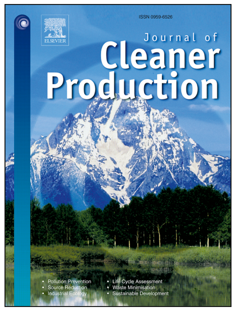

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Martin E. Wainstein, Adam G. Bumpus

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Business Models as Drivers of the Low Carbon Power System Transition: A Multi-Level Perspective

Martin E. Wainstein[1]*, Adam G. Bumpus[2,3]

* corresponding author: martin.wainstein@climate-energy-college.org
[1]- Australian-German Climate & Energy College. School of Earth Sciences. The University of Melbourne, Australia
[2]- School of Geography, Faculty of Science. The University of Melbourne, Australia
[3]- Visiting Scholar, Bill Lane Center for the American West, Stanford University.

ABSTRACT

Decarbonising the electrical power system holds a critical role in climate change mitigation. Recent developments in technology are helping change the current centralized paradigm into one of integrated distributed clean energy resources. In spite of these developments, radical transformation is not occurring at a speed to effectively meet environmental targets, mostly due to the incumbent carbon lock-in trajectory. We argue that business model (BM) innovation dynamics are key drivers in accelerating the low carbon power system transition, often operating irrespective of the underlying technology. We combine BM theory with the multi-level perspective on sociotechnical transitions to present a useful framework to analyze this potential transition. This paper presents the application of this framework characterizing relevant BM dynamics of niche and regime business actors, and supporting these with illustrative examples. Particularly, we find that new actors in the distributed energy business are achieving market scale by offering financially innovative BMs that do not require upfront costs from customers. Higher penetrations of renewable energy sources in liberalized electricity markets are destabilizing the historical BM of large centralized utilities through erosion of wholesale prices. Furthermore, a shift towards distributed and dynamic energy resources further challenges incumbents and might bring opportunities for BMs focused on active customer participation and social value creation. As these tendencies are expected to accelerate, we find analyses of BMs will have important relevance for future power system transition research.

1. Introduction

The electrical power system holds a central role in meeting emission targets for climate change mitigation. In order to keep global mean temperature rise within 1.5-2^{o}C relative to pre-industrial levels, as recommended by the IPCC and restated in the 2015 UNFCCC Paris Agreement (IPCC, 2013; UNFCCC, 2015), feasible energy transformation pathways –developed with Integrative Assessment Models– require significant reduction in energy intensity (i.e. efficiency), a radical electrification of the energy system, and a fast decarbonisation of the electricity sector (Kriegler et al., 2014; Rogelj et al., 2015). But considering that electricity corresponds to just 18% of total energy consumption, and 67% of its primary source is fossil based (IEA, 2014), this scenario requires a challenging technological and systemic revolution in this sector. This shift is not occurring at the speed required: wide scale renewable energy technologies and carbon-saving innovations have faced significant resistance when attempting system-wide diffusion (Bumpus et al., 2014; Geels, 2014). Resistance comes from a complex structure of actors mostly centered around fossil fuel incumbent firms that have been locked into sustaining carbon intensive business models (BMs)(Dangerman and Schellnhuber, 2013; Unruh, 2000).

Recent increases in electricity prices, reduction in renewable technology manufacturing costs, and government clean energy incentives, are, however, producing opportunities for cleantech entrepreneurs and new BMs (Frankel et al., 2014; Huijben and Verbong, 2013). The result is yielding increased incorporation of distributed energy resources (DER) such as photovoltaics, smart meters, stationary batteries and electric vehicles. DERs are helping change the essential paradigm in the electricity sector of industrialized nations, evolving from a traditional value chain to a more complex participatory network (Klose et al., 2010). This tendency is expected to further accelerate in coming years (Frei, 2008; Schleicher-Tappeser, 2012). Furthermore, since conventional utility BMs were not designed to tap the most value from distributed renewable generation, they are a current locus of destabilization and thus experimentation, innovation and emerging opportunities (eLAB, 2013; Richter, 2012; Schoettl and Lehmann-Ortega, 2011b).

The dynamics in the transition between old and new power system business models involves tensions between incumbent and new business actors, a centralized versus a distributed technological paradigm, and a societal shift from a passive to an active user role in its value chain. Some industrialized nations with an ongoing energy transition are showing early signs worth noting. Large incumbent utilities are forced to reconfigure their BM (Jeevan Vasagar, 2015; Richter, 2013a) whilst new distributed energy corporations are achieving financial scale with competitive BMs (Biello, 2014; Hess, 2013). In parallel, modern markets are hosting BMs with increased customer participation, both through collective value creation through peer-to-peer (P2P) platforms (Andersson, 2013; Belk, 2014), and through socially active initiatives such as grassroots innovations and for-benefit firms (Hess, 2013; Seyfang et al., 2014). Collectively, these dynamics may present windows of opportunities to destabilize the rigid foundations of the current carbon lock-in and accelerate the inertia towards a low carbon power system. This paper discusses the relevance of these systemic signals by considering BMs as a critical unit of analysis, and provides specific illustrative examples for a qualitative characterization of these emerging tendencies.

This article adopts a sociotechnical framework for its analysis. It recognizes the transformation required in the power sector does not only involve a change in technology, but at a system level shift in elements such as user