and networking activities that builds the quality and quantity of Kenyan entrepreneurs and startups delivering innovative climate and clean energy solutions to local and international markets.
>
> Impact
>
> The CIC is here to deliver a mix of economic, environmental and social results, including job creation, reduction of carbon dioxide emission, greater climate resiliency, and access to clean energy, safe drinking water, better sanitation and strengthened technology transfer and local innovation capacity.
>
> Our Goals
>
> - Providing flexible financing mechanisms that support entrepreneurs and new ventures at varying levels of innovation and scale.
> - Building innovation capacity through the delivery of advice, assistance and training products.
> - Enabling collaboration and developing policies that support an innovation ecosystem in East Africa.
> - Identifying and unlocking new opportunities through access to information and market intelligence.

- Providing access to facilities that support business development through co-working and networking space and technical development for rapid design, adaptation, proto-typing, testing and manufacturing.

While the mission is firmly focussed on Kenyan entrepreneurs and start-ups, the goals of the CIC make for interesting reading in the context of this book. The second goal speaks of 'building innovation capacity', the third of supporting 'an innovation ecosystem in East Africa', and the fourth mentions 'access to information and market intelligence'. Both 'building innovation capacity' and supporting 'an innovation ecosystem' are clearly linked to aspects of the Innovation Studies theory introduced in Chapter 2, and facilitating 'access to market intelligence' was one of the key contributions of donors highlighted in our analysis in Chapter 4 and Chapter 5. Clearly, then, at least at the level of the Kenyan CIC's aims and ambitions, a more systemic approach to transforming sustainable energy access, or markets for other climate-relevant technologies in Kenya, is an idea with which the CIC is sympathetic.

When we look at the various 'global activities' that the CTP brochure (infoDev 2015) sets out, which are designed to support entrepreneurs and SMEs and to network CICs across the different constituent countries where they are being rolled out, we see additional activities that resemble more systemic interventions. These activities (detailed in the brochure and summarised on the CTP website) include:[6]

- *CIC Design and Implementation*: CIC LAUNCH will lead scoping, design, resource mobilisation and implementation activities to meet client country demand for CICs.
- *Global Financing*: The IGNITE Fund will mobilise and syndicate global funding for high-impact climate technologies and offer deal-flow to public and private investors eager to support promising climate ventures in developing countries.
- *Evidence-based Analysis*: Climate TRACK will actively package lessons from individual CICs and provide cutting-edge analytical products and policy toolkits on supporting private sector innovators in developing countries.
- *Connecting Markets*: Market CONNECT will provide software, web-enabled services and networking technology to build interconnectivity between CICs and link promising companies with global partners and expertise.
- *Measurement Tools*: Impact Xchange will provide each CIC with a web-based Impact Monitoring System (IMS) to track results and impacts in real-time.

The ideas of lesson-sharing and learning in relation to Climate TRACK and the networking activities under Market CONNECT are certainly, on the face of it, activities that intersect with some of the key elements of the Socio-Technical Innovation System Building highlighted in previous chapters.

As emphasised above, without more in-depth empirical research, it is impossible to get an accurate picture of the extent to which actual activities on the ground are delivering against these stated aims, which pertain to pursuing more systemic interventions. From the perspective of the public information available on the Kenyan CIC website, the actual activities being pursued look, on the face of it, to fall well short of the stated aims above regarding building what they call innovation ecosystems. Activities are grouped around four categories:[7]

1. *Business Acceleration*: Kenya CIC provides diverse services to support entrepreneurs in cleantech to grow their ideas.
2. *Financing*: CIC aims at facilitating flexible access to finance to fund clean technology businesses through their growth cycle.
3. *Market Development*: The CIC provide market intelligence products including the market opportunity for various clean technologies.
4. *Matchmaking*: The KCIC provides a one-stop matchmaking service that offers a range of quality services.

The market development activity sounds like it might deliver something of interest in the context of the activities described in previous chapters regarding donors investing and making publicly available market research. Drilling down under the market development activity, the website claims that the CICs will provide:[8]

- *Market Information*: The KCIC provides market intelligence products including the market opportunity for various clean technologies, current market penetration, and information on ideal price points for large-scale consumer adoption. We also provide information on competing solutions in the market.
- *Sector Trends*: The KCIC provides technical information on a regular basis to enable technology development in line with market needs. The CIC is developing a database that will provide entrepreneurs with information on cleanTech component sourcing as well as providing consumers with clean technology options to meets their needs.
- *Technical Information*: The KCIC provides a database of financial support from various sources available in Kenya to provide entrepreneurs and consumers with information on financing options. The CIC also provides access to the latest information, market research and trends for various technologies, enabling technology to be developed in-line with market needs.

But there is nothing on the website that resembles this kind of information. The only relevant material in the document repository is a report and policy brief on the regulatory environment for solar energy in Kenya. Perhaps the intention is that this kind of market development information will be provided on a bespoke basis to individual CIC 'clients' (as the website refers to the entrepreneurs and the SMEs the CIC supports). But such private provision of information is not in line with the publicly available market research funded by donors during the development of the solar PV market. It would therefore be unlikely to underpin any transformative change, benefiting, as it would, only the individual private 'clients' in receipt of such CIC-funded research.

The website showcases an impressive range of example clients across the three sectors on which the Kenyan CIC focusses (renewable energy, water management and agri-business). Drilling down into the details of the services that each client is receiving, however, it seems that the main focus is on providing support for accessing finance, developing business plans and other (often unspecified) business development support. Interestingly, several of the renewable energy-related examples include provision of support to test and improve technology hardware, presumably by funding access to R&D and testing facilities through one of the Kenyan CIC partner organisations. None of the activities that seem to currently be underway in the Kenyan CIC, therefore, seem to be focussed on anything much beyond assisting with accessing finance or other mainstream business incubation activities, together with some support for technology hardware development.

Notwithstanding the caveat of further empirical research being required to triangulate the analysis presented here, it does seem as though the CIC's current activities are squarely located within a two-dimensional technology-finance approach. This mirrors the dominant two-dimensional focus of the literature on energy access in Sub-Saharan Africa that we critiqued in Chapter 1. The predominant emphasis on financing SMEs and entrepreneurs also positions the CICs as typical of a Private Sector Entrepreneurship framing of potential solutions to sustainable energy access. It would not be unreasonable, therefore, bearing in mind the alternative perspective proposed in this book, to question the extent to which the CICs are likely to deliver the kinds of transformative long-term impacts that their brochure claims they will.

However, we do not wish to argue that the CTP and constituent CICs are negative initiatives. Funding or financing entrepreneurs to engage in innovative activities that engage with any of the climate-relevant sectors the CICs support must have *potential* social, economic and environmental benefits. As we were at pains to emphasise in the Introduction to this book, our argument is certainly not that hardware financing or private sector entrepreneurship are unimportant. They aren't. Furthermore, it seems clear both from the evidence available in the public realm, and the authors' conversations with stakeholders in Kenya, that the CICs are having a positive impact in terms of convening diverse stakeholders around the issue of climate technology and innovation. This, at least, is providing a new platform on which these stakeholders can engage with one another, develop new networks, or cement existing ones. These are all critical to the development of well-functioning socio-technical innovation systems.

But the question remains, no matter how successful the SMEs and entrepreneurs supported by the CICs become: is this enough to transform sustainable energy access or, for that matter, the CICs' other focal sectors? To what extent will the new technologies and business models supported by the CICs lead to wider impacts across Kenya? Will they remain isolated examples of SME success stories, or will they connect with other stakeholders, building momentum and improving technological capabilities across the country, enhancing its innovation system? It seems quite an ambitious assumption to think that the creation of a number of new companies – the brochure lists a target of 2,500 new companies across all seven countries where CICs are being established – will be enough to transform energy access, or technology availability and adoption in other climate-relevant sectors. In what way does the CIC approach encourage innovation that engages with the social practices of technology users? To what extent will they be able to compete with existing energy interests (or the interests of mainstream, non-sustainable agricultural and water management actors) and influence dominant socio-technical regimes? Is the expectation that this will all happen of its own accord, or is something more deliberate and proactive required to connect the dots and lift the CICs beyond their core focus on financing private sector entrepreneurship and business incubation?

These are all empirical questions. Some are perhaps answerable now with proper empirical research efforts, some perhaps answerable in time, once we reach a point where we are able to look back at the history of the CICs and what they were able to achieve. But it would be a shame, particularly in light of the historical evidence analysed in this book, not to at least attempt some level of a priori analysis and recommendations for policy and practice that might catalyse transformative change.

Of course, Socio-Technical Innovation System Building could be integrated as part of the CICs' activities under an extended remit. This may be something that infoDev, DFID, Danida, and national governments and local partners in the CICs might wish to consider in future. CICs are, after all, likely to represent important networks of climate technology-relevant individuals and organisations across the public, private and NGO sectors, and provide excellent potential routes for identifying and engaging with key actors. Indeed, as discussed below, innovation system building was an explicit intention of the originators of the idea that eventually became the CICs (Sagar *et al.* 2009).

Practical approaches to Socio-Technical Innovation System Building

Having conducted a somewhat critical analysis of PVMTI and the CICs, it would be remiss of us not to conclude the analysis in this chapter with some concrete suggestions of how policy could be designed in ways that operationalise a Socio-Technical Innovation System Building approach. In the final section of this chapter, we therefore describe an approach that builds on Ockwell and Byrne (2015), which elaborates proposals that responded to a new interest within the United Nations Framework Convention on Climate Change (UNFCCC) in achieving technology transfer by means of strengthened national innovation systems. While the paper dealt specifically with the context of the UNFCCC, here we describe how this policy approach is equally relevant to efforts to transform access to sustainable energy in developing countries. We begin by outlining the key policy goals that are implied by the theoretical framework developed in Chapter 2 and Chapter 3, and the empirical analysis given in Chapter 4 and Chapter 5. We then proceed to outline two linked policy proposals through which these policy goals might be achieved.

Overarching policy goals

The overall goal of policy must be to build functioning socio-technical innovation systems that augment the transfer, development and diffusion of sustainable energy technologies and related practices in developing countries, enhancing technological capabilities through a range of targeted interventions. These must be inclusive in their approach – attending to the self-defined needs of those countries and different groups within – if sustainable energy technology adoption is to be widespread and underpin pro-poor sustainable development pathways. Material presented in this book provides some clues as to what such an inclusive approach might be. The various interventions described in Chapter 4 and Chapter 5 – where they have achieved some measure of success – were designed and implemented on the basis of careful and context-specific understandings of the needs in the market and of users. Notable in this regard is Lighting Africa, which conducted highly detailed studies of the lighting practices and needs of poorer users in Kenya (and elsewhere). This suggests that further gains might be achieved by including users more actively in the design of promising solutions to their needs, rather than merely observing these needs and eliciting users' feedback on products already on the market. The overall desired result is to provide protective spaces in which sustainable energy technologies and practices can be fostered, thus promoting their adoption, adaptation and further innovation.

In order to achieve this, we suggest the following overarching policy goals should orient interventions. However, it is important to note that interventions to build socio-technical innovation systems are deeply interdependent. They are therefore best implemented together in systemic fashion rather than separately. We conclude this subsection with a list that articulates a range of specific policy interventions that could be pursued in order to fulfil each goal. In subsequent sections, we go into detail on how interventions through policy and practice could deliver such interventions.

Goal 1: Build networks of diverse stakeholders

Efforts are required to link diverse arrays of stakeholders, from technology importers and suppliers through to policy-makers and technology users. Such networks enable the flow of knowledge among stakeholders, each of whom can bring different resources, experiences and perspectives to bear on problem-framing and problem-solving activities. They can also become a fundamental element of socio-technical innovation systems by establishing the linkage component of capabilities. But these linkages must be strong and meaningful. In order to achieve this, stakeholders need to work proactively together in projects, programmes and other interventions. In doing so, they are more likely to build mutual trust and understanding, as well as identify strengths and weaknesses in local technological capabilities. Simultaneously, by pursuing such activities, new technological capabilities can be built, including the development of relevant knowledge and skills.

Goal 2: Foster and share learning

Learning is critical to the development of technological capabilities and functioning innovation systems, and the resulting successful markets for climate technologies that these can support. A key role for policy lies in commissioning research – whether market research, academic analysis, monitoring and evaluation, baseline studies, R&D and so on – and making sure the results are publicly available. Because contexts evolve in unpredictable ways, incremental innovation supported by reflexive analysis offers a practical strategy to shape sustainable development pathways. Research at all levels from local to international, and from different perspectives, can provide crucial information to help realise such reflexive change. The public availability of such information can play a fundamental role in reducing perceived risks among both potential investors and technology users, as well as enhance the transparency of policy processes. This facilitates clear and evolving understandings of things such as user needs and preferences, appropriate hardware components relative performance of different technology brands approaches that have met with success factors that contributed to difficulties or failures and how to overcome these training and education needs and so on. The learning and experience that result can feed into future projects and programmes, whether publicly or privately funded.

Goal 3: Promote the development of shared visions

Linked to the need to build meaningful networks and foster learning, there is the need to create shared visions of what pro-poor sustainable energy access – and sustainable development more broadly – look like in particular contexts, and what roles different sustainable energy technologies play in those contexts. This is not simply a top-down effort in which sustainable energy technology solutions are chosen and then stakeholders are persuaded of their merit through dissemination and awareness-raising activities. As everyone is affected by both sustainable development issues and efforts to address them, consensus-building around sustainable development, including sustainable energy access, is critical. Learning from research and experience provides an essential component for constructive debate and is itself enhanced by the flow of knowledge through diverse stakeholder networks. By fostering understandings of what sustainable energy technologies can and cannot provide, how they work and the ways others have benefited from them, visions can develop around informed understandings of different technological options. It also affords opportunities for users to provide feedback on both their self-defined needs and their experiences (good and bad) with different technologies. As a result, shared visions develop among technology users, suppliers and other stakeholders relating to how and in what way sustainable energy technologies can underpin different development pathways. This simultaneously provides vital user feedback into both technology design and the configurations and brands that vendors and suppliers provide, with attendant implications for potential market size and profitability.

Goal 4: Support diverse experimentation

Again linked to learning, funding is needed to provide protected spaces for experimentation with promising sustainable energy technologies, practices and policies. Stakeholders throughout the supply chain need to gain experience of technologies and learn what works and what does not within specific contexts (across different countries, regions, villages, technologies, social practices, political contexts, etc.). Experimentation can target a range of different aspects. It might, for example, include supporting new multi-stakeholder projects that test and develop ideas. These could relate to new technical configurations, new hardware, new practices around existing technologies, new consumption and production practices that could improve the benefits accrued by users and so on. Experiments might also focus on mutually supportive interventions that link different stakeholders across markets, thereby building supply chains and fostering new market opportunities where potential market players lack awareness of each other or potential market opportunities they might target. Interventions could also experiment with working 'upwards' through value chains, building on existing markets to develop progressively higher-value segments, adding value to existing sectors and fostering increasing economic returns from sustainable energy technology initiatives across developing countries.

Specific policies and interventions for delivering against these overarching goals

Below is a (non-exhaustive) list of specific policies and interventions that could deliver against these overarching goals and contribute to Socio-Technical Innovation System Building.

Goal 1: Network building

- Link diverse stakeholders nationally.
- Link diverse stakeholders internationally.
- Link diverse stakeholders locally.
- Link diverse stakeholders across markets.
- Link diverse stakeholders across sectors (private, public, NGOs, research, etc.).
- Link supply-side actors (e.g. supply chain, policy, NGOs, etc.) with technology users.
- Link national government with technical experts.
- Link national firms with international firms.

Goal 2: Learning

- Commission market research.
- Commission research into technology user needs and preferences.

- Commission research into technology performance.
- Commission research into education and training needs.
- Monitor and evaluate projects and programmes.
- Conduct baseline studies.
- Conduct comparative research across local, national, international scales that addresses the various research foci above.
- Make results of research and monitoring and evaluation publicly available.
- Create spaces for stakeholders to reflect on research and experiences.
- Provide training for firms.
- Provide training for suppliers and installers.
- Provide training for technology users, villages, households.
- Advise on and develop technology certification schemes.
- Advise on education and training needs (up to and including postgraduate training).

Goal 3: Foster shared visions

- Convene consensus-building events with different national stakeholder groups.
- Convene scenario-building events to discuss alternative development pathways that different sustainable energy technologies might contribute to or constrain.
- Facilitate opportunities for different stakeholders to feed back into the technology design and configuration process.

Goal 4: Provide protected spaces for experimentation

- Encourage and incentivise treatment of 'failures' as valuable points for learning.
- Commission projects as experiments (examples of potential foci for experimentation are provided below).
- Experiment with technological hardware.
- Experiment with policies.
- Experiment with social practices in relation to sustainable energy technologies.
- Experiment with new stakeholder configurations.
- Experiment with production processes.
- Experiment with linking stakeholders across markets to create new market opportunities and market awareness.
- Experiment with value-adding experiments, working upwards through supply chains.

Existing international policy mechanisms

While working towards the overarching goals above, it is essential that policies designed to nurture socio-technical innovation systems are implemented in a way that recognises and builds on existing relevant policy mechanisms and institutions. Designing effective policy also requires an understanding of what these existing initiatives are doing that is of relevance to nurturing socio-technical innovation systems and where there are gaps that need to be filled. Here we review two core areas of relevant policy efforts: (1) the UNFCCC's Climate Technology Centre and Network (CTCN); and (2) four parallel climate technology centre and network initiatives currently being funded by the Global Environment Facility (GEF). We then provide a visual overview of the coverage of these existing programmes, together with the CICs, against the overarching policy goals articulated above.

It should be noted that a range of other institutions (e.g. the International Renewable Energy Agency, IRENA), policies, mechanisms (e.g. the Clean Development Mechanism, CDM) and centre-based models (e.g. Innovación Chile and CGIAR, the Collaborative Group for International Agricultural Research) also exist and deserve consideration when implementing the recommendations in this chapter. It is, however, beyond the scope and space available here to provide a full review of all relevant initiatives. We have therefore opted instead to focus on the most relevant emerging initiatives.

The Climate Technology Centre and Network (CTCN)

In the context of actions under the Convention (the UNFCCC), one of the most relevant institutions is the Climate Technology Centre and Network[9] (CTCN), the operational arm of the UNFCCC's Technology Mechanism under the strategic guidance of its own Technology Executive Committee (TEC). As its name suggests, the CTCN is structured around a core climate technology centre that coordinates a broader network. The Centre is hosted and managed by the UN Environment Programme (UNEP) in collaboration with the UN Industrial Development Organisation (UNIDO) and support from 11 centres of excellence located in developing and industrialised countries.

The CTCN's *Network* refers to a range of technical experts and centres of excellence who have expertise that might be matched against requests for technical assistance from countries. Requests from countries come from national designated entities (NDEs). NDEs[10] (usually government ministries or agencies) are granted responsibility by Parties to the Convention to manage national technology-related requests to the CTCN. These requests are coordinated by the Centre, which responds itself to some, while others are farmed out to relevant experts in the Network. This NDE-instigated approach attempts to facilitate a process that is demand-driven by Parties. There are three core services offered by the CTCN (see CTCN 2014 for a detailed description of these services):

1. Provide technical assistance to developing countries to enhance transfer of climate technologies.
2. Provide and share information and knowledge on climate technologies.
3. Foster collaboration and networking of various stakeholders on climate technologies.

The first core service follows requests from NDEs, while the other two services can be initiated by the CTCN or other stakeholders as and when common needs are identified.

From the perspective of building socio-technical innovation systems, there are several key points to note with regard to the CTCN:

1. The Network is not an in-country network of actors of relevance to different (existing or emerging) climate technologies as prescribed in the list of overarching goals above.
2. There is nothing, in theory, stopping Parties requesting, via NDEs, support from the CTCN in advising on and instigating the kind of Socio-Technical Innovation System Building policies detailed in our list above.
3. NDEs are usually government institutions – not locally nested, climate technology-specific institutions.
4. At present, the CTCN's activities do not explicitly recognize the need to nurture socio-technical innovation systems as a key part of the technology transfer, development and diffusion process – although elements of innovation system building are implicit within two of the CTCN's core services: those that focus on information and knowledge sharing, and fostering collaboration and networking between stakeholders.
5. The recognition of knowledge-sharing, networking and the emphasis on capacity-building elaborated in the operating manual for NDEs suggests significant potential for the CTCN to coordinate its attempts to achieve a stronger focus on Socio-Technical Innovation System Building. However, this would require more explicit attention to, and understanding of, Socio-Technical innovation System Building, and processes for strengthening them to be integrated into the CTCN's approach
6. The TEC has recently initiated a work stream focusing on National Systems of Innovation as a means for strengthening efforts under the UNFCCC to develop and transfer climate technologies. This suggests considerable potential to engage productively with efforts under the CTCN and UNFCCC more broadly around implementing the policy proposals outlined further below.

Global Environment Facility-funded initiatives

The other key initiatives of note here are those being implemented by the GEF under its Long-Term Program on Technology Transfer. These include:[11]

1. The project 'Pilot Asia-Pacific Climate Technology Network and Finance Center', which is being implemented with the Asian Development Bank (ADB) and UNEP.
2. The project 'Finance and Technology Transfer Centre for Climate Change' by the European Bank for Reconstruction and Development (EBRD).

3. The project 'Pilot African Climate Technology Finance Center and Network' by the African Development Bank (AfDB) (which includes regional partners that are part of the CTCN consortium).
4. The regional project 'Climate Technology Transfer Mechanisms and Networks in Latin America and the Caribbean (LAC)' by the Inter-American Development Bank (IADB), which is currently in preparation, again with regional partners that are part of the CTCN consortium.

As with the CICs, the emphasis of the second of these various initiatives (the EBRD one) is mostly focussed on finance. However, the other three all have elements that pertain to a more networked, capacity-building focus and hence have potential to act as socio-technical innovation system builders. For example, the ADB-led Asia-Pacific initiative (number 1 above) includes aims[12] of facilitating a network of national and regional technology centres, organisations and initiatives; building and strengthening national and regional climate technology centres and centres of excellence; designing, developing and implementing country-driven climate technology transfer policies, programmes, demonstration projects and scale-up strategies. These activities are pursued in parallel to another part of the initiative, that focusses explicitly on finance.

While detailed information is difficult to obtain on number 3 (the AfDB-led African initiative), it seems that, as well as a core finance component, more network and capacity-building activities will be included, with publicity materials released by AfDB suggesting that 'enhancing networking and knowledge dissemination' is seen as the key way the project will 'scale-up deployment of [climate technologies]'.[13] The final one (number 4, IABD) is not yet operational. However, it is very much focussed on network and capacity-building. As well as providing finance, it seeks to 'strengthen existing activities on [environmentally sound technologies] in LAC and aim at the consolidation of long-term collaborative initiatives that are aligned with the objectives and modalities of the Technology Mechanism under UNFCCC'.[14] Planning, assessments and networks are very much at the foreground of the activities proposed under this initiative.

As with the CTCN, however, the extent to which these GEF-funded initiatives support the development of socio-technical innovation systems depends on the extent to which an explicit focus on innovation system building can be mainstreamed across the various activities. The language used is certainly open to a systemic perspective, but achieving real impacts will depend on more deliberate integration of Socio-Technical Innovation System Building activities across the board.

Gaps analysis of existing policy

In order to get an overview of the extent to which the initiatives reviewed above are delivering the kind of policy interventions that would be likely to achieve Socio-Technical Innovation System Building, delivering against the overarching

TABLE 6.2 International policy mechanisms and innovation system building goals

Climate innovation system building goals	*CTCN*	*CIC*	*ADB*	*EBRD*	*AfDB*	*IADB*
Explicit focus on climate innovation system building?	N	N	N	N	N	N
1. Network building						
Linking diverse stakeholders nationally	P	Y	Y	N	P	Y
Linking diverse stakeholders internationally	Y	Y	Y	N	Y	Y
Linking diverse stakeholders locally	P	P	P	N	P	P
Linking diverse stakeholders across markets	P	P	Y	N	P	P
Linking diverse stakeholders across sectors (private/public/NGO/ research, etc.)	Y	P	Y	N	Y	P
Linking supply-side actors (e.g. supply chain, policy, NGO, etc., actors) with technology users	P	P	P	N	P	P
Linking national government with technical experts	Y	P	Y	Y	Y	Y
Linking national firms with international firms	Y	P	Y	N	Y	P
2. Learning						
Commission market research	P	N	P	N	P	P
Commission research into technology users' needs and preferences	P	N	P	N	P	P
Commission research into technology performance	P	N	P	N	P	Y
Commission research into education and training needs	P	N	P	N	P	P
Monitoring and evaluation of projects/programmes	P	N	Y	N	P	P
Conduct baseline studies	P	N	P	Y	P	P

Climate innovation system building goals	*CTCN*	*CIC*	*ADB*	*EBRD*	*AfDB*	*IADB*
Conduct comparative research across local/national/international scales that addresses the various research foci above	P	N	P	N	P	P
Make results of research and monitoring and evaluation publicly available	P	N	P	P	P	P
Create spaces for stakeholders to reflect on research and experiences	P	N	P	N	P	Y
Provide training for firms	P	N	P	P	P	P
Provide training for suppliers and installers	P	N	P	P	P	P
Provide training for technology users/villages/households	P	N	P	N	P	P
Advise/develop technology certification schemes	P	N	Y	P	P	Y
Advise on education and training needs (up to and including postgraduate training)	P	N	P	P	P	P
3. Foster shared visions						
Convene consensus-building events with different national stakeholder groups	P	N	P	N	P	P
Convene scenario-building events to discuss development pathways that different climate technologies might contribute to/constrain	P	N	P	N	P	P
Facilitate opportunities for different stakeholders to feed back into the technology design and configuration process	P	N	P	N	P	P
4. Provide protected spaces for experimentation						
Encourage/incentivise treatment of 'failures' as valuable points for learning	P	N	P	P	P	P
Commission projects as experiments (examples of potential foci for experimentation are provided below)	P	N	P	P	P	P
Experiment with technological hardware	P	N	P	P	P	P

Table 6.2 (continued)

Climate innovation system building goals	*CTCN*	*CIC*	*ADB*	*EBRD*	*AfDB*	*IADB*
Experiment with policies	P	N	P	N	P	P
Experiment with social practices in relation to climate technologies	P	N	P	N	P	P
Experiment with new stakeholder configurations	P	N	P	N	P	P
Experiment with production processes	P	N	P	P	P	P
Experiment with linking stakeholders across markets to create new market opportunities and market awareness	P	N	P	P	P	P
Experiment with value-adding experiments working upwards through supply chains	P	N	P	P	P	P

IADB = Climate Technology Transfer Mechanisms and Networks in Latin America and the Caribbean (LAC) – Inter-American Development Bank (IADB) goals articulated above, Table 6.2 provides a graphical overview of the current and potential coverage of each initiative. Table 6.2 also provides a useful overview of the aggregate pattern of coverage across the initiatives. Each initiative is assessed, based on available public documentation, on the extent to which it: (1) explicitly includes activities akin to the policy options under each goal within its existing remit and structure (the Ys for 'yes'); (2) has potential to deliver against a policy option within (or with incremental adjustments to) its existing remit and institutional structure (the Ps for 'possible'); and (3) requires significant revisions to remit and institutional structure in order to deliver against a goal (the Ns for 'no'). The initial row also indicates whether Socio-Technical Innovation System Building is an explicit goal of each initiative.

Several key observations can be made from Table 6.2:

1. Most initiatives have potential within, or via incremental adjustments to, their existing remit and structure to extend their activities to include Socio-Technical Innovation System Building activities.
2. At present, however, there is limited focus on activities that would nurture socio-technical innovation systems in developing countries.
3. The most coverage exists in the area of network building. However, even this coverage is patchy, with most initiatives focussing on high-level national or, more commonly, international networking activities, or linking national entities with international technical experts. Many of the essential networking activities that are necessary to build socio-technical innovation systems in ways that will result in sustained pro-poor socio-technical change are generally not addressed (e.g. linking with technology users or fostering local networks along supply chains).
4. Learning receives a small amount of patchy coverage across the initiatives.
5. Fostering shared visions and providing protective spaces for experimentation are not covered at all at present.

Two linked policy proposals

Our Socio-Technical Innovation System Building approach can be implemented using two distinct but linked proposals, as summarised here and described in more detail below:

1. *Creation of Sustainable Energy Access Relevant Innovation-system Builders*[15] *(SEA-RIBs).* This involves the creation of specific institutions (preferably based in existing organisations) in different countries that are focussed on building socio-technical innovation systems around sustainable energy technologies (SEA-RIBs). These institutions would then work to coordinate efforts to implement Proposal 2 below, as well as engaging in broader functions (described in more detail below). This approach could be pursued as an initiative under SE4All. It could also be integrated with an extension of the UNFCCC architecture (specifically with the CTCN) and/or link with various

centre-based initiatives under the GEF (see Ockwell and Byrne 2015 for more detail on the nature of such integration). It is also feasible for it to be pursued bi- or unilaterally through donor, individual government or NGO-driven activities. As emphasised below, however, such centres would be likely to have greater impact if networked across different countries and regions (e.g. via the CTCN).

2. *Using projects and programmes to build socio-technical innovation systems*. This proposal focusses on the possibilities of designing project- and programme-based investments in sustainable energy access to maximise impacts on building socio-technical innovation systems. It can be pursued by any actors engaged in work on sustainable energy access. Again, it is likely to have far greater impact if actors pursuing such approaches coordinate via new or existing networks.

Proposal 1 could be adopted in a way that is integrated with Proposal 2, working to ensure that as many project-based interventions as possible are pursued in ways that maximise opportunities for Socio-Technical Innovation System Building. Proposal 2, on the other hand, could be pursued in isolation from Proposal 1. For actors involved in attempts to improve sustainable energy access, it could represent a strategic commitment to maximising the impact of their activities on Socio-Technical Innovation System Building. Clearly, however, the transformative impact of activities pertaining to Proposal 2 is likely to be far higher if pursued as part of nationally and internationally coordinated efforts via the kinds of institutions suggested in Proposal 1. We describe each proposal in more depth below.

Proposal 1: Creation of Sustainable Energy Access Relevant Innovation-system Builders (SEA-RIBs)

As the analysis in Chapter 4 and Chapter 5 has demonstrated, the socio-technical innovation system that emerged around the Kenyan PV market was, in important ways, developed via the targeted, long-term efforts of specific actors, or 'champions', acting as socio-technical innovation system builders. This proposal is therefore intended to create institutions that are able to take on such a system-building role. There are examples of similar roles having been taken on in the past, such as the CGIAR, Innovación Chile and the UK's Carbon Trust – all of which represent nationally situated, long-term institutional presences that pursue approaches that are sensitive to the needs and contexts of the people and organisations with whom they engage. The proposal here is to learn from the successes of such nationally focussed, strategic initiatives and bolster them with insights from the kind of in-depth historical research on what has worked for sustainable energy access in the past, such as the empirical evidence presented in this book.

SEA-RIBs would play a strategic facilitating role within countries, acting as the convening point for a national network of actors across the spectrum of those involved in relevant or potential socio-technical innovation systems (from users, through supply chains, to NGOs and policy-makers) and championing the development of socio-technical innovation systems around different technologies. Their core remit would be to link together national actors around a strategic, long-term, nationally defined vision that is cognisant of national policy goals and local realities. They would develop detailed knowledge of national capabilities and key areas where opportunities exist for rapid development and growth, and they would identify areas where international expertise and knowledge sharing are required. SEA-RIBs would provide strategic oversight, advising on how to target sustainable energy access (or broader climate technology) programmes and projects in a coordinated way that responds to identified priority areas for both rapid growth and long-term capability-building. As implementers of Proposal 2 below, such institutions would also work to ensure that all projects and programmes are used strategically to build and strengthen socio-technical innovation systems.

Careful attention will be needed from the outset to ensure that activities conform to the funding criteria of potential funders (e.g. donors, the development banks, GEF, the Green Climate Fund). This may require specific tailoring and packaging of different initiatives accordingly. The key added value of such funding being channelled through, or at least engaging with, SEA-RIBs is the opportunity to increase coordination and ensure every dollar spent leverages further benefits in building relevant aspects of national socio-technical innovation systems via a grounded understanding of the context-specific needs of individual countries and technologies. This would provide the most powerful and effective means of mainstreaming Socio-Technical Innovation System Building activities in individual countries, with myriad benefits in terms of driving transformations in sustainable energy access.

It is likely that SEA-RIBs would meet with the most success if they were situated in existing organisations in respective countries, preferably organisations with some level of existing knowledge of sustainable energy access and development. Such organisations would need a broad policy-level perspective on these issues as opposed to specialising, for example, in technology hardware and R&D, or finance. It should be evident from the analysis in this book that what is required is a perspective that goes well beyond the traditional narrow focus on technology and finance.

As outlined above, as with Proposal 2, it is easy to imagine the adoption of SEA-RIBs under international initiatives around sustainable energy access. If it were considered of value to connect with efforts around climate technologies under the UNFCCC, this could be achieved by framing sustainable energy access within the broader agenda around climate technology transfer and development. This could then entail using CRIBs (the climate-technology specific version of this proposal, described in Ockwell and Byrne 2015) as a means to strengthen the capabilities of the NDEs that currently are the only national level presence that the CTCN has. NDEs usually represent a small percentage of a civil servant's time – nothing like the level of dedicated institutional presence and resources required to engage in meaningful Socio-Technical Innovation System Building. The introduction of CRIBs could work well within the UNFCCC, as they could be Party-led, responding directly to requests for support from specific countries and delivered via a simple extension of the existing architecture of the UNFCCC's Technology Mechanism.

It is important to note that the concept of a centre-based approach to Socio-Technical Innovation System Building has synergies with, but differs in important ways from, existing centre-based ideas, both in the literature and in practice. A centre-based approach formed the central thrust of at least two proposals at the time of the critical UNFCCC negotiations in Copenhagen in 2009, in the form of a policy brief by Ockwell *et al.* (2009) and, most notably and more substantively, a paper by Sagar *et al.* (2009). Both called for the establishment of 'climate innovation centres' in developing countries, citing the successes of initiatives such as the CGIAR and the UK Carbon Trust (Sagar *et al.* 2009) and institutions such as Innovación Chile (see Ockwell *et al.* 2010b). Significantly, Sagar *et al.*'s paper led to infoDev's commissioning further analysis by Sagar (see Sagar and Bloomberg New Energy Finance 2010), which led to the establishment of infoDev's CICs. Importantly, however, the CIC approach differs in practice from the approach suggested by Sagar *et al.* (2009), which had as its central tenet the use of CICs to build national innovation systems.

Sagar *et al.*'s (2009, p. 280) proposal was for 'a network of regional "Climate Innovation Centres"' that would focus explicitly on building 'innovation ecosystems' around specific low carbon energy technologies (note: they referred to innovation ecosystems while citing the literature on national systems of innovation). This included a range of capacity-building activities – activities that go well beyond what eventually became the infoDev-led CICs. The CICs also differ from Sagar *et al.*'s proposal in that they are nationally situated, not regional. But, as discussed above, their activities are far more limited and focus very much on financing the activities of entrepreneurial SMEs, ignoring the activities of the multitude of other relevant actors who make up national innovation systems, or the kinds of activities that nurture them.

As emphasised in Ockwell and Byrne (2015), there are important differences between the CRIBs and SEA-RIBs proposed here and either Sagar *et al.*'s (2009) proposal or any of the existing international policy initiatives around sustainable energy or climate technologies. First, both CRIBs and SEA-RIBs are intended to operate at the national and sub-national level and reach out from here to the regional or international level. This responds to the emphasis in the literature reviewed in Chapter 2 and Chapter 3 on national and sub-national level interventions. For example, the actors identified in Chapter 4 and Chapter 5 who played a Socio-Technical Innovation System Building role in Kenya's solar PV sector were nationally situated actors, most having been present in the country and focussed on work on solar PV for decades. A similar knowledge of national circumstances and capacities has been observed in China's strategic use of the CDM to strengthen its own national innovation system (Watson *et al.* 2015). Indeed, it is difficult to find innovation system level analyses that focus at any level above the national level. Most examples cited in the literature on climate change and innovation are national-level interventions – the UK's Carbon Trust, Chile's Innovación

Chile. Only the CGIAR represents a regional-level initiative, although arguably much of its success was achieved by targeted interventions during sustained periods of national presence.

Second, CRIBs or SEA-RIBs are intended to focus on the broader socio-technical innovation systems as described in this book. This goes beyond the scope of Sagar *et al.*'s (2009) definition of an 'innovation ecosystem' or the conventional definitions of national innovation systems within the Innovation Studies literature. Rather, it focuses on the extended understanding developed in Chapter 2 and Chapter 3, which uses insights on innovation system building from the Innovation Studies literature and brings these to bear in the context of Socio-Technical Transitions theory. The latter attends, in particular, to the social practices of technology users and the existing socio-technical regimes, both of which shape the enabling and competitive environments within which sustainable technologies must survive and, hopefully, thrive.

Proposal 2: Using projects and programmes to build socio-technical innovation systems

Ideally, Proposal 2 would be pursued in tandem with Proposal 1 as part of the strategy of SEA-RIBs in boosting Socio-Technical Innovation System Building across countries. Proposal 2, can, however, viably pursued independently. Actors engaged in any sustainable energy access-related activities could adopt the approach described here as a means to ensure the maximum impact of their individual projects and programmes. The more they coordinate such efforts with other actors, the greater the likely impacts.

Proposal 2 essentially involves mainstreaming Socio-Technical Innovation System Building across all sustainable energy access projects and programmes, ensuring every opportunity is taken to use projects and programmes to achieve broader Socio-Technical Innovation System Building impacts. This requires mainstreaming a focus on building innovation systems across all projects and programmes and designing and implementing them as real-world experiments in which to better foster learning, and capability and system building. The specifics of how projects and programmes can be used as opportunities for Socio-Technical Innovation System Building, in line with the overarching policy goals articulated above, are outlined in more detail below.

From the evidence and analysis presented in this book, it is clear that there is a role for donors (and other funders, including inter-governmental organisations and NGOs) in such projects to provide adequate protection against the full force of market selection pressures. It is under these conditions that stakeholders can experiment to generate the learning needed for the sustained development, transfer and diffusion of sustainability-related technologies and practices, and to nurture the development of socio-technical innovation systems. But there are other aspects to the design of projects and programmes that appear to be important. First, we should be clear about what a project or programme is meant to achieve. Is it the demonstration of a ready-made solution for others to imitate, or is it experimentation to contribute to understanding of what solutions could work? Second, the motivation of project participants needs to be considered, as does, third, the scope of projects. And, finally, the way in which projects relate to each other can have powerful impacts, which also generates implications for the role of institutions at national and international levels. Each of the aspects related to projects, donors and other public funding bodies, as well as national and international institutions, is elaborated below. Included in these elaborations are non-exhaustive suggestions of how each aspect of projects might relate to the four goals recommended above, underlining the importance of the interrelatedness of the goals as we emphasised before: (1) build networks of diverse stakeholders; (2) foster and share learning; (3) promote the development of shared visions; and (4) support diverse experimentation.

Projects as experiments

Projects and programmes should be seen and used as experiments that are implemented in order primarily to learn, rather than aiming solely to achieve or demonstrate particular solutions. In other words, they could be recast as experiments to make this learning function clearer, in a similar sense to the way R&D activities are often characterised. As such, the measures of success of a project (or programme, experiment) need to be considered carefully. Quantitative indicators can be useful but they can become the sole focus of evaluation. A range of qualitative 'indicators' could help to identify more subtle but important impacts, such as the kinds of knowledge created from experimentation or the nature of relationships fostered in network-building. This could also help to reduce the tendency to assess projects and programmes in 'failure' versus 'success' terms, thereby encouraging the sharing of outcomes. In essence, this is about the need to redefine success as the generation of important lessons, rather than ready-made solutions.

In terms of the four goals recommended above, this aspect of projects most clearly relates to supporting diverse experimentation (goal 4). But the purpose of experimentation, as has been argued, is to create opportunities for learning, and so there is a direct link to the goal of fostering and sharing learning (goal 2). That is, the experiments themselves are the spaces in which learning is fostered. However, learning is only useful to broader innovation system building if it is shared. These lessons will, of course, be immediately available to project participants who, by working together, will form a network (at least for the duration of the project) and thereby contribute to network-building (goal 1). But, for wider and longer-term network and innovation system building, lessons need to be shared publicly. This will not only help to build networks of diverse stakeholders (by providing lessons of potential interest to actors external to projects themselves), but it can also promote the development of shared visions by grounding possible visions in real-word experience (goal 3).

Motivation of project participants

In order for projects and programmes to generate useful learning, the participants must be motivated to solve real problems. That is, the problems the project or experiment explores need to be relevant to those involved and so should be defined by them. The motivation will be further enhanced if the participants have material interests in the outcomes – if the learning will have value for them. There is a clear link here with the issue of risk. While mitigating risk is important, particularly for private sector actors, the elimination of risk could be de-motivating. So participants should be expected to invest some material resources in experiments, partly to demonstrate to others their commitment but also to ensure that they have a stake in the outcomes.

This aspect of projects highlights the need for them to be attractive to potential participants and so, considering the goal of building diverse stakeholder networks (goal 1), reinforces the point above that problems should be defined by potential participants. Moreover, this self-definition of problems will raise the chances that projects will be both relevant to diverse stakeholders and create opportunities for learning from a diversity of individual perspectives and particular contexts. Clearly, there are links to fostering and sharing learning (goal 2). But responding to participant motivations for project involvement is also more likely to mean deeper commitment to projects and attempts to develop shared visions (goal 3). And, if attempts to attract a wide variety of participants are successful, then there will be more opportunities to conduct a diversity of experiments, thereby linking with goal 4.

The scope of projects

It is clear that learning is facilitated by deep interactions among a broad range of actors who can bring their problem-solving efforts to bear on the many dimensions of development pathways as they unfold in different contexts. This suggests that there needs to be experimentation on many of these dimensions simultaneously (and links with our notion of systemic intervention). However, it would be extremely difficult for a small number of actors to achieve this. To overcome this difficulty, either complex projects involving a wide range of stakeholders could be implemented or many simpler projects could be implemented programmatically, each one operating on a selection of the dimensions of a development pathway. Each approach will have its advantages and disadvantages. The point is to generate learning across the multiple dimensions of a pathway so that sustainability-related technologies and practices can emerge in a co-evolutionary process. The assumption here is that co-evolutionary learning will tend to produce mutually reinforcing technologies and practices that operate in sympathy with their context, thereby increasing the chances of widespread adoption of those technologies and practices – and their sustainability.

Another important point here relates to continuity of efforts. Here, programmes may have the potential to deliver innovation system building in ways that individual projects may not. Funders often want to see results within a few years. Although funders should monitor progress and stop activities when they are clearly not functioning, really making headway on an innovation system might take much longer than a project period – although the potential contribution of individual projects should not be underestimated. Nevertheless, unless within a programmatic context with a timespan of, say, ten to fifteen years, or within the context of a more coordinated national approach to commissioning projects (as would be achieved via the creation of the SEA-RIBs advocated in Proposal 1 above), projects run the risk of being one-off efforts with limited structural contributions. A related point is a trusting relationship between different actors. In societies where contracts do not play a huge role but relations make the difference, having the same person run the same programme (or SEA-RIB) for longer can be a key success factor.

In terms of the recommended goals, projects (or programmes) with a wide scope – as indicated by the range of development dimensions along which a project or programme is operating – are more likely to result in a diversity of learning opportunities and lessons generated. Most clearly, this links with the goal of fostering and sharing learning (goal 2). And, of course, this links clearly with the recommendation to support diverse experimentation (goal 4). But projects with wide scope are also likely to need to engage with a wide range of actors, and so they increase the opportunities to build networks of diverse stakeholders (goal 1). If there is support for projects and programmes over the longer term – as per the point above about continuity of efforts – then there is also more chance that such networks will develop strong relationships (also contributing to goal 1). The combination of learning from diverse experimentation and the continuity of network building should also help actors to develop shared – and grounded – visions (goal 3).

Interactions with other projects

Following on from the previous recommendation, even complex projects or programmes of projects could be constrained in their learning, particularly if the funding is from a narrow range of sources. Moreover, if they are under the same management, they will be dependent on the particular abilities of that management. As the case study explored in this book demonstrates, projects or programmes implemented from different perspectives, if encouraged to interact meaningfully over the long term, can generate learning that helps to achieve significant results. This requires some degree of coordination, of course, but not necessarily management. That is, the individual projects and programmes need to be able to communicate directly with each other as well as via a central actor. It is here that value could be added by making SEA-RIBs internationally networked, e.g. through the UNFCCC's Climate Technology Centre and Network (especially in the CRIBs version of our proposal).

Encouraging interaction across projects clearly links with the recommendation to foster and share learning (goal 2) but there are also links to the other goals. Interactions will help to further build networks of diverse stakeholders (goal 1) by creating opportunities for various stakeholders to meet and share their knowledge. But interactions of this kind can also create spaces in which stakeholders discuss, debate and develop shared visions (goal 3). And awareness and understanding of other projects mean the possibility to ensure that any new projects or programmes do not replicate unnecessarily experiments already conducted, thereby contributing to the goal of supporting diverse experimentation (goal 4).

Role of donors and other public funding

Many private sector actors, particularly small players in developing countries, cannot risk much of their capital to undertake experiments. However, there might be significant benefits if they were able to do this, for them and for wider society. Therefore, a substantial share of the risk inherent in experimentation could be borne by donors, who can justify their support in terms of these potential social benefits. Other sources of public funding, including the Green Climate Fund and the regional development banks, could serve a similar purpose – although it is important to ensure that funding sources are also accessible to smaller actors who might not have the capacities to engage with large, multilateral funding streams (suggesting a role for donors and NGOs in bridging or plugging this gap). The involvement of public funding also has the additional significant benefit of making learning from projects publicly available, thus contributing to wider learning and long-term capability building.

Another aspect of the risk issue is the stability and long-term provision of support, as noted above in regard to the continuity of efforts. If the support is unstable, intermittent or short term, then it is more likely to increase risk than mitigate it. This is not to argue that support should be unconditional. There needs to be a way to maintain motivation in individual projects but the thematic, or overarching, support can be maintained so that there is confidence among stakeholders that it is worth their investing effort in particular experiments.

Linking with the recommended goals, we can see that the risk-bearing nature of public funding will more likely foster learning (goal 2) because of the space it creates in which to experiment (goal 4). And public funding means a greater likelihood to share learning because of the demand to make available publicly-funded research (goal 2). But the public availability of lessons can also help in building wider networks of stakeholders (goal 1). And wider availability of learning can help in public discussions and debates about shared development visions (goal 3).

Role of institutions

In order to achieve all of the above in a way that maximises the potential impacts in terms of Socio-Technical Innovation System Building, appropriate institutional structures are necessary. It is this that drives the rationale for the creation of SEA-RIBs under Proposal 1 above. In the absence of such central, nationally-based institutions, organisations seeking to operationalise Proposal 2 would need to look at ways of mainstreaming such Socio-Technical Innovation System Building through their own approaches to developing, supporting, monitoring and evaluating projects and programmes.

Finally, with regard to the recommended policy goals above, institutions of the kind discussed can provide formal channels and mechanisms for coordination and linking. So, institutions can link to other institutions in formal arrangements, whether they are sub-national, national or international. This directly helps to achieve network building (goal 1). It also helps to coordinate the sharing of lessons from projects (goal 2) and, indeed, can be useful for the coordination of projects and programmes themselves, such that there is a continuing diversity of experimentation (goal 4). And, in exploiting formal links and stakeholder networks, institutions can organise more structured forums in which to develop shared visions (goal 3).

Conclusion

Building on the theoretical developments in Chapter 2 and Chapter 3, and the empirical analysis in Chapter 4 and Chapter 5, this chapter has demonstrated a number of things in relation to policy and practice. First, clear limitations are evident in the extent to which Hardware Financing interventions, such as PVMTI, and Private Sector Entrepreneurship interventions, such as the CICs, have achieved or, in the case of the CICs, are likely to achieve transformative impacts, in the future. Second, there is clear potential for interventions such as the CICs, as well as the other international policy initiatives described above, to broaden their aims and activities in order to more effectively engage in interventions that are likely to have wider impacts through contributions to Socio-Technical Innovation System Building. Finally, and critically, the analysis above has articulated a number of key goals for policy interventions aimed at building socio-technical innovation systems, together with an elaboration of more specific interventions that would support the achievement of such goals. As is clear from the discussion above, there is no reason why such interventions need be limited to a focus on sustainable energy technologies – they could (if desired) be levelled more broadly at climate technologies or other technologies of relevance to different aspects of sustainable development.

While we stand by the policy proposals articulated above as positive ways forward in relation to sustainable energy access and broader attempts to achieve low carbon or climate-compatible development and 'green growth', it is important to flag at this point some critical caveats. As is dealt with more centrally in Chapter 7, proposals such as the two detailed above raise important issues relating to the governance of the kinds of transformations in access to sustainable energy technologies that initiatives such as SE4All and discourses around ideas like green growth imply. Implicit in both of the policy proposals above is some sense of organisations or individuals who have the agency, closely related to financial and political resource availability, to drive the establishment of the kinds of institutions that we advocate (whether CRIBs, SEA-RIBs or some other version). This also applies to any actor who would change their practices in order to implement activities around Proposal 2, implementing strategic changes to their projects and programmes to maximise potential for Socio-Technical Innovation System Building. We might usefully refer to such actors as *Socio-Technical Innovation System Builders*. It was clear from the empirical analysis in Chapter 4 and Chapter 5 that key actors did indeed play a central role in driving the development of the Kenyan solar PV market, building socio-technical capabilities around solar PV, lobbying government and donors, connecting different actors. But, when thinking about applying this idea to other technologies, practices, services, and so on, who should these actors be? How can we ensure that when Socio-Technical Innovation System Building is pursued, it does not play out in ways that serve the interests of powerful elites as opposed to the poor people who, it is assumed, will benefit from sustainable energy access? Who gains? Who loses? Beyond the pro-poor focus at a national scale, how will these dynamics play out globally? How can we be sure a similar story as was observed with the CDM is not observed with sustainable energy access, with benefits flowing to emerging economies like China and India as opposed to low-income countries like Kenya? Will the kinds of nationally situated, potentially more engaged and participatory institutions that we envisage in our proposals really emerge in practice? If they do, can they overcome the entrenched political economies within and across nations to truly deliver pro-poor transformations in technology development, transfer and access? These issues concerning the politics of any transformation in sustainable energy access, and the questions of governance raised by the analysis in this book and the policy proposals above, are revisited in Chapter 7.

Notes

1 SolarNet was a network for renewable energy promotion in the region and published a widely read newsletter a few times per year. It was formally closed down in 2010 (Kilonzo 2013, interview).
2 Ten per cent of PVMTI money was already available for grants for exactly the kinds of activities the stakeholders wanted funded (IFC 1998). It is unclear why it took so long for the money to be made available in-country. But additional grant money was made available after the grant component was increased to 20 per cent (IFC 2007b; Ngigi 2008, interview).
3 A wide range of materials is available on the Lighting Africa website: www.lightingafrica.org/
4 See www.infodev.org/articles/climate-technology-read-more-about
5 Taken from www.kenyacic.org/?q=node/59
6 Taken from www.infodev.org/articles/climate-technology-read-more-about
7 Taken from www.kenyacic.org
8 Taken from www.kenyacic.org/?q=node/17
9 See www.unep.org/climatechange/ctcn/Home/tabid/131937/Default.aspx
10 For a full list, see http://unfccc.int/ttclear/templates/render_cms_page?s=TEM_ndes
11 See http://unfccc.int/resource/docs/2013/sbi/eng/05.pdf and http://unfccc.int/resource/docs/2014/sbi/eng/inf03.pdf (Appendix 1).
12 See www.adb.org/sites/default/files/pub/2012/pilot-asia-pacific-climate-technology-flyer.pdf
13 See www.afdb.org/en/news-and-events/article/afdb-creates-african-pilot-climate-technology-and-finance-centre-with-gef-support-13344/

14 See www.iadb.org/en/projects/project-description-title,1303.html?id=RG-T2384
15 These proposals are drawn from Ockwell and Byrne (2015) in which they refer to Climate-Relevant Innovation system Builders (CRIBs). Here, we have adapted the acronym to reflect the fact that our primary focus in this book is on sustainable energy access.