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Make low-carbon energy an integral part of the knowledge economy

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Perspective

From knowledge comes power

For a faster and more secure transition, low-carbon energy needs to become an integral part of the knowledge economy, says Roger Fouquet

Major phases of economic growth are inextricably linked to the emergence of new sources of energy. In the late eighteenth century, the ability to use coal instead of woodfuel in iron production ushered in the Industrial Revolution. Iron steam engines, fuelled by coal, then reduced the cost of power to the benefit of other industries, such as textiles, stimulating economic growth and development into the nineteenth century. In the twentieth century, the combination of electricity and mass production, and of oil and the internal combustion engine, created mutual markets for each other's products, achieving economies of scale and bringing down costs (Freeman and Louça 2001). Energy transitions both depend on economic change and enable economic transformation.

Some argue that these industrial and technological interconnections are crucial to expansion and market dominance, notably by stifling competition (Grübler et al. 1999). Infrastructure, in particular, creates a network effect — reducing the cost of related technologies. The growth of the railroads, for instance, helped engineers travel so that they could expand the telegraph network; increased use of telegraph services made it profitable to set up new railway tracks. Compatible technologies co-evolve and are likely to experience faster cost reductions, have more market success, and remain dominant for longer than isolated technologies. Indeed, one reason why the global economy struggles to leave the fossil fuel energy system is that there are strong interconnections between the coal and natural gas industries and electricity production, and the petroleum and automobile industries, which have allowed fossil fuels to dominate society (Barbier 2013).

Over the past two decades, the global economy has been transformed, most notably by the growth of the 'knowledge economy' founded on networks of information and communication technology (ICT). The World Bank (2012) estimates that, in developing countries, a 10% increase in the amount of people who can connect to the internet boosts economic growth by 1.4%. Economic growth, in turn, drives uptake of computing and internet-based activities. Until recently, energy has not been central to the ICT explosion; the businesses within the knowledge economy have a low energy intensity – individually, they do not require a lot of energy to operate. As they increase in number, however, they account for a growing share of electricity demand, which makes energy an increasingly important consideration (Koomey 2008, Koomey et al 2013). If low-carbon energy can become tightly connected with the knowledge economy, it could help to out-compete fossil fuels and become locked-in.

There are early signs that this integration might happen. Because the knowledge economy has a high value-added to energy-use ratio — that is, energy expenditure is relatively low per dollar generated — many ICT businesses are willing to pay a modest upfront cost or even a premium for renewable energy without greatly influencing production costs. For instance, Google is the largest corporate consumer of renewable power in the world, buying 5.7 terawatt hours, covering 44% of its electricity demands. It plans to be powered entirely by renewable energy from this year, either by investing directly in capacity or by buying electricity on the wholesale market (Vaughan 2016). Microsoft, Apple and Intel already generate nearly 100% of their direct electricity demands from a combination of solar, wind, small-scale hydro and biogas (EPA 2017), equivalent to 6.7 terrawatt hours. There are historical precedents where the power preferences of an economic elite have shaped the wider

adoption of technologies: exclusive shops, restaurants and theatres in New York, London and Paris in the late nineteenth century helped spread electric lighting. Seemingly niche applications can push development and reduce the cost of energy sources and technologies (Fouquet 2010).

The rise of smart meters also reflects the growing integration between renewable energy and ICT. The devices provide a detailed two-way flow of information: power companies can learn what households use power for and when, while customers gain an understanding of market conditions through price fluctuations — and can adjust their consumption accordingly. These benefits are not unique to energy derived from renewable sources, but this flow of information could prove particularly useful in tackling some of the challenges specific to renewable energy. Wind and solar power generation, for example, is greatly affected by weather conditions, making for a volatile electricity market. By signalling to users and appliances to moderate consumption in periods of low solar or wind activity, smart meters can go some way to managing demand to better match the fluctuating supply, helping to stabilize electricity prices (Feuerriegel et al 2016).

Smart meters are also important for the expansion of distributed or small-scale generation of renewable energy, such as households with solar panels. In the long run, these producers are likely to provide an important share of renewable energy. Producers need to signal the amount of electricity they wish to supply to the grid — or to small, local energy networks — using a smart meter to communicate with the electricity market. Thus, demand for intelligent control systems will increase as distributed renewable electricity generation takes off, with ICT at the centre (Parag and Sovacool 2016).

Finally, blockchain technology, which has famously been used by Bitcoin and enables all past transactions to be formally identified, may have a critical role to play. Electricity appears indistinguishable. Thus, consumers wanting to buy or regulators needing to accredit 'green' power may be concerned about the legitimacy of the electricity's source. Blockchain provides the crucial trust in the origins, improving certification schemes and small-scale trading (Orcutt 2017).

The knowledge economy does not have to be low carbon, but there are signs that a mutually beneficial relationship between ICT and renewable energy could emerge, binding them together on an upwards trajectory to positions of dominance. In order to cement this relationship, governments can encourage partnerships between ICT companies and renewable electricity suppliers, such as the US Environmental Protection Agency has done (EPA 2017). This encouragement could extend as far as brokering deals between the two industries. Governments can also support the roll-out of technologies such as smart meters which are so crucial to the development of renewable energy (Zhou and Brown 2017). The next phase of economic growth is underway. Now is the time to ensure it is fuelled by renewable power.

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