Tendencies of World Power Development

By Dr. E. F. Armstrong, F.R.S.

IN the modern world the question of natural power supply becomes more and more important. There is the tendency, not by any means confined to power alone, to exploit national resources and to make these available even if they are uneconomic. Power resources are of two kinds: those which are limited, including coal, oil, natural gas, peat, oil-shale; and those which are perpetually renewed, such as water, wood, wind or even the tides. A recent analysis shows that for 1935 the world power supply consisted of 56.6 per cent coal, 3.7 per cent lignite, 16.5 per cent oil, 3.8 per cent natural gas, 12.8 per cent firewood, 6.6 per cent water.

The proportion derived from coal has been stationary over the last four years, but has gone back materially since 1913; that from oil and water has increased. The consumers of power take little heed that these resources are limited, and the less wasteful use of recent years has been in the main imposed by increasing cost. Modern technique does aim constantly at a reduction of the amount of power used per product or per working unit, a factor which must tend towards a decline in the total consumption of power unless the trend of general industrial development is upward. This growth will determine in the future whether the production and consumption of fuel will rise slowly or rapidly.

In Great Britain during the last twenty-five years the gas industry has increased its yield of gas per ton of coal by more than 27 per cent: it is unlikely, however, that this figure will improve further. In the electrical industry the increase has been more than 130 per cent per unit of weight: substantial technical economies and improvements are being effected. The chief cause of the decrease in home consumption of coal is shown by the statistics to be due to the diminished use in blast furnaces and steelworks owing to more efficient methods of production. The coke consumption per ton of pig iron actually stood still for forty years at 40 cwt. per ton—to-day it is down to 33 cwt. per ton of pig. For steel the corresponding figures are a fall from 37.8 cwt. in 1920 to about 21 cwt. to-day. There is still more to be done in this direction in almost every industry; moreover, the change will be accelerated by the largely increased price of coal.

There are thus strong reasons for a decline in consumption of coal even with accelerated industrial development.

Actually the protection of oil and coal resources will first be attained when these materials cease to be squandered and are used only in the form of 'residual products' after more or less extensive chemical changes.

Coal resources are variously estimated as lasting some hundreds or even thousands of years; the mineral is becoming increasingly costly to mine. Oil resources at the present rate of consumption are given only a very short life. Water resources are in a sense inexhaustible, but it must be remembered that in the more advanced countries the most accessible falls are already developed, and that in consequence every expansion of water-power meets with more unfavourable conditions and therefore involves high costs of development. About 35 per cent of the total electric current generated is hydro-electric.

It is difficult to say in assessing the competition between coal and water-power which of the two is the cheaper: this largely depends on the continuity of the load. It is stated, for example, that the kilowatt hours produced in steam plants or water plants cost the same on an average yearly performance of 3,000 hours, water-power being cheaper above and steam-power being cheaper below this factor. The most satisfactory modern development aims at establishing a combined use of water-power and steam-power: it is preferable to use them to supplement one another rather than in competition. There is still ample water-power available in the world, only 55 million h.p. being so far developed out of 470 million h.p. available. One of the factors with electricity produced by water-power in remote places is its economic transportation with a minimum of loss to the point where it is used. Should industry, however, be thrown back more largely on water-power, it would mean a transference of manufacturing plants to countries or localities where this is available. For this reason, there are many who regard Canada as having great potentialities as a manufacturing country.

Oil competes with coal for motoring and for the aeroplane, both new uses for which there is no alternative source of power, and for shipping—this last turnover constituting a serious loss to coal. Its use for transportation and general purposes is regionally limited. The development of the competition is influenced far more by the price of oil derivatives than by that of crude oil, and it appears likely that the advance in the use of

synthetic oils having special and valuable properties will in the long run involve their production from coal even at a higher cost. The purely economic point of view alone will not be sufficient to prevent this development as it does to-day—military, political and fiscal points of view are likely in the near future to make the advent of oil from coal nearer than is generally believed.

Whereas in the United States coal only makes up half of the power production, in Germany it is necessary for 90 per cent. Hence Germany is forced to make oil from coal, the more so as in times of peril she will have no easy access to world supplies without command of the sea.

The position in Great Britain is an intermediate one; with no natural oil we are staking everything on the command of the sea and the ability to continue supplies of oil on an enormous scale. To-day, as for many years past, our industrial supremacy is based on coal.

In any event, under present-day conditions, crude oil production can scarcely keep step with the rate of increase in demand. The share of the United States has declined, though the production of Venezuela, Rumania, Iran and Iraq has assumed greater importance.

There is always a change in the particular oil product required: thus the proportion of gasoline (petrol) to crude oil has risen from 7 per cent in 1913 to 35 per cent in 1931, since when it has slightly declined as the production of heavier gas

oil has increased. The position of oil supplies twenty years hence is obviously one of uncertainty.

In England, where the wood resources are so small, it comes perhaps somewhat as a surprise that 12·8 per cent of the world power supply is produced from wood, the equivalent figure in 1913 being 17·6 per cent. In heavily timbered countries, however, both on the continent of Europe and abroad, wood is still of prime importance. The forests which cover so much of northern Quebec represent to-day what the English Lake District must have looked like before the trees were felled—largely to smelt copper—in the time of Elizabeth: the oft-related destruction of the Sussex woods to smelt iron ore before the discovery of sea-coal is another parallel of what is happening abroad to-day. Scientific attempts are being made to utilize wood and its products in the best manner for a variety of purposes connected with power production and also as a raw material for the paper industry. Actually about half the total wood cut is used as firewood—a quantity estimated at 680 million cubic metres.

At the turn of the nineteenth century, coal seemed to dominate the field and to have pushed all other sources of power into the background. To-day coal, oil and water compete: the situation is determined in the various countries by conditions which have relation to factors not purely economic.

Modern Study of Plants in Relation to Education*

By Prof. E. J. Salisbury, F.R.S.

FROM the cultural point of view, plant life and all that it implies may be regarded as the foundation of a vast extent of human activity and the basis of a large and essential part of every human environment. Because neither we nor the animals could persist without plant life, it follows that much of the present distribution of these organisms over the face of the earth can only be understood in terms of the plant life either of the present or the past. Even man's industrial activities have been largely localized and in part determined by the geographical distribution of vegetation, whether it be that of the forests, of perhaps 280 million years ago, which gave origin to our coal deposits, or the vast extent of grasslands that have determined the location of pastoral communities.

A realization of the widespread demands made upon plant products would probably astonish

many of those who, like Mr. Babitt, find in the mechanistic devices of the age their chief delight. Yet it has been recently estimated that a thousand Ford motor-cars utilize in their manufacture the entire plant yield of more than six hundred acres, and this quite apart from the indirect demands for grazing necessary to furnish the materials of animal origin. Despite the vast areas of the earth's surface devoted to the growth of foodstuffs, of textile fibres, of timber, rubber, tea, tobacco and innumerable other plant products, the plant remains perhaps the least known and appreciated of all man's servants by those who lay claim to any cognizance of their environment.

Even the town dweller can scarcely fail to recognize the indirect contacts of his everyday existence with the activities of agriculture, forestry and horticulture, and, if education is to be interpreted as a means of enabling the individual to

*Continued from p. 671.