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## The Path to Sustained Growth: England's Transition from an Organic Economy to an Industrial Revolution (Edward Anthony Wrigley, 2016)

**Référence bibliographique**

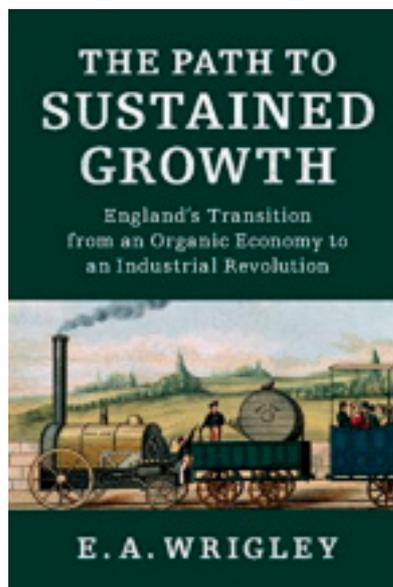
Edward Anthony Wrigley, *The Path to Sustained Growth: England's Transition from an Organic Economy to an Industrial Revolution* (Cambridge, Cambridge University Press, 2016).

**Résumé**

The Path to Sustained Growth is Edward Anthony Wrigley's latest and hitherto most comprehensive book on his highly influential notion of the early modern energy revolution as a precondition for the English industrial revolution. In an erudite and compelling way he has further expanded his idea of organic and mineral economies. While this has become one of the key elements in (neoclassical) economic history, now is perhaps the time to move beyond the classical economists towards a more integrated energy history, in which energy is framed in its social, economic, political, and cultural meanings, contexts, and realities.

**Plan de l'article**

- A pioneer in the economic history of energy
- *The path to sustained growth*: in search for explanations of the industrial revolution
- Moving beyond the classical economists?
- Energy, economy and society: towards an integrated history of energy?



### A PIONEER IN THE ECONOMIC HISTORY OF ENERGY

1 The great merit of Edward Anthony Wrigley is that he has put energy on the agenda of economic history. As one of Britain's leading economic historians, Wrigley has written a wealth of publications on a wide range of topics such as energy transitions, historical demographics, agricultural change, and urbanisation – all of which were employed to explain the industrial revolution.<sup>1</sup> Indeed, Wrigley has fruitfully dedicated most of his academic career to seeking for the long-term explanations of the English industrial revolution. One of his most known and influential theses is the role of new energy forms in producing modern economic growth. Since 1962, when he published his first article on the supply of raw materials in the industrial revolution, Wrigley has

<sup>1</sup> A selection from his bibliography: Edward Anthony Wrigley, *Industrial Growth and Population Change: A Regional Study of the Coalfield Areas of North-West Europe in the Later Nineteenth Century* (Cambridge: Cambridge University Press, 1961); *Id.*, *People, Cities and Wealth: The Transformation of Traditional Society* (Oxford: Blackwell, 1987); *Id.*, *Continuity, Chance and Change: The Character of the Industrial Revolution in England* (Cambridge: Cambridge University Press, 1988); *Id.*, *Poverty, Progress, and Population* (Cambridge: Cambridge University Press, 2004); *Id.*, “The Transition to an Advanced Organic Economy: Half a Millennium of English Agriculture”, *The Economic History Review*, vol. 59, n° 3, 2006; *Id.*, *Energy and the English Industrial Revolution* (Cambridge: Cambridge University Press, 2010); *Id.*, “Urban Growth in Early Modern England: Food, Fuel and Transport”, *Past and Present*, vol. 225, 2014.

worked out an innovative model on the relation between energy and economy.<sup>2</sup> By pointing at the importance of England's early embrace of coal, he has put greater emphasis on one of the earlier “revolutions” that preceded industrialisation. Due to its land-saving effects, coal allowed the agricultural output of food and raw materials to grow, while its physical characteristics also supplied a vastly greater amount of energy required to meet large-scale consumer and industrial demand. Through energy, Wrigley found a way to integrate the complex historical dynamics between demographic changes, agricultural productivity, urban growth, changing occupational structures, changes in transport facilities, and technological changes into the grand narrative on the English “industrial revolution”.

In this respect, Wrigley's most recent book *The Path to Sustained Growth: England's Transition from an Organic Economy to an Industrial Revolution* is a continuation of his series of volumes on the topic. The central argument remains the same: the exploitation of fossil fuels as a new energy source was essential for “organic economies” to transform into an industrialised “mineral economy”. The organic economy is defined as an energy-scarce economy relying on *flows* of energy generated by photosynthesis, a process by which solar energy is captured and stored by plants. This traditional energy system predominantly remained an agrarian regime where farmers fetched whatever they needed from the land: food and fodder for human and animal muscle power, complemented by water and wind power; and wood as building material and fuel for their fires. A mineral or industrial economy, on the other hand, is characterised by high levels of energy consumption, primarily drawn from pre-existing *stocks* of fossilised energy – “the product of plant photosynthesis accumulated over geological ages” – which are used to break the photosynthetic constraint

<sup>2</sup> Edward Anthony Wrigley, “The Supply of Raw Materials in the Industrial Revolution”, *The Economic History Review*, vol. 15, n° 1, 1962.

on growth in organic economies.<sup>3</sup> The industrial revolution can thus essentially be viewed as an energy revolution, a significant breakpoint in the material circumstances of mankind after the mastery of fire and the Neolithic agricultural revolution as earlier transformations of energy supply.<sup>4</sup> Eventually, this transition paved the way for modern economic growth, of which the essence consists in its sustained character. In the words of Sieferle, who is quoted by Wrigley, “[t]he history of energy is the secret history of industrialisation”.<sup>5</sup>

3 While scholars like Alfred Crosby and Vaclav Smil have more focused on the “big history” of energy, Wrigley pioneered in writing energy’s economic history.<sup>6</sup> Although it probably was the Italian historian Carlo M. Cipolla who wrote the first real economic history of energy through its relationship with population growth,<sup>7</sup> Wrigley has fundamentally shaped this entire field. A first wave of publications appeared during the 1970s and 1980s. In the wake of the oil crisis scholars such as Jan-Willem de Zeeuw, Paul Bairoch, Brinley Thomas, and Jean-Claude Debeir, Jean-Paul Deléage and Daniel Hémerly – to name but a few – searched for the historical meanings of energy in processes of economic development.<sup>8</sup>

<sup>3</sup> Edward Anthony Wrigley, *The Path to Sustained Growth: England’s Transition from an Organic Economy to an Industrial Revolution* (Cambridge: Cambridge University Press, 2016), 18.

<sup>4</sup> See *Ibid.*, chapter 1 (“Organic economies”).

<sup>5</sup> Rolf Peter Sieferle, *The Subterranean Forest: Energy Systems and the Industrial Revolution* (Cambridge: The White Horse Press, 2001), 137.

<sup>6</sup> Alfred W. Crosby, *Children of the Sun: A History of Humanity’s Unappeasable Appetite for Energy* (New York: W.W. Norton, 2006); Vaclav Smil, *Energy in World History* (Boulder: Westview Press, 1994); Vaclav Smil, *Energy and Civilization. A History* (Cambridge: MIT Press, 2017).

<sup>7</sup> Carlo M. Cipolla, *The Economic History of World Population* (Harmondsworth: Penguin, 1962).

<sup>8</sup> Jan-Willem de Zeeuw, “Peat and the Dutch Golden Age. The Historical Meaning of Energy Attainability”, *AAG Bijdragen*, vol. 21, 1978; Paul Bairoch, “Énergie et révolution industrielle: nouvelles perspectives”, *Revue de l’Énergie*, vol. 356, 1983; Brinley Thomas, “Was there an energy crisis in Great Britain in the 17<sup>th</sup> century?”, *Explorations in Economic History*, vol. 23, n° 2, 1986; Jean-Claude Debeir, Jean-Paul Deléage and Daniel Hémerly, *Les servitudes de la puissance: une histoire de l’énergie* (Paris: Flammarion, 1986).

But it is only since very recently that energy is being taken seriously in (economic) history again. Some of the most elegant examples of this renewed scholarly interest in energy history are the book series directed by Paolo Malanima providing a great amount of data on energy consumption in various European countries,<sup>9</sup> the synthesis *Power to the People* written by Astrid Kander, Paul Warde and Paolo Malanima on the historical entwinement between energy consumption and economic development,<sup>10</sup> and the collection of case studies looking for a typology of (hybrid) energy transitions in the past within their economic, political and social frameworks in *L’Europe en transitions* edited by Yves Bouvier and Léonard Laborie.<sup>11</sup> The scope of energy historians has not been limited to Europe, as is apparent in the work of Christopher F. Jones and Ruth Wells Sandwell for instance who investigated the energy history of America and Canada, respectively.<sup>12</sup> In global history as well, energy has become a potential factor in explaining divergent paths of regional development, particularly so in Kenneth Pomeranz’ concept of “ghost acreage”, by which he not only refers to the European colonies in the New World but also to the domestic coalfields in Britain, both alleviating pressures on the land.<sup>13</sup> While adding different accents in each of their narratives, all

<sup>9</sup> Paul Warde provided the data for *England and Wales: Energy Consumption in England & Wales, 1560–2000* (Naples: Consiglio Nazionale delle Ricerche, Istituto di Studi sulle Società del Mediterraneo, 2007).

<sup>10</sup> Astrid Kander, Paolo Malanima and Paul Warde, *Power to the People: Energy in Europe over the Last Five Centuries* (Princeton: Princeton University Press, 2013). See also: Roger Fouquet, *Heat, Power and Light: Revolutions in Energy Services* (Cheltenham: Edward Elgar, 2008).

<sup>11</sup> Yves Bouvier and Léonard Laborie (eds.), *L’Europe en transitions. Énergie, mobilité, communication, XVIII-XXI<sup>e</sup> siècles* (Paris: Nouveau Monde Éditions, 2016).

<sup>12</sup> Christopher F. Jones, *Routes of Power, Routes of Power: Energy and Modern America* (Cambridge: Harvard University Press, 2014); Ruth Wells Sandwell (ed.), *Powering up Canada: A History of Power, Fuel, and Energy from 1600* (Montreal: McGill-Queen’s University Press, 2016).

<sup>13</sup> Kenneth Pomeranz, *The Great Divergence: China, Europe, and the Making of the Modern World Economy* (Princeton: Princeton University Press, 2000).

these historians have stressed the importance of energy transitions in history.<sup>14</sup>

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### **THE PATH TO SUSTAINED GROWTH: IN SEARCH FOR EXPLANATIONS OF THE INDUSTRIAL REVOLUTION**

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- 4 At the beginning of his introduction Wrigley states that the object of his book is “to describe the transformation in the capacity to produce goods and services which took place in England over a period of three centuries between the reigns of Elizabeth I and Victoria, and which is conventionally termed the industrial revolution”.<sup>15</sup> A largely agrarian society, England was still on the economic periphery of Europe at the beginning of the sixteenth century. By the eighteenth and nineteenth centuries, however, it had turned into the leading power of the global economy. In search for explanations for this remarkable transformation, Wrigley has found a solution in the energy basis which an economy relies on. In order to escape the trap of energy scarcity and organic stagnation, he claims, societies had to gain access to a different source of energy. Mining coal was the solution. Exploiting a stock of fossil fuels that provided abundant and cheap energy enabled the English economy to attain a scale of production that was otherwise beyond reach.<sup>16</sup>
- 5 Much of Wrigley’s resource-intensive view is constructed on the notion of positive and negative feedback. In organic economies negative feedback was common. Population growth was kept in check by the natural limits on agricultural productivity. Cultivation of marginal land or intensification of existing land would eventually experience diminishing marginal returns (involution), thus inhibiting further growth and

reducing living standards. The increasing importance of England’s underground ghost acres from the sixteenth to nineteenth centuries gradually alleviated these pressures on land, turning negative feedback into positive feedback. Coal not only allowed to break the energy constraints on economic and demographic growth, it also provided a drastic expansion of the limited supply of land by substituting fields and forests by the stores of minerals lying beneath them. In other words, if an industrial revolution was to take place, England first had to transform from an energy-scarce to an energy-rich society.

This “energy revolution” binds all the chapters of the book together. But other topics that interacted with the changing balance between traditional and new energy sources are grasped by Wrigley as well. In chapters 3 to 6 he tackles the interplay between energy consumption, urban growth, agricultural productivity, changing occupational structures, and demographic changes.<sup>17</sup> A first fundamental process was the urbanisation of early modern England. The intense nature of this process stimulated the production of both an agricultural and energy surplus that needed to meet ever growing urban requirements of food and fuels. Next, the expansion of the secondary and tertiary sectors amplified the incentive for farmers to produce for an urban market even further. Not only resulted this into a rise in the total consumption of energy, the per capita energy consumption increased as well. Wrigley explains this mostly through the rise of the Western European marriage system, which, by increasing the number of nuclear families, probably increased the demand for home heating. Most of the per capita increase in energy consumption, however, was due to rising demand for heat-intensive manufacture like metallurgy, glassmaking, and dyeing, which, in its turn, benefited from growing consumer demand for such products of urban “comfort” as a result of a rise in the real income per head. In chapter 7, Wrigley describes the role of transport improvements in making

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<sup>14</sup> A recent overview in Alain Beltran, “Introduction: Energy in History, the History of Energy”, *Journal of Energy History/Revue d’Histoire de l’Énergie*, vol. 1, 2018.

<sup>15</sup> Edward Anthony Wrigley, 1 (cf. note 3).

<sup>16</sup> See also Robert C. Allen, *The British Industrial Revolution in Global Perspective* (Cambridge: Cambridge University Press, 2009) who emphasised the combination of high wages and cheap energy in Britain’s process of cost-effective industrial mechanisation.

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<sup>17</sup> Edward Anthony Wrigley, chapters 3 to 6 (“Energy consumption”, “Urban growth and agricultural productivity”, “Changing occupational structure and consumer demand”, and “Demography and the economy”) (cf. note 3).

coal cheaply and abundantly accessible to a wide market area.<sup>18</sup> All of these processes were symptomatic to an advancing organic economy that, with the invention and steady improvement of the steam engine, eventually turned into a mineral economy at the beginning of the nineteenth century, when the English industrial revolution finally reached its completion and the way to sustained growth was paved.<sup>19</sup>

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### MOVING BEYOND THE CLASSICAL ECONOMISTS?

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7 It is evident from the entirety of Wrigley's work on the industrial revolution that energy mattered, if not only, then primarily. Wrigley has certainly not neglected various other historical processes in the build-up to the industrial revolution, as I mentioned above, but his binary model of organic and mineral economies is fundamental in his understanding of the genesis of a modern self-sustaining economy. Most of the economic historiography on energy is firmly rooted in a Malthusian and Ricardian terminology, which could be deemed as an "ecological model of economic development", as Ricard G. Wilkinson has attempted to reconstruct.<sup>20</sup> Coal is then perceived as an exogenous factor that helps explaining why England, anchored in its energy endowments, was able to overcome the limits to both production and reproduction. The turn to fossil fuels thus formed the answer to Ricardian land scarcity and Malthusian checks on population growth in a pre-industrial context, enabling the country to establish a Smithian economy of growth.

8 Wrigley has closely read the writings of the classical economists, to whom he devotes an entire chapter in his book.<sup>21</sup> In economic history Adam Smith, David Ricardo and Thomas

Malthus obviously continue to have a tremendous influence. While highly original, Wrigley's narrative, however, follows the classical economists rather blindly at times. Part of his thesis might therefore appear to be somewhat self-explanatory; as soon as coal replaced traditional forms of energy, modern economic growth was the logical outcome. But was it? There is a long history between England's energy revolution in the sixteenth and seventeenth centuries and its industrial revolution in the eighteenth and nineteenth centuries. As said, Wrigley has convincingly pointed at the importance of the long-term effects of an early transition to coal, but the way how he ties both revolutions to one another is not always as convincing. For Wrigley, the industrial revolution in the long run – "between the reigns of Elizabeth I and Victoria" – was the energy revolution to coal.<sup>22</sup> But was this coal revolution so inextricably linked to a process of industrialisation, if until far into the nineteenth century most coal was consumed by households?<sup>23</sup> Surely coal, whether consumed for industrial or domestic purposes, afforded land-saving effects. But when the industry definitively liberated itself from natural constraints at the beginning of the nineteenth century, households had already done so two or three centuries earlier. Perhaps we need in the future to devote more attention to the role of the household economy in "learning to heat a house with coal", rather than focusing on the industrial benefits and applications of new energy sources.<sup>24</sup>

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### ENERGY, ECONOMY AND SOCIETY: TOWARDS AN INTEGRATED HISTORY OF ENERGY?

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Wrigley's celebratory narrative on England's energy transition and his rather uncritical reading of the classical economists runs the risk of rectifying a somewhat a-historical view on the "normal state of affairs" of poverty and stagnation in economic history. Wrigley sees in coal a necessary condition for the industrial revolution to happen. The rare blessing – or "geographical

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<sup>18</sup> Edward Anthony Wrigley, chapter 7 ("Transport") (cf. note 3).

<sup>19</sup> *Ibid.*, chapters 8 and 9 ("England in 1831" and "The completion of the industrial revolution").

<sup>20</sup> Richard G. Wilkinson, *Poverty and Progress: An Ecological Model of Economic Development* (New York: Praeger, 1973).

<sup>21</sup> Edward Anthony Wrigley, chapter 2 ("The classical economists") (cf. note 3).

<sup>22</sup> *Ibid.*, 1.

<sup>23</sup> William M. Cavert, "Industrial Coal Consumption in Early Modern London", *Urban History*, vol. 44, n° 3, 2017.

<sup>24</sup> Robert C. Allen, 90 (cf. note 16).

accident”, as Pomeranz has called it<sup>25</sup> – that England found in its accessibility to an abundance of coal explains how it escaped the “logical constraints of an organic economy”.<sup>26</sup> Chance lied in between continuity and change. The lack of a transition to coal is then the reason why an economy like the Dutch, which in the early modern period was most comparable to the English economy, failed to capitalise on all the features it had of becoming a prosperous and modernised society. Less so in *The Path to Sustained Growth* but rather bluntly in his earlier work, Wrigley refutes the connection between industrial capitalism – as a social-economic system – and the rise of fossil fuels, by depicting it as “casual rather than causal”.<sup>27</sup>

10 Energy, as an exogenous factor, can never be an autonomous explanation in itself. Wrigley interprets coal mostly as an independent explanatory factor in trying to understand the industrial revolution. But the question why modern economic growth could be achieved by eighteenth- and nineteenth-century England is inextricably linked to the reverse question: why coal? Most economic historians of energy would reply that coal was the obvious answer to pre-industrial scarcity. But this is an insufficient answer. How could a fuel already known and used since the Middle Ages and long considered inferior because of its foul smell and smoke only be popularised from the sixteenth to nineteenth centuries?

11 Moving beyond the classical economists might help us in establishing future perspectives in the economic history of energy. Current challenges in society will urge energy historians to engage more with ecological issues in their broadest sense: the historical interaction between “energy”, “economy”, and “society”. Scholars like Stephen Mosley and William M. Cavert pioneered in writing an environmental-economic history of energy, by scrutinising the feedback between processes of urbanisation, economic growth, and

their environmental consequences.<sup>28</sup> The dialectic relation between “energy” (or, more broadly, “environment”) and “economy” is further elaborated in the concept of urban metabolism, as initiated by Fridolin Krausmann and Sabine Barles for instance. They illustrate how urban economies were not only made by energy endowments but how they also co-produced their own ecological hinterlands.<sup>29</sup> A book like Timothy Mitchell’s *Carbon Democracy* also shows how energy systems and their histories are closely intertwined with structures of political and economic power.<sup>30</sup>

“Society” is the last part of the ecological triad. 12 A recent initiative on the material cultures of energy led by Frank Trentmann and Hiroki Shin for instance shows that homes, rather than industrial workshops or factories, have long been the sites in which energy regimes were produced and reproduced within the social and cultural practices of domestic life.<sup>31</sup> According to David E. Nye the electrification of America was largely a social product made by ordinary consumer behaviour, eventually reaching “technological momentum”

<sup>28</sup> Stephen Mosley, *The Chimney of the World: A History of Smoke Pollution in Victorian and Edwardian Manchester* (London: Routledge, 2008); William M. Cavert, *The Smoke of London: Energy and Environment in the Early Modern City* (Cambridge: Cambridge University Press, 2016).

<sup>29</sup> Fridolin Krausmann, “A City and its Hinterland: Vienna’s Energy Metabolism 1800–2006”, in Simron Jit Singh, Helmut Haberl, Marian Chertow, Michael Mirtl, and Martin Schmid (eds.), *Long Term Socio-Ecological Research: Studies in Society-Nature Interactions across Spatial and Temporal Scales* (Dordrecht: Springer, 2013); Sabine Barles, “The Main Characteristics of Urban Socio-Ecological Trajectories: Paris (France) from the 18<sup>th</sup> to the 20<sup>th</sup> Century”, *Ecological Economics*, vol. 118, 2015.

<sup>30</sup> Timothy Mitchell, *Carbon Democracy: Political Power in the Age of Oil* (London: Verso, 2011). See also: Andreas Malm, *Fossil Capital: The Rise of Steam Power and the Roots of Global Warming* (London: Verso, 2016).

<sup>31</sup> See <http://www.bbk.ac.uk/mce>. See also: Ruth Schwartz Cowan, *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave* (New York: Basic Books, 1983); Priscilla Brewer, *From Fireplace to Cookstove: Technology and the Domestic Ideal in America* (Syracuse: Syracuse University Press, 2000); Elizabeth Shove, *Comfort, Cleanliness and Convenience: The Social Organization of Normality* (Oxford-New York: Berg, 2003); Christopher F. Jones, “The carbon-consuming home: residential markets and energy transitions”, *Enterprise & Society*, vol. 12, n° 4 (2011).

<sup>25</sup> Kenneth Pomeranz, 62 (cf. note 13).

<sup>26</sup> Edward Anthony Wrigley, *Continuity, Chance and Change*, 115 (cf. note 1).

<sup>27</sup> *Ibid.*

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as soon as social pressures on this large-scale energy network grew high enough.<sup>32</sup> In a similar vein, Yves Bouvier very recently introduced in this journal the concept of “energy consumers” to emphasise the deeper societal roots of energy consumption and transitions.<sup>33</sup> Ultimately, according to Roger Fouquet, energy systems were subjected to the path-dependent effects of technologies, infrastructures, institutions, and behaviours.<sup>34</sup> Moving beyond the Ricardian–Malthusian idea of “external” constraints on the “internal” dynamic of social and economic development, all these new approaches of research have stressed the interconnectedness between economy, society, and energy.

- 13 In a way, Wrigley ends *The Path to Sustained Growth* on a similar note. It is no coincidence that he has already attracted the attention of environmental historians. In his coda, Wrigley nuances the success story of England’s industrial

revolution, by pointing out the potential dangers of resource exhaustion, pollution and global warming.<sup>35</sup> Even if it provided the opportunity to radically expand the productivity of the economy, in the longer term the energy basis of a mineral economy cannot be sustained. As I said at the beginning of this article, the great merit of Wrigley is that he has made energy central to the research agenda of economic historians. Wrigley’s work provides many answers, but also raises numerous new questions. In the future, energy historians will depart from where Wrigley has ended.

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**32** David E. Nye, *Electrifying America: Social Meanings of a New Technology, 1880-1940* (Cambridge: The MIT Press, 1992); *Id.*, *Consuming Power: A Social History of American Energies* (Cambridge: The MIT Press, 2001).

**33** Yves Bouvier, “Energy consumers, a boundary concept for the history of energy”, *Journal of Energy History/Revue d’Histoire de l’Énergie*, vol. 1 (2018). See also the very recent special issue on this topic in *The History of Retailing and Consumption*: Ruth Wells Sandwell and Abigail Harrison Moore, “Off-grid empire: rural energy consumption in Britain and the British Empire, 1850-1960”, *The History of Retailing and Consumption*, vol. 4, n° 1, 2018.

**34** Roger Fouquet, “Path dependence in energy systems and economic development”, *Nature Energy*, vol. 1 (2016).

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**35** Edward Anthony Wrigley, chapter 10 (“Review and reflection”) (cf. note 3).

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