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Arrested Development? Energy Crises, Fuel Supplies, and the Slow March to Modernity in Scotland, 1450–1850

In common with records from many parts of northern Europe through the period 1450–1850, Scottish record sources portray a protracted crisis regarding energy resources generally and the supply of fuel to urban centers specifically, despite the fact that, unlike many European states, Scotland was a relatively energy-rich environment. Several factors hindered intensification of industrial activity and retarded national economic growth: an underdeveloped communications infrastructure for bulk intra-regional transportation, strong regional variation in the natural presence or accessibility of particular fuel types, often punitive pricing strategies, and localized fiscal-legal systems that limited the potential or incentive for infrastructure or internal trade development. Lack of capital for investment in commercialized fuel extraction completed a picture of abundant but inaccessible fuel resources. This hampered the development of economic activity, activity that might stimulate demand and so encourage investment in the resource exploitation. Further pressure was introduced by social and cultural factors in the eighteenth and early nineteenth centuries, where use of particular fuel types became linked to theories of social progress, politeness, and modernity. The pressure encouraged abandonment of the use of an abundant and relatively cheap resource—peat—and promoted the use of a scarcer and more expensive alternative—coal. Rapid expansion of the banking sector, access to capital for investment in mine engineering technology, and progressive enhancement of transport networks relieved those pressures and completed a transition to a marketization of the energy supply and a redeployment of labor from activities like fuel-winning to what were perceived as more economically productive tasks.

For most of the period under review in this paper, reliable quantitative data concerning population levels in Scotland is lacking. Estimates, however, suggest that around 1450 the majority of Scotland's urban centers had populations below 1,000. Probably only Aberdeen, Dundee, Perth, and Edinburgh had populations over 5,000 before 1500, with Edinburgh rising to about 12,000 in the later sixteenth century. These urban centers were classed as "royal burghs"—communities that had received royal charters bestowing exclusive economic privileges over aspects of trade and commerce

and assigning exclusive rights over the natural resources of a defined hinterland. One key aspect of these privileges was the right to fuel resources, mainly specified as peat by the later Middle Ages.

Documentary records indicate that peat supplies were already under pressure in some burghs before 1300. However, legislation to control extraction dates mainly from the post-1500 period. With fuel supply having a large influence on the nature of craft and industrial activity as well as affecting domestic routines, local access to alternative energy resources determined winners and losers in urban economies and regional development. The natural distribution of accessible fuel resources imposed limits to development in certain regions. Late medieval Scotland had abundant fuel, especially peat, but most was concentrated in the "wrong" places. On the mainland, the main peat supplies by the fifteenth century were in upland blanket peat bogs, far from the main centers of population, or in coalfields that were accessible only on the fringes of the Lowlands. These geographical and geological factors meant that in the late medieval and early modern periods, Scotland was energy rich but economically poor.

Given that the majority of Scotland's population was rural and had access to the upland peat supplies that lay distant from the small urban centers, pressure to develop alternative sources or types of fuel was driven largely by the small urban population, mainly the mercantile and craft elites who dominated urban government. Intensification of extraction of bulk fuel supplies for urban domestic and industrial needs remained limited where easy access to peat sources still existed. It was further hampered by the prevalent use of personal ("free" or cheap labor) to "win" fuel for private, domestic use. There was, consequently, limited market pressure for developing alternative fuels.

Seasonal labor patterns up to the early nineteenth century also encouraged the use of personal labor for fuel-gathering activities. Until the era of rapid urbanization and industrialization in Scotland after about 1750, the bulk of the population satisfied domestic fuel needs through the use of their "free" labor to cut peat from common resources. Urban population growth, however, broke the link between personal labor and household fuel supply. Contemporary economic theorists, whose ideas gained wide currency amongst the political and economically-dominant classes, saw the "free" labor used in fuel-gathering as a subtraction from the notional labor pool. This wasted human

energy and time, they argued, could be applied instead to market-oriented production. There followed an era of rapid expansion of the waged-labor sector, limiting the ability of a significant portion of the laboring population to involve themselves in direct production of their own food and fuel requirements and consequently stimulating demand for basic commodities on the market that could be purchased with wage income. One result was a stimulus to the commercial production of fuel on a large scale to meet that demand.

Greater demand, however, was being created by the industries in which many of this new waged laboring class were employed. Scotland's early industries had been small-scale and intensely localized, many lying in districts like the Carse of Stirling, where fuel had once been easily accessible in the formerly peat-covered carse (low-lying, fertile valley land). This was the center of medieval Scotland's principal "industry": the manufacture of salt through the sleeching and boiling of brine. As peat-sources became exhausted in the Middle Ages, salt-masters began to seek alternative fuels. Coal was being mined further east along the shores of the Firth of Forth before 1200, and salt production moved closer to this new fuel source. Mining expanded rapidly after 1400, perhaps partly in response to climatic deterioration in the "little ice age," when increased rainfall is recorded as affecting peat-cutting, supply, and use. The coal that was mined, however, was mainly consumed locally because the transport infrastructure remained rudimentary. Mine operations, too, were under-developed and non-commercial, most being mere seasonally exploited adjuncts of private landed estates, intended to supply their owners and their immediate dependents. Only mines close to major urban centers in the immediate vicinity of the workable seams, like Edinburgh and its satellites along the Fife and Lothian coasts, had increased output to supply burgh markets. Ironically, northern Scottish burghs were importing coal mainly from northeast England by the fourteenth century and continued to do so into the nineteenth century.

Apart from in the burghs closest to mines, coal remained principally a fuel used for industrial processes. It had largely replaced peat for boiling seawater in salt-pan operations around the Firth of Forth by the fifteenth century. It was improvements in mining technology, however, plus access to capital for investment in the eighteenth century, that boosted output and delivered cheaper coal to some markets. This availability of an abundant and reliable supply of fuel for industrial development finally removed any

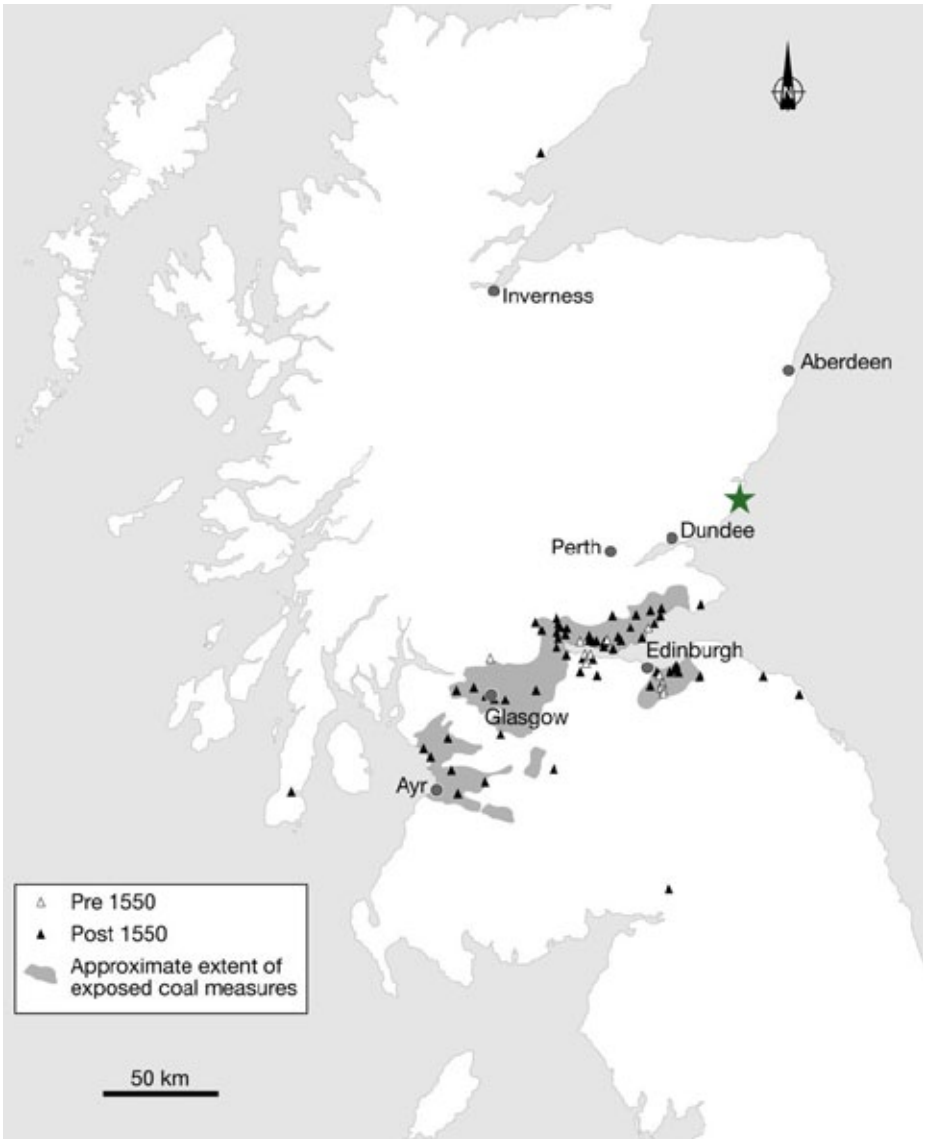

Figure 1: Scottish coalfields. The star marks the position of Red Head, the coastal headland north of which transportation of coal by sea was subject to punitive levels of duty.

lingering dependence on peat close to the coalfields. Taxes on long-distance transport of coal, however, continued to hinder the economic development of areas remote from mines.

Industrial demand led the way in stimulating the development of mining and an increase in output, but domestic use remained low as long as cheaper alternatives that could be obtained with personal labor remained accessible. There was also resistance to the new fuel. Knowledge of the different hearth technology necessary to burn coal and how to cook with it remained limited. Introduction of hearths that were designed for burning coal and that channeled the fumes out of domestic settings was limited due both to cost and to cultural conservatism. In some regions, an impetus towards adopting coal was provided by to the increasing scarcity of peat. From the 1760s, "improving" landlords (who capitalized their property and introduced "scientific" land management and agricultural methods to intensify and increase production) were stripping peat mosses to reach the alluvial clay below them, believing this to be good agricultural soil. At the Flanders and Blair Drummond mosses west of Stirling, for example, the owner of Home Drummond dumped tens of thousands of cubic meters of fuel-quality peat into the River Forth. Former users of this resource were then obliged to burn coal instead.

Further pressure for a move to coal came from fashion and the status of coal in elite society as an icon of modernity. In much Enlightenment-era literature, coal use was seen as a key indicator of an advanced, "modern," and "polite" society, with traditional fuels (especially peat) viewed as indicators of social, economic, and cultural backwardness. Edinburgh's New Town physically embodied the symbolic transition, with all new houses built there being designed and constructed with coal-fired hearths. Elsewhere, the social elite began to convert formerly wood- or peat-burning hearths for coal use, displaying their cultural advancement publicly and encouraging the rest of society to emulate them.

The argument over the merits of coal as opposed to peat and other traditional fuels was also being won on the grounds of thermal efficiency versus economic viability. As the table below shows, although peat was far from useless as a fuel for industrial processing, its lower calorific value per unit volume rendered it uneconomic to produce and store at the scales necessary to supply the needs of manufacturers who were operating at the new, industrialized levels. Extraction, processing, transportation, and storage were all cheaper and easier for coal. Greater labor expenditure and the greater volume required to produce equivalent thermal energy rendered peat impractical as a fuel for intensive industrial use within the limits of the available technology.

Substance	Megajoules/kilogram
Wood	17–20
Peat	20–23
Coal	28–33

Figure 2: Effective calorific value of dry substance. 1 megajoule = 239 kilocalories. Peat has thermal efficiency capable of smelting iron but significantly lower calorific value per unit volume—only 16 to 25 percent of that of coal.

Pressure from the "improving" landlords like the Scotts of Duninald in Angus, who wanted cheap coal to fuel the limekilns on their estates just north of Red Head, led in 1793 to the repeal of the punitive levels of duty on the shipment of coal by sea. Overnight, coal became cheaper in seaports and soon displaced peat, but in inland and non-industrialized areas it remained prohibitively expensive.

In 1800, coal mined at Dollar, east of Stirling (fig. 3), sold at four times its mine-head price 20 km to the north in Auchterarder and at six times its price only 16 km further in Crieff, rising to nine times in winter. It would take the nineteenth-century transport infrastructure revolution, constructed on the back of the rapid industrialization that occurred in the decades up to about 1840, to change that inequality. By the middle of the nineteenth century, coal was very much king and the use of older, "traditional" fuels was limited to the inhabitants of economically marginal or peripheral areas in Highland and Hebridean regions, where the local economy still functioned largely at a subsistence level.

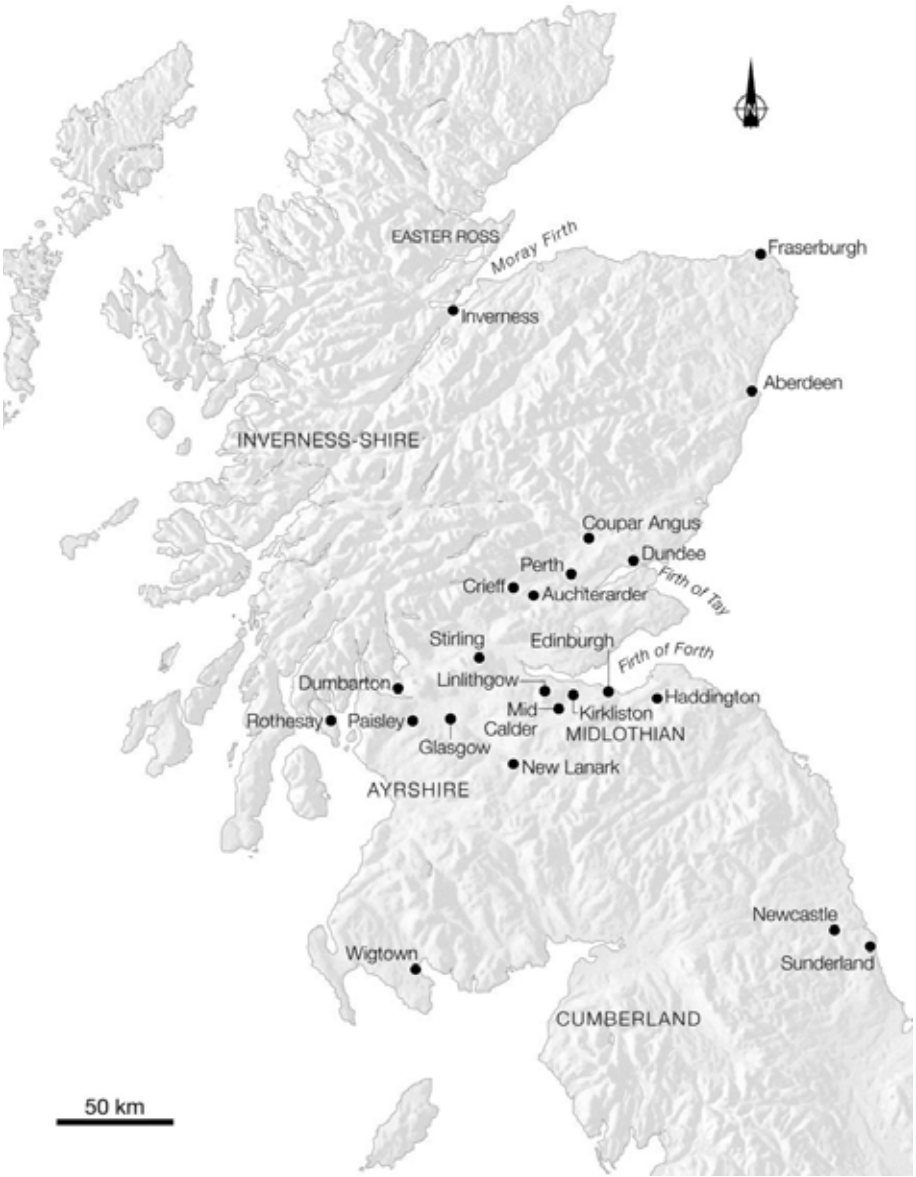

Figure 3:
Scottish towns and coal sources c. 1800

Further Reading

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