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The political economy of technological capabilities and global production networks in South Africa's wind and solar photovoltaic (PV) industries

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ABSTRACT

We examine underlying conflicts between technological capabilities and global production networks in South Africa's solar photovoltaic (PV) and wind energy industries. This includes an analysis of the complex and multi-scalar relationships that exist between international and local institutions, as well as the embedded nature of renewable energy technology within a national and international political economy. In South Africa's case, this encompasses endogenous factors such as the introduction of a regulatory framework for renewable energy independent power producers as well as international dynamics such as rapidly evolving trends in renewable energy investment, trade, and technology development. While South Africa's wind and solar industries have been celebrated internationally, tensions exist within national government between commercial priorities and requirements for economic development including local content. We provide an empirically rich description to explore how competition and manipulation have posed obstacles to the localisation of renewable energy technologies at the national level.

Introduction

South Africa's utility-scale, renewable electricity from independent power producers now constitutes a small but significant source of generation alongside its coal-fired, crisis-ridden state-owned monopoly electricity utility Eskom.[1] While a number of studies have explored the policies and politics behind the implementation of a renewable electricity generation sector, (e.g Eberhard, Kolker, & Leigland, 2014; Baker, 2016), we expand that focus to examine the significant challenges that exist to the creation of national technological capabilities in renewable energy. Drawing from literature spanning innovation studies, development policy, and geography, we ask: what is the political economy of technological development in solar photovoltaics (PV) and wind in South Africa? What does this tell us about technological capabilities as well as emerging international trends?

While the country's renewable electricity industry has been celebrated internationally (Dodd, 2014), tensions exist between commercial priorities and requirements for economic development including local content. Such tensions can be found within national government between the demands for least cost technology, and national priorities for the establishment of a local manufacturing industry and job creation; and between global production networks (GPNs) for solar PV and wind technologies and national local content requirements. Consequently we explore how competition and manipulation within GPNs have posed obstacles to the realisation of the localisation of renewable energy technologies at the national level. Our analysis separates the experiences of wind and solar PV given that while both industries are increasingly competitive, there are significant variations that exist between them in terms of their GPNs and technological capabilities.

Our analytical approach is informed by the literature on technological capabilities (Bell, 2009) and global production networks (GPNs) (Coe, 2012). Together these literature facilitate an analysis of the complex and multi-scalar relationships that exist between international and indigenous institutions and the embedded nature

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[1] Between 2014 and 2015 the country faced its worst electricity crisis for 40 years.

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of technology within a national and international political economy. In South Africa's case this political economy includes endogenous factors such as the introduction of a regulatory framework for renewable energy independent power producers, and international dynamics such as rapidly evolving trends in renewable energy investment and technology development. While these literature are rarely linked, we argue that there is particular relevance for doing so. Firstly because of the GPN literature's recent engagement with renewable energy technologies (Curran, 2015), and secondly given the influence that GPNs can have over the realisation of technological capabilities at the national or even international level, through for example intellectual property restrictions, access to capital, or standards.

This paper also draws from and contributes to a growing body of research on technological innovation and the creation of renewable energy manufacturing industries in the emerging markets of China and India (Altenburg, Johnson, & Engelmeier, 2014; Lema, Berger, & Schmitz, 2012; Fu & Zhang, 2011), green industrial policy in developed countries (Pegels & Lütkenhorst, 2014), and comparisons between the two, for example China and Germany (Dunford, Lee, Liu, & Yeung, 2013). Moreover, limited consideration has thus far been dedicated to South Africa with exceptions being Rennkamp and Boyd (2013), and Mulcahy (2012) given the recent emergence of the industry. The findings of this paper therefore may have important policy implications for other non-OECD countries in the sub-Saharan African continent and elsewhere which have recently embarked, or are about to embark, on programmes for the deployment of utility-scale electricity generation from renewable energy, for instance Tanzania, Namibia, Mexico and Uruguay.

Our paper's primary source of data is field work undertaken between 2013 and 2015 (Baker, 2015; Baker, Burton, Godinho, & Trollip, 2015). This includes 47 semi-structured research interviews with members of the renewable energy industry, government departments, the electricity utility, the financial sector, civil society and labour in South Africa (see Annex 1). The field work also involved site visits to renewable energy projects and manufacturing/assembly facilities. A number of the interviews are cited here but individuals have been heavily anonymised due to the commercially and politically sensitive nature of the material. For the same reason it has not been possible to disclose detailed information pertaining to the facilities visited.

As a secondary method, we also draw from significant content analysis of government documents and policies as well as grey literature on renewable energy technology. One challenge to this is that many of the bid documents for the country's renewable energy independent power producers' procurement programme, the RE IPPPP, are not available in the public domain. For this reason we have drawn from publicly available secondary sources. The research is also informed by a long-term and systematic consultation of media sources on the renewable energy industry in South Africa and globally, including: *Engineering News, ESI-Africa, Wind Power Weekly* and *Recharge News.* Given the breath of the subject matter, the research does not pretend to be exhaustive and in light of the fast moving nature of the topic inevitably contains some empirical gaps.

The paper's structure is as follows. Firstly we outline our analytical framework before setting out the national context from which the country's renewable electricity generation sector has emerged. We then consider the national measures and systems that exist for the support of technological capabilities in renewable energy. We proceed to explore how tensions between the two concepts of global production networks and technological capabilities play out within the South African context, which together with the themes of competition and manipulation, are further illustrated with two case studies of wind and solar PV.

Linking technological capabilities and global production networks

Our analytical framework draws from two literature which though related, are rarely combined: technological capabilities and global production networks. In tandem, such concepts—one emphasising the nature of indigenous technological development and innovation, the other the interlinkages between local, national, and international supply chains —enable us to reveal the networks of firms and institutions participating in South Africa's renewable energy sector. We maintain that together these concepts offer a more nuanced and complete picture of the political economy of technological development and allow us to consider dimensions such as the distribution of power within those networks (Bridge, 2008); the significance of skills development (Lall, 1993); the role of trade and the deepening international division of labour across global value chains (Curran, 2015); and broader political, socio-cultural, and environmental implications resulting from these trends (Coe, Dicken, & Hess, 2008; Gereffi et al., 2005).

Acknowledging the diversity of literature on technological capabilities, Bell and Pavitt (1993) define this concept as a spectrum that spans from 'production capabilities' to advanced 'innovation capabilities'. While the former refers to the operation and maintenance of existing products and processes, the latter refers to the ability to innovate to the extent of developing new products and processes. Consequently, Bell and Albu (1999:1717) argue that technology, rather than just machinery "is a much more complex body of knowledge, with much of it embodied in a wide range of different artefacts, people, procedures and organisational arrangements". Technological change therefore goes beyond the mere diffusion of hardware such as designs, complete equipment and installation services, which was a common perspective on production and trade until late 1960s (Bell, 2009). Rather, 'software', such as skills, system building and knowledge flows is significant for its ability to contribute to the accumulation of knowledge stocks and resources often referred to as 'technological capabilities'. Technology and technological innovation therefore, are part of numerous inter-linked, comprehensive and interactive processes and bundles, for which reason the transfer of physical assets alone will be inadequate to ensure the development and acquisition of the know-how necessary to reproduce technology hardware (Lema, Iizuka, & Walz, 2015). This is particularly the case in the international solar PV and wind industries which are growing in technical complexity.

The case of South Africa illustrates concepts central to technological capabilities, including the nature of technology transfer to developing countries and related definitions of research and development (R&D); knowledge spill-overs and knowledge leakage (Bell & Pavitt, 1993); industry clusters and innovation systems (Bell & Albu, 1999); and the Asian driver debate at the centre of which is the notion of China as the 'workshop of the world' (Lema et al., 2012:40). Our study also illustrates long-standing debates over the relationship between imported technology and indigenous technological development in low and middle income countries (Lall, 1993, 1987). This includes the difficulties of transplanting foreign technology into a country where adapted institutions have not evolved jointly, resulting in serious incongruities and disruptions (Mokyr, 1998). Byrne et al.'s (2011:29) discussion on the increasing 'knowledge embeddedness' of energy technologies and the requirement for increasingly specialised technical knowledge are similarly relevant. As Schmidt and Huenteler (2016) point out, while there has been significant renewable energy technology diffusion in non-OECD countries, the ability of such countries to successfully implement industry localisation beyond the point of installation, and operation and maintenance is much less evident