Energy and Economic Growth: Why We Need a New Pathway to Prosperity by Timothy J. Foxon. 2018. Earthscan for Routledge. Abingdon.

Tim Foxon's latest book is an ambitious endeavour, seeking to understand how energy transitions drive major phases of economic transformation. He uses historical experiences as a guide to anticipating the potential for a low carbon transition and its ability to stimulate a new 'Industrial Revolution'.

Mainstream economists have tended to ignore the role of energy in long run economic growth. A main reason is that models of economic growth did not include energy as a key input in the production process. The key inputs in traditional models included labour, capital and land. In 1956, Robert Solow's model of long run economic growth simplified this relationship for industrializing economies by only using labour and capital. Although, in 1974, he - as well as Joseph Stiglitz, Bill Nordhaus and Geoff Heal – began to consider the role of energy, the outcome was mainstream economists were locked-into a tradition that suffered from an energy blind-spot.

This blind-spot remained despite real world events (particularly the Oil Shocks of the 1970s) and the emergence of economists, such as James Hamilton and more recently Lutz Kilian, who identified the importance of increases in energy prices on short-run economic growth. In addition, economic historians, particularly Carlo Cipolla, Michael Flinn, Tony Wrigley, David Landes and Bob Allen, have emphasized the central role energy played in long run economic growth, especially during the Industrial Revolution. Thus, mainstream economics has had a schizophrenic understanding of the relationship between energy and economic growth.

As a result, much of the understanding of the impact of energy on long run economic growth has been developed from a non-neoclassical perspective. The implication is a less formalized and more creative understanding. This has included Bob Ayres and Benjamin Warr's (2009) analysis incorporating technical efficiency in driving growth. Two other examples are the books by Chris Freeman and Francisco Louça (2001) and by Carlota Perez (2002), which explore the synergies between resources, technologies, financial markets and industries at different periods in economic history. In 2013, the economic historians Astrid Kander, Paul Warde and Paolo Malanima (2013) also stressed these dynamic interactions. These perspectives are welcome as economists have also too often ignored these interactions and synergies. The main reason for ignoring them are the difficulties in providing robust analysis – both theoretically and empirically.

In the most recent book taking this perspective, Tim Foxon seeks to understand the role energy has played in driving the major economic transformations observed since the Industrial Revolution. His ultimate objective is to use this perspective to offer insights about how a low carbon transition may influence economic growth. Thus, as a reader, three questions emerge: first, does he provide a good summary of our understanding to date? Does he successfully analyse the relationships between energy and economic

growth? And, does this perspective shed light on a possible future industrial revolution stimulated by a transition to a low carbon economy?

On the first question, Tim Foxon provides a lucid and concise explanation of the many strands of energy research. If a reader wanted to catch up on many of the key economic and engineering concepts related to energy issues, then this book would be an excellent starting point. It introduces the reader to entropy, exergy and energy services. It also covers discussions on energy returns on investment (EROI), limits to growth and energy transitions.

On the second question, the author charts the changing energy systems over the last three centuries, and their influence on 'surges' in economic growth. In the first surge, cotton and iron production, combined with the importance of canals in carrying goods, led to the rise of factory-based production. It also created a structural adjustment crisis that triggered social tensions and, eventually, social progress. In this surge, the key energy source was a renewable energy source, hydropower - a point that could have been explored in more detail to draw lessons from the only surge spurred by renewable energy. The second surge related to the steam engine both in stationary power and transport. This created synergies between the production of goods in factories and the distribution of goods across the railway network. Again, crises of structural adjustments occurred initially and after the phase of high profitability had subsided. An important issue that emerged was the limits of the ecological system, associated with the availability of energy resources and with air pollution. Here, it would have been valuable for the author to touch upon the recent debate by economic historians using econometric analysis to assess the causal role of coal availability on this phase of economic growth. The third surge was also dependent on the expansion of world coal production. It related to electrification, the steel industry and globalization. This surge led to the destabilization of the international political order, which ultimately triggered the two World Wars. The fourth surge was associated with the synergies between the automobile and the oil industries. This powerful force was the result of mass production and the exploitation of cheap natural resources. There is a great deal of overlap and synergies between the third and fourth surges, which is reflected by the discussion on the 1930s Great Depression. Finally, the most recent past has seen the beginnings of a new surge related to information and communication technologies.

Foxon's concept of the surge is instructive. It suggests the history of economic development moves in episodic lurches forward – he argues that have been propelled, in part, by cheaper energy services. It presents the economy as a powerful and uncontrollable mass. This Schumpeterian force creates a new landscape, very different from the previous one. Some gain great fortunes, and many benefit through higher incomes and consumption. This force also destroys, with concentrated areas suffering in the adjustment process. Based on Carlota Perez's (2002, 2013) analysis, he states that surges in economic growth are the culmination of phases of financial speculation and of technological and institutional deployment.

The author is also convincing about the value of wanting to analyse these surges using a co-evolutionary framework. This proposes that the cheaper energy services and economic surges are the result of complex interactions between many agents and factors. Building on Eric Beinhocker's (2006) work, which was heavily influenced by Richard Nelson's evolutionary economics approach, he proposes five key factors that are critical in the surges. These are technologies, institutions, business strategies, user practices and ecosystems. While it is hard to disagree with this proposition, the book is descriptive of the great economic transformations, and does not explore in detail the role of these five factors in the transformations. The framework deserves a deeper and more rigorous analysis. This would involve a richer theoretical framework and a statistical analysis testing the hypothesis that Foxon has proposed. Until then, the jury is out about the validity and the empirical aspects of the framework – in particular, the pivotal role of energy in driving these surges remains unconfirmed.

On the third question, Foxon offers useful insights. For instance, he argues that low carbon technologies will only replace fossil fuels following lengthy processes of niche development and of learning-by-doing cost reductions. These processes will depend on generating complementarities and synergies with institutions, business strategies and user practices. He is also cautious in pointing out that low carbon technologies are different from past experiences because of the public good aspect of the environmental benefits of low carbon technologies, the strong role of government in promoting an energy transition and the urgency of the transition needed.

Regarding the broader economic and social impacts of a low carbon transition, Foxon is more tentative, but still manages to be constructive. He notes that if low carbon technologies have similar characteristics to general purpose technologies, broader economic benefits may ensue. These characteristics are the capacity for continued innovation and falling costs, a wide range of applications and a potential to generate positive spillovers by creating complementary innovations. He notes that, while the first characteristic appears to be present, the other two are not obviously present – for instance, renewable energy technologies are not yet generating new uses. Equally, major spillovers have not yet occurred from the new energy system, though the influence of 'smart' energy on the 'internet of things' may lead to some interesting economic developments. If sufficiently large, these could trigger a new surge, a 'low carbon industrial revolution' as envisaged by Nick Stern. He compares this vision with the prospect of 'de-growth' as outlined by Tim Jackson. Given the evidence from past economic surges, it is worth considering the crises of structural adjustment that are likely to occur during and after a new 'Industrial Revolution'.

To conclude, Tim Foxon's book is a successful synthesis of the exciting debate on the historical role of energy in driving economic growth, the current low carbon transition and its potential to unleash a new 'Industrial Revolution'. He shies away from pushing his own co-evolutionary framework, which deserves more detailed analysis and empirical testing. Hopefully, this will come soon.

References

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Review by Roger Fouquet, London School of Economics and Political Science (LSE), r.fouquet@lse.ac.uk