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The pre-industrial energy crisis and resource scarcity as a source of transition☆

W. Edward Steinmueller

SPRU Science and Technology Policy Research, University of Sussex, United Kingdom

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ABSTRACT

The historical British 'timber famine' of the 18th century is re-examined in the light of contemporary concerns about transitions in energy use. The alternatives of scarcity-induced and opportunity-led transition are considered in relation to the economics of sustainable fuel timber production for industrial uses. The paper finds that the production of timber was an economically sustainable use of land and that observations of timber shortages may have therefore either been claims made by interests favouring the use of coal or the consequence of abandonment of fuel timber cultivation in favour of coal use. The longer-term sustainability of domestic UK sources for industrial timber fuel timber is shown to be problematic. The consequences of the alternative views of the 'timber famine' for contemporary policies attempting to promote transition to low carbon or sustainable energy use are examined. In particular, if the present is an echo of the past, opportunity rather than crisis may be the more powerful lever of change.

1. Introduction

This article examines the issues of resource sustainability from an historical perspective. Historical understandings of the use and depletion of natural resources have played a major role in policy debates in cases such as enclosure (the privatization of agricultural commons land in the UK beginning in the 16th century) (Hardin, 1968; Ostrom et al., 1999) and the decline of the Chilean nitrate industry with the invention of the Haber-Bosch process for fixing nitrogen and thus for making artificial fertilizer substitutes (Hughes, 1969). Among the lessons drawn from these historical cases are ideas about the governance of resource use and the potential for resource substitution given the potential for resource depletion. A major historical reference point for resource depletion debates is the 'timber famine,' the depletion of the forests of the British Isles which began prior to the industrial revolution. Forest depletion has been cited as a motive for technological innovation in the industrial applications of coal, initially for process heat and then as the primary energy resource for the inter-linked development of the iron and steel, steam engine and railroad industries – which, along with textile manufacture, were the defining industries of the English industrial revolution.

In the present era, concerns about the accumulation of carbon in the earth's atmosphere have prompted discussion of a 'transition' in the use of energy to sources that are more sustainable, either because they involve lower carbon emissions or employ a carbon cycle which takes up and releases carbon (e.g. the alternating cycle between accumulation and combustion of biomass). Historically, there have been several transitions in the use of fuels as an industrial heat source; wood to charcoal, charcoal to coal and coal to petroleum.[1] Only fragmentary evidence about the nature of the first transition survives from its pre-Roman origins. The second transition occurred in England and Wales between the reigns of Henry VIII (1491–1547) and George III (1760–1820). Coal was known in Roman times.[2] However, in that age of wood and charcoal fuel, as well as for many of the centuries that followed, stones that burned were curiosa in traveller's accounts.

There are two primary narratives describing the transition from charcoal to coal. The first is that timber reserves were depleted

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E-mail address: w.e.steinmueller@sussex.ac.uk

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[1] While electricity is vitally important means of *transporting* energy, its generation relies upon other energy sources including hydroelectric and nuclear power, neither of which plays a dominant role outside of a handful of countries such as Norway (hydro) and France (nuclear). More broadly, wind and water energy sources are also of historical and contemporary importance, see Nye (1999) for an examination of the interplay of different energy sources in American industrialization.

[2] Nef (1932).

due to the expansion of industrial activity and the growth of urban populations in the 17th and 18th centuries. This narrative draws upon contemporary accounts of the forest depletion and appeals to national security concerns regarding the use of timber, not only as a fuel, but also to construct ships for the Royal Navy and merchant shipping. The 'timber famine' has been central to the existing accounts of the transition to coal and is supposed to have been of cataclysmic proportions. Two modern accounts state:

> All the evidence suggests that between the accession of Elizabeth I and the Civil War England, Wales, and Scotland faced an acute shortage of wood, which was common to most parts of the island rather than limited to special areas, and which we may describe as a national crisis without laying ourselves open to a charge of exaggeration.
> Nef (1932:161)

> "...by the time we come to the end of the sixteenth century, an alarming picture of timber famine is emerging", though there was still sufficient woodland in the early 18th century to permit "a last feverish clutching at unexploited forest". They found that, "had no alternative to timber been available, the expansion of industry that England experienced in the Elizabethan era would have been abortive", and see many of the technological advances in English industry of the 16th to 18th-centuries as "the means whereby a timber starved civilization surmounted its problems."
> Flinn (1959:109) quoting from Clow et al. (1956)

A contemporary observation made in a petition to Parliament to secure a patent in the production of iron using pit coal stated:

> This use of charcoal in our iron works, has greatly exhausted our woods; the waste and destruction of which in Sussex, Stafford, Hereford, Warwick, Worcester, Monmouth, Gloucester, Pembroke, Glamorgan, and Shropshire, and many other counties, is not to be imagined. So great is the scarcity of wood in many of those places, that where cord wood had been sold at six and seven shillings per cord, it is now sold for upwards of fifteen and twenty shillings; and in some places is all consumed. As the price of wood-coal [charcoal] therefore is rather upon the increase than diminution, the evil will grow greater and greater. This will either lessen our homemade manufacture of bar iron, and consequently increase our importation of foreign iron or it will render the same dearer and dearer to all British manufacturers, to the great injury of every branch of our iron trade in general. Besides, if care be not take to preserve our timber from those consuming furnaces, they will lay hold of our oak, and deprive us of a supply for the Royal Navy and merchant's shipping, to the greater discouragement of ship-building and navigation, upon which the safety and splendour of these Kingdoms depend.
> Postlewayt (1747:2–3)

There is no evidence that the author of this petition, Malachy Postlewayt, was aware of Abraham Darby or his son's endeavours at Coalbrookdale (Mott, 1957; Raistrick, 1953). The internal evidence from this pamphlet document suggests that Postelwayt believed that the technological solution to the use of coal for iron production required the building of larger furnaces, an endeavour that would have been difficult to finance without securing a patent, the aim of the pamphlet. In addition, the pamphlet's subtitle 'Thereby to save the nation above two hundred thousand pounds per annum, we at present pay for foreign bar iron' indicates the mercantilist logic underlying the appeal.

The second narrative describing the transition from charcoal to coal is an account of how the innovations in the use of coal opened up new production possibilities and heralded the substitution of coal for charcoal, an example of conquest of the material world made possible by the use of technology.[3] These writers have expressed an optimistic view of the efficacy of technological innovation in solving a substantive problem of economic growth, the acquisition of adequate energy supply. Moreover, the substitution of coal for charcoal is seen as a key feature of the organizational and technological inventions that we call the industrial revolution.[4] A key turning point in this historical narrative is the successful smelting of iron ore with coke in 1709 by Abraham Darby[5] and the later opening of the era of 'cheap energy' resulting first from innovations in coal extraction and then still later, from the use of petroleum, a series of transition that spans over two centuries.[6]

Applying these historical lessons to our contemporary energy use problems yields two rather different views of the nature of the causes of technological transitions.[7] In the first view, innovations are the product of "crisis"; the anticipation of crisis sets in motion forces of innovation to produce a different path of development in order to overcome the crisis. From a "crisis" viewpoint, the contemporary "denial" of the consequences of carbon emission in stimulating climate may be impeding the scale and intensity of the innovative effort necessary to achieve a transition to a more sustainable pattern of resource production and use. In the second view, the transition to alternative means of energy production in our era is the consequence of the absence of sufficiently promising technological alternatives to redirect and hasten innovative effort to seize the opportunities provided. These are, of course, simplified views of the processes of transition. Because each has rather different implications for the timing, location and level of effort that can be expected, however, it is worth revisiting the historical example to see consider the path not taken – the continued use of timber and charcoal as an industrial fuel.

The principal thesis in what follows is that whatever depletion of timber resources might have been observed from 1600 to 1800, this was largely the result, rather than the cause, of the use of coal as a fuel. In other words, although fuel timber production was sustainable, the use of coal offered several specific advantages that may have discouraged fuel timber production. The ability to transport coal greater distances was helpful in supplying heating for London and other increasingly urban areas. Perhaps of greatest significance, the use of coal offered an opportunity to establish a new pathway for economic development. As Wrigley (2010:21) observes, a '...necessary condition for the escape from the constraints of an organic economy was success in gaining access to an energy source which was not subject to the limitations of the annual cycle of insolation and the nature of plant photosynthesis.' As momentous as subsequent developments have been, it is the beginnings of the path not taken that are considered here, a path in which energy use remained bound by the limitations that Wrigley identifies. Following this path for an extended period would have led to a world very different from our own. One can only speculate as to whether it might have been a path that was sustainable for millennia rather than for centuries, even though it would have been a path that seems likely to have discouraged many other developments that are intrinsic features in our contemporary world. From this perspective, the 'timber famine' seems to be a consequence, rather than the cause, of Postlewayt's pamphlet and similar expressions.

[3] Nef (1964), Ashton (1951), and Rosenberg (1973) and Wrigley (2010) are examples.
[4] Mokyr (1992), von Tunzelmann (1993), Wrigley (2010).
[5] Mott (1957) and Raistrick (1953).
[6] Wrigley (2010).
[7] This view should be contrasted with the more nuanced and multi-level perspective arising from the work of Geels (2002, 2004, 2010) and Geels and Schot (2007) and other scholars interested in the co-evolution of social and technical factors, many of which are cited in these papers.