WOOD AS A FUEL IN CANADA

By

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NOTWITHSTANDING rapid advancement in the science of heating and developments in the use of coal, peat, coke, oil, gas and electricity, wood is probably still the world's most important fuel. In certain districts Canada is particularly fortunate in having extensive coal deposits, and coal is the predominant Canadian fuel. However, the importance of wood for this purpose is probably not fully appreciated. The Dominion Bureau of Statistics estimate that, annually, over 10,000,000 cords of wood are cut normally for fuel, with a value of nearly \$45,000,000. In addition to this over 400,000 cords are sold by sawmills and wood-working plants in the form of slabs, edgings, etc. Firewood, as a product of our forests, is second in quantity only to logs and bolts, about four-fifths as much wood being cut for firewood as for the latter purpose, and about seven-fifths as much as for pulpwood.

While it is not the purpose of this paper to deal comprehensively with the Canadian fuel problem, nevertheless, in order to get a clearer conception of the significance of wood as a Canadian fuel in the different provinces, a few facts regarding the consumption of coal may be of interest.

The annual consumption of coal both hard and soft, is about 32,000,000 tons. Of this amount about 15,000,000 tons is mined in Canada; the balance, between 15 and 20 million tons, being imported, about 1,500,000 tons of anthracite from Great Britain and the remainder mostly from the United States. The value of the coal produced in Canada in 1930 was about 53 million dollars, and in 1933, about 37 million dollars. The value of wood used for fuel is therefore almost the same as that of the coal mined in Canada. Canada has an abundance of coal in British Columbia, Alberta, and Nova Scotia, a certain amount in Saskatchewan and New Brunswick, but in the great Central Region of Manitoba, Ontario and Quebec practically none of present commercial importance. More specifically, the situation for the period 1923-1930 was about as follows:

British Columbia consumed about 2½ million tons per year mostly of domestic origin, a certain amount being obtained from Alberta, and a very small amount imported from the United States.

Alberta consumed about 5 million tons, practically all of which is produced

locally, only a very small amount being obtained from British Columbia and the United States.

Saskatchewan consumed about 2 million tons annually, about 1/3 of this being of domestic origin, most of the remainder being obtained from Alberta, with a small amount imported from the United States.

Manitoba and Head of the Lakes District consumed about 2.5 million tons, about 1 million tons being obtained from Alberta and 1.5 million tons imported from the United States. (Note—This situation has changed radically during the past three years. Less than 200,000 tons of American coal is now entering Canada.)

Ontario consumed about 13 million tons, by far the greater portion of which is imported from the United States, with a small amount from Nova Scotia and Great Britain.

Quebec consumed about 5.5 million tons, over half of which comes from Nova Scotia, New Brunswick and Great Britain and the remainder from the United States.

New Brunswick consumed about $\frac{3}{4}$ million tons, one-third of this being of domestic origin, most of the remainder being brought in from Nova Scotia and a small amount from Great Britain and the United States.

Nova Scotia consumed nearly 3.5 million tons, practically all of it being of domestic origin with a small amount from Great Britain and the United States.

Prince Edward Island consumed about 100,000 tons, practically all of which is obtained from Nova Scotia.

These figures show that Ontario and Quebec are at present large importers of coal. They are also heavy users of wood for fuel. In times of fuel shortage or of economic depression there is always a tendency to draw more heavily on wood than in normal times. This has been particularly noticeable during the past two or three years, during which time a great many enquiries have been received by the Forest Products Laboratories, Forest Service, Department of the Interior, regarding the fuel value of wood, particularly in comparison with that of coal. Reports have been received of large increases in wood consumption, especially in the provinces of Quebec and Ontario, and also in certain cities and towns which, in connection with relief programs, have provided labour in cutting wood and effected economies in the distribution of relief fuel through changing from coal to wood.

Enquiries became so insistent that last spring we approached the Fuel Testing Laboratories of the Department of Mines to see whether it would be possible to get some more definite data than that which existed with respect to the heating value of different Canadian woods. Considerable work

had already been done by other laboratories and by certain organizations interested in heating and ventilating problems. Most of this work, however, related only to the heat which, theoretically, can be developed in burning wood and evaporating moisture from the wood. This was of some general practical value, but the problem with which the consumer of coal and wood is concerned is not so much the actual number of heat units which can be evolved but rather the heat which can actually be harnessed and put to useful work in raising the temperature of the water or air used in heating a building.

While it is not my purpose in this paper to discuss this subject in technical detail, a few simple data may help to make clearer the problem which I wish later to open up for your critical discussion. The calorific value of a fuel is measured, usually, in British Thermal Units. The B.T.U. is the amount of heat required to raise the temperature of one pound of water 1° Fahr. Either wood or coal contains a certain amount of moisture; in anthracite coal this is generally a fairly definite and relatively small amount, viz., between 3 and 4 per cent of the gross weight of the fuel; in wood it is a very variable amount. Kiln-dried planing mill waste may have only about 5 or 6 per cent moisture. Green poplar may have 200% moisture when computed on the oven-dry weight of the wood, or 67% moisture when computed on the gross weight of the wood. Well seasoned air-dry maple cordwood has a moisture content of about 20% of its gross weight, or in other words, a pound of air-dry maple consists of 4 parts of wood and one part of water. In burning a pound of such wood, therefore, one is really only burning $\frac{4}{5}$ of a pound of dry wood substance. Not all the heat units developed in burning this $\frac{4}{5}$ of a pound are obtainable, since a certain amount of this heat is used up in evaporating the water from the wood and in raising the resulting gas to the temperature of the chimney gases.

The number of heat units which can be developed from a pound of perfectly dry wood does not vary greatly with species. A pound of basswood will yield just as much heat as a pound of hard maple. For the Canadian hardwoods commonly used as fuel, such as maple, birch and beech, a pound of oven-dry wood will in burning yield about 8400 B.T.U.'s. Air-dry hardwood will yield about 6500 B.T.U.'s per pound. Woods which are rich in resin, oils, gums, etc., will give higher yields, white pine about 9000, Douglas fir 9200, and western red cedar about 9700 B.T.U.'s per pound of oven-dry wood.

American anthracite coal yields about 12,900 B.T.U.'s per pound at a moisture content of 3.8%. However, a direct comparison of the heating value of anthracite coal and air-dried hardwood cannot be made on the basis

of 12,900 B.T.U.'s and 6500 B.T.U.'s respectively. An important practical question must be interjected here, viz., what efficiencies are obtainable in burning the two kinds of fuel, or in other words, what percentages of the actual heat evolved in burning the two fuels can be put to effective work in heating. This is governed by a good many factors, such as relative rapidity of burning, amount of draft required, temperature of flue gases, etc. A great deal of information is available with regard to efficiencies in burning coal, but when the Laboratories looked into this matter last summer it was found that little reliable information existed with respect to the efficiency obtainable in burning wood, and that where experiments had been carried on, fuels had been used which were not of much interest in Canada.

To test all species of wood used for fuel in Canada would be a long and expensive undertaking, so we decided to obtain, first of all, a reasonably definite idea of the efficiencies which might be expected, and for that purpose chose one of our heaviest and most popular fuel woods, hard maple, and one of our lightest softwoods, white pine, as approaching the two extremes. These were tested in both the green and air-dry condition, the maple being ordinary cordwood and the pine, sawmill slabs. Time does not permit a full description of the methods of testing. Suffice it to say that the wood was burned in an ordinary domestic hot water heater installed in the Fuel Testing Laboratory for conducting tests on coal. In homes accustomed to burning wood, stoves have been used which were designed as wood burners. However, in cities and large towns which, during the past few years, have turned to wood, as a measure of economy, heating equipment has been largely designed for burning coal. Our object in burning the test wood in a unit designed for burning coal was to find out what efficiencies were obtainable in such a unit, and the extent to which it was practicable to burn wood in coal furnaces. For air-dry pine an efficiency of about 50% was obtained and for air-dry maple almost 60%. This compares with an efficiency of 73% for American anthracite coal burned in the same heating unit. In a burner designed particularly for wood it is conceivable that even higher efficiencies might be obtained. Green wood was, of course, found to be lower in total heat developed per cord than dry wood, being only equal to about 80% of the value of air-dry wood.

In testing a standard cord of pine slabwood and maple cordwood careful computation was made of the volume of the piled cord, and it was found that there were about 85 cubic feet of solid wood in a cord of pine slabwood and 90 cu. ft. in a cord of maple.

Having now the heat units obtainable per pound of wood, the weight per cubic foot of the wood from previous investigation of the Laboratories, the

solid contents per cord and the efficiency of the heating equipment, we were in a position to compute the total effective heat units obtainable from a cord of wood, and compare this data with that obtainable from a ton of anthracite coal. We have estimated that 1.2 cords of air-dry maple or 2.2 cords of air-dry white pine slabs will provide as much effective heat as 1 ton of anthracite coal. The heating value of other woods varies closely with their densities, and on this basis the Laboratories prepared tables showing the heating value of all the Canadian woods commonly used as fuels. These tables may be slightly in error, but we believe that they may be used safely with a tolerance of $\pm 5\%$. Besides, they are based on a high efficiency for anthracite coal and are, we believe, so far as wood is concerned, conservative estimates.

Based on available heat units, if we assume a price of \$15. per ton for American anthracite coal, the consumer would be effecting an economy by using air-dry maple at any price less than \$12.50 per full cord 4'x4'x8'. The tendency in heating apparatus, especially in cities and larger towns, in recent years has been definitely in the direction of automatic heating, and therefore towards those fuels susceptible to thermostatic control such as oil, gas, pulverized coal, etc. Wood burns rapidly, and wood-burning furnaces require frequent attention, especially in the winter months. In the rural districts where economy frequently outweighs convenience in stoking, wood will continue to be used in large quantities, but if wood is to compete with imported coal and other fuels, it is essential that attention be given to the preparation of the wood for fuel and to mechanical apparatus for stoking wood-burning furnaces.

Reference might here be made to advances which have been made in the past 6 or 7 years in domestic furnaces burning wood refuse, especially on the Pacific Coast. Visitors to that district are always impressed by the huge refuse burners consuming sawdust, and small edgings and trim from the sawmill. Very often consideration is not given to the very large output of the sawmills served by these burners, and the impression is obtained that coast sawmills are extraordinarily wasteful. As a matter of fact, studies have shown that the percentage of waste in coast mills is lower than in many other districts where smaller mills prevail. However, the total amount of wood wasted was so large that attention was directed to the possibility of using for fuel the waste wood not used for steam production in sawmill boilers or already sold as fuel. Accordingly, apparatus was devised for attaching to the ordinary domestic furnace which permits the use of sawdust with practically automatic stoking. This apparatus consists of a hopper and Dutch oven attached to the fire-box of the ordinary furnace. The sawdust feeds

by gravity and the rate of burning is regulated by thermostatically controlled draft. Gradual improvements suggested by experience have been made in the original apparatus until now equipment has been developed which has proved very popular and which has effected very appreciable reductions in fuel costs when compared with the costs of heating with soft coal. This equipment is principally designed for sawdust and has not proved very satisfactory in domestic furnaces for hogged fuel of the chip-size now produced, which is closely similar to pulp chips. The use of hogged fuel at present is largely confined to sawmill boilers and industrial heating plants. However, so great has been the demand for sawdust for domestic furnaces that at times mills have been faced with an actual shortage, and I understand consideration is now being given to the development of an improved type of 'hog' which will produce much more finely comminuted fuel suitable for domestic use.

The domestic sawdust burner has gone a long way on the Pacific Coast toward removing one of the principal objections to the use of wood fuel, viz., the amount of attention required in stoking. Practically the only work required is the filling of the hopper with fuel once or twice a day. There is of course, little ash, much less than with coal, and this is in itself of value as a fertilizer. Considerable storage space is required, however, as generally it is desirable to put into the fuel bin about 2 units of fuel at a time, which requires a bin of 400 cu. ft. capacity.

The development of hogged fuel for domestic heating has taken place in a district well served by extensive deposits of a good grade of soft coal of a quality quite suitable for domestic use. The question suggests itself—is it possible to apply the experience of the Pacific Coast with sawdust and hogged fuel to other parts of Canada, principally to the great central district not containing its own coal deposits but abundantly supplied with wood? Or, more specifically, is it practicable to draw on our forests to supply fuel to a type of burner designed to use wood in a finely divided state in addition to the cordwood now supplied. There are a great many ramifications to the problem, but the forestry aspect is the most important. If it is impracticable from a forest management standpoint to draw on our forests for a larger amount of fuelwood than they now supply, there is really no problem, and we might as well forget it. If, however, it is practicable to obtain large quantities of logging waste, thinnings, over-mature timber, limbs, etc., without impairing forest stands, the economic and engineering phases are probably not beyond solution. The question of transportation is, of course, one of the most vital questions.

The limitations of a paper of this kind have permitted setting up the problem in skeleton form only. The Laboratories have so far only touched

the fringe of the problem. In outlining the problem to this society I was prompted by a full appreciation of the prime importance of its forestry aspects and by the fact that members of this society are in a position to give, from their direct experience, practical information and guidance in evaluating the importance of the problem, and, if it has any merit, in suggesting methods for further analyzing it.

In view of the widely representative character of the membership of this society, it might not be out of place to suggest that a committee from it be set up to study this problem, having in view particularly reporting on (1) the practicability from a forestry standpoint of the wider use of wood for fuel (2) what, if any, further investigative work is required.