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Technology complexity, technology transfer mechanisms and sustainable development

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ABSTRACT

Merging climate change mitigation and sustainable development in developing countries is pivotal for the transition towards low carbon growth pathways. This paper combines the field of technology transfer and technology-specific aspects with sustainable development objectives.

The general climate change mitigation paradigm has shifted from project oriented mitigation action to more strategic, country-wide, cross-sectoral mitigation plans, in order to explicitly take into account also economic development goals.

Local technology needs and socio-technical circumstances are important towards economic development induced by technology transfer. Yet, this approach is not sufficient for the success of technology transfer, which shall also deliver on economic development. A strategy for the adoption of technologies, as well as the broadening of the domestic technology manufacturing base, needs to consider also the technology properties itself in greater detail. The technology transfer process should emphasize the economic developmental purpose as well as the properties of technologies. Thus, I propose a detailed assessment of the technology and its potential of being adopted by suggesting that technology complexity assessments should be integrated into technology transfer mechanisms. By using CSP, PV and wind technology as examples, I describe how the evaluation of technology complexity and of potential economic development, determined by demand for manufactured goods and services within domestic economies, which could lead to job creation and value added, could be used to inform policy makers.

Introduction

Climate change mitigation as well as sustainable economic development has been prioritized on the international political agenda in recent years, which has been confirmed at the Rio + 20 Conference and by several multilateral international organizations (UNEP, 2011; Stern & Noble, 2008). In the re-design of global climate policy architecture currently under negotiation, developing countries[1] are assumed to take over greater responsibilities in climate mitigation action (Kanie et al., 2010). The world faces two major challenges: unleashing economic growth opportunities with a constantly growing global population, and addressing environmental pressures, which could undermine the chance to seize these growth opportunities (OECD, 2011a).

The combustion of fossil fuels for the production of energy generated 84% of global greenhouse gas emissions in 2009 (OECD, 2011b). Transforming the energy system is at the heart of the low carbon economic development discussion. The private sector is argued to have a great potential of contributing to climate change mitigation and the removal of fossil fuel subsidies and market-based instruments to promote the diffusion of low carbon technologies are seen to be indispensable for that (Metz et al., 2000).

Sustainable development means fostering economic growth and development by ensuring that natural environmental assets continue to provide the natural resources and services which are the basis of our well-being (OECD, 2011a). Existing and available production technologies and current consumer behaviour can be expected to produce positive outcomes only to a certain point, as the environmental assets are limited or can be stressed only to a certain degree of intensity. Innovation can help to decouple economic growth from the pollution of environmental assets, especially in the energy sector. Exploiting technology and innovation is crucial to achieve increasing returns on capital (Reinert, 2007; Cimoli et al., 2009). Access to technology in the form of technology ownership is a key determinant of the level of economic development. It increases the likelihood of self-reliant development and poverty alleviation by offering the possibility to move up the value chain and diversify as well as to substitute for products originally imported by developing countries (Bell, 1997). Raising the competitive advantage and development of new products is associated with growing employment and tax income (Lall, 1998). The acquisition of new

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[1] The term "developing countries" is being used for ease to refer to both developing and emerging economies. It is not meant to obscure the differences between, for example, BRICS countries and countries of Sub-Saharan Africa.

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technologies and innovation, and broadening its manufacturing base, is thus a core motivation of developing countries to foster economic development. The transformation towards sustainable development pathways can also open up opportunities for new institutional practices and change (Deuten, 2003). If technology change shall unleash its potential to systemic change and positive impact on the environment, then it is important to fully understand technology and embed that knowledge into policy frameworks and global governance architecture in order to avoid detrimental outcomes (Byrne et al., 2011).

The right to economic development, anchored in the current global climate negotiations, is a key principle of sustainable development in developing countries (UNFCCC, 2010b). Major concerns of developing countries are the costs of mitigation action and that emission reduction targets could be countervailing to their economic development and poverty alleviation goals (Dubash et al., 2013; Wlokas et al., 2012). Developing countries understand access to technology as key for economic development and by joining the United Nations Framework Convention on Climate Change (UNFCCC), they see the chance to gain stronger technology ownership and reduce their technological dependency on the developed countries (Roberts and Parks, 2007). The vulnerability to negative environmental impacts is another motivation for developing countries to pursue innovation in the area of environmentally friendly technologies (Olsen, 2013). Countries have different technology needs. Domestic energy technology needs are based on geography, domestic industries, demand patterns, and resource potentials. But, taking a general view on renewable energy technology per se, it is necessary to assess its complexity, if the technology manufacturing capacity in developing countries shall be addressed in order to stimulate industrial development and thus economic development. National policy-makers will need to decide, amongst others, which renewable energy technologies and which components they select to contribute to economic development and also about import regulations with regards to the other parts of the value chain, which are not produced domestically.

Besides efficient financing mechanisms, which are definitely one of the key determinants of successful renewable energy technology diffusion in developing countries, this paper addresses the question:

> *How does the possibility to induce domestic economic development through specific technology deployment influence renewable energy technology transfer policy making?*

More precisely, it will be asked, how can technology complexity on component level and the potential economic value added along the value chain be integrated in the decision making of certain renewable energy technology pathways, in addition to already established technology needs assessments frameworks.

The above mentioned concerns of developing countries have been expressed through the right to sustainable development in the context of clean technology innovation. They need to be integrated in a holistic technology innovation and technology transfer approach, which takes into account both, climate change mitigation and national sustainable development planning.

The structure of the paper is as follows: In the second section, I discuss the international low carbon development policy landscape. The third section deals with the theory of innovation, technology transfer and technology complexity. Then, in the fourth section, I describe how technology complexity and economic development potentials can be assessed. The fifth section highlights implications for a technology specific climate policy design. The sixth section concludes.

International low carbon development policy

The international low carbon development policy debate has dynamically evolved. It has attempted to merge technology transfer and sustainable development aspects. National sustainable development goals are a key policy measure in developing countries to take action for mitigating greenhouse gas emissions (Olsen, 2013). From a developing country's standpoint, mitigation action has to be mainstreamed into sustainable development frameworks to achieve emission reduction and at the same time meet national development priorities. Developing countries could choose to use low carbon technologies instead of running into lock-in in high carbon technology pathways (Sauter and Watson, 2008). Thus, it has been acknowledged by the global community that low carbon technology transfer is indispensable for the design of low carbon growth trajectories (UNFCCC, Articles 4.3 and 4.5). Several mitigation technology deployment policy frameworks exist, which embrace low carbon technology transfer as a means to sustainable development. In the following I describe the most prominent frameworks, which are rooted in the global UNFCCC climate policy framework.

Marrakech Accords

In the Marrakech Accords of 2001, the technology transfer requirement has been added to the Kyoto Protocol. In case the respective technology and capacities are not available in the host country, technical and financial support is part of the diffusion of clean technology in non-Annex 1 countries, leading to technology transfer. This transfer includes technical equipment and know-how (Seres, 2007; Dechezleprêtre et al., 2008; Schneider et al., 2008). These rules shall help with the implementation of the Kyoto Protocol.

The Clean Development Mechanism

According to the Clean Development Mechanism under the Kyoto Protocol (CDM), industrialized countries, which have set emission reduction targets under the Kyoto Protocol, can develop greenhouse gas mitigation projects in other countries in exchange for emission reduction credits (World Bank, 2013). The CDM approach is a market-based instrument which is driven by private companies (Wang-Helmreich et al., 2011). It has been mainly applied in countries where framework conditions were most promising. CDM projects have been criticized for instance, because they appeared to be ill-suited to multifaceted projects involving public policy actions and capacity building (World Bank, 2013). Also, high transaction costs due to sophisticated evaluation and monitoring procedures in greenhouse gas abatement and technology diffusion undermine its potential. The CDM has not proven to foster sustainable development, since projects have been heavily skewed towards BRIC[2] countries, whilst effective reduction of mitigation cost has been shown (Olsen, 2007; Sutter and Parreno, 2007).

Nationally appropriate mitigation actions

According to the Bali Action Plan (BAP), developing countries shall take nationally appropriate mitigation actions (NAMAs) in the context of sustainable development, by considering technology transfer, financing and capacity-building (UNFCCC, 2008). The rationale is that developing countries achieve a deviation in greenhouse gas emissions relative to their "business as usual" emissions in 2020. The BAP provisions consider that developing countries undertake mitigation actions in a nationally appropriate manner. This means that actions are tailored to countries' national circumstances and in line with the UNFCCC's principles of common but differentiated climate mitigation responsibilities. The mitigation measures are to be embedded in broader sustainable development strategies. The first step towards NAMAs are technology needs assessments (TNAs) with the goal of prioritizing sectors and technologies for climate change mitigation and identify barriers for technology deployment in developing countries (UNFCCC, 2010).

[2] Brazil, Russia, India, China.