



# China's rise: Challenging the North-South technology transfer paradigm for climate change mitigation and low carbon energy<sup>☆</sup>



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## ARTICLE INFO

### Keywords:

China  
Wind  
Solar  
Hydropower  
Technology transfer  
Technology cooperation

## ABSTRACT

Historically, technology transfer from the global North to China played a large role in renewable energy pathways in China, particularly for wind energy, partly also for solar energy. Yet, the rise of China and other emerging economies means a shift away from a reliance on technology transfer and production capabilities to strengthening indigenous innovation capabilities. Drawing on evidence from the hydropower, solar and wind energy industry in China, the paper introduces the concept of ‘geographies of technology transfer and cooperation’ and challenges the North-South technology transfer and cooperation paradigm for low carbon innovation and climate change mitigation. The empirical evidence shows that for low carbon innovation, the conception that China is lacking behind in innovation capabilities is partly outdated. Instead, there is an increase in indigenous innovation capabilities, resulting in South-South technology transfer and cooperation as well as elements of ‘reverse’ South-North technology cooperation.

## 1. Introduction

Historically, technology transfer from the global North to China has played a large role in renewable energy pathways in China, particularly for wind energy, partly also for solar (Urban et al., 2015a; Lewis, 2013; Watson et al., 2014). Technology transfer of hardware occurred from OECD countries to China, as well as knowledge transfer of how to maintain and operate these technologies. This reliance on foreign technology imports has decreased in recent years as China has become a rising power at political, economic and technological levels.

This goes hand in hand with China's rising importance for global climate change and its dominant role in the climate change negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). Climate change mitigation and low carbon energy transitions are strongly supported by the Chinese government (Zhang et al., 2017) as evidenced by China's ratification of the Paris Agreement, its strong support for global climate change mitigation even after the US' withdrawal, the country's plans to peak CO<sub>2</sub> emissions by 2030 and to increase the share of non-fossil fuels in primary energy consumption to 20% by the same year (Duan et al., 2016). At the same time, China is building up its indigenous innovation capabilities for climate-relevant technology and low carbon energy technology.

About a decade ago, Altenburg et al. (2008) found that China, as well as India, is in the process of a transition from production capabilities to innovation capabilities, yet it has not achieved this

transition yet. Yet, the Chinese government referred to the Chinese wind and solar energy industry for several years as a “wind energy industry/solar PV industry with Chinese characteristics” (NDRC, 2012:1), meaning that low carbon technologies acquired through technology transfer from the global North by Chinese wind and solar PV firms had been amended, improved and turned into technologies that are more suitable for the Chinese market.

This paper analyses the latest empirical evidence to assess how far China has transitioned from a leader in manufacturing to a leader in innovation in low carbon energy technologies for climate change mitigation in the last few years. It combines empirical data from interviews, focus group discussions and site visits with patent analysis and document analysis.

This paper aims to assess the rise of China and the shift away from a reliance on technology transfer and production capabilities to strengthening domestic innovation capabilities. Drawing on evidence from the hydropower, solar and wind energy industry in China, the paper introduces the concept of ‘geographies of technology transfer and cooperation’ and challenges the North-South technology transfer and cooperation paradigm for low carbon innovation and climate change mitigation. Theoretically the paper adds value by expanding the current narrow framing of technology transfer and cooperation to a wider understanding that addresses various geographic directions of technology transfer and cooperation, exploring their characteristics and focusing on a cross-sector comparison across several major low carbon energy

<sup>☆</sup> This article is part of a Virtual Special Issue entitled 'South-South Technology Transfer and Cooperation for Low Carbon Energy Technologies'.

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sectors. Empirically, the papers adds value by using a mixed methods approach, drawing on qualitative data from primary fieldwork as well as quantitative data from patent analysis to support these findings.

The paper finds that the conception that China is lacking behind in innovation capabilities is partly outdated for low carbon innovation. This is not limited to one industry or sector, but can be seen in evidence gathered from the hydropower, wind and solar energy sectors, thereby examining a broader trend for low carbon innovation. Instead, the paper finds a rise of South-South technology transfer and cooperation as well as elements of ‘reverse’ South-North technology cooperation with regards to low carbon energy technologies for climate change mitigation.

Section 2 presents the background and literature review, Section 3 presents the findings, Section 4 discusses the findings from the hydro-power, solar and wind energy industry and Section 5.1 concludes the paper and raises some policy implications.

## 2. Background and literature review

The paper draws on the theories of international technology transfer for low carbon innovation (Ockwell and Mallett, 2012; Bell, 1990; Brewer, 2008). Rogers (2003) defines innovation as developing a new idea, product or service. Low carbon innovation is important for mitigating climate change and for enabling transitions to low carbon economies and societies. Achieving this requires the diffusion of low carbon technology innovation, which is a complex task and typically includes research and development (R&D), demonstration and deployment. The diffusion of low carbon technology innovation depends on several factors, including skilled labour, adequate incentives for firms, governments and other organisations to enable technology development and to help create markets for these technologies. (Ockwell and Mallett, 2013; Saviotti, 2005).

Less developed countries usually have lower capacities to create indigenous innovation, including in the energy sector (Ockwell et al., 2014; Ockwell and Byrne, 2015). This means they have a strategic disadvantage, as energy innovation is crucial for alleviating energy poverty, increasing energy security and for building an energy sector that reduces greenhouse gas emissions and is resilient to climatic shocks at the same time. Brewer (2007) hence calls for increasing technology innovation and its diffusion through international technology transfer, under the ‘technology transfer paradigm’.

Technology transfer is here defined as per the IPCC’s definition: a ‘broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change [...] The broad and inclusive term ‘transfer’ encompasses diffusion of technologies and technology cooperation across and within countries. It comprises the process of learning to understand, utilise and replicate the technology, including the capacity to choose it and adapt it to local conditions and integrate it with indigenous technologies’ (Hedger McKenzie et al., 2000, 1.4). This terminology refers to both technology transfer and technology cooperation.

In the past, technology transfer and cooperation was often limited to ‘hardware’, while other ‘software’ issues that are essential to create, operate and maintain technologies such as skills, knowledge and experience, were often excluded from the traditional understanding of technology transfer and cooperation (Urban et al., 2015a, 2015b). Also, for a long time the focus was on the traditional North–South model of technology transfer and cooperation. In recent years, partly due to the rise of emerging economies like China, India, South Africa and Brazil, this thinking has shifted towards a broader and more balanced understanding of technology transfer and cooperation. Hence, this term is here divided into four geographic flows: Technology transfer and cooperation (1) from North to South (e.g. EU to China), (2) from South to North (e.g. China to EU), (3) from South to South (e.g. China to Asia or Africa) and (4) from North to North (e.g. EU to US or vice versa) (Urban et al., 2015a, 2015b).

Types of technology transfer and cooperation include cooperative approaches between firms and/or countries such as foreign direct investment (FDI), overseas development assistance (ODI), licencing, joint ventures, mergers and acquisitions. Other forms of technology cooperation can include movement of skilled labour, networks and joint publications. Technology transfer and cooperation can be a short- or long-term process, formalised or informal, depending on its specific nature and the objectives of the parties involved in it. Technology transfer and technology cooperation can be horizontal, taking place between firms, or vertical, such as from R&D to commercialisation (Ockwell and Mallett, 2013). Urban et al. (2015a:236) distinguish between three flows of technology transfer and technology cooperation: “(1) capital goods and equipment, (2) skills and know-how for operation and maintenance and (3) knowledge and expertise for innovation/technological change”. Byrne et al. (2011, 2012) argue that a change in understanding is required from technology transfer to socio-technical transformations to enable countries in the global South to build up their indigenous innovation capabilities.

While technology transfer and cooperation has been a hot topic since the 1980s, not least as part of the UNFCCC climate negotiations, the focus has overtly been on North-South technology transfer and cooperation. In contrary, South–South technology transfer and cooperation is a rather under-researched and novel phenomenon. Urban et al. (2015a) argue that much of the literature and debates on technology transfer and cooperation is restricted to North–South technology transfer from high income countries to low and middle income countries. The rise of emerging economies like China, India, South Africa and Brazil as new economic, political, social and technological powers however challenges the pre-conceptions about technology transfer and rebalances the focus towards South–South technology transfer and cooperation. Yet, much of the literature on China’s rise in the low carbon energy field is on catch-up strategies (e.g. Awate et al., 2012, 2014; Lewis, 2013; Gosens and Lu, 2013; Lema et al., 2013; Dai et al., 2014) or on analysing China’s role for the Clean Development Mechanism (CDM) (e.g. Lema and Lema, 2016). While this is important much of China’s South-South technology transfer and cooperation actually happens outside of the CDM. South-North technology transfer and cooperation from China to high income countries in the global North is even less researched, although a few authors have started to acknowledge the complex set of technology cooperations that Chinese and OECD firms are engaged in (Lema and Lema, 2012), yet empirical evidence in this field remains rare. This is where this paper adds value.

Urban et al. (2015a) developed a framework for characterising South-North technology transfer and cooperation. This paper uses an amended version of the framework and examines the following factors for China’s role in technology transfer and cooperation for hydropower, wind energy and solar energy: 1. China investing in low carbon energy technology overseas (a South-South or South-North flow of capital), 2. China driving market access to overseas low carbon energy technology markets (South-South or South-North drivers for market access), 3. Technology and/or R&D leadership by Chinese low carbon technology firms (South-South or South-North technology/R&D leadership), and 4. China’s approach to innovation capabilities (South-South or South-North origins of innovation such as patents, citations and other intellectual property rights (IPRs)). South-South and South-North technology transfer and cooperation could therefore be defined by taking into account the direction of flow of capital, the direction of drivers of market access, the direction of technology leadership (including R&D) and the origins of innovation (including patents).

## 3. Methodology and data

This paper is based on results from in-depths interviews, Focus Group Discussions (FGDs) and field visits conducted in China, Southeast Asia and the European Union (EU) between 2011 and 2016, as well as firm strategy analysis, literature review, policy analysis, data analysis

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