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Enabling frameworks for low-carbon technology transfer to small emerging economies: Analysis of ten case studies in Chile

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HIGHLIGHTS

- We analyse 10 case studies of low carbon technology transfer to Chile.
- We identify enablers of technology transfer to developing countries.
- We provide policy recommendations focusing on small and medium economies.

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ABSTRACT

Technology transfer is crucial to reduce the carbon intensity of developing countries. Enabling frameworks need to be in place to allow foreign technologies to flow, to be absorbed and to bring about technological change in the recipient country. This paper contributes to identifying these enabling factors by analysing 10 case studies of low-carbon technology transfer processes based in Chile. Our findings show the importance of strong economic and institutional fundamentals, a sound knowledge base, a sizable and stable demand and a functioning local industry. Policy recommendations are derived to improve the penetration of foreign low-carbon technologies in developing countries, focusing on the particularities of small and medium emerging economies.

1. Introduction

Emerging and developing economies almost quadrupled growth rates of advanced economies in 2011 (International Monetary Fund (IMF), 2012). This trend is expected to continue for years to come, resulting in increasing energy demand and Greenhouse Gas (GHG) emissions. Emerging and developing economies and in particular the larger ones will therefore become responsible for most of the future growth in GHG emissions (International Energy Agency (IEA), 2011). However, these countries are reluctant to set absolute caps to their GHG emissions to mitigate climate change. They consider that caps would constrain growth and impede the key goal of poverty eradication. Besides, they argue, advanced economies are historically responsible for bringing about this global phenomenon. But without action from these countries, the stabilisation of GHG emissions will not be attained and global warming will not be limited to safe levels.

Against this background, economists and policy makers advocate a fundamental shift towards low-carbon growth based on higher participation of renewable sources in the energy mix and increased material, resource and energy (MRE) efficiency (Hoffman, 2011). The development, transfer and implementation of low-carbon technologies play a fundamental role in this proposed path towards climate change mitigation.

Developing countries have embraced the paradigm that places technology at the centre of their response to climate change mitigation, as shown by their advocacy for a new Technology Mechanism with an increased political status as part of the international climate change negotiations under the United Nations Convention for Climate Change (UNFCCC) (Pueyo et al., 2012). Low-carbon technologies allow not only climate change mitigation but also energy security, one of the main concerns of developing countries. However, most countries cannot develop on their own the portfolio of low-carbon technologies required to bring about this change and often do not have the capabilities to implement, operate, maintain and repair them. International technology transfer (TT) to developing countries is therefore a key aspect of low-carbon growth. The private sector has indicated that appropriate national enabling frameworks are needed to accelerate climate change technology diffusion to developing countries (World Business Council for Sustainable Development (WBCSD), 2010). This recommendation is particularly relevant as

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the private sector owns most climate change mitigation technology and is responsible of most international TT through trade and foreign direct investment (FDI) (Stern, 2007; Brewer, 2009; World Bank, 2009).

This paper aims at understanding the enabling factors that facilitate low-carbon TT to developing countries and at providing policy recommendations to enhance these. Previous literature on low-carbon TT to developing countries has focused on the largest, fast growing countries, commonly called BRIC (Brazil, Russia, India and China). Some examples of this literature include the analysis of strategies including incentives for TT, for local wind industry development in twelve countries among which three developing countries: Brazil, India and China (Lewis and Wiser, 2007); the impact of the Kyoto mechanisms on patterns of diffusion of renewable energy technologies in the BRICs (Bodas Freitas et al., 2012); the reasons for the low penetration of wind and solar technologies in Brazil (Ramos Martins and Bueno Pereira, 2011); the emergence of wind turbine manufacturers in India and China (Lewis, 2007; Wang, 2010; Zhang et al., 2009); the world-leading Chinese photovoltaic technology (de la Tour et al., 2011); the transfer of hybrid vehicles and integrated gasification combined cycle (IGCC) technologies to India (Ockwell et al., 2008); or the transfer of CCS technologies to China (Liu and Liang, 2011). This literature provides valuable insights on the national and international policies that have worked to enable low carbon TT processes in the BRICs.

Smaller emerging and developing economies have been widely neglected by the current literature. However, they can hardly replicate the lessons learnt by BRICS as they lack a large internal demand for low-carbon technologies, an important requirement for the development of a national industry (Lewis and Wiser, 2007). Their smaller demand also involves a lower bargaining power next to foreign technology providers (Wei, 1995) and a lower scope to implement industrial policies, such as local content requirements, which have worked in the BRIC countries (Pueyo et al., 2011). The inability of the UNFCCC to address the diverse needs of different types of developing countries has indeed been identified as one of the main gaps of its approach to promoting TT (Pueyo et al., 2012).

This paper addresses this gap by analysing 10 case studies of low carbon TT to a small emerging economy, Chile. A case study approach is preferred over a quantitative top-down approach because the tacit nature of technology in its broader sense means that measuring TT is inherently difficult. Case studies can provide a more detailed account of the technology flows and the extent of knowledge spillovers attained beyond the equipment transferred. To our knowledge, only one previous paper has addressed the issue of low carbon TT to Chile (Pueyo et al., 2011), but it was limited to a single case study involving a local company starting up the production of wind blades. A multiple case study approach can increase the external validity and the generalisation of the research findings (Cook and Campbell, 1976; Patton, 1990). Given the complexity of the TT process, multiple case studies are also necessary to show the diversity of channels through which technologies can be transferred and the challenges faced by different types of organisations involved in the transfer of technologies at different stages of maturity.

The paper is structured as follows. Section 2 presents the methodology used for the case study analysis and introduces the 10 case studies. Section 3 presents the main findings as regards enabling frameworks and barriers to low carbon TT to Chile in the light of the evidence provided by the 10 case studies. Section 4 discusses the main findings and concludes, synthesising the major arguments in the paper, providing policy recommendations and suggesting further areas or research.

2. Methodology

2.1. Analytical framework

This paper looks at TT from a horizontal perspective, as the transfer of technology across borders. It does not address vertical processes of TT understood as the transfer of knowledge or inventions from the R&D stage through to commercialisation.

For the case study analysis, TT is defined in its more holistic sense as involving from the more basic transfer of foreign equipment and blueprints to the more advanced knowledge and expertise for generating and managing technical change (Bell, 1997; Wei, 1995;). Under this broad definition, TT would provide the recipient country the capacity to install, operate, maintain and repair imported technologies; produce lower cost versions of imported technologies; adapt imported technologies to domestic markets and circumstances, and develop new technologies (United Nations Framework Convention for Climate Change (UNFCCC), 2009).

Departing from this definition of TT, the author has developed an analytical framework to dissect the case studies' processes of TT in the following elements:

- A final, direct objective of the TT process, defined as its output. Some examples of outputs for a TT process are the local production of low-carbon technologies; the implementation of renewable energy, energy efficiency or GHG reduction projects; the supply of services, components or raw materials to low-carbon energy projects; the publication of scientific research about low-carbon technologies; the generation of electricity through low-carbon energy sources or local patents filed for low-carbon technologies. These technology outputs must involve the transfer of foreign technologies to be considered elements of a technology transfer process.
- Technological inputs to achieve the desired output. They are a combination of local and foreign inputs. Local inputs are essential for the success of every TT process. They include the internal capabilities of local organisations and the technological infrastructure of the recipient country. However, by definition, in a process of international TT, local inputs are not enough to deliver an intended technology output efficiently. Foreign TT is hence required when local capabilities and equipment are not sufficient, when they cannot compete with international alternatives or when foreign multinationals prefer to use their own resources or trusted foreign product and service providers instead of unknown local alternatives.
- Technology transfer channels making foreign inputs available locally. Technologies can be transferred through several channels, mainly trade, foreign direct investment (FDI), licensing agreements, official development assistance (ODA), foreign human resources and person-to-person pathways, such as training programmes, conferences or scientific exchanges. Different types of TT channels convey different outcomes on the recipient country, with disembodied transfers (such as demonstration projects or foreign staff) expected to provide additional benefits to recipients by enabling them to develop skills for further technological development (Popp, 2011).
- Technology spillovers or effects, which are indirect outputs of the process. For example, they might involve knowledge spillovers to local organisations through forward and backward linkages. Horizontal knowledge spillovers can also happen when the acquired capabilities are used to implement other low-carbon energy projects. Technology cost reductions through learning-by-doing are another example of the effects of TT processes, which can also lead to improvements in national productivity because local companies get involved