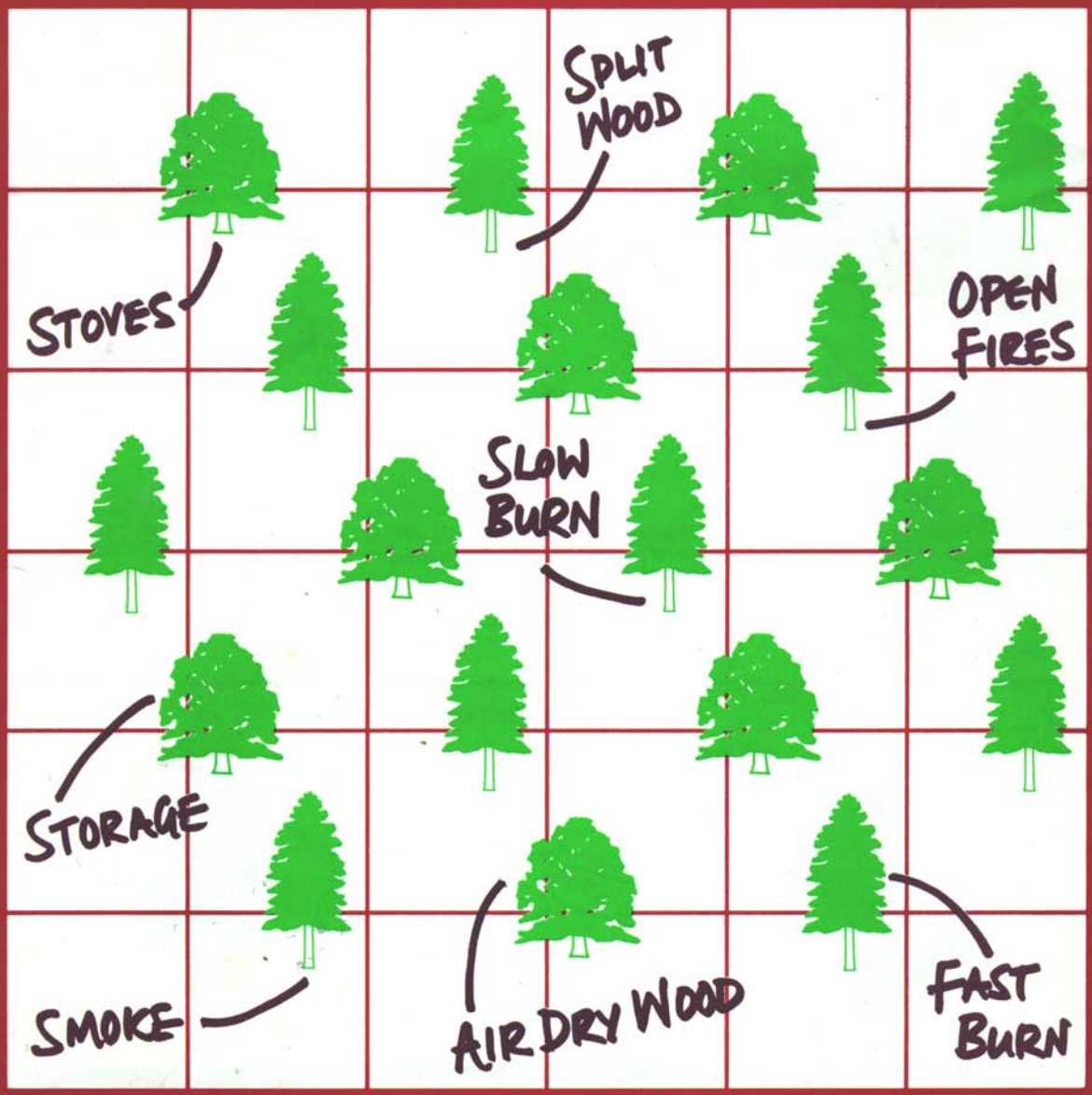
WOOD as FUEL

A Guide to Burning Wood Efficiently



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Forestry Commission

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WOOD as FUEL

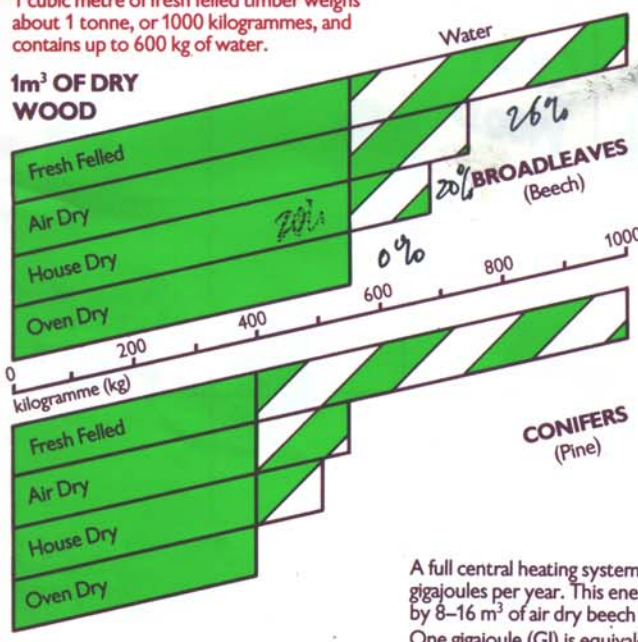
Wood has always been the traditional fuel in Britain, being replaced by coal, gas, electricity and oil over the last 300 years.

Wood is a major source of renewable heat energy, and burnt efficiently, it produces virtually no smoke and no acid rain.

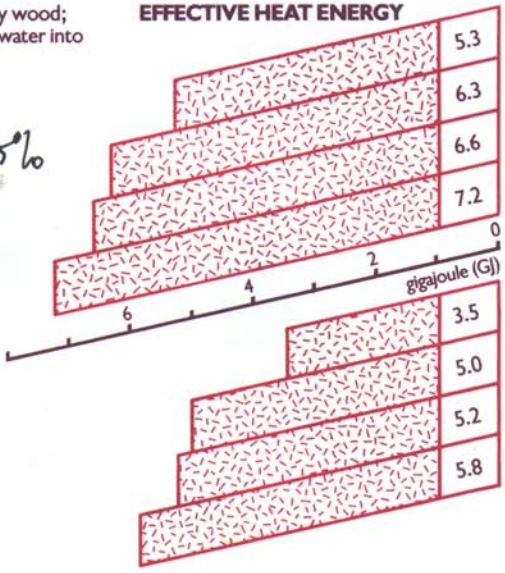
The woodland area in Britain is limited, but with efficient management, a substantial quantity of fuel wood is available from parts of trees which are not suitable for saw timber.

USE DRY WOOD

1 cubic metre of fresh felled timber weighs about 1 tonne, or 1000 kilogrammes, and contains up to 600 kg of water.



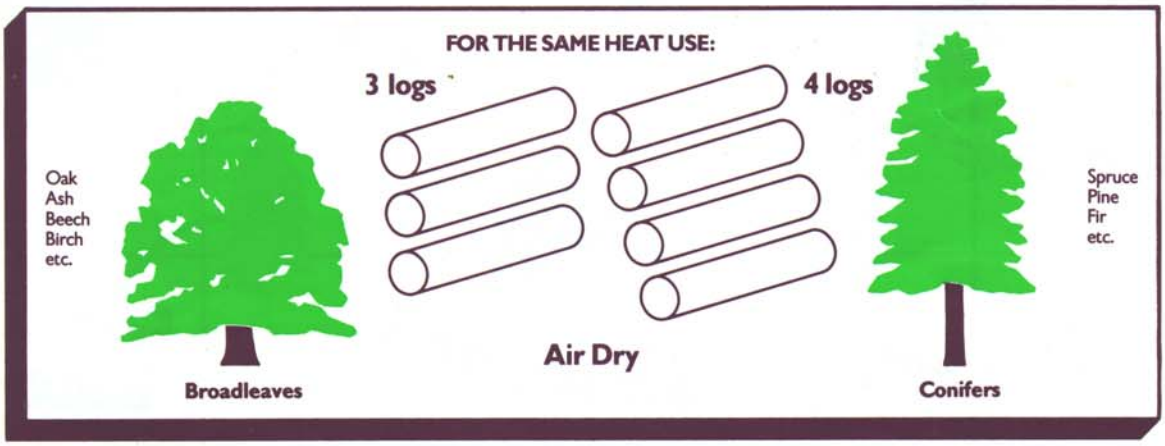
Heat energy comes from the dry wood; some is used up converting the water into steam.



Wood is a poor conductor of heat, it burns best if logs are less than 10 cm thick.

A full central heating system needs 50–100 gigajoules per year. This energy is produced by 8–16 m^3 of air dry beech logs.

One gigajoule (GJ) is equivalent to about 280 kWh or 10 therms or 1 million Btu/hour.



HOW TO DRY WOOD

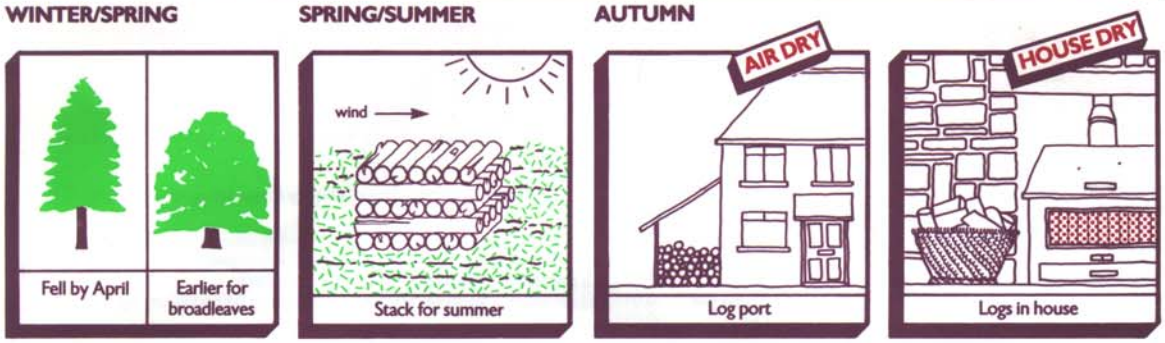
Fell trees in winter for **next** winter's fuel.

Stack on a sunny site until autumn to become **air dry.**

Store under cover – e.g. **log port** – it will not reabsorb water.

Convert into logs under 10 cm thick and convenient length for stove.

Bring logs indoors a few weeks before use to become **house dry.**



Aim always to use **air dry wood** (**house dry** is even better.)
It is not practicable to achieve the **oven dry** condition before burning.

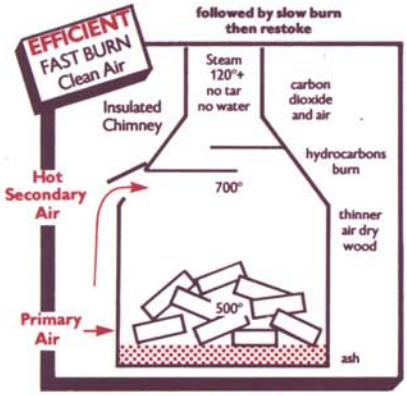
BURN WOOD EFFICIENTLY

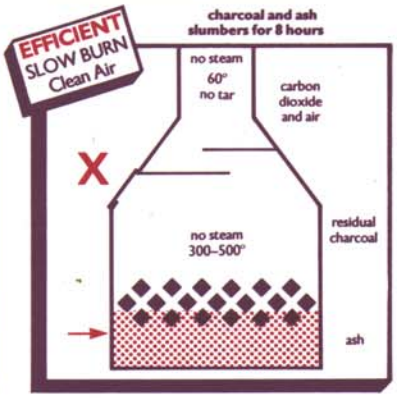
Under efficient controlled conditions of burning, wood breaks down with air into ash, carbon dioxide and steam.
Control of the air supply is critical. Burning occurs in three stages:

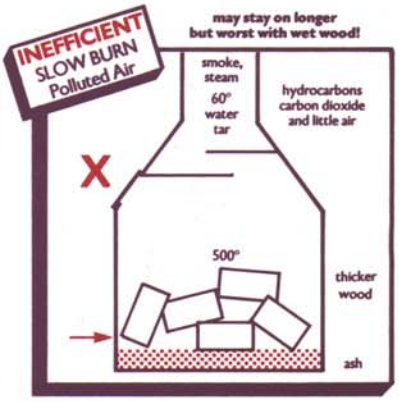
Pre-heating to 200°C to **oven dry** wood and steam.
1. With **primary air, wood burns** at 200 to 500°C to hydrocarbon gases and charcoal.
2. With **hot secondary air, gases burn** at 600 to 700°C into carbon dioxide and steam.
3. With **primary air, charcoal burns** at 300 to 500°C into carbon dioxide and ash.

If hydrocarbons are not all burnt they set as tar in the chimney.

Conifers and broadleaves produce similar amounts of hydrocarbon gases.







EFFICIENT STOVES

STOVE DESIGN: Choose the smallest fire box for your heat requirement, with controlled hot secondary air, and ash retained in the base of fire.

The use of fans for secondary air and ducted hot air and/or pumps with thermostats for water circulation provide improved control at a lower cost.

Stoves with doors open provide extra radiant heat but are less efficient.

OPEN FIRES: Traditional fire places provide radiant heat and some convection heat. They need a solid base to retain an ash bed in the smallest practicable fire base.

A coal grate is not suitable for wood – cover it with a metal base plate.

Reduce the area of the lowest part of fire with sloping fire bricks to deepen the ash and charcoal bed but leaving more space for logs above.

Modern double-box fires provide radiant heat and more convection heat, circulating warm room air.

All open fires need a fine mesh spark guard.

CHIMNEY DESIGN: Insulated chimneys are essential. Whenever steam is in the chimney the temperature at its outlet must be above 100°C to avoid water condensing.

Visible smoke emission from the chimney is a sign of inefficient burning.

OPERATING: After stoking, set to **fast burn** ensuring all gases are fully burned. Only set to **slow burn** when all wood has been reduced to charcoal and ash. Newly added wood set to burn slowly will create smoke and tarry deposits in the chimney.

Users of older stoves are advised to consult their stove centre about current recommendations to achieve the best results.

Open Fires: Maintain a fast burn with a few thin logs at a time until there is enough ash and charcoal for a slow burn.

OVERNIGHT: The stove should not be banked up with logs. A bright fire which has turned the wood into charcoal should be left with the day's ash, no secondary air and minimal primary air. Charcoal briquettes could be added.

WOOD SUPPLY

USERS WITH STORAGE SPACE: Air dry at home.

Order logs for delivery in the spring ready for use **next** winter; stack in a log-port with sunny aspect, **or** order lengths of round timber of, say, 4–15 cm diameter; stack one diameter apart in a sunny position and convert to logs in the autumn for storage in a log-port
or buy a stack of round timber at forest roadside.

USERS WITH LIMITED STORAGE: Buy wood as dry as possible.

Order well in advance from a supplier who can organise and guarantee summer drying, **or** in winter accept delivery as far ahead as space permits and store in a warm location as long as possible before burning.

BUY WOOD BY VOLUME: Buy by solid cubic metres.

Merchants should sell logs or lengths by solid measure. A lorry with a capacity of 1.8m^3 holds about 1 solid cubic metre of logs. A wire netting cage 2m x 1m x 0.9m high will hold one solid cubic metre of logs. Sales by weight can be checked for volume and cost per cubic metre in a cage. One solid cubic metre of broadleaved round wood lengths built into a compact stack also occupy about 1.8m^3 of space.

Cleanly trimmed, straight conifer lengths occupy about 15% less space.

SUPPLIERS: Up-to-date lists of firewood merchants, woodburning stove centres and heating consultants covering the counties of Cornwall, Devon, Somerset, Dorset, Avon and Wiltshire are available from Forestry Commission offices and woodburning stove centres.

Additional lists covering Isle of Wight, Oxfordshire, Buckinghamshire, Bedfordshire, Berkshire, Hertfordshire, Hampshire, Surrey, West Sussex, East Sussex and Kent are being prepared and should be available from local offices of the Forestry Commission and Timber Growers UK by the end of 1986.

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COPIES of this leaflet can be obtained from local offices of the Forestry Commission, woodburning stove centres, or by post (20p + stamped addressed envelope) from:
Publications, Forest Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey GU10 4LH
or from the author: Geoff Keighley BSc, 86 Buriton Road, Winchester, Hants SO22 6JD, Tel. (0962) 880553.

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COMPARATIVE VALUE OF WOOD FOR HEATING

Comparisons must take into account the fuel **Calorific Value, the Burning Efficiency** of stove, fire or boiler and **Fuel Price.**

CALORIFIC VALUE – a measure of the total heat energy (expressed in gigajoules G J**) per unit of fuel,** e.g:

Broadleaves 7 to 11 GJ per m^3 of air dry wood (19 GJ per oven-dry tonne)
Conifer 7 to 9 GJ per m^3 of air dry wood (20 GJ per oven-dry tonne)
Coal 27.2 GJ per tonne **Electricity** 0.00360 GJ per kWh
Mains gas 0.0952 GJ per therm **Butane** 0.0458 GJ **Propane** 0.0463 GJ per kg
Oil 0.0357 GJ per litre

BURNING EFFICIENCY: The type of stove, fire or boiler, at winter loading, determines how much useful heat is obtained per unit of fuel.

Coal or **Air dry wood**	burns at	70% efficiency in free-standing stoves	(15% less efficient when doors are open)
		60% efficiency in built-in stoves	
		40–50% efficiency in double fire-box fires	
		35% efficiency in fire places	
		60% efficiency in central heating boilers	
Gas or oil burns at		65% efficiency in central heating boilers	
Electricity operates at		90% efficiency in night storage heaters	

EFFECTIVE HEAT ENERGY = Calorific Value x Burning Efficiency %
Values for domestic central heating systems at winter loading are:

EFFECTIVE HEAT ENERGY FROM FUELS

Fuel	Unit of Supply	Effective Heat Energy GJ/unit	Units of fuel for 1 GJ
Smokeless fuel & house coal	tonne	16.4	0.061
Mains gas	therm	0.062	16.2
Propane	kg	0.031	33.2
Butane	kg	0.030	33.6
Oil	litre	0.023	43.1
Electricity	kWh	0.0032	309

Air Dry Wood (m^3)	Effective Heat Energy GJ/m^3	Units of Fuel for 1 GJ
Beech, oak	6.3	0.160
Ash, birch	6.1	0.164
Sycamore, elm	5.5	0.181
Poplar	4.5	0.224
Pines	5.0	0.200
Spruces	4.6	0.217
Larch	5.4	0.187
Douglas fir	5.1	0.197

COMPARISON OF FUEL PRICES AND VALUES

The cost of 1 gigajoule of effective heat energy can be calculated using the values in columns headed Effective Heat Energy GJ/unit and Units of Fuel for 1 GJ of the tables above and the following formula:-
Units of fuel for 1 GJ x price per Fuel Unit = Cost per GJ Effective Heat Energy, eg:

For coal: at £110 per tonne, 0.061 x £110 = £6.71 per GJ.
For oil: at £0.19 per litre, 43.1 x £0.19 = £8.19 per GJ.

Air dry beech logs, split and ready for burning, would need to be valued at £42 and £51 per cubic metre respectively to equal these costs of coal and oil. Lower wood values apply to unseasoned or partly seasoned wood and to wood which has to be collected or sawn up or split.

OTHER FACTORS – In considering costs and values, coal and wood are directly comparable. However, for electricity, oil and gas systems, allowance must be made for the convenience of automatic operation and for differing capital costs. Some credit may be claimed for the aesthetics of wood fires – the flicker of flames and the tang of wood smoke.