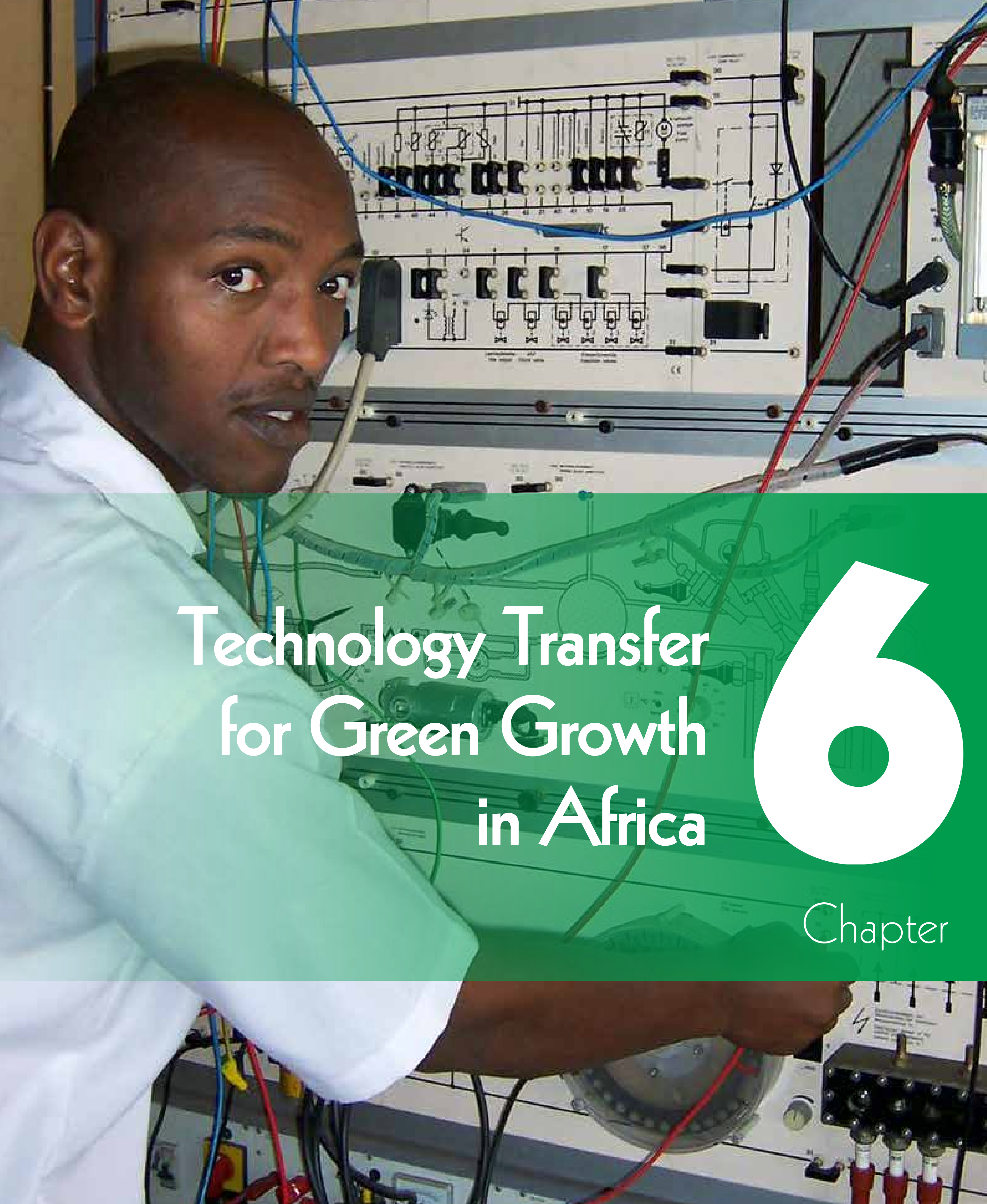


Technology Transfer for Green Growth in Africa

6

Chapter

6 Technology Transfer for Green Growth in Africa

6.1 Introduction

Access to technology is directly correlated with economic productivity in nearly all sectors of the economy. For this reason, there has been an increasing attention in recent years towards transfer of green technologies to developing countries. However, technology ownership is still skewed towards the North (IPCC, 2000). Despite this, facilitating access to green technology can play a crucial role in Africa's development process.

This chapter highlights the flaws of traditional understandings of, and policy approaches towards, green Technology Transfer (hereafter abbreviated as "TT"). It also describes how a new understanding, subject to building of indigenous innovation capacities, could position Africa to capitalize on opportunities presented by green technologies in fostering long-term green growth and human development. This is buttressed by some country case studies on sectors that could benefit from TT and why green TT is uniquely superior to conventional TT. The discussion also highlights some areas of controversy surrounding the use of Intellectual Property Rights (IPRs) and how these might constrain green TT to Africa. Green TT should reflect local contexts of African countries, such as the needs of poor people, and how Africa can leverage on existing international policy instruments and green TT financing instruments. These issues and Africa's ability take a strategic approach to benefit from green TT are considered in the ensuing discussion[22].

22 For more detailed coverage, readers are encouraged to consult Ockwell and Mallett (2012). The insights in this section reflect years of collaborative research at the Sussex Energy Group, University of Sussex, also involving researchers at Carleton University, Canada, TERI and IIT in India and ECN in the Netherlands.

6.2 Opportunities for TT in Africa

While it might be possible to identify green technologies that could benefit Africa, facilitating their transfer rests on a revised understanding of what TT is and how it can be facilitated. Therefore, a proper assessment of appropriate technology needs in Africa, as part of a broader green growth strategy, should be facilitated by nationally located Climate Innovation Centers. Cross country variations and multiple context-specific considerations would normally translate into very different technology needs and interventions.

Technology transfer can help sustain natural resources and improve the livelihoods of people who depend on those resources. Increasing water scarcity and the attendant unreliability of water supply coupled with competition for land arising from other non-agricultural demands necessitate the need for TT. Thus, when properly sourced and managed, TT can enhance land productivity and tackle problems of food and water insecurity. For example, Moussa (2002) argues that biotechnological approaches and technologies that promote decreased inputs of water, energy, fertilizer and pesticides have immense potential to increase crop yields. The same applies to appropriate agricultural practices, such as improved irrigation and soil management techniques. These 'soft' technologies could have similar effect with physical machinery or high-yielding, drought resistant strains of seeds.

Thus, whilst the need to finance investment in hard technologies is crucial, capacity building initiatives and other institutional technologies also deserve equal attention as forms of facilitating TT. These 'soft' technologies include, inter alia, training; effective linkages between markets, storage and distribution systems; availability and access to rural micro-finance; and improved networking between research institutions, rural infrastructure providers, and the private sector.

Forest management and biodiversity conservation could also benefit from TT, especially in light of new funding streams such as REDD+ and other emerging international financing mechanisms. Green TT could be used to increase sustainability and productivity of forests, enhancing biodiversity conservation and profitability at the level of forest stand through to broader socioeconomic levels (IPCC, 2000; 2007). Other areas green TT can make a discerning impact include silvicultural practices for afforestation and reforestation programs; genetically superior planting material; efficient harvesting and processing, and end use technologies. Technology transfer would be particularly effective if blended with indigenous knowledge of forest conservation practices and methods.

In many coastal areas of Africa, the fisheries sector contributes substantially to socioeconomic conditions of the people. Thus, by enhancing sustainable fisheries management, green TT can play an important role in improving people's livelihoods. A range of equipment and techniques designed to improve stock assessment continue to evolve. Similarly, technological innovations meant to improve efficiency of the supply and value chain of aquatic resources and products are being explored across the world (FAO, 2012). For example, fishing vessels which promote efficient fuel consumption could be explored to increase profitability of Africa's fishing industry.

In addition, TT might overcome technological constraints local communities face in accessing offshore fish stocks, often perceived as misappropriated by large foreign fleets. New equipment and techniques can also yield huge environmental benefits for fisheries by increasing selectivity of the catch, reducing by-catch (marine life caught accidentally) and waste (e.g., through use of ice) and utilizing previously underutilized resources (FAO, 2012). However, it is essential that the transfer and use of more efficient equipment and techniques is accompanied by knowledge transfer on usage and maintenance in order to foster ownership.

In the energy sector, TT can improve energy access and enhance resilience to effects of climate change across Africa. Green, low carbon energy technologies, whether for energy generation (e.g., biomass, wind, solar, hydro, geothermal and marine energy) or increasing the efficiency of energy production and consumption (e.g., energy efficient boiler technologies, energy efficient light bulbs and other electrical goods, and energy efficient vehicles), can contribute to better energy access. This is particularly the case in areas where grid extension is prohibitively expensive and/or presents technological challenges which result in efficiency losses over long distances, or institutional problems which prevent effective payment enforcement for electricity in remote areas. Droughts are a common phenomenon in African countries and often impact the supply of hydroelectricity by limiting generation capacity while floods cause damage to electricity grid infrastructure. Therefore, green energy technologies that improve resilience of hydro power to droughts and floods can significantly contribute to improving energy security.

Multiple opportunities exist for both hardware and knowledge TT in developing transport infrastructure across Africa. Examples include urban transport planning and increased use of biofuels, as well as the adoption of more energy efficient vehicles with subsequent resource savings and related economic benefits. As discussed in Section 5.9, South Africa has recently showcased a range of sustainable transport initiatives during the hosting of the Fédération Internationale de Football Association (FIFA) World Cup 2010. These include non-motorized walkways in Polokwane, Rea Veya Bus Rapid Mass Transit in Johannesburg, and travel demand management in Cape Town. These examples highlight existing potential opportunities for intra-Africa sharing of learning from these initiatives as well as TT from outside Africa.

The development of efficient rural and urban infrastructure, just like in transportation, can benefit from TT. Developing economically and environmentally efficient rural and urban infrastructure requires careful consideration of appropriate technological needs. These might relate to technologies and techniques for efficient water supply and use, urban planning, energy efficient commercial and domestic housing, or state of the art heating and cooling solutions.

6.3 TT and Green Growth: the Need for a New Understanding

While all the sectors mentioned in the previous section could potentially benefit from access to new, green technology, understanding how this might be facilitated requires careful consideration of the unique characteristics of green TT relative to conventional TT, as well as the nature of "technology" itself. To date, TT policy has failed to achieve the scale or pace required to deliver significant economic and human development benefits to developing countries, or to address global environmental problems like climate change. The principal focus has been on providing additional funding to incentivize investment in green technological hardware in developing countries, such as the provision of carbon credits under the CDM. But this "hardware financing" approach fails to recognize the critical role that innovation capacities play in both facilitating technology uptake and ensuring connections with long-term development processes.

High-income countries generally have greater access to technologies than their low-income counterparts. However, there are multiple examples where countries in the same income bracket exhibit very different levels of technological diffusion across their economies (World Bank, 2008; Tomlinson et al., 2008). For example, technology diffusion in countries of the former Soviet Union tends to be higher than in other countries in the same income bracket. Similarly, upper-middle and lower-middle income countries in Latin America and the Caribbean exhibit lower levels of technology diffusion than other countries in the same income bracket. The implication is that "*... although ability to pay is clearly an important issue for technology diffusion, it may not be sufficient in isolation*" (Tomlinson et al., 2008).

Therefore, it is important to understand what factors influence technology diffusion, beyond the current model of finance flows for hardware. This points to a revised understanding of TT as a process which can best be facilitated by efforts to develop innovation capacities and systems through knowledge flows and integration of relevant actors within and across developing countries. If Africa is to be successful in realizing green growth, it is not enough for a new green technology to be in use by one national firm or one large project. The key concern should be for green technologies to diffuse across a country, becoming widespread in use and underpinning broader national productivity gains and environmental and development benefits. To properly understand how this might be achieved in relation to green technologies, it is important first to be aware of the unique challenges green technologies raise relative to conventional technologies.

6.3.1 Unique Considerations for Green TT

There are a number of ways in which green TT is different from conventional TT. The first, recognized by "hardware financing" policy mechanisms like the CDM, is that green technologies yield benefits to society which are of a public good nature and therefore not captured by the market. This includes technologies that reduce costs to society from GHG emissions or negative impacts on biodiversity. To a large extent, this is what justifies public support for green TT.

Another unique characteristic of green TT is that it is both "horizontal" and "vertical", and could contribute to higher costs. Horizontal transfer refers to technology diffusion from one country to another. Green technologies are often at early stages of technological development and/or commercial maturity. Even when fully developed and mature, they often require testing and revising to be effectively operational under different environmental, economic and social conditions. This means green TT also often involves "vertical transfer" – the transfer of a technology along the innovation chain, from early research and development (R&D) through demonstration and commercial viability.

Technologies at earlier stages of development are subject to far more risks and uncertainties than conventional, already commercially viable ones. From an investment perspective, this would include working with new, unfamiliar finance models; from an end user perspective, it would involve adopting, operating and maintaining unfamiliar technologies; from a policy perspective, incentivizing development and uptake of non-conventional technologies not yet commercially tested and from a technology developer perspective, developing new technologies in uncertain funding and investment contexts. This entails dealing with the widely referred to "valley of death" (see Figure 6.1), where limited funding is available for the critical middle stages of the technology development/innovation process, which leads to many promising green technologies never becoming commercially viable.

Even when considering conventional horizontal transfer (devoid of the risks associated with vertical transfer), green technologies are now widely observed to follow a wider range of trajectories than has been observed with conventional technologies in the past. Following in the pattern of traditional north-south flows, south-south green technology flows are also becoming increasingly common (e.g., exports of solar technologies from China). South-north flows are also gaining prominence. Examples include exports of wind technologies from India and China (Brewer, 2008).

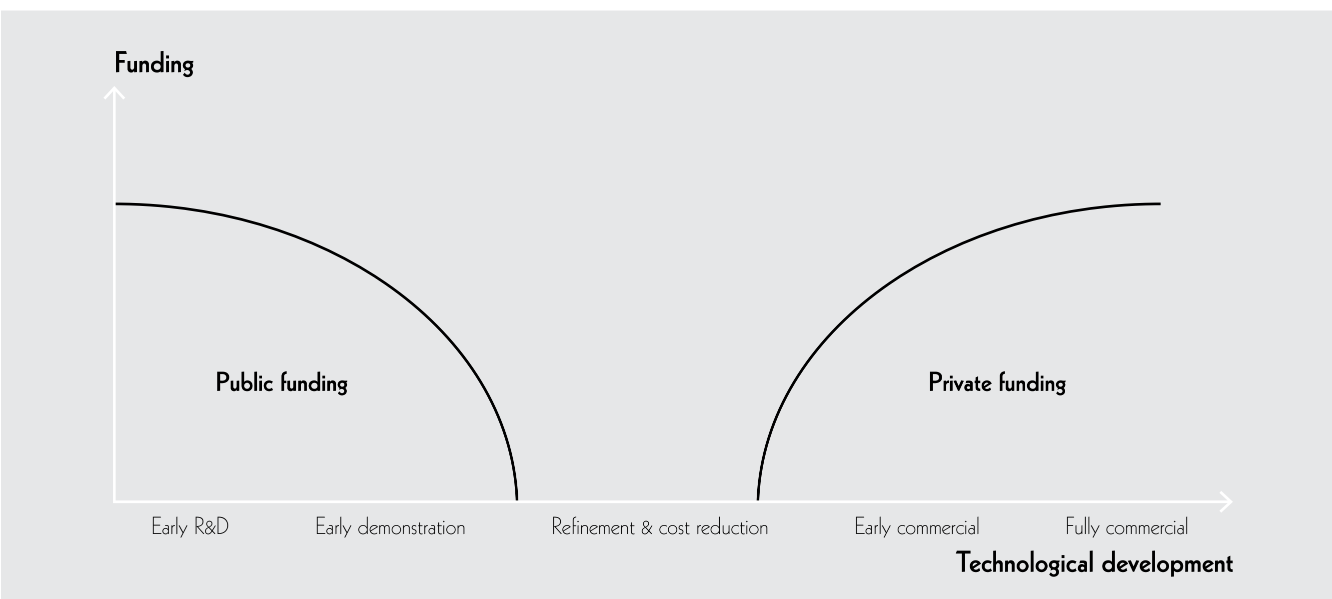
All these unique characteristics suggest a need for strategic policy intervention to facilitate the transfer and uptake of green technologies in Africa. But to date, hardware financing policy mechanisms like the CDM have yielded little benefits for Africa. Around 83 percent of cumulative investment under the CDM has been in the BRICs – Brazil, Russia, India and China (Byrne et al., 2012b). In contrast, sub-Saharan Africa is estimated to have received just over 1 percent of cumulative investment[23] under the CDM, with actual certified emission reductions pegged as low as 0.2 percent from the LDCs - Least Developed Countries (De Lopez et al., 2009).

6.3.2 Beyond Hardware Financing: Knowledge Flows and Innovation Capacity Building for Green Growth

The starting point for understanding the failure of hardware financing policy mechanisms in facilitating widespread green TT to Africa is the appreciation of the fact

23 Figure from author's personal correspondence with Dr. Rob Byrne, University of Sussex, based on analysis of data from the UNEP Risoe website.

Figure 6.1. The "Valley of Death" Between Public and Private Funding

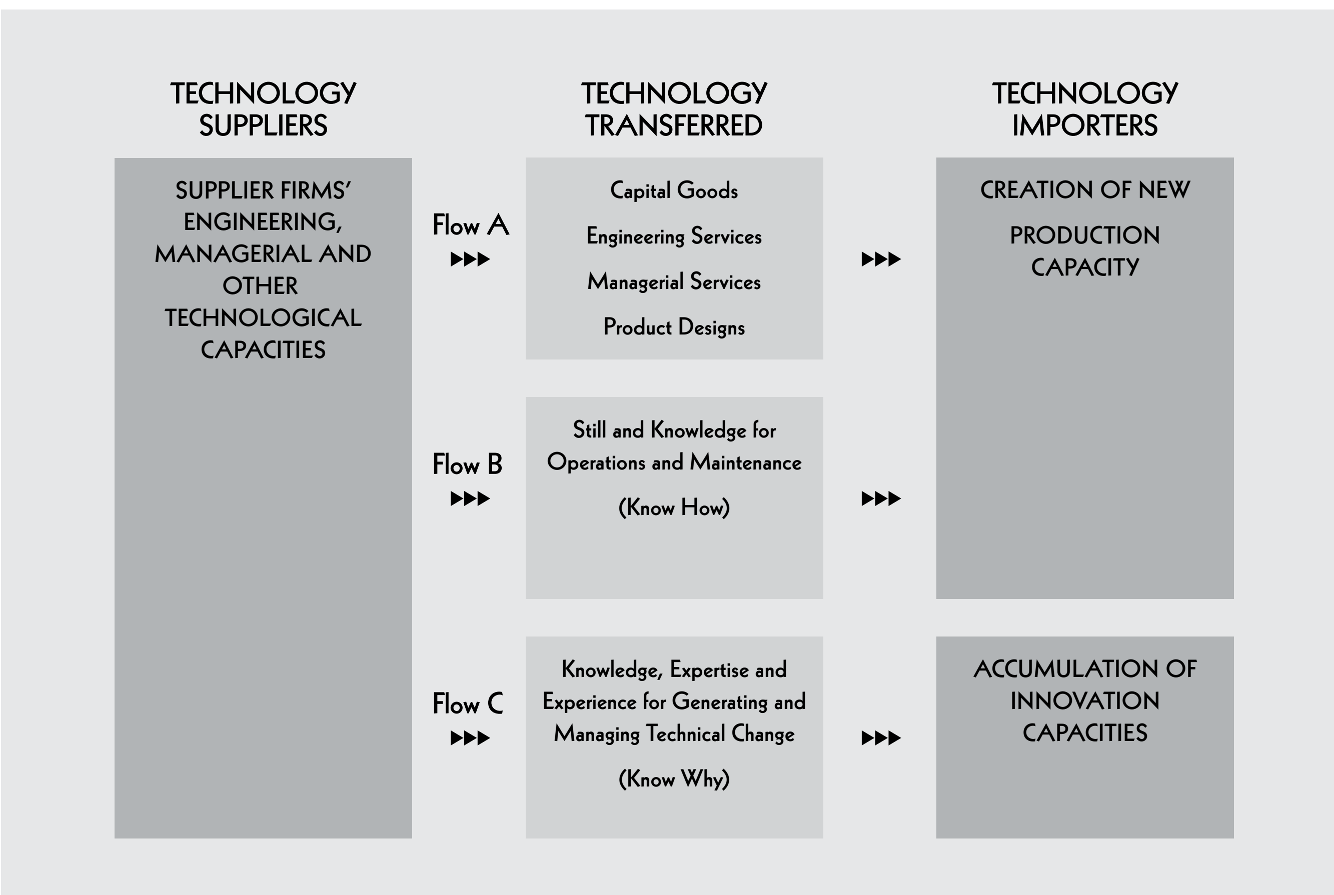


Source: Adapted from Murphy and Edwards (2003).

that technology is not just hardware. It also fundamentally encompasses knowledge. Knowledge, expertise and experience for generating and managing technical change are critical in facilitating green TT in Africa. And TT involves qualitatively different flows of knowledge, which have critical implications for the types of new capacity that TT can contribute in a country and whether this is enough to underpin economic growth and development. This is best illustrated by Martin Bell's diagram in Figure 6.2, depicting three flows of technology.

Flows A and B consist of the hardware, services or designs that are being transferred (Flow A) and the knowledge (skills and know-how) to operate and/or maintain (Flow B). These flows create new production capacity in the recipient country (or firm, farm, or household). But this in itself is unlikely to underpin any kind of long-term, sustained process of green growth and development. This is because neither Flow A nor B is likely to be channeled into African nations at any significant scale unless these nations are also in receipt of Flow C. Flow C therefore represents the knowledge, expertise and experience for generating and managing technical change – knowledge about how and why a new, green technology works and the process of innovation that underpinned it. Therefore Flow C leads to the development of new, green innovation

Figure 6.2. Qualitatively Different Flows of Hardware and Knowledge in the TT Process and Their Contribution to Different Types of New Capacity



Source: Adapted from Bell, 1990.

capacities in recipient countries (firms, farms, households etc.). These innovation capacities determine where international flows of Types A and B tend to be directed, and whether TT is likely to result in long-term economic growth and development in a recipient country (Bell, 1990; 2009; Bell and Pavitt, 1993).

This point might seem strange on the face of it. After all, why should LDCs be concerned about innovation capacities, rather than focusing on increasing their industrial base by importing existing technologies? However, this is based on an incomplete understanding of the necessity of innovation and the direct relationship between innovation capacities and the flow of technologies (see UNCTAD, 2007).

In a development context, innovation is largely "incremental" where small efficiency gains accumulate over time, or adaptive innovation, where existing technologies are adapted to work in new countries, industries, firms, farms or households. Thus, a proper understanding of innovation goes beyond the common assumption of inventing technologies that are new to the world, i.e., radical innovations. As espoused in the Oslo Manual (OECD et al., 2005) and amplified by Bell (2007), it is equally innovative when a firm, farm or household is the first to introduce a new piece of hardware, or a new technique, or does so itself for the first time, even when others have already been doing/using it. For example, incremental efficiency improvements which characterized the Korean steel industry eventually moved to the international technology frontier (D'Costa, 1998; Gallagher, 2006), and the adaptive innovation of the internal combustion engine facilitated Brazil's international leading role in transport related biofuels. This could equally apply to Africa. For example, a farmer in Sudan adopting water efficient farming techniques and adapting them to specific environmental conditions, or an entrepreneur in Kenya configuring small waste solar panel parts to create a business in supplying mobile phone solar charging modules (see Byrne, 2011).

Green innovation capacities entail the capacity to adopt, adapt, work with and develop green technologies within the specific context of a particular country, industry, firm, farm or household. A critical component of innovation capacities is the presence of well-functioning innovation systems made up of *"...interconnected firms, (research) organizations and users all operating within an institutional environment that supports the building and strengthening of skills, knowledge and experience, and further enhances the interconnectedness of such players"* (Byrne et al., 2012a). The emphasis on an appropriate institutional environment highlights the role that policy can play in fostering interconnectedness and promoting the components of successful innovation systems, such as skills development through tertiary education and international links between indigenous companies, universities, and overseas technology experts.

The divergence in technology diffusion across countries within similar income brackets, discussed above, may be explained by differences in innovation capacities. In explaining this divergence, Tomlinson et al. (2008) and the World Bank (2008) highlight factors such as foreign direct investment (FDI), openness to and ease of doing trade, the presence of well-functioning markets, legal and regulatory frameworks, diaspora communities, and levels of tertiary education, as having more relevance to the diffusion of technologies within countries than relative income levels. These are all elements of well-functioning innovation systems. This perspective facilitates a systematic way of thinking about these individual elements and how technology diffusion is facilitated when they function together. This helps to explain why hardware financing flows, such as those under the CDM, have generally gone to rapidly emerging countries like the BRICs, which already have a certain degree of innovation capacity – especially China, which accounts for a lion's share of the funding flows and existing innovation capacities[24].

The main goal for Africa should therefore be to ensure that green TT processes have the maximum possible impact on building new innovation capacities. The continent needs to take advantage of the available opportunities to put in

24 Lack of institutional capacity to administer CDM finance is also a major barrier to many LDCs in accessing CDM investment.

place specific measures to develop innovation capacities and systems. This will galvanize widespread diffusion and penetration of green technologies across Africa.

6.3.3 Capacity Building and Hardware Finance: Case Studies from Africa

The landscape for Africa's technological transfer is slowly changing, and some countries have moved ahead to embrace these changes. Here we illustrate with two case studies the contrasting policy approaches to facilitating the uptake of solar home systems in Africa. This comparison illustrates the importance of building innovation capacity to benefit from technology transfer. These studies are based on Byrne (2011) and depict examples of Global Environment Facility (GEF) funded projects for the diffusion of Solar Home Systems (SHSs).

One project based in Kenya was initiated in 1998 was part of the Photovoltaic Market Transformation Initiative (PVMTI). It involved the GEF working through the International Finance Corporation (IFC). This initiative adopted a hardware financing approach. The other project was initiated in 2004 in Tanzania, bringing together the GEF and the UN Development Program (UNDP), focusing more on market creation and capacity building. Unlike the Kenyan project, the Tanzanian undertaking achieved far greater success in terms of TT and diffusion.

In Kenya, despite making an investment of US$ 5 million to address a perceived finance bottleneck on both the supply and demand sides of the SHS market, negotiations on finance deals with local supply consortiums and financial institutions were generally unsuccessful. As a result, only 170 SHSs capacity was installed by the early 2000s, causing a high degree of frustration among local PV actors. There are several factors that contributed to the failure to broker finance deals for SHSs through the scheme. These include:

» The minimum deal size was too large for the Kenyan market. The minimum counterpart investment from a local consortium was set at US$ 0.5 million and had to be matched by PVMTI. However, few local suppliers had the capacity to mobilize such level of investment on their own.

» Misalignment between the IFC and local banking rules, which made it impossible for either party to finalize deals.

» High transaction costs for mainstream banks, despite some interest in bundling deals for on-lending to micro-finance institutions (MFIs). The deal flows ended up being too small relative to the costs of managing them.

These issues highlight the need for policy mechanisms that respond to local contexts and needs if TT is to be successful.

In response to their frustration with the PVMTI, Kenyan PV stakeholders lobbied for an increase in funding to support capacity building as opposed to direct funding for technology uptake. This proved successful, resulting in increased funding, channeled into the development of a Kenyan PV training curriculum, introduction of technical standards for the industry, and courses for vendors and technicians, accompanied by printed manuals for these groups and their customers. These are fundamental building blocks for developing innovation capacities and creating the networks necessary for effective innovation systems, with high potential for lasting impacts on the ability of Kenyan stakeholders to adopt and adapt low-carbon energy technologies to meet their economic and development needs.

The Tanzanian case study provides an insight into the potential success of schemes which choose to focus on capacity building from the outset. Based in Mwanza Region, near Lake Victoria, the US$ 2.5 million project focused at the level of government energy policy, and aimed at building capacity and creating markets around SHSs. There were five main elements: policy influence (technical standards, lower duties and taxes); private sector capacity building (technical and sales); raising awareness (demonstrations, advertising); enhancing affordability; and replication in nearby regions.

This approach was one of the factors contributing to the successful building of regional innovation capacities around SHSs, establishment of standards-setting institutional framework and process, as well as in galvanizing broader policy influence. In addition, the local population became increasingly aware of the project and enhanced potential for sustained uptake amongst technology users. Within few years, the market for SHSs had expanded to other parts of Tanzania. Between 2006 and 2007, 14,000 solar modules had been sold and by 2008, the annual market for solar modules was estimated to be worth US$ 2 million.

The main shortcoming of the Tanzanian project was the inability to tap into micro-finance to increase affordability of SHSs. This has been attributed to difficulties in securing high-level management support within the banks for SHS loan products, and high risks associated with lending to dispersed rural customers (Byrne, 2011).

The two case studies provide an illustration of how a well-designed and focused capacity building policy can be successful in fostering green TT and diffusion. For example, once the Kenyan PVMTI refocused efforts towards capacity building, confidence in the market for SHSs increased. This reversed the previous negative perception of the technology, which had resulted from poor quality components, scarcity of independent information about SHSs, and lack of supporting capacity such as skilled technicians (Byrne, 2011). It is therefore important to consider long term benefits from capacity building efforts beyond the lifetime of projects.

6.3.4 A Note on Intellectual Property Rights

Intellectual property rights (IPRs) have sparked a lot of controversy in relation to TT in Africa and elsewhere. Some commentators claim that inadequate IPR protection is a barrier to the transfer of new green technologies, as firms that own them fear that lack of protection of their commercial knowledge could stifle technological innovations. Thus, proponents of IPRs advocate for policies to strengthen IPR protection. This led to the agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS)[25]. However, critics argue that IPR protection is a barrier to green TT by limiting access to technologies, especially for developing countries. Instead, they advocate for alternative options, such as establishment of a fund to buy up and make publicly available IPRs for climate technologies, similar to approaches applied on antiretroviral drugs.

Researchers are gradually increasing the evidence to assess the validity of claims that IPRs undermine access to TT (see, for example, Barton, 2007; ICTSD and UNCTAD, 2003; Lewis, 2007; Harvey, 2008; Mallett et al., 2009; Abdel Latif, 2012; Srinivas, 2012). A recent assessment of this evidence shows a mixed picture (Ockwell et al., 2010a). Much of the evidence is biased towards certain technologies (wind and solar photovoltaics, in particular) and mainly in rapidly emerging economies (especially China and India). Generally the evidence suggests that IPRs have not acted as a barrier to TT although several firms regularly express concerns that IPRs might prevent them from reaching the technological frontier for some technologies such as thin film solar PV.

Lack of conclusive empirical evidence makes it difficult to design appropriate policies for treatment of IPRs in relation to green TT. As Ockwell et al. (2010a) assert, the more nuanced understanding of technology and innovation capacities described above makes it difficult to conclude that IPR access will be sufficient in itself to facilitate widespread green TT. What is far more important is the development of indigenous innovation capacities and related systems in African countries. Without careful capacity building strategies to facilitate tacit knowledge flows, education, training and strong networks between research institutions and the private sector, access to IPRs is likely to achieve little in promoting TT. Moreover, a fund to buy up IPRs for new green technological innovations

25 TRIPS, the agreement on Trade Related Aspects of Intellectual Property Rights, aims at creating uniform IPR protection across developed and developing countries. It is administered by the WTO and has brought IPRs into international trade negotiations for the first time. Developing countries were given a longer period to conform to the agreement than their developed counterparts and have until 2016 to conform.

without building human capacity to manage it would equally be less effective in increasing access to TT.

6.3.5 Pro-poor TT: A Context-Specific Needs-Based Approach for Africa

It is vital for policy mechanisms and other initiatives to respond to context specificities of green technologies, the locations where they will be used, and the needs of local actors. There are multiple levels at which context specificities come into play.

Green technology initiatives need to be aligned with countries' development needs – including a focus on poverty alleviation. For example, a critical component of realizing green growth in Africa is the need to increase access to modern energy services by ensuring "socio-technical fit" (Rip and Kemp, 1998; Geels, 2002; Smith et al., 2010). Socio-technical fit refers to technologies designed to fit with the socioeconomic characteristics of countries, firms, regulatory structures and communities where they are to be used.

As noted earlier, there are well-documented case studies where projects introducing energy efficient cook stoves have failed because the technology was not consistent with local cooking practices. On the other hand, there are also many examples of successful energy efficient cook stoves mainly because projects engaged with local end users in the design of stoves, used local materials to construct them, and trained end users to maintain them and educate others in their use and maintenance (see Agarwal 1986 for a more comprehensive discussion of considerations relating to fuel-efficient wood stoves).

Technologies are embedded interdependently in social practices and reflect knowledge of these practices as much as technical principles (Byrne et al., 2012b). The important insight is that technologies will be widely adopted if they successfully harness technical principles and their form and function are aligned with dominant social practices, or provide opportunities to realize new practices that are attractive in specific contexts. Thus, while energy infrastructure in Africa is currently defined by fossil-based infrastructure, there is an opportunity to build on the continent's relatively low level of existing energy infrastructure with new, green energy technologies that are well aligned with local needs and characteristics.

Some of the most relevant context specificities are discussed below:

» *Rural Versus Urban:* Rapid urbanization makes cities key areas for low-carbon infrastructure development. Therefore, it is essential that factors specific to the urban setting such as transportation, building designs, water supply, electricity and heat are integrated into urban planning. In rural areas, energy supply often requires long-term investments with low levels of immediate financial return, despite the transformative aggregate impacts of energy access. This creates a need for governments and utility companies to put in place fiscal incentives and regulatory requirements to encourage such investment (Parthan et al., 2010).

» *Environmental Context:* Some areas might be more suited to wind energy technologies, others to geothermal. Contexts can also differ at the national level, such as the BRICS relative to LDCs or Small Island Developing States (SIDS). There also are differing needs of households, farms, firms and industries.

» *Innovation Capacity:* Careful assessment and analysis of existing innovation systems (e.g., the range of, and connectivity between, relevant actors, regulations, training opportunities, etc.) is critical to assessing the nature of TT initiatives most likely to meet with success in a particular country. This approach has a greater chance to yield maximum benefits from available investments if capacity development targets areas that would most benefit from further development – whether by strengthening existing capacities or building new capacities.

6.3.6 Climate Innovation Centers (CICs) as International Opportunities for Funding and Capacity Building

A range of opportunities exist for leveraging funding support and capacity building to facilitate green TT. This section discusses how Africa might take a strategic approach to building on these opportunities. The need for more effective approaches to facilitating the transfer and uptake of climate technologies in developing countries has been a key issue in recent years and initiatives have emerged in international climate policy negotiations to facilitate this process. Transfer of technology is enshrined in the United Nations Framework Convention on Climate Change (UNFCCC) in several articles and under the Kyoto Protocol. Increasing emphasis on "climate compatible development" in other funding streams (e.g., bilateral aid), creates opportunities for African nations to exploit funding and related activities to gain access to, and uptake of, climate technologies.

African countries need to focus explicitly on building indigenous innovation capacities through a network of CICs across developing countries (Sagar et al., 2009; Sagar, 2010). The idea is to create centers that can coordinate activities around climate technology innovation and transfer, including essential capacity building activities. Essentially, CICs could provide a catalyst for climate TT, innovation and capacity building in developing countries by shifting focus from short-term hardware financing towards enhanced capacity building.

The use of CIC is currently being pursued under two separate initiatives. The first, with particular relevance to Africa, is implemented by DFID and InfoDev under the Climate Technology Program[26]. This includes pilot CICs in Kenya, Ethiopia, India and Vietnam.

26 See http://www.infodev.org/en/Topic.19.html

The second CIC-related initiative forms part of the broader Technology Mechanism[27] developed under the UNFCCC. This "Climate Technology Center and Network" is implemented around a central "Center" hosted in one developing country and linked to a network of other centers (or "Nationally Designated Entities") distributed across developing countries where impetus exists to participate. To strengthen capacity and enhance access, this initiative will be run by a consortium led by the United Nations Environment Program[28]. However, details about actual implementation are yet to be firmed up.

6.4 Leveraging Opportunities for Green TT in Africa: A Strategic Approach

A coordinated and strategic approach to green TT development can maximize the leverage of international funding and maximize the potential of green technology to increase economic productivity and leverage human development gains. Building on the most promising emerging international policy practices and the head start made in Kenya and Ethiopia, it would be beneficial to galvanize a pan-African initiative to establish a network of CICs across the continent. This initiative should engage existing international efforts in Africa, and the Climate Technology Center and Network under the UNFCCC. Coordination of this approach could be facilitated by the African Development Bank. Consideration should also be given to the benefits of an African central coordinating body or central African coordinating CIC to catalyze development of, and coordinate networking between, national CICs across Africa.

Activities of national CICs and any continental-level coordinating body must be guided by a number of key considerations. It is important that the CICs avoid the pitfalls of some past African center-based initiatives,

27 This is the central pillar being negotiated for delivery of TT under a post-Kyoto agreement. Pilot CICs are currently under development in Kenya and India with funding and coordination coming from DFID in the UK in partnership with infoDev.

28 See http://unfccc.int/files/cooperation_and_support/technology/application/pdf/main_proposal_unep.pdf

such as efforts around centers for science and innovation, which historically failed to deliver needs-driven, capacity building opportunities beyond the elite actors involved in the centers (Leach and Waldman, 2009). To achieve this, a number of key considerations are important to ensure that meaningful benefits are delivered across Africa and to respond to the context-specific needs of individual nations and communities. These are discussed next.

Technology Needs Assessments

Initial activities under CICs should include completion of stakeholder led assessments of existing opportunities for TT based on careful consideration of country-specific needs and opportunities. These can borrow from some of the guidance for preparing Technology Needs Assessment (TNA) under the UNFCCC (UNDP, 2010). In particular, it is critical that emphasis is placed on an engaged approach with national stakeholders in order to avoid the tendency of past TNAs under the UNFCCC to produce a "wish list" of available technologies.

Instead, assessments must aim at producing a carefully prepared list of priority areas that match the context-specific needs of the country, map the existing innovation capacities and system components, and identify the key areas and ways in which these will benefit from TT at different points from innovation to production and consumption.

Building Indigenous Innovation Capacities and Systems

To be effective, CICs should focus on nationally and locally appropriate facilitation and capacity building in order to understand existing capacities and improve the coordination of networks. Activities should span a range of areas, including, but not limited to:

» Facilitating networks between relevant actors;

» Undertaking training programs;

» Developing and implementing technology standards and certification schemes;

» Brokering personnel exchanges, seminars and knowledge sharing with international technology leading firms;

» Identifying relevant international innovations whose transfer might be beneficial nationally;

» Undertaking applied research, development and demonstration activities (including at the end user level);

» Providing business incubator services;

» Supporting enterprise creation;

» Granting early stage funding for climate technology ventures;

» Supporting projects to deploy existing climate technologies and energy efficiency measures; and

» Assessing and engaging with revision of national policy and regulatory regimes (see below).

Guidance could be sought on best practices from existing center-based institutions, such as the Consultative Group for International Agricultural Research (CGIAR) or the Chilean based Fundacion Chile, which has been successful across a range of industries in leveraging international innovations to the benefit of national economic productivity (see Ockwell et al., 2010b for a description of Fundacion Chile's approach to technology transfer and innovation).

Leveraging Finance

The CICs should provide a national focus point for identifying appropriate international and national financing opportunities and engaging with national stakeholders to develop indigenous capacities.

National Policy Assessment and Realignment

National policy and regulatory environments form a critical part of effective innovation systems. It is therefore essential that CICs conduct assessments of national policy environments and engage with the government to help develop an enabling environment for green TT and innovation.

International assistance should be sought to assist with countries' strategy development in partnership with national actors and institutions to maximize opportunities for learning and capacity building. This could include engagement with initiatives under IRENA. Bilateral support from developed countries may also be explored. For example, the UK Foreign and Commonwealth Office (FCO) provided financial assistance to meet costs of providing UK expert input into some developing countries' climate TNAs as part of country engagement under the UNFCCC.

A range of national financing options to address cost barriers to green technologies could also be considered. These may include:

- Rebates for green technology investments as part of a project development subsidy. These should be enacted on a flexible basis with a defined phase-out time accompanied by technology standards and monitoring programs. Finance could be leveraged through capital investment support from international grants and aid programs (van Alphen et al., 2008). Results-based financing and/or advance market commitment approaches to addressing cost barriers could also be considered, including multilateral development banks and the Program on Scaling-Up Renewable Energy in Low Income Countries (SREP)[29].

- Long-term, low-interest loans might also be considered. The Maldives provides an excellent example of such instruments (van Alphen et al., 2008). Loan guarantees for small and medium enterprises developing green technology based businesses could also be beneficial (Parthan et al., 2010).

29 See http://www.climateinvestmentfunds.org/cif/srep

- Micro-finance and hire purchase (installment payment plans) facilities to assist farmers, households and communities to implement green technology initiatives can also be great value. However, attention must be paid to context-specific considerations. Micro-finance schemes seem to have worked well in parts of Asia (Yadoo and Cruickshank, 2010), and Latin America (Allderdice et al., 2007), but their success is less clear in Africa (Krause and Nordström, 2004). Instead, hire purchase seems to be a more successful financing model although it may be restrictive for the poorest people who may not be in salaried employment (Hankins, 2004).

Encouraging Strategic Private Sector Behavior

By taking a strategic approach to international engagement around technology, it is possible for firms to maximize opportunities to increase their own innovation capacities, say through deliberate engagement with international technology owners and careful in-house knowledge management such as production of manuals and standards, project management procedures. In the long run, this is likely to translate into demonstrable competitive advantages. National level CICs (and continental networks thereof) should make efforts to communicate these opportunities and ways of realizing them to African firms.

Ensuring Context-Specific, Needs Based Approaches

All activities under CICs should be based on a careful assessment of national context specificities and needs, facilitated by assessments. This applies to the industry level as well individual firms and farms, communities and households. An important starting point for CICs would be a comprehensive assessment of existing continental and national level innovation capacities, as well as an assessment of the type of international green innovations best suited to African contexts and needs.

Regional and International Engagements

The CICs should be outward looking, seeking to learn from international best practices and in particular to benefit from and share insights with CICs in other developing countries and international hubs. International initiatives such as IREDA (Indian Renewable Energy Development Agency) and REEEP (Renewable Energy and Energy Efficiency Partnership) should be explored as potential innovative business models and regulatory tools. Consideration should also be given to opportunities for regional cooperation around green technology and knowledge-based initiatives. For example, in 2006 the Economic Community of West African States (ECOWAS) launched a Regional Energy Access Policy aimed at building regional cooperation on energy access, development of strategy and enabling policy and institutional frameworks (UNDP, 2007).

6.5 Conclusion

Green TT, as part of a broader green growth strategy in Africa, should go beyond traditional hardware financing efforts, such as the CDM, which have failed to yield widespread benefits for Africa. Instead, a more holistic emphasis on building innovation capacities and systems can be developed through CICs. By taking a strategic approach to implementing networks of CICs, Africa has the potential to leverage finance and pursue related capacity building activities across the continent.

This broad emphasis on capacity building has long-term green growth and related human development benefits. They could unlock Africa's economic productivity which has been elusive for a long time, allowing it to leapfrog forward to a cleaner, more efficient and economically productive future based on green technology adoption and innovation.

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