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Renewable electrification and local capability formation: Linkages and interactive learning☆

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ABSTRACT

This paper discusses the prospects for developing production and innovation capabilities arising from renewable electrification efforts. This discussion falls at the intersection of several literatures within innovation studies and development studies. It requires a combination of ideas from across several academic fields of study. This paper focuses on value chain linkages and interactive learning. Because this is largely unexplored terrain, the paper seeks to provide conceptual framing based on insights from the literature and it discusses whether linkages within the global South offer specific advantages over North–South linkages. It then uses this conceptual framing to draw insights from the case of renewable electrification with wind and solar PV in Kenya. It ends by identifying key avenues for promoting interactive learning in this context.

1. Introduction

In recent years, the potential for more effective and appropriate linkages has resurfaced as a prominent topic as developing countries become increasingly interconnected by economic flows: importing capital goods (Hanlin and Kaplinsky, 2016), engaging in value chains (UNCTAD, 2015) and undertaking foreign direct investments (FDIs) (Arita, 2013). This has received renewed attention as a means of progress with respect to the sustainable development goals (SDGs), including those of ensuring access to affordable and sustainable energy to all (Goal 7) and promoting sustainable industrialisation and fostering innovation (Goal 9).

The overall objective of this paper is to inform policy-driven research that ultimately aims to create and deepen synergies between these two SDGs, thereby facilitating a process of 'low carbon development' (Lema et al., 2015; Urban and Nordensvärd, 2013). Within this terrain, the paper is concerned with the following. Generally, it is concerned with the creation of relevant ('developmental' or 'inclusive') pathways and associated economic activities involved in clean energy provision. Specifically, it is focused on the 'learning opportunities' that may provide in the context of renewable electrification. Learning is understood here as the accumulation of relevant capabilities; we are informed by the increasing body of literature that emphasises the importance of local production and innovation capabilities for effective low carbon development (Ockwell and Mallett, 2013; Urban and Nordensvärd, 2013; de Coninck and Sagar, 2015).

Given the importance ascribed to such capabilities in the literature, there is relatively little attention to 'where' and 'how' such capabilities arise in local economies, particularly the role of interactive learning as a means to building these production and innovation capabilities. In this paper, we therefore address the following closely related issues:

- First, we address the issue of local capability formation in the context of low carbon electrification technologies in developing countries. Large investments are made in renewable energy in developing countries, not least in sub-Saharan Africa and South Asia where access to energy is a top priority on the policy agenda. Clearly, the levels and types of pre-existing capabilities are of crucial importance for the success of these investments. However, we are not focused (primarily) on such existing capabilities, but instead on the opportunities for further capability formation arising in and from such investments.
- Second, given the gap in resources and capabilities between advanced and developing economies and because of global governance mechanisms in support of the SDGs, there is a *de facto* high degree of inbound flows of 'technology' related to these investments. We

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therefore focus on the learning opportunities that may potentially arise in and around the linkages that facilitate these flows.

- Third, we address the issue of linkages between emerging economies, such as China, India or South Africa, and poorer parts of the world. In the 1980s economists began to argue that 'South-South technology transfers offer undoubted advantages since the technologies exported are better adapted to the needs of the developing countries' (Sabolo, 1983, p. 606). Considering the many years in which South–South technology transfer and co-operation for climate-relevant technologies has been on the agenda, the literature provides surprisingly little empirical evidence on this. We argue that the relative lack of progress in shedding light on the third issue so far is the difficulty of framing it and connecting it to the first two issues.

This paper therefore starts, in Section 2, providing background for the discussion by outlining the challenges of creating access to electricity in low and middle-income countries and South–South flows of trade and investment in this respect. Section 3 provides an outline of the key conceptual building blocks from across the innovation studies and development studies fields. It draws on and seeks to bring together perspectives from the literatures on technology transfer, interactive learning, global value chains (GVCs) and appropriate technology. Section 4 seeks to recast international technology transfer as occurring in value chain relations with opportunities for interactive learning between users (importers) and producers (exporters) of electrification technology. Section 5 then seeks to go deeper by considering typical value chain structures in and around renewable electrification projects, using the case of wind and solar photovoltaic in Kenya as an example, drawing on new vocabulary for analysing capability formation in the context of renewable electrification. Section 6 concludes by highlighting the key insights of the paper, asking what the implications are for South–South discourse and emphasising different types of interactions for local capability formation and the importance of local shaping of technology as key areas of attention for those involved in researching or promoting low carbon development activities.

2. Renewable electrification

We start by providing a background to the drive to create access to electricity and the importance of South–South connections in green energy, particularly electrification. This provides an essential foundation for later analyses of whether and how investment in the field can be harnessed for local capability formation.

2.1. Access to energy

One of the most critical issues to development in low and middle-income countries is access to energy, not least in sub-Saharan Africa and South Asia. Electrification is one of the most critical issues here. In total, more than one billion people do not have access to electricity. Sub-Saharan Africa has an electrification rate of 32% and in rural areas it is just 17% according to the International Environmental Agency (see Table 1).

Table 1
Access to electricity.
Source: OECD/IEA (2015).

Region	Population without electricity millions	Electrification rate %	Urban electrification rate %	Rural electrification rate %
Developed countries	1	100%	100%	100%
Developing countries	1200	78%	92%	67%
Sub-Saharan Africa	634	32%	59%	17%
Developing Asia	526	86%	96%	78%
India	237	81%	96%	74%
Latin America	22	95%	98%	85%
Middle East	17	92%	98%	79%
World	1201	83%	95%	70%

Note: Electricity access in 2013 – Regional aggregates.

Table 2
Renewable energy in Africa: installed capacity and projections.
Source: AEEP Power Project Database/AEEP (2016).

	2010	2015	2020 Growth Scenario 1 (Linear)	2020 Growth Scenario 2 (25%)	2020 Growth Scenario 3 (50%)	2020 Growth Scenario 4 (75%)
Hydro	33.01	35.18	37.36	41.97	48.63	55.30
Wind	1.12	3.13	5.14	4.93	6.62	8.30
Solar	0.10	1.55	2.99	3.25	4.61	5.96
Other	0.95	1.50	2.05	2.49	2.94	2.98

Note: Other = Geothermal, biomass.

Fossil fuel and renewable energy sources will be used to bring electricity to poor countries and rural areas within them. Renewable energy sources are particularly high on policy agendas, however, due to the foreseen socio-economic development opportunities in terms of local employment and industrial development. As seen in Table 2, hydropower is the predominant renewable energy source in sub-Saharan Africa. While starting from a much lower base, wind and solar are growing much faster, with wind moving forward at a compounded annual growth rate of almost 23% while solar grew 73% between 2010 and 2015. In terms of added capacity, hydropower amounted to 2.17 GW compared to 2.01 GW of wind and 1.45 GW of solar photovoltaic (PV) in the same period.

Table 2 also shows projections for growth. Scenario 1 is linear growth whereas scenarios 2–4 are pessimistic (25%), middle ground (50%) and optimistic (75%) realisation rates of project pipelines. With all the scenarios, there are massive investments in renewable energy on the African continent currently and in the foreseeable future.

There are various ways in which these investments are organised to increase rural and renewable electrification. First, there are those focused on grid connection. These are typically large hydro and solar projects. For these to make a difference for rural communities they need to be combined with extension of grids into areas that currently do not have access. Second, there are mini grids where self-contained grids are established in rural villages, using micro hydro, solar and micro wind, or a mix of these. Finally, there are various off-grid solutions where electricity generation is tied to the household or factory – typically solar rooftop or other solar stand-alone solutions, sometimes combined with micro wind. These off-grid solutions range from small solar home systems that power a couple of lights and can charge a mobile phone to stand-alone systems that power factories or public institutions. Electrification in Africa will involve all of these pathways, but the question is about the balance between them and about how they are set up to maximise inclusiveness and economic development (NRECA International, 2017).