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Leveraging innovation for electricity utilities

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ABSTRACT

Innovations in energy products and services, facilitated through effective partnerships with research centers, may provide benefits to utilities across the value chain. Policy implications could be significant in shifting from traditional regulatory models to flexible frameworks that encourage innovation. A collaborative mindset will be needed to ensure utilities recognize the role they must also play in guiding regulatory reform.

1. Introduction

1.1. Research and development in the electricity industry

> Right now, the world spends only a few billion dollars a year on researching early-stage ideas for zero-carbon energy. It should be investing two or three times that much . . . because it is a public good.

Ever since the electricity grid was developed in the late 1800s, there have been no revolutionary changes to the structure of the system. Today, we still have a centralized grid system, with electrons flowing from generation sources, through transmission and distribution networks, to a final load. There may have been gains from technology innovation incorporated into generation plants, making them more efficient, cheaper, or cleaner. And the safety and reliability of the system has been steadily improving. But the concept and structure of the centralized grid has stood the test of time, and leveraged the economies of scale and existing infrastructure for more than 200 years (King, 2016).

This structure is now under the threat of disruptive innovation. The centralized model is being challenged by new products such as solar photovoltaic (PV), battery storage, microgrids, and smart meters (Kind, 2013). These technologies and other market led innovations have been slowly entering the sector over the past decade through various trials, pilots, and experiments by forward-looking commercial enterprises and university led research. They have now entered the lexicon of every day users. Consumers are recognizing they no longer need to be passive recipients of electricity at increasingly higher prices, but can become "pro-sumers" (producers and consumers) and have independence and control over their consumption and costs. The result so far has been both a reluctance from the large incumbent utilities to acknowledge the threats, and existing regulatory and policy frameworks being too inflexible to manage the transition away from the established, traditional centralized model (Richter, 2013).

The disruption has begun, and even banks and financial institutions have recognized the risk of continued to fund traditional large-scale infrastructure in the mold of the centralized model (Caldecott and McDaniels, 2014). Governments and regulators are also facing increasing pressure to manage the cost structure changes.

Financing within the energy sector is already incredibly complex, with a myriad of subsidies, cross-subsidies, incentives, and tariffs across market participants, consumers, and utilities. However, in dealing with the evolution of the sector amidst this inevitable disruption, very little funding is directed into the research and development (R&D) of innovative products and services. The International Energy Agency (2015) noted that publicly funded R&D accounted for only 4% of global research budgets, with renewables less than half of that. This is in contrast to a level of 11% in 1981 (IEA, 2015).

This is not just a problem for sustainable-energy enthusiasts, but in the medium to long term it is inefficient for utility businesses, and therefore a risk and a cost for participants and consumers as well (Nyquist, 2016). In order to maintain their relevance, and continue to sustain profitable business models, utilities must not simply defend against this disruptive innovation, but must get ahead of the curve and be leading innovators themselves, by re-prioritizing their investments in R&D.

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2. Background

2.1. Technology innovation: the role of universities

While research and development is a broad term that can cover several different ideas, in this article, we use Wonglimpiyarat's (2016) description of "incubator" to define the process of knowledge transfer and commercialization:

> The incubator is an umbrella term referring to a mechanism for technology transfer to promote the growth of innovation and entrepreneurship.

There are many studies that have explored the link between businesses and incubators – and how these partnerships can drive technology innovation (Sagar, 2004; Bakouros et al., 2002; Allen and McCluskey, 1990; Acs and Naude, 2011; Smilor and Gill, 1986).

Rubin et al. (2015) and Klofsten and Jones-Evans (2000) conducted empirical research into the role and ability of incubators to facilitate entrepreneurs' performance and ultimate success. Their findings suggest that, for incubators they studied across Australia and Israel (Rubin et al., 2015) and for entrepreneurs studied in Sweden and Ireland (Klofsten and Jones-Evans, 2000), the collaboration and knowledge shared through the incubation process allowed new startups to increase their understanding of financial, technical, and market processes and, perhaps most importantly, assisted in the ability for the new businesses to raise capital.

The studies also found that university partnerships and the academic environment also played a vital role in assisting with product development. The research suggests that university-based incubators have an important role to play as an intermediary between the academic sector and industry in order to provide the iterative link that allows for effective application and development of university research (Rubin et al., 2015; Fu, 1995; Klofsten and Jones-Evans, 2000).

These findings are consistent with other literature that has outlined how universities around the world are recognizing a shift in their traditional role away from providing conventional academic research and educational functions, to one that promotes innovation, knowledge sharing, and commercialization linked closely with industry developments (Youtie and Shapira, 2008; Haoour and Mieville, 2011; Etzkowitz, 2002).

Of course, the concept of incubators to encourage general business development innovation is not new in Australia – technology parks (also known as science, business, or research parks) were established across the country throughout the 1970s and 1980s to facilitate the flow of knowledge and commercialize research from universities (Phillimore, 1999; Currie, 1985; Monck et al., 1988; Eul, 1985).

Perhaps the most cited example of these parks working with industry is through the telecommunications and information and communications (ICT) space, which was also supported with direct federal government funding of over $150 million to promote innovation in the ICT industry and address existing market failures (Garrett-Jones, 2004). However, Australia is still ranked poorly amongst the Organisation for Economic Co-operation and Development (OECD) nations for collaboration between industry and public researchers.

The importance of research and development is becoming increasing relevant to the energy industry, already grappling with understanding and implementing the next wave of technology development. From their perspective, utilities should develop and strengthen partnerships with university and research institutions and recognize the value they can provide as incubators and as a "vehicle for technology and knowledge transfer" (Rothaermel and Thursby, 2005). Not only do external parties provide new points of view to assist with critical thinking and "outside-the-box" brainstorming, but access to this external knowledge base would either have been incredibly difficult and more expensive to drive internally, or unachievable due to institutional lock-in and the mindset to conform to existing methods and practices (Chesbrough, 2003). Whilst potentially new to the energy sector and incumbents within, these advantages are already widely acknowledged in business innovation and entrepreneurship literature (Bøllingtoft, 2012; Johannisson, 2000; Lofsten and Lindelof, 2001; West and Bogers, 2014).

2.2. Technology policy

Wider than just the energy sector, government must recognize that innovation is critical to creating and maintaining growth across all industries and sectors, and therefore coherent and consistent federal policy is necessary to promote the environment in which this growth can be sustained (Lundvall, 1998; Freeman, 1987). Dalton and Gallachoir (2010) go one step further and suggest that effective technology and innovation policy requires a focus on the creation of user markets to promote technology projects in the short term.

The literature on technology policy also suggests that in order to enable diffusion of the technology innovations, markets as well as "innovation networks" are a necessary part of the process (Norberg-Bohm, 2002; Sagar and Gallagher, 2006; Zhu and Zou, 2006; Guo et al., 2016).

This policy certainty facilitating the creation of markets is observable from the successful cases of the solar PV, wind power, and biofuel industries in China, India, and Brazil (Lewis and Wiser, 2007; Zhang and Gallagher, 2016).

2.3. Case study: China's solar success

Research has shown the rapid success of China as a world leading solar PV manufacturer relies heavily on strong government policy support for technology innovation (Zhang and Gallagher, 2016; Lall and Teubal, 1998; Ockwell et al., 2008; Zhi et al., 2014).

In their research, Zhang and Gallagher (2016) deconstructed the solar PV value chain to analyze the determinative factors that drove China's success in the technology. What they found was a successful strategy that saw the Chinese firms' first acquiring low-cost module manufacturing technologies, before increasing their competitiveness through a step-by-step vertical integration up the value chain.

Success was also contingent on strong government policy incentives, China's manufacturing market's flexibility, and the globalization of engineering and research talent that allowed appropriate knowledge transfer to occur (Zhang and Gallagher, 2016).

2.4. The Western Australia opportunity

The challenges facing electricity utilities around the world are the result of a significant innovation disruption – a transition from the centralized model of service delivery to a renewable distributed model of electricity networks. For Western Australia, this disruptive transition is occurring more acutely, due to a market structure that includes government-owned monopoly utilities that rely heavily on subsidies to provide electricity across the state. As a result, the WA government is now grappling with escalating costs and has recognized the importance that technology innovation will play in allowing the system to take advantage of the renewable resource that is in abundance (Nahan, 2015; Bromley, 2015).

WA utilities are already exploring how the increasing penetration of solar PV may impact the grid, as well as preparing for the