ARCHAEOLOGY DATASHEET 305
The supply of fuel for post-medieval metal industries

Introduction

Fuels for metallurgical and other industrial uses were derived from wood or from coal. The wood-based fuels comprised charcoal, white coal [kiln-dried wood] and fire-wood. Mineral coal was used either as mined or as coke. Over the post-medieval period there was a shift to coal, either due to the cost of suitable wood, or to inherent attractions of innovative coal-using processes.

The supply of wood for industry

The perception of post-medieval English woodlands as a dwindling resource, felled to fuel industries whose consumption of charcoal and wood was unsustainable, was common in older studies of British industrialisation. This has been corrected by research into woodland and industrial management. On many estates coppicing made woods a renewable resource. After a peak in the use of wood-derived fuels at the threshold of the Industrial Revolution, woodland management shifted towards the production of timber, with cutting-cycles longer than those for the fuel trades.

Archive sources

Increasing precision in estate surveying and accounting in the 16th and 17th centuries led to informed decisions over the use of the 'semi-natural' woodlands possessed by many estates. Some were converted to managed coppice, others cleared for agriculture, with field boundaries reflecting those of former woods or their sub-divisions.

Woodwards' accounts enable the identification of managed woods and their products. The potential of woodlands depended on proximity of markets, for fire-wood sold in towns and for industrial fuel. The woodward was responsible for the organisation and recording of cutting. His measurement of woods was not only by acre but by yield, in cords, a measure of wood packed into a stack generally 8 feet long, 4 feet high and 4 feet wide (2.4 by 1.2 by 1.2m), with local variations.

Coppice or 'spring-wood' management depended on the regeneration of deciduous trees by new growth from the base stool. When a timber-wood was converted to coppice, certain trees (standards) would be left to grow to maturity. The rest would be felled and re-growth encouraged by the exclusion of animals. Growth depended on species and environment and the local market determined the age at felling: charcoal-burners catering for the iron industry needed wood of 8-14 years growth, while the fire-wood merchants, glass-makers, brick-makers, potters, lime-burners or lead smelters, required growth of 20-25 years. The retention of timber trees amongst the coppices was required by laws such as the 1543 Act which required 12 timber trees to be grown per acre of coppice. Despite the attention given to coppicing, its use was not universal; in some districts top-and-lop and hedgerow wood was adequate until the 17th century.

Field evidence

The archaeological study of woodlands covers study of how woodlands, particularly coppices, were managed, and of evidence for the processing of the products. Former management is shown by boundaries and by relict coppice trees. Coppices were divided into plots, corresponding with the system of rotational cutting. Some divisions were marked by tracks, others by stones or posts, but these rarely survive. External boundaries could be as substantial as medieval park pales. They comprised fenced banks and ditches, proof against cattle and deer and impeding attempts of trespassers to remove wood.

Relict coppice trees can be identified by multiple trunks growing from single stools. Their survival is greater in woods managed as coppices into the 19th or 20th century, such as in the Sheffield area where the cementation steel industry used charcoal until WWI, or in districts with gunpowder or chemical industries, which also required charcoal into the 20th century.

A promising approach to identifying old managed woods is to trace product-associated structures and earthworks:

Charcoal platforms survive as terraces on hill-slopes, shown by charcoal-laden earth. This derives from charcoal burning, in which the stack of wood was covered by earth or turves, stripped off after the burn.

White-coal kilns are associated with the ore-hearth phase of the lead industry. They survive in Derbyshire woods east of the Derwent, adjacent to smelt-mill sites and in the north Pennines and Lakeland. The kilns, used to dry billets of wood, were in some cases fuelled with coal. The kiln was stone-lined, built into a hill-slope, drawing air through a horizontal flue. Wood was stacked on fire-bars, of which stone examples survive in Froggatt Wood, Derbyshire. Details of superstructures are not known. In Lakeland there are potash kilns, superficially resembling those used for white-coal, but generally smaller.

Bark was stripped from poles prior to charcoal burning, and was sold to tanneries. Platforms for *bark-rick stands* and *bark-peelers' huts* have been identified in woods in Furness. They can be confused with charcoal platforms, but lack the characteristic blackened earth.

In woods where timber was a major product, *saw-pits* were dug, but these rarely survive, being superseded on most estates by water-powered *saw-mills*. In the wooded areas of Lakeland, streams adjacent to woods were used not only for saw-mills, but also for bobbin-mills, catering for the textile industry.

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Woodlands and industry

Estimates of the area of coppice required to operate an industrial unit in perpetuity highlight the relationship between woods and industry. In the Forest of Dean 13,000 acres of coppice were required for indefinite operation of a blast-furnace and forge. The Dean furnaces were larger than usual, and a mid-17th-century Wealden ironmaster would require charcoal from 4,000-5,000 acres of coppice for a furnace and forge.

Wood-fuel was required for smelting lead and tin, and for the secondary metal trades, while charcoal was an essential ingredient of gunpowder. In none of these cases has research been carried out into fuel consumption. The ore-hearth lead industry of the Pennines, Mendips and north Wales required white-coal: ore-hearth smelting-mills were leased with tracts of coppice, and the areas involved can be estimated. However, in many cases the products of these coppices were supplemented by bought-in supplies. The consumption of wood by the tin-smelting mills, the blowing-houses of Cornwall and Dartmoor, has not been quantified; upland mills drew their supplies from the valleys fringing the moors.

For the secondary metal industries, such as nail-making, blade forging and the manufacture of wire, chain and plates, of both iron and non-ferrous metals, any estimates of consumption of wood are hindered by the shift to coal. High-quality products continued to be made using wood and charcoal until well into the Industrial-Revolution period, but in the Black Country the use of mineral fuel was becoming significant during the 17th century.

Other uses of managed woodlands

Although many coppices were managed for fuel, other products could determine the pattern of woodland management. Coppices were also important for crafts which needed wood of small diameter: for turning, basketry, hurdles or wattle-and-daub. Although the emphasis was on coppicing for industrial and domestic fuel, production of heavy constructional timber was also important and could bias the management of woodlands and increase the price of fuel.

Mineral fuel

The change to coal freed many industries from constraints of scale and costs which had slowed technological development over the 16th and 17th centuries. In the iron industry, 18th-century blast-furnace design responded to the ability to use coke, which, being stronger than charcoal, permitted taller furnaces with greater capacity. However, the industry remained a consumer of wood until late in the 18th century, for the adoption of coke in the blast furnace was no sudden change. Despite the attention given to Darby's first successful smelting of iron with coke in 1709, there was a long period of transition, with furnaces being modified to use coke and structures designed expressly for coke being rare before 1780. Many operators in the forge trade, converting pig iron to smiths' bar, required charcoal until the end of the 18th century, despite a series of innovations culminating in Cort's perfection of puddling.

The smelters of lead changed from the white-coal-fuelled ore-hearth to the coal-fired cupola during the 18th century, and could thus utilise lower-yielding ores and re-smelt slags discarded from the earlier process. Nevertheless local woods continued to have an outlet in the industry, for timber used for roof-supports (punch-wood) in lead and coal mines.

In other industries the change was gradual, with the secondary metal trades adapting to coke or coal over a lengthy period, the dyers, potters, salt-boilers, brewers and the food trades likewise.

Estate management reflects this shift. In some cases former coppices were allowed to evolve, poles being selected and singled to mature into timber. In others, coppices were cleared, the centuries-old stumps being grubbed out and new plantings made. In some cases parkland areas were planted. The literature of woodland improvement sets out means by which profitable use of woods could be maintained.

Estates in which coal-seams outcropped stood to prosper from the change. Traditional methods of shallow mining continued to be used, with coke production in stacks resembling charcoal production. Steam power for haulage and for pumping water from workings spread only slowly as engine design improved. The inefficient Newcomen atmospheric engine with its characteristic engine-house was the industry standard until the final quarter of the 18th century, the improvements associated with Smeaton and Watt being taken up only gradually from the 1780s onwards and used in tin mines as well as in the coalfields. Before the mid-18th century the typical mine was drained by adits and horse-gin-operated pumps, whose surface remains rarely survive, in coalfields where much evidence for early mining was swept away by large-scale development in the 19th century.

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